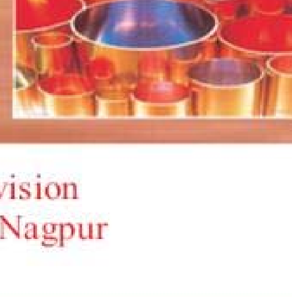
Market Survey Series No. MS -33

Government of India
Ministry of Mines

MARKET SURVEY ON COPPER



Mineral Economics Division
Indian Bureau of Mines, Nagpur
May 2011

GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES
MINERAL ECONOMICS DIVISION

COPPER

A MARKET SURVEY

ISSUED BY

CONTROLLER GENERAL
INDIAN BUREAU OF MINES
NAGPUR

May, 2011

Price: (Inland) Rs. (Foreign) $

Indian Bureau of Mines, Nagpur

C. S. Gundewar
Controller General

R. N. Meshram
Chief Mineral Economist

Dr. P.A. Verghese
Supdtg. Mineral Economist (Intelligence)
(Retd.)

Dr. S.S. Bhake
Supdtg. Mineral Economist (Intelligence)

Mujib U. Siddiqui
Deputy Mineral Economist (Intelligence)

S. K. Shami
Deputy Mineral Economist (Intelligence)
(As A.M.E. (Int.) from June 2007 to June 2008)

S. G. Indurkar
Mineral Officer (Intelligence)

A. K. Singh
Chief Editor

Typing Credit
Smt. S. Y. Rayalu
Stenographer Grade-II

Prepared by
MINERAL ECONOMICS DIVISION

PREFACE

The present report on Market Survey on Copper is the 33rd publication in the series of Market Survey Reports brought out by the Mineral Economics Division of the Bureau. Copper, one of the base metals has gained significant importance in the recent years both globally and in the domestic context. Country's demand of copper metal is met largely through imported concentrates. The last five years witnessed wide fluctuations in the prices of copper metal. Copper being a versatile metal finds uses in many sectors right from households, infrastructure to telecommunication. Hence, from the raw material security point of view it was considered necessary to take up a Market Survey on Copper to analyse its domestic availability / demand, import dependence, the global scenario and the future outlook.

In this survey, domestic demand has been forecast. The supply position analysing the resources and production in the country has been dealt with in detail. The scrap processing industry to augment the supply position for meeting both the domestic demand and export market is also discussed. An attempt has also been made to analyse the foreign markets.

The co-operation extended by various Central and State Government Departments, producers, processors and consumers of copper and the agencies concerned with trade, National laboratories and different manufacturers' associations who responded to our questionnaires is thankfully acknowledged. We are also thankful to Central Pollution Control Board, State Pollution Control Boards, Bombay Non Ferrous Metal Association Ltd., and India Lead-Zinc Development Association (ILZDA), New Delhi for their co-operation. Our thanks are also due to the Indian Embassies and Foreign Embassies in India who responded to our request for information.

It is hoped that this Market Survey Report on Copper will be helpful to the producers, exporters, processors, consumers and planners in the development of copper based industries and also to formulate export strategies.

NAGPUR
Dated: 30 /05/2011

(C. S. GUNDEWAR)
Controller General
Indian Bureau of Mines

CONTENTS

List of Annexures

List of Figures

List of Plates

Chapter 1. Introduction

The Market Survey on Copper is of topical interest in the sense that copper is important metal used in India from ancient times. In fact, one age of human civilization is named after copper. Copper is also used in the alloy form as brass and bronze because of the added advantages.

Copper was a scarce metal with respect to India but recent setting up of copper smelters has entirely changed the scenario of copper production/availability in the country. However, these copper smelters, except that of HCL, are producing copper based on the imported concentrates. In the recent past the country's status has changed from a net importer to a net exporter.

Over the years the use of copper has witnessed growth in electrical, transport, Consumer durables, engineering, construction, telecommunication etc. sectors. In the present survey the demand has been projected up to 2024-25 in the above sectors keeping in view the economic growth in future. The domestic demand works out to be 2.3 million tonnes. To meet the demand in future the copper industry has already geared up. The supply projection of 2.8 million tonnes by 2024-25will satisfy the domestic demand in addition to exports demand.

The world scenario vis-à-vis India is necessary to find out the country's position. The world's leading producers with their present and future projects are also discussed in the report. The global consumption of copper has been projected at 31 million tonnes by 2025.

The prices are the dominating economic indicators to control the copper production activity. Enough weightage is given to this aspect by analysing the prices for present and future.

With this background, Indian Bureau of Mines has taken up for the first time a Market Survey Study on metal namely copper. In this study an attempt has been made to study the present and future availability of metal from primary as well as secondary sources and their demand in present and future based on the role in overall development of end-user industry.

In this study the methodology adopted basically consisted of desk survey comprising literature consultation, documentation of information from the reports/records and also collection of information from producers, processors, exporters, consumers of copper and other concerned organizations through questionnaires. Besides field surveys were undertaken to important producing and consuming centres of copper in the country like Gujarat, Rajasthan, Maharashtra, Delhi etc. for gathering first-hand information on demand supply position, marketing problems, etc.

Chapter 2. Uses and Specifications

Copper is an important non-ferrous metal used in various forms for different applications. Copper is acclaimed for its conductivity and antibacterial quality. It is also known for alloying with a number of other metals to produce important alloy such as brass. Electrical/electronic industry is by far the largest consumer of copper, where it is used in the form of cables, winding wires as it is the best non-precious metal conductor of electricity as it encounters much less resistance compared with other commonly used materials. In electronic industry, semi-conductor manufacturers have launched a revolutionary 'copper chip' . By using copper for circuitry in silicon chips, microprocessors are able to operate at higher speeds, using less energy. Copper heat sticks help remove heat from transistors and keep computer processors operating at peak efficiency. Copper is used in construction industry as plumbing, taps, valves and fittings components. In Transportation industry copper is used in various components. According to an estimate by ICSG (International Copper Study Group) most cars contain an average of 20 kg copper and luxury & hybrid vehicles contain about 45 kg copper. Copper is extensively used in industrial machinery and equipment. It is used in a number of consumer products such as coinage, utensils, fixtures etc. Large quantities of copper are consumed in making copper based alloys such as brass and bronze.

In this chapter, the industrial uses of copper in its original form have been covered in detail. The uses of alloys of copper, such as brass, bronze have also been touched upon as these alloys consume a fair amount of copper as well as find wide range of applications in industry.

2.0 USES AND SPECIFICATIONS

Copper being a major industrial metal, ranks third after iron and aluminium in terms of quantity consumed. Copper is a reddish malleable and ductile metal valued for its excellent thermal and electrical conducting qualities and resistance to corrosion. Copper combines with a number of elements to form a wide variety of copper minerals and ores. The properties of copper are depicted in **Figure-2.1**.

Though more than 150 copper bearing minerals have been identified, only a small number of these are of economic importance, the main being chalcopyrite ($CuFeS_2$).

The copper bearing minerals can be classified into 3 groups. The first group contains primary or hypogene minerals which are formed by processes related to igneous activities. They are mainly sulphides like chalcopyrite, bornite, energite etc. The second group comprises the minerals formed by chemical weathering of exposed sulphide minerals of copper. These are mainly oxides such as Malachite, Azurite, Chrysocolla, etc. The third group is secondary supergene sulphides. These minerals are generally formed by copper leached sulphide exposed near the surface of the earth. Chalcocite, Covellite, Cubanite, etc. are included in this group. List of some of the copper minerals is given in **Table: 2.1**.

Figure : 2.1 - Properties of Copper Metal

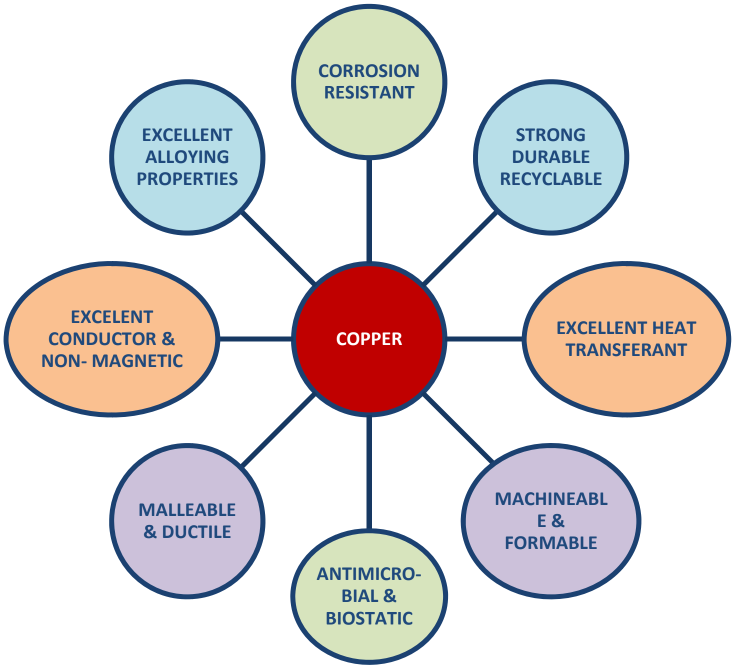


Figure : 2.2 - Uses of Copper

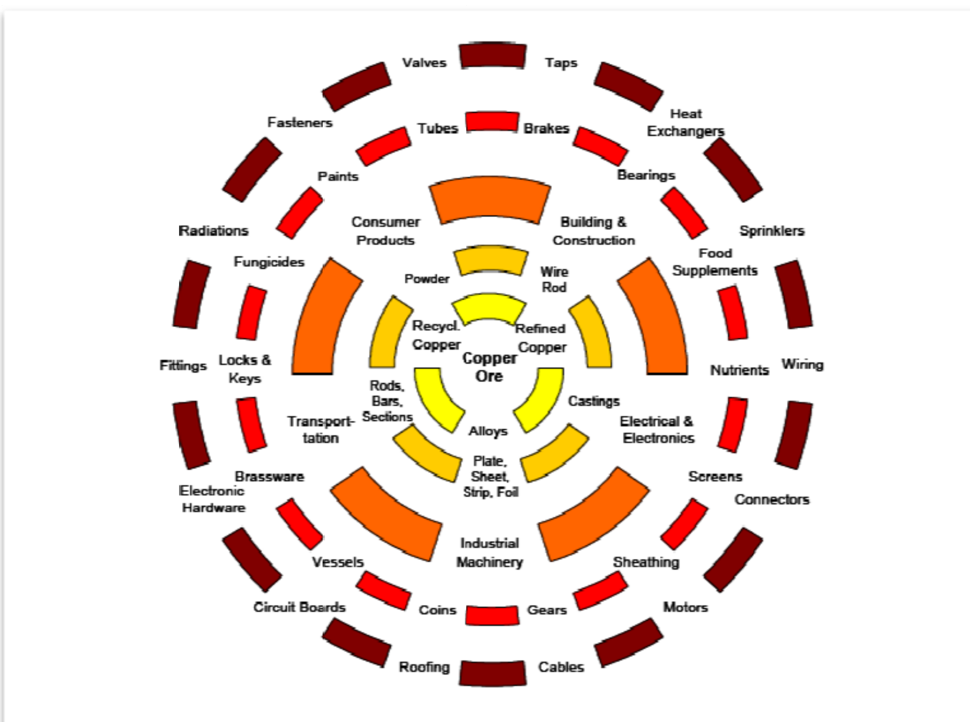


Table : 2.1 - List of Copper Minerals

Sl. No.	Name of Mineral	Chemical Composition	Hardness	Specific Gravity
1.	Antlerite	$Cu_3SO_4(OH)_4$	3	3.39
2.	Atacamite	$Cu_2Cl\ H_2O$ or $CuCl_2\ 3Cu(OH)_2$	3-3.5	3.75
3.	Azurite	$Cu_3(OH)_2(CO_3)_2$	3.5-4	3.7-3.9
4.	Bornite	Cu_3FeS_4	3	5.0
5.	Brochantite	$Cu_4(SO_4)OH_6$	3.5-4	4.0
6.	Chalcanthite	$CuSO_4.5H_2O$	-	-
7.	Chalcopyrite	$CuFeS_2$	3-4	4.2-4.3
8.	Chalcocite	Cu_2S	2-3	5.5
9.	Chrysocolla	$CuSiO_3\ 2H_2O$	2.4	2-2.3
10.	Covellite	CuS or CuS_2	1.5-2	4.6
11.	Cubanite	$CuFe_2S_3$	3.5-4	4.0
12.	Cuprite	Cu_2O	3.5-4	6.15
13.	Enargite	$Cu_3As_5S_4$	3.5	4.5
14.	Malachite	$CuCO_3\ Cu(OH)_2$	3.5-4	4.0
15.	Native Copper	Cu	2.5-3	8.5-8.9
16.	Tennanite	$Cu_{12}As_4S_{13}$	3-4	4.4-5.4

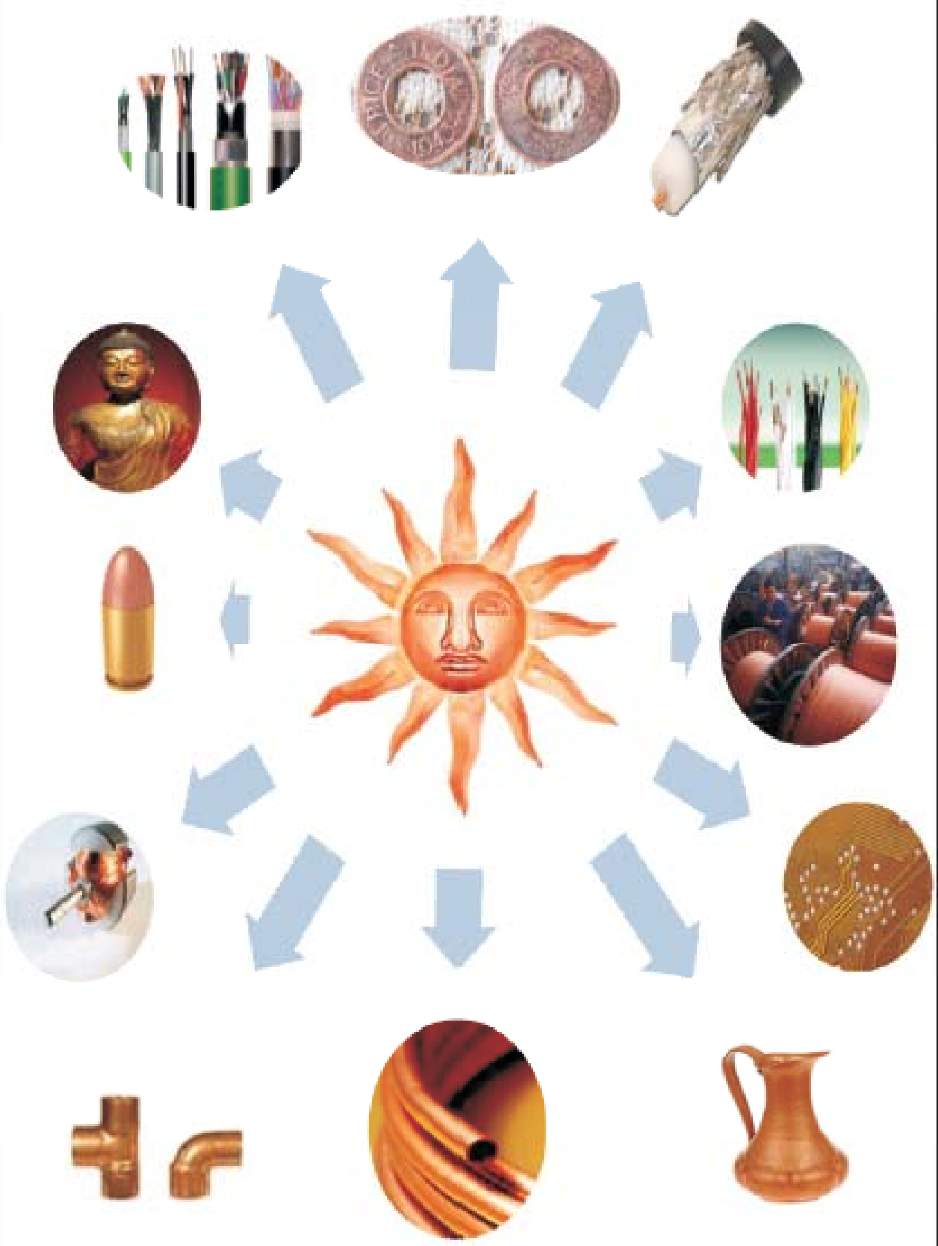
2.1 USES

The ability to conduct electricity and heat are two of the most important properties of copper. When alloyed with other metals, it acquires additional properties including increased hardness, tensile strength and improved corrosion resistance. Brass and Bronze are two of the most important alloys of copper. Copper's malleability and ease of use in machines during the fabrication process allows for a high production rate of accurate copper shapes for a relatively lower cost than that of its substitutes. Various uses of copper are shown in **Figure 2.2, Plate 2.I.** As per the International Copper Study Group (ICSG), the final application of copper varies widely; in the USA the dominant sector is 'construction' (50%), in Europe, it is 'transport' (41%) and in Asia it is 'electrical' (33%). These differences are at least partly caused by differential statistical methodologies.

The chief immediate use of copper is in electrical circuits, wiring and cables, regardless of the final application. The consumption of Copper in various industries as adopted in the Report of the Working Group of Mineral Exploration and Development for 11th Five Year Plan, Planning Commission, Government of India, is given at **Figure 2.3**. Electrical industry is the main dominant segment accounts for about 40% of copper consumption followed by wire and cable which accounts for 28%. The electrical industry comprises transformers, motors switch gears etc. The wire and cables industry consists of house wire, telecom cables and power cables.

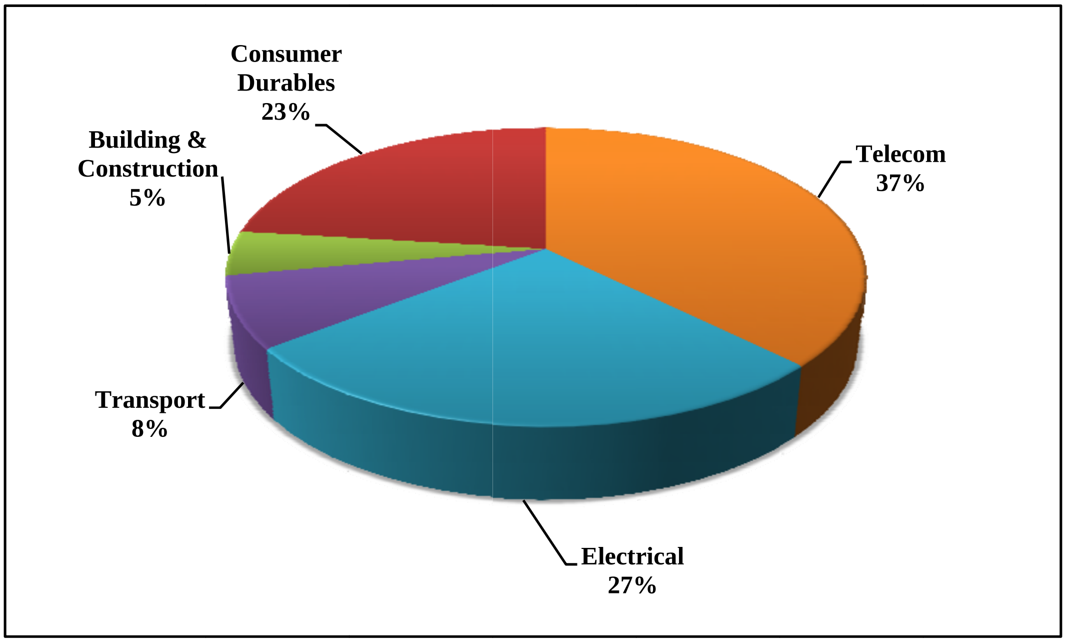
The global pattern of consumption in different sectors is given in **Figure 2.4.** The consumption pattern of copper in Asia and United States of America is depicted in **Figure 2.5 and 2.6.**

Plate 2.I



Different Products of Copper

Figure : 2.3 - COPPER CONSUMPTION BY END USE



Source: Working Group on Exploration and Development for XI[th] Five Year Plan, Planning Commission.

Figure : 2.4 - USES OF COPPER WORLD WIDE

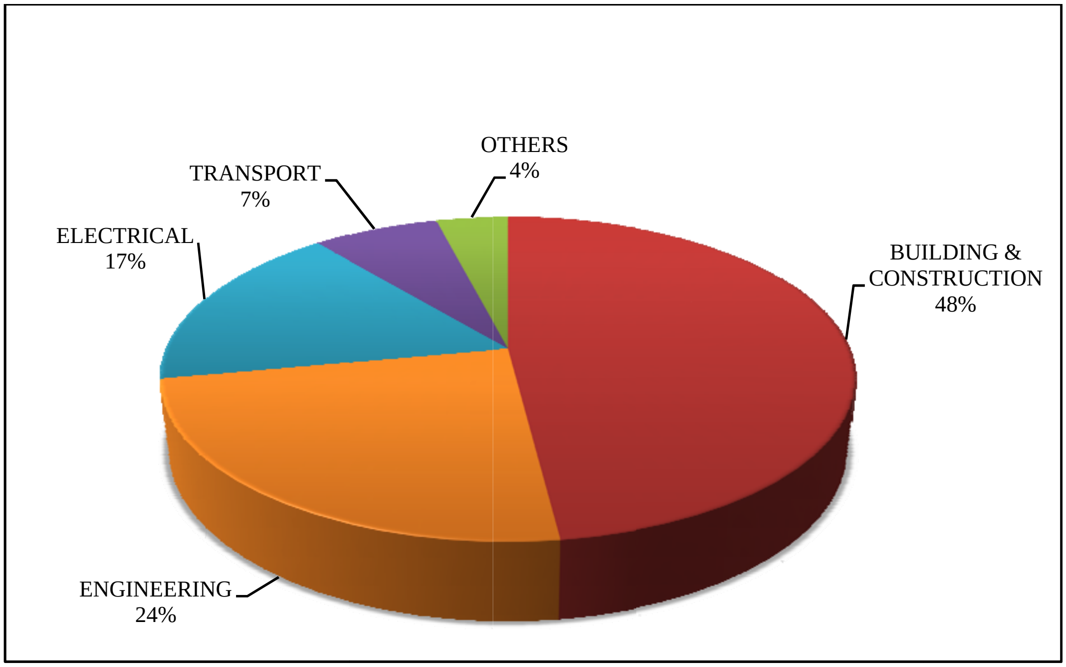


Figure : 2.5 - CONSUMPTION PATTERN OF COPPER IN ASIA

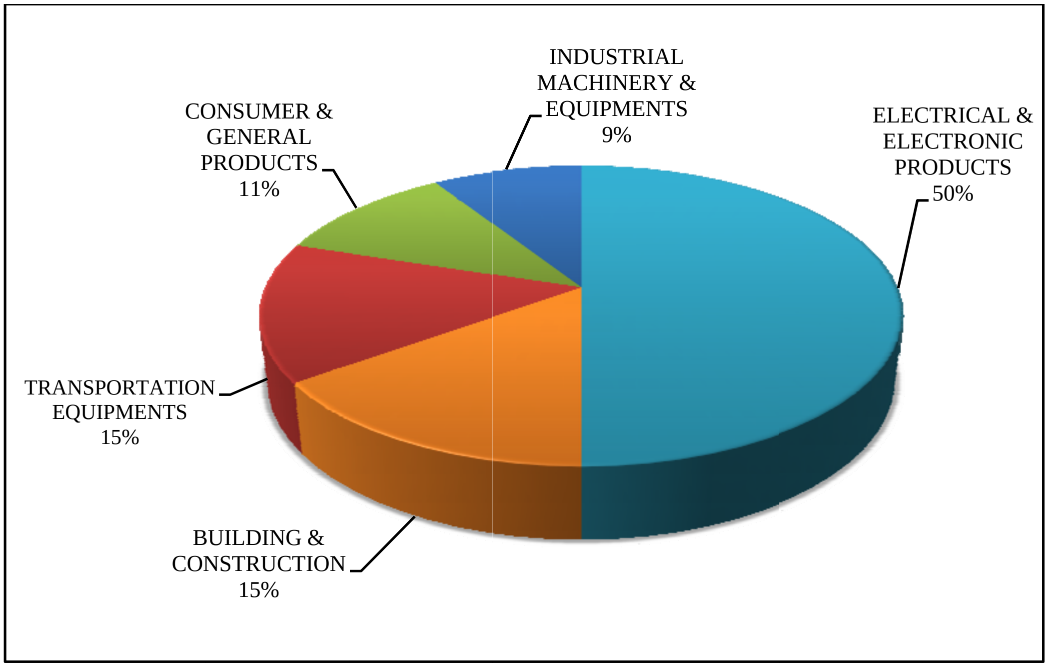
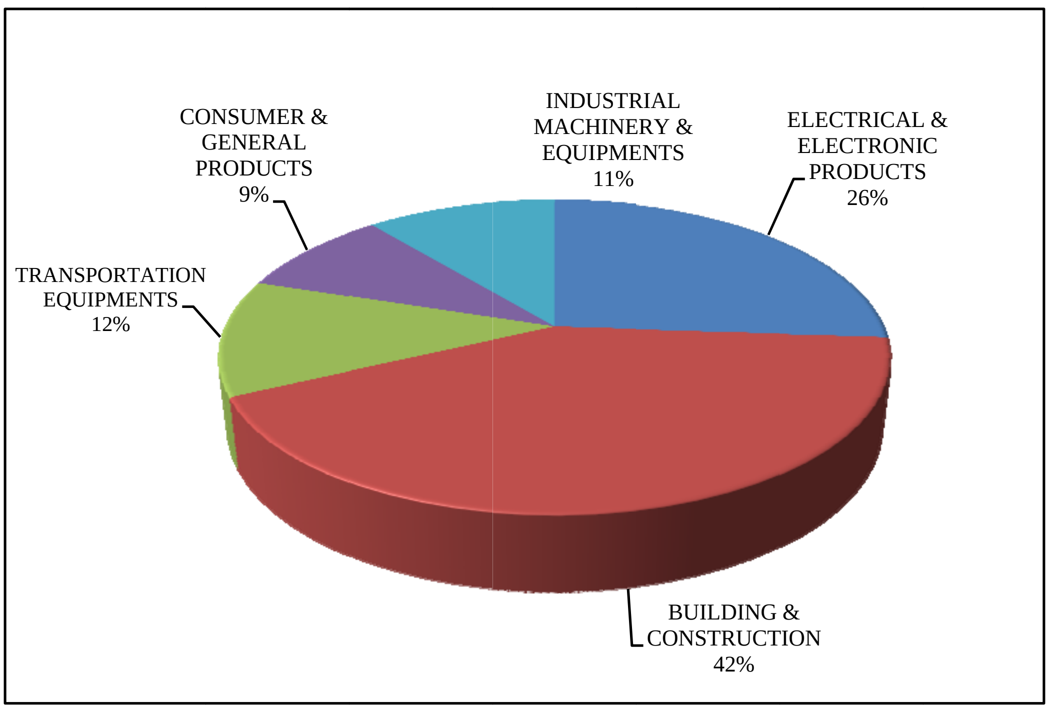


Figure : 2.6 - CONSUMPTION PATTERN OF COPPER IN UNITED STATES



The end-use of copper is determined by its chemical, physical, electrical, mechanical properties, etc. The major industries where copper is used are as follows:

1. Electrical industry as wires, cables etc.
2. Industrial and engineering applications
3. Building and construction
4. Transport
5. Coinage
6. Ordnance & other uses
7. Wrought copper & alloys
8. Copper compounds
9. Refrigeration & Air Conditioning:

2.1.1 Electrical Industry

Copper is the best electrical conductor after silver as it encounters much less resistance compared with other commonly used metals. It sets the standard to which other conductors are compared. It is the single largest metal used in Electrical industry. Being good conductor of electricity, malleability, corrosion resistance, ductility i.e. ability to be drawn as wires of varying thickness, copper is most sought after material for electric cables, both industrial as well as domestic. However, with aluminium and its alloys as well as cost difference, copper wires were substituted by aluminium specially in overhead power transmission lines, as well as underground cables.

However, in household electrical fittings, power generation and electric motor winding, copper is the most preferred material.

Use of copper in cables and wire industry vary from continent to continent. In Asia, the share of electrical and electronics products is 50% while in USA it is 25%, whereas world wide the consumption in electrical industry is 17%. As per Planning Commission, the share of electrical industries in total consumption is only 39% while as per ICRA, the consumption in electrical industry is 26%.

Copper is used for high grade copper wire cable used in the transmission of electrical power and in telecommunication, motor and generator windings and in industrial, commercial and domestic electrical machinery and appliances.

2.1.2 Power Cable and Wire

Power cables and wires are the carriers of electricity from electric source to user equipment. Cables of varying thickness and types are used to carry out heavy current load from one point to another, mostly underground. The wires used in various applications are of lesser thickness. Wires are used as winding wires in electric motors as well as domestic electrical fittings.

Copper consumption in electrical power has competition from aluminium. Aluminium has lower volume conduction than copper (about 63% of copper) but a much lower density (about 30% of copper). Therefore for a given level of conductance, the aluminium needed is only about 50% of the copper required by volume and has 25% greater diameter. For motor winding and other applications in industrial and consumer machinery, volume is critical and aluminium substitution has been limited. The key areas of use are in the production of heavy electrical equipment, such as motors and generators.

In electronic equipment, integrated circuit boards require wire or strip, which may be of copper for connections between components.

2.1.3 Telecommunications Cable and Wire

Copper is the traditional material for telecommunications cable and wire, but the industry as a whole and its use of copper is undergoing major developments, some of which are expanding the use of copper. HDSL (High speed Digital Subscriber Line) and ADSL (Asymmetrical Digital Subscriber Line) Technology help high speed data transmission in telecommunication including Internet Service through the existing infrastructure of ordinary telephone wires made of copper without switching over to high cost fiber optic cables. Copper and copper alloys are used in domestic subscriber lines, wide and local area networks, mobile phone and personal computers. Semi-conductor manufacturers have launched a revolutionary ‘copper chip’. The use of copper for circuitry in silicon chips microprocessors are able to operate at high speed using less energy. Copper is also used to a great extent in other electronic equipments in the form of wires transformers, connectors and switches. Copper Development Association (CDA) is working on a project to develop die materials for use in casting motor rotors. Such rotors would dramatically increase motor efficiency as well as the use of copper.

2.1.4 Refrigeration & Air Conditioning

The refrigeration and air conditioners are becoming necessity in the average household. The industrial uses and modern offices require large size of AC plants to keep the working environment cool. An average Refrigerator consumes about 2 Kg of copper and average size of air conditioner consumes about 6.8 kgs of copper per unit. The copper is used in the form of copper tubes in refrigerators as well as in T.V.tubes and electrical wires.

2.1.5 Industrial and Engineering Applications

Copper and its alloys are extensively used in industrial machinery and equipments. The durability, machineability and ability to cast with high precision and tolerances are the most important properties of copper and alloys in the field of industrial machinery and equipments. The corrosion resistance of copper and its alloys (such as brass, bronze, etc.) make them especially suitable for use in marine and other such environments. Vessels, tanks and pipes exposed to sea water, propellers, oil platforms and coastal power stations are some of the major areas where copper is effectively used. Heat exchangers and condensers account for a substantial proportion of the total, while the balance is used in vessels, pipes and a variety of hardwares, such as, connectors and fasteners.

a) Heat Exchangers and Condensers

Copper being tough, ductile and malleable makes it extremely suitable for tube forming, wire drawing, spinning and deep drawing. It is non magnetic, corrosion resistant and high thermal conductor. Hence, copper and copper alloys are included amongst the various alternative materials which are suitable for use in condensers and heat exchangers in all types of environments including marine environment and where inland water is seriously polluted.

Heat exchangers and condensers have a wide range of applications in industrial plants of many types. Copper alloys, generally with nickel, compete with aluminium, titanium and stainless steel. Substantial quantities of material may be required in individual application. Copper alloys are acknowledged to be superior to plastics and ferrous metals but facing increasing competition from titanium.

b) Valves, Pumps, Pipes and Vessels

Copper and copper alloys are widely used for industrial process plants which are exposed to non- oxidising acids, such as, sulphuric, hydrochloric, phosphoric and acetic acids. Some copper alloys are also suitable for use in solutions of nitrates, sulphates and chlorides of sodium and potassium.

Valves and pumps controlling the flow of liquids and gases in industrial processes are often made of brass or bronze or other copper alloys. In addition to corrosion resistance, copper alloys also provide good physical strength.

An additional advantage provided by copper and copper alloys in process plants is the resistance to bio-fouling. This helps to prevent the build-up of bacteria in the equipment and avoid the need for other treatment. It is, similarly, an advantage in heat exchangers and in any other equipment which handles sea water as it helps to prevent the build-up of marine organisms on the surface of the equipment. Such a build-up reduces the flow and the efficiency of the equipments or may require the installation of large diameter pipes or large capacity pumps.

2.1.6 Building and Construction

Copper and brass are the materials of choice for plumbing, taps, valves and fittings for their aesthetic appeals. Large quantities of copper used in the industrialised countries in the construction of buildings are consumed in the form of copper tubing, taps, valves, tanks, connections and fittings used in conjunction with it. Copper tube systems are used for domestic water supply systems both hot and cold and for central heating systems. Copper tube may be used in buildings for piping gas between the intake and appliances in which gas is used as fuel. Unlike plastic tubing, copper does not burn, melt or release noxious or toxic fuels in the event of fire. Copper tubes also help protect water systems from potentially lethal bacteria. The copper is used in buildings in a wide range of builder's hardware or architectural ironmongery. Builder's hardware is made of copper alloys such as architectural bronze. Hinges, locks, catches and stays for windows & doors and fasteners, such as, screws, washers, and nuts and bolts are all made of copper and its alloys. Although they tend to be more expensive than iron and steel fittings, which may be galvanized or otherwise coated to improve their corrosion resistance or their appearance, brass and bronze fittings are selected because they are widely regarded by consumers and specifiers as being of higher quality. On an average, a single family house uses 199 kg of copper and an average multi-family unit uses 126 kg of copper in various applications such as building wire, plumbing tube, fitting, valves, plumber's brass goods, built-in-appliances, builder's hardware and other wires and tubes in developed countries.

2.1.7 Transport

Copper is used in the cooling fans and water tubes used in the production of both radiators and heaters in automobiles. Automobiles rely on copper motors, wiring connectors, brakes and bearings. A medium size automobile contains about 22.5 kg of copper. Electric and hybrid vehicles can contain even higher quantity of copper. An average motorised farm vehicle uses 28.5 kg of copper while construction vehicle uses an average of 30 kg and about 2% of total weight of a Boeing 747-200 Jet Plane is copper. Copper is also used extensively in new generation air planes and trains. New high speed train can use 2-4 tonnes of copper as compared to 1-2 tonnes used in traditional electric trains. This is the scenario mostly in developed countries.

Copper and its alloys are used in all major forms of transportation. Copper nickel alloys are used on the hulls of boards and ships and other offshore structures to reduce marine bio-fouling, thereby reducing drag and improving fuel consumption.

2.1.8 Coinage

Copper has been used by various countries to make coins for currency since the beginning of civilisation. Despite increased use of credit card and cheque transactions, the coinage is still important.

Coins are minted mainly from ingot and strip but up to 10% of the total material used is from recycled coins. Coins can be used which may have a useful life of 20-40 years or more, instead of paper notes which have a very short-useful life, especially for lower denominations.

2.1.9 Ordnance

The use of copper in ordnance obviously varies according to the levels of hunting and sporting activities and the level of armed conflict or insurgency.

There are good reasons why the consumption of copper in ordnance should go unrecorded. Some of the major powers have imposed restrictions on the shipment of ornaments and ordnance to belligerent states and insurgency operations around the world.

Copper and copper based products are used in offices, household and work places for decorative wares. Locks and keys are just some of the products where copper is extensively consumed.

2.1.10 Copper Compounds

Copper has four oxidation states, but only two of them copper (I)(cuprous) and copper (II)(cupric) are common or have any commercial importance. A wide range of copper compounds is used in agricultural and industrial end uses, mainly as pesticides which will be transparent as much as 3 or 4 mm, it is generally applied as a thin layer on a much thicker substratum. The rate of application required to produce the required range of colours is 2.5 to 5 kg of cuprous oxide per tonne of glass. The total demand for this oxide of copper in the colouring glass is relatively small.

2.1.11 Copper Alloy

Pure copper contains 99.99% copper, a number of copper alloys are made with the addition of other metals in varying proportion for enhancing one or the other property. The alloys are made as cast copper alloys and wrought copper alloys. Cast copper alloys have a greater range of alloying elements than wrought copper alloys. Wrought copper alloys are produced using a variety of different production methods such as annealing, cold working, and hardening by heat treatments or stress relieving. Within the wrought and cast categories for copper alloys, the composition can be divided into the following main families.

I) **Pure Copper:** It has copper content of 99.3% or higher.

II) **High copper alloys-Wrought High Copper alloys**: It has copper contents of less than 99.3% but more than 95%. **Cast High Copper alloys** have copper contents in excess of 94%.

III) **Brasses-** contain zinc as the principal alloying element. Brasses are divided into two major categories. The Alfa alloys with less than 37% zinc. These alloys are ductile and can be cold worked and the Alfa/beta or duplex alloys with 37-45% zinc. These alloys have limited cold ductility and are typically harder and stronger.

There are three types of wrought alloy brasses:

a) Copper-zinc alloys,

b) Copper-zinc alloys (leaded brasses),

c) Copper-zinc-tin alloys (tin brasses) and cast brass alloys contain four types of alloys.

i) Copper-Zinc-tin alloys

ii) Manganese bronze (high strength brass) and leaded manganese bronze (High tensile brass)

iii) Copper-zinc-silicon alloys (Silicon brass and bronze) and

iv) Cast Copper-bismuth & Copper-bismuth-selenium alloys

IV) Bronzes- The term bronze originally describe alloys with tin as the only principal alloying element. The wrought bronze alloys include (a) Copper-Tin-Phosphorus alloy (Phosphor bronzes) (b) Copper-tin-lead-phosphorus alloys (leaded phosphor bronzes) (c) Copper-aluminium alloys (aluminium bronzes) and (d) Copper-silicon alloys (silicon bronzes). The cast bronze alloys include (a) Copper-tin-alloys (Tin bronzes) (b) Copper-tin-lead alloys (leaded & high leaded tin bronzes) (c) Copper-tin-nickel alloys (Nickel-tin bronzes) and (d) Copper- aluminium alloys (aluminium bronzes).

There are some more alloys made of copper namely copper-nickel alloys, copper-nickel-zinc alloys or ‘nickel silver’, leaded copper-20% or more lead, etc.

2.2 CLASSIFICATION AND GRADES

2.2.1 American Standard

Copper is classified according to the method by which it is refined, and is specified as fire-refined copper, electrolytic copper and chemically refined copper. Fire refined copper is produced from crude copper by pyrometallurgical process.

Some grades of fire-refined copper can be used as electrical conductor, but most are used for alloying. Most electrolytic copper is produced by electrolytic anode-to-cathode transfer of metal through a copper sulphate solution.

Cathode copper has become the single most important commercial form of copper and it accounts for nearly three-fourth of the refined copper consumed annually.

A considerable quantity of refined copper is settled and cast into various refinery shapes for consumer use. Commercially, this type of copper is classified by the method of processing. During melting and casting of final shapes, the amount of oxygen absorbed has a critical influence on the properties of the metal. Accordingly, apart from cathode, there are three basic classes of commercial copper.

(a) Tough-pitch copper, which is electrolytic or fire-refined copper cast in refinery shapes and containing 0.02 to 0.05 per cent oxygen as cuprous oxide.

(b) Oxygen-free copper, which is refined copper under deoxidising atmosphere.

(c) De-oxidised copper, which is refined copper free from cuprous oxide through the use of deoxidisers

The details of classification are given in **Table: 2.2.**

Table: 2.2- Classification of Copper according to ASTM

Forms in which copper is available									
		From Refines				From Fabricators			
Class & type	**ASTM Design -ations**	**Wire bars**	**Billets**	**Cakes & Slabs**	**Ingots**	**Flat Products**	**Pipe & tube**	**Rod & Wire**	**Shapes**
Cathode Electrolytic cathode	CAT	CAT	CAT	CAT	CAT	-	-	-	-
Tough-pitch: Electrolytic tough-pitch	ETP	X	X	X	X	X	X	X	X
Fire-refined, high-conductivity tough-pitch	FRHC	X	X	X	X	X	X	X	X
Silver-bearing tough-pitch.	STP	X	X	X	X	X	X	X	X
Fire-refined, tough-pitch	FRTP		X	X	X	X	-	-	X
Oxygen- free electronic	OFE	X	X	X	-	X	X	X	X
Oxygen-free.	OF	X	X	X	-	X	X	X	X
Oxygen-free Silver-bearing[1]	OFS	X	X	X	-	X	X	X	X
Deoxidised Boron-deoxidised, high conductivity	BDHC	-	-	-	-	X	X	X	X
Phosphorised low residual Phosphorous	DLP	-	X	X	-	X	X	X	X
Phosphorised low residual Phosphorus, silver-bearing	DLPS	-	X	X	-	X	X	X	X
Other copper Sulphur-bearing	-	-	X	-	-	-	-	X	-
Zirconium-bearing	-	-	X	X	-	X	-	X	-

CAT- Cathodes only,
1. Silver is counted as copper in analysis
X- Indicates commercial availability.

2.2.2 Indian Standards

The chemical composition of different grades of copper as per IS 2378–1974 (reaffirmed in March 2001) is given in **Table: 2.3**.

Table: 2.3 - Chemical Composition of Various Grades of Copper

Constituent	CATH	ETP	FRHC	FRTP-1	FRTP-2	ATP	DHP-1	DHP-2	DPA	OF
	1	2	3	4	5	6	7	8	9	10
Copper and Silver present to be counted as copper percent, min.	99.90	99.90	99.0	99.80	99.50	99.20	99.80	99.5	99.20	99.95
Antimony, percent, max.	-	-	-	0.01	0.05	0.01	0.005	0.005	0.01	-
Arsenic, percent max.	-	-	-	0.01	0.10	0.20 to 0.50	0.05	0.05	0.20 to 0.50	-
Bismuth, percent max.	0.001	0.001	0.0025	0.01	0.02	0.005	0.003	0.003	0.003	0.001
Iron, percent, max.	-	-	-	0.01	0.03	0.02	0.03	0.03	0.03	-
Lead percent, max	0.005	0.005	0.005	0.10	0.10	0.02	0.01	0.01	0.10	0.005
Nickel percent max.	-	-	-	-	-	0.15	0.151	0.151	0.151	-
Selenium & Tellurium percent Max	-	-		0.05	0.07	0.03	0.02	0.02	0.02	-
Tellurium percent max.	-	-	-	-	-	-	0.01	0.01	0.01	-
Tin, percent max.	-	-	-	0.010	0.05	0.03	0.01	0.01	0.01	-
Phosphorous	-	-	-	-	-	-	0.02 to 0.10	0.02to 0.06	0.02 to0.10	-
Oxygen, percent max.	-	-	0.10	0.15	0.10	-	-	-	-	-
Total of all impurities excluding silver, nickel, arsenic and phosphorous, percent max.	-	-	-	-	-	-	0.06	0.06	0.07	-
Total of metallic impurities excluding silver, percent, max.	0.03	-	-	-	-	-	-	-	-	-
Total of all impurities excluding oxygen and silver, percent, max.	-	0.03	0.04	-	-	-	-	-	-	-
Total of all impurities excluding silver, percent, max.	-	-	-	-	-	-	-	-	-	-

**In the case of copper conforming to grades FRTP-2 produced in Ind. and incidental nickel up to a maximum of 0.7 percent shall be counted as copper.*

***Note** : **CATH** Electrolytic cathode; **ETP**-Electrolytic tough pitch; **FRHC**-Fire refined high conductivity tough pitch; **FRTP** (1&2)-Fire-refined tough-pitch; **ATP** Arsenic tough pitch; **DHP** (1&2)-Phosphorised high residual phosphorous; **DPA** Phosphorised arsenical; **OF**-Oxygen-free without residual deoxidants. **Max** Maximum*

2.3 SPECIFICATIONS

The specifications of copper vary for different end-use industries. The physical as well as chemical parameters are important factors to be considered before deciding the end-use specifications of copper. There are a number of industries where copper is consumed and the specifications of copper consumed in every industry are different as per the requirement of the individual industry. Therefore, it is difficult to arrive at uniform specifications for every industry. The Bureau of Indian Standards (BIS) has developed and published standard specification for copper consumed in various industries. The active documents in respect of specifications of copper used in some major industries are listed in the **Table: 2.4.**

Table: 2.4 - BIS Specifications of Copper Consumed in Various Industries

Sl. No.	Document No.	Standard Title
1.	IS 191 : parts 1-10 :1980	Copper (Third Revision)
2.	IS 613 : 2000	Copper Rods and Bars for Electric Purpose Specifications (Third Revision)
3.	IS 1897 : 1983 (Re-affirmed in March 2001)	Copper strip for Electric Purposes (Second Revision)
4.	IS 1972 : 1989	Copper Plate Sheet and strip for Electric Purposes
5.	IS 2501 : 1995 (Re-affirmed in 1999)	Solid Drawn Copper Tubes for General Engineering Purpose-Specifications (Third Revision)
6.	IS 2532 : 1965	Hard Drawn Copper Wire for Telegraph and Telephone Purposes
7.	IS 2603 : 1983	Copper Anodes for Electroplating
8.	IS 2768 : 1982 (Re-affirmed in March 2004)	Copper Alloy Strip for Bullet Envelope (First Revision)
9.	IS 3331 : 1977 (Re-affirmed in March 2001)	Copper and Brass Strips/Foils for Radiator Cores (First Revision)
10.	IS 4131 : 1967 (Re-affirmed in March 2004)	Nickel Copper Alloy Castings
11.	IS 4171 : 1983 (Re-affirmed in March 2001)	Copper Rods and Bars for General Engineering Purposes
12.	IS 4412 : 1981 (Re-affirmed in March 2001)	Copper wires for General Engineering Purposes (First Revision)
13.	IS 8328 : 1977 (Re-affirmed in March 2001)	Free Cutting Copper Bars, Rods and Sections

Sl. No.	Document No.	Standard Title
14.	IS 8572 : 1993	Paper Covered Flexible/Stranded Copper Conductors for Transformer Leads
15.	IS 8631 : 1977 (Re-affirmed in March 2001)	Copper Base Alloys for Marine Propellers
16.	IS 8859 : 1978	Cast Copper Tuyeres
17.	IS 9064 : 1979 (Re-affirmed in March 2001)	Specifications for Copper Hammers
18.	IS 9713 : 1983 (Re-affirmed in March 2004)	Hot Rolled Electrolytic Copper Wire Rod for Electric Conductors (First Revision)
19.	IS 9805: 1981 (Re-affirmed in March 2001)	High Conductivity Copper Castings
20.	IS 10773 : 1995 (Re-affirmed in October 1999)	Wrought Copper Tubes for Refrigeration & Air Conditioning purpose-Specifications(First Revision)
21.	IS 10922 : 1984	Specification for Copper file for use in the manufacture of Copper-Clad Base Material
22.	IS 11110 :1984	Copper Lead Powder
23.	IS 11174 : 1984	Aromatic Polyamide Paper covered rectangular & square copper wires with temperature index 200
24.	IS 11184 : 19984	Enameled & Varnish bonded glass fibre covered round copper wires
25.	IS 11395 : 1985	Tape wrapped round copper wires with temperature index of 220
26.	IS 12444 : 1988 (Re-affirmed in March 2004)	Continuously cast and rolled electrolytic copper wire rods for electrical conductors
27.	IS 12558 : 1988 (Re-affirmed in March 2004)	Recommended shape, size and mass of copper and copper alloy ingots for re-melting purposes.
28.	IS 13730 : Part 0 :Sec 1:1993	Specifications for particular types of winding wires-Part 0 : General Requirements – Section 1 : Enameled Round Copper wire
29.	IS 14214 : 1994	Annealed Stranded copper conductors for jumper wires
30.	IS 14810 : 2000	Copper tubes for plumbing – Specifications
31.	IS 14811 : 2000	Rolled Copper Plate, Sheet, Strip and Foils for General Engineering purposes - Specifications

Chapter 3. Supply

Copper is an important non-ferrous metal which is used in almost all the industries in some form or the other. The resources of copper ore are distributed in different parts of the country and mining & processing of copper is being done since ancient times. India produces copper metal using indigenous ores and imported copper concentrates. The present position of indigenous supply of copper ores, concentrates and metal is discussed in this chapter along with the geographical distribution of copper ore, quantitative assessment of the resources of copper ores and its beneficiation and smelting processes.

3.1 GEOLOGICAL/GEOGRAPHICAL DISTRIBUTION

Copper ore occurs in various types of host rocks of all ages in the geological time scale under varying structural conditions. Most of the occurrences of copper mineralisation are associated with the igneous activities. A few occurrences are also reported in sandstones and shales. The occurrences of copper ores in India are reported from 14 states however the important occurrences having economic values are reported from Rajasthan, Jharkhand, Madhya Pradesh, Andhra Pradesh, Karnataka and Sikkim. Almost all the deposits are confined to Archeans and Delhi Super groups of Cudappah age. Depending upon the geological and geographical settings these copper deposits have been grouped under different copper belts.

3.1.1 Resources

India is endowed with large resources of copper ore. The total resources of copper ore as per the National Mineral Inventory as on 1.4.2005 have been placed at 1394.42 million tonnes. Of these, 369.49 million tonnes (26.5%) fall under "reserves" (proved and probable categories) while 1024.93 million tonnes are "remaining resources" (feasibility, pre-feasibility, measured, indicated & inferred categories). Gradewise, 28.03 million tonnes (2.0%) comprises ore containing 1.85% Cu or more, 621.98 million tonnes (44.61%) comprises ore containing 1% to below 1.85% Cu, 604.94 million tonnes comprises ore with above 0.5% to below 1.0% Cu and 139.92 million tonnes with below 0.5% Cu content as given in **Table 3.1**.

Table: 3.1- Reserves/Resources of Copper, As on 1.4.2005 (By Grades)

(In '000 tonnes)

State	Reserves	Remaining Resources	Total Resources
All India			
Ore (Total)	**369493**	**1024934**	**1394427**
By Grades			
Ore with 1.85 % & above Cu	7322	20709	28031
Ore with 1.00 % to below 1.85 % Cu	346654	275331	621985
Ore with (+)0.5% to below 1.00% Cu	3431	601063	604494
Ore with (-)0.5% Cu	12086	127831	139917
Metal (Total)	**4383.97**	**7033.75**	**11417.72**

Figures rounded off.

Out of total 1394.42 million tonnes of resources of the country, Rajasthan is credited with the largest resources of copper ore at 688.5 million tonnes (47.9%), Madhya Pradesh with 404.3 million tonnes (29%) and Jharkhand possessing 226.08 million tonnes (16.2%). Copper resources are also estimated in Andhra Pradesh, Gujarat, Haryana, Karnataka, Maharashtra, Meghalaya, Orissa, Rajasthan, Sikkim, Tamil Nadu, Uttarakhand and West Bengal. The details of statewise/gradewise/districtwise resources of copper ores are given in **Table: 3.2, Table:3.3 and Figure- 3.1.**

Table: 3.2 - District wise Reserves/Resources of Copper as on 1.4.2005

(Unit : 000 tonnes)

State/District	Reserve	Remaining Resources	Total Resources
All India : Total			
Ore	**369493**	**1024933**	**1394426**
Metal	**4384**	**7034**	**11418**
Andhra Pradesh			
Ore	**1457**	**6791**	**8248**
Metal	**17**	**106**	**123**
Guntur			
Ore	791	2311	3102
Metal	8	36	44
Khammam			
Ore	666	-	666
Metal	9	-	9
Kurnool			
Ore	-	1340	1340
Metal	-	13	13
Prakasam			
Ore	-	3140	3140
Metal	-	57	57
Gujarat			
Ore	**5800**	**7260**	**13060**
Metal	**95**	**114**	**209**
Banaskantha			
Ore	5800	7260	13060
Metal	95	114	209
Haryana			
Ore	**-**	**17230**	**17230**
Metal	**-**	**57**	**57**
Bhiwani			
Ore	-	2230	2230
Metal	-	12	12
Mahendragarh			
Ore	-	15000	15000
Metal	-	45	45

Contd….

State/District	Reserve	Remaining Resources	Total Resources
Jharkhand			
Ore	**75895**	**150187**	**226083**
Metal	**718**	**1686**	**2404**
Hazaribagh			
Ore	-	571	571
Metal	-	13	13
Singhbhum (East)			
Ore	75895	149616	225512
Metal	718	1673	2391
Karnataka			
Ore	**3558**	**30846**	**34404**
Metal	**26**	**200**	**226**
Chikmagalur			
Ore	-	160	160
Metal	-	++	++
Chitradurga			
Ore	2307	1373	3680
Metal	20	12	32
Gulbarga			
Ore	-	1840	1840
Metal	-	11	11
Hassan			
Ore	1251	4163	5414
Metal	7	40	47
North Kanara			
Ore	-	500	500
Metal	-	6	6
Raichur			
Ore	-	8230	8230
Metal	-	79	79
Shimoga			
Ore	-	14580	14580
Metal	-	51	51
Madhya Pradesh			
Ore	**227149**	**177199**	**404348**
Metal	**2986**	**1169**	**4155**
Balaghat			
Ore	227149	97420	324569
Metal	2986	294	3279
Betul			
Ore	-	4660	4660
Metal	-	35	35
Jabalpur			
Ore	-	75119	75119
Metal	-	841	841

Contd….

State/District	Reserve	Remaining Resources	Total Resources
Maharashtra			
Ore	**2180**	**7401**	**9581**
Metal	**17**	**84**	**101**
Bhandara			
Ore	-	1072	1072
Metal	-	14	14
Chandrapur			
Ore	2180	2171	4351
Metal	17	19	37
Gadchiroli			
Ore	-	830	830
Metal	-	7	7
Nagpur			
Ore	-	3328	3328
Metal	-	44	44
Meghalaya			
Ore	-	**880**	**880**
Metal	-	**9**	**9**
Khasi Hills (East)			
Ore	-	880	880
Metal	-	9	9
Orissa			
Ore	-	**6051**	**6051**
Metal	-	**64**	**64**
Mayurbhanj			
Ore	-	3430	3430
Metal	-	38	38
Sambalpur			
Ore	-	2621	2621
Metal	-	26	26
Rajasthan			
Ore	**52942**	**615515**	**668457**
Metal	**516**	**3466**	**3982**
Ajmer			
Ore	-	8340	8340
Metal	-	67	67
Alwar			
Ore	37	7300	7337
Metal	++	100	100
Bharatpur			
Ore	-	22	22

Contd….

State/District	Reserve	Remaining Resources	Total Resources
Metal	-	++	++
Bhilwara			
Ore	-	7148	7148
Metal	-	83	83
Bundi			
Ore	-	1980	1980
Metal	-	18	18
Chittorgarh			
Ore	-	18720	18720
Metal	-	158	158
Dausa			
Ore	-	3200	3200
Metal	-	35	35
Dungarpur			
Ore	-	1090	1090
Metal	-	13	13
Jaipur			
Ore	-	23810	23810
Metal	-	113	113
Jhunjhunu			
Ore	37164	510394	547559
Metal	437	2711	3148
Pali			
Ore	-	1997	1997
Metal	-	17	17
Rajsamand			
Ore	-	53	53
Metal	-	2	2
Sikar			
Ore	-	7000	7000
Metal	-	34	34
Sirohi			
Ore	3655	4100	7755
Metal	66	47	113
Udaipur			
Ore	12086	20361	32447
Metal	12	68	80
Sikkim			
Ore	**511**	**450**	**961**
Metal	**9**	**13**	**21**

Contd….

Concld….

State/District	Reserve	Remaining Resources	Total Resources
Sikkim East			
Ore	511	450	961
Metal	9	13	21
Tamil Nadu			
Ore	-	**790**	**790**
Metal	-	**4**	**4**
Villupuram			
Ore	-	790	790
Metal	-	4	4
Uttarakhand			
Ore	-	**4220**	**4220**
Metal	-	**60**	**60**
Almoda			
Ore	-	500	500
Metal	-	3	3
Dehradun			
Ore	-	390	390
Metal	-	1	1
Pitthorgarh			
Ore	-	3330	3330
Metal	-	56	56
West Bengal			
Ore	-	**113**	**113**
Metal	-	**2**	**2**
Purulia			
Ore	-	113	113
Metal	-	2	2

++ : Negligible

Table: 3.3- Statewise Resources of Copper Ores

(In '000 tonnes)

Sl. No.	State	Resources (as on 1.4.2005)	District
1.	Andhra Pradesh	8,248	Guntur, Khammam, Kurnool,Prakasam
2.	Gujarat	13,060	Banaskantha
3.	Haryana	17,230	Bhiwani, Mahendrgarh
4	Jharkhand	226,083	Hazaribagh, Singhbhum (East)
5.	Karnataka	34,404	Chikmagalur, Chitradurga, Gulbarga, Hassan, North Kanara, Raichur, Shimoga
6.	Madhya Pradesh	404,348	Balaghat, Betul, Jabalpur
7.	Maharashtra	9,581	Bhandara, Chandrapur, Gadchiroli, Nagpur
8.	Meghalaya	880	Khasi Hills (East)
9.	Orissa	6,051	Mayurbhanj, Sambalpur
10.	Rajasthan	668,457	Ajmer, Alwar, Bharatpur, Bhilwara, Bundi, Chittorgarh, Dausa, Dungarpur, Jaipur, Jhunjhunu, Pali, Rajsamand, Sirohi, Udaipur
11.	Sikkim	961	Sikkim (East)
12.	Tamil Nadu	790	Villupuram
13.	Uttarakhand	4,220	Almora, Dehradun, Pithoragarh
14..	West Bengal	113	Puruliya

The resources of copper ore are distributed in 14 states namely, Andhra Pradesh, Gujarat, Haryana, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Meghalaya, Orissa, Rajasthan, Sikkim, Tamil Nadu, Uttarakhand and West Bengal and are grouped under seven important belts as given in **Table 3.4**. Description of these important belts is given below. The State Wise, District Wise Deposits of Copper in the country is given at **Table: 3.5.**

Table : 3.4 - List of Important Copper Belts in India

Sl.No.	Name of Belt	State
1.	Singhbhum Copper Belt	Jharkhand
2.	Khetri Copper Belt	Rajasthan
3.	Malanjkhand Copper Belt	Madhya Pradesh
4.	Agnigundala Copper Belt	Andhra Pradesh
5.	Chitradurga Copper Belt	Karnataka
6.	Ambamata Multi Metal Deposit	Gujarat
7.	Rangpo Multimetal Deposit	Sikkim

Figure : 3.1 - STATE WISE RESOURCES OF COPPER ORE (As on 1.4.2005)

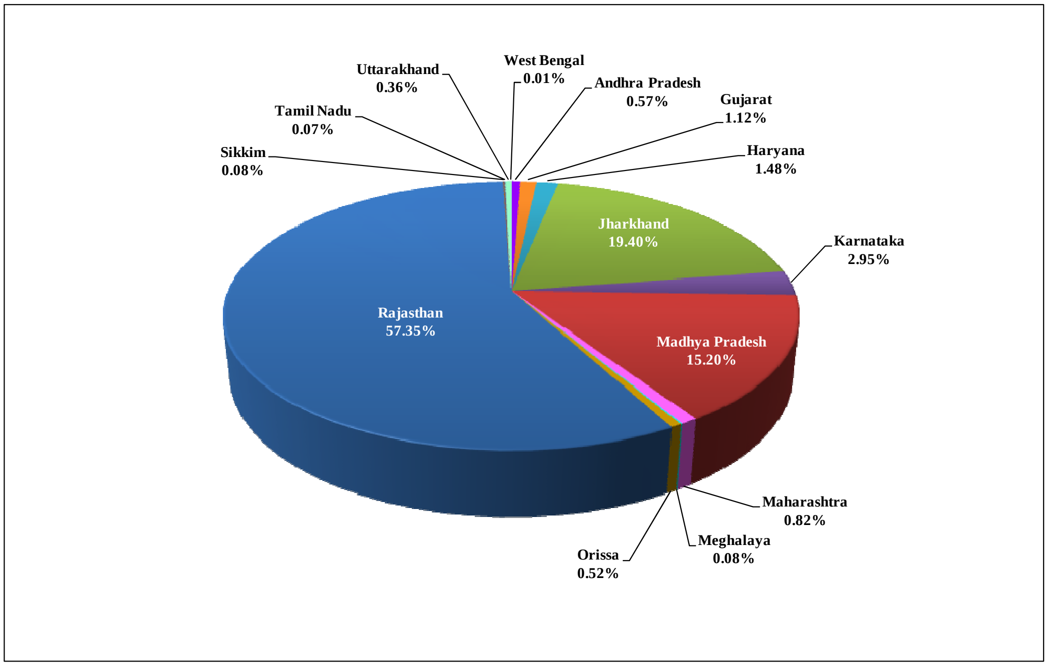


Table: 3.5- State Wise, District Wise Deposits of Copper

State	District	Deposit Name
Andhra Pradesh	Guntur	Agnigundala-Dhukonda
		Agnigundala (Bandalamottu)
	Khammam	Mailaram Project
	Kurnool	Gani
		Chetmallapuram North Block Gadwal Schist
	Prakasam (Ongole H.Q.)	Nallakonda
Gujarat	Banaskantha	Ambamata Multi Metal
		Ambaji
		Sitlamata
Haryana	Bhiwani	Tosham
	Mahendragarh	Golwa-Gangutana
		North of Gangutana (Block-I)
Jharkhand	Hazaribagh	Baraganda
	Singhbhum (East)	Bahargora Sector
		Bayanbil

Contd...

State	District	Deposit Name
		Dhadkidih
		Kendadih - Chapri Sidheswar
		Khadan Dungri
		Mosabani Group of Mines
		Nandup
		Rakha Mine
		Ramchandra Pahar
		Turamdih
		Chirudih-Somiadih
		Tamajhuri
Karnataka	Chikmagalur	Kalaspura
	Chitradurga	Ingaldhalu
		Ingaldhalu North Block
	Gulbarga	Tenthini
	Hassan	Aladahalli-Dasapura-Balahalli
		Kalyadi
	North Kanara	Kaiga-Mothimakki
	Raichur	Machanur
		Kallur
	Shimoga	Masanikere
		Tavarekere Magyathapalli
Madhya Pradesh	Balaghat	Malanjkhand
	Betul	Dehalwara Block
		Ghisi Prospect
		Banskhapa Piparia Belt of KherI Bazar
		Muariya Block
	Jabalpur	Imalia-Bhula-Nawalia
Maharashtra	Bhandara	Garara
	Chandrapur	Dubarpeth
		Thanewasana
	Gadchiroli	Ramangh
	Nagpur	Parsori
		Pular-Parsori
		Thutanbori
Meghalaya	Khasi Hills East	Umpyrtha Potymetallic Deposit
Nagaland	Phek	Satuza

Contd...

State	District	Deposit Name
		Ziphu
Orissa	Mayurbhanj	Kesarpur
	Sambalpur	Adash-Ramapali
Rajasthan	Ajmer	Delwara
		Hanotia
		Kishangarh
		Sawar-Bajta
		Tikhi Extension Block
	Alwar	Bhagoni
		Dariba
		Golbadshapur
	Bharatpur	Khankheda
	Bhilwara	Banera-Forest
		Belwa
		Devpura-Banera
		Devtalai
		Gurla
		Pur-Dariba
		Satdhudia
	Bundi	Cchari
	Chittorgarh	Aakola (Dariba)
		Banrai Gariwana
		Bhagal
		Gujaron- ki- Bhagal
		Rawatia & ParI
		Rewara
		Wari
	Dausa	Dhani Basri
	Dungarpur	Padarkipal
	Jaipur	Ladera-Sakhun
		Sanganer
	Jhunjhunu	Singhana Extn. Block-II
		Ajit Sagar
		AkwalI-North
		Akwali-South

Contd...

State	District	Deposit Name
		Chandmari
		Chinchroli
		Dholamala
		Kalapahar
		Khetri & Banwas
		Kolihan
		Kolihan (Intervening Block)
		Malwali
		Satkui
		Singhana-Muradpur-Pacheri
		Surahari
		Karmari
		Singhana Extension Block(Phase-1)
	Pali	Birantiya-Khurd(North Block)
		Chitar
		Kalabar
		Nayakheda
	Rajsamand	Gopa Kuda Base Metal
		Karoli
		Majera
		Gangas,(Jasma-Bhupalsagar Belt.)
		Gangas Extension (Jasma-Bhupal Sagar Belt
	Sikar	Baleshwar
		Baniwala-ki- Dhani
		Dokan (North)
		Dokan
		Dokan
		Tejawala-Ahirwala-Chiplata
	Sirohi	Basantgarh
		Deri
		Danva
		Golia
		Pipela
	Udaipur	Anjani
		Bedwal-ki-Pal (Isarwas)

Contd...

Concld…

State	District	Deposit Name
		Bedwal-ki-Pal (Kalipol)
		GhagrI
		Kotri
		Ladana
		Pari
		Phalet
		Rajpura Dariba
		Saran Bhawawat
Sikkim	Sikkim East	Dikchu
		Pacheykhani(Upper)-Rorathang
		Rangpo (Bhotang)
Tamil Nadu	Villupuram	Mamandur
Uttaranchal	Almoda	Dhaula Devi
	Dehradun	Chamri
	Pithoragarh	Askot
	Darjeeling	Kamaai -Samsing
West Bengal	Purulia	Tamakhun

i) Singhbhum Copper Belt

The Singhbhum Copper Belt in the state of Jharkhand stretches over a length of 128 km between Baharora and Durgapuram. This deposit is localised in a shear zone (named as Singhbhum shear zone) occurring along the northern and north-eastern margins of Singhbhum granite. The country rock is generally mica schist and sheared granite. These country rocks were intruded by soda granite and granophyres. Significant mineralisation is reported over a distance of 13 km from Tamapahar towards east and up to Surda.

The host rock here comprises various types of schists, quartzite, conglomerates and mylonites. The zone of intense shearing is the locus for mineralisation. Copper ore is found in stringers and streaks as breccia filling and thin veins. The copper ores are predominantly sulphide ores. Chalcopyrite and pyrite are the principle ores occurring in this deposit. Chalcopyrite accounts for about 70-80% of the total copper ores by volume. Other sulphide ores reported in this deposit are pentlandite, molybdenite, marcasite, arseno-pyrite, etc. **Plate-3.I.**

ii) Khetri Copper Belt

The Khetri Copper Belt extends over a length of 80 km from Singhana to Raghunathgarh in Jhunjhunu district of Rajasthan. The host rock for copper mineralisation in this area comprises metamorphites of sedimentary origin, such as phyllites, quartzites schists, etc. Intrusions of granite, pegmatites and quartz veins are reported in this country rocks. The economic deposits of copper occur at Madhan – Kudan, Kolihan and Chandmari. The copper minerals found in this belt are sulphides predominantly pyrrhotite, chalcopyrite and pyrite. Cubanite is also reported at places. **Plate-3.II.**

iii) Malanjkhand Copper Belt

This deposit is situated on Malanjkhand hill which is raised above the surrounding terrain which forms a part of Baihar plateau in Balaghat district, Madhya Pradesh. There are six peaks with intervening saddles and form an arcute chain of about 2.6 km length. The rocks occurring in this area are classified into broad categories, the older granite rocks and younger sedimentary rocks of Chilpi Ghat series. The bulk of mineralisation is reported to have been confined to the quartz veins and reefs. The younger sedimentary rocks are lying uncomfortably over the granitic rocks. The older granitic rocks are covered by soil with outcrops exposed being traversed by quartz reefs, veins and veinlets and are highly sheared, fractured and brecciated. Bulk of the sulphide mineralisation is present in this zone as fracture filling in these quartz reefs and veins. Small amounts of copper also occur as disseminations in the quartz bands in granitic rocks. **Plate-3.III.**

The major copper minerals occurring in this deposit are sulphides namely chalcopyrite, pyrite, covellite, bornite and chalcocite. The oxide ore occurring in this deposit is cuprite. Native copper and hydroxide ores such as malachite and azurite are also occasionally reported.

iv) Agnigundla Copper Belt

This deposit is located in the Guntur district of Andhra Pradesh. It is situated near Vinukonda in the north-east corner of Cuddappah basin. A part of this deposit is also extended in Prakasam district. Bandalmottu and Dhukonda deposits in Guntur district and Nallakonda in Prakasam district are well known. The host rock in this deposit is coarse grained calcareous quartzite and dolomite of cuddappah super-group. This deposit is divided into 3 blocks, namely: Bandalmottu lead-copper deposit, Nallakonda copper deposit and Dhukonda copper-lead deposit. The copper mineralisation is confined to quartzite which is mainly in the form of disseminations. The deposits were originally syngenetic but subsequently remobilised and localised in favourable structural lithologic zones. The major copper ore occurring in the Dhukonda deposit is chalcopyrite and it is confined in the coarse grained quartzitic rocks. The average copper content in the Dhukonda area is assessed as 1.51 per cent.

v) Chitradurga Copper Belt

This deposit extends from Gadag in the north to Srirangpatnam in South over a length of 460 km with a maximum width of 40 km near Chitradurga in the state of Karnataka. The general trend is NNW-SSE. The host rock comprises meta-sediments and meta-volcanics which are traversed by dykes of chlorite and gabbro. The sulphide mineralisation with copper, lead, zinc, antimony, arsenic and silver values is located over a strike length of 40 km in the eastern part of the deposit. This mineralised belt is designated as Chitradurga Sulphide belt. Copper mineralisation is prominent in Bellugudda, Ingaldhal, Kuchiganahalu sector, over a strike length of 5 km. The copper ore occurs mainly as chalcopyrite, malachite, pyrite and arsenopyrite disseminations. The copper contents vary from 0.77 to 1.72%.

vi) Ambamata Multimetal Deposit

This deposit is located in the Banaskantha district of Gujarat in the temple town of Ambamata. The rock types found in the area are quartz schist, biotite and sericite schist, which belong to Delhi super group. These rocks are intruded by meta-basics and Erinpura granite. The surface indications are in the form of acurite and malachite. The primary sulphides occurs in the region are, sphalerite, galena, chalcopyrite and pyrite. The copper mineralisation occurs in arenaceous rock. The total strike length of Ambamata deposit is 2.14 km trending NW-SE and the maximum width is 700 metres.

vii) Rangpo Multimetal Deposit, Sikkim

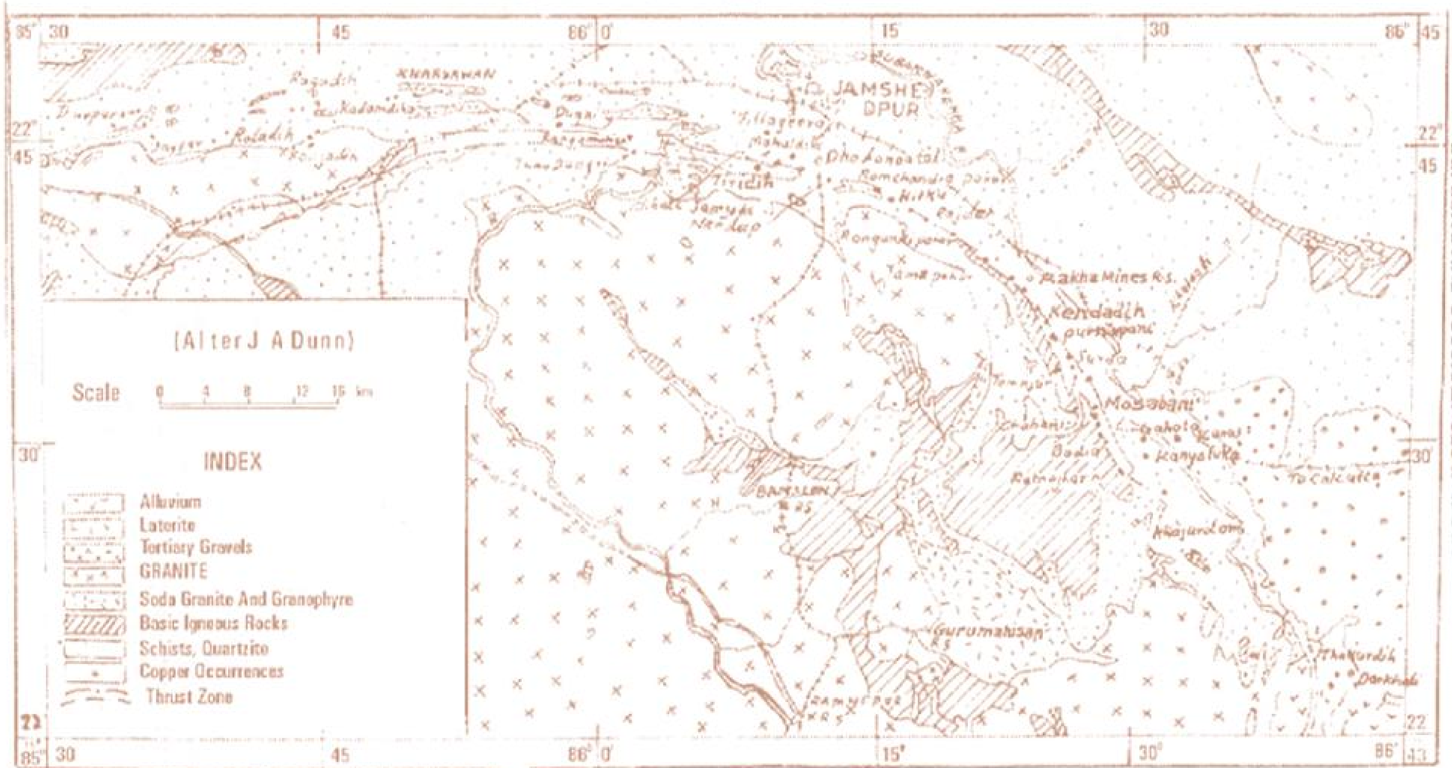
This deposit is situated at Rangpo in Sikkim about 40 km south of Gangtok. The mineralised zone extends from Bhotang, Rangpo in East Sikkim district to Dikchu in North Sikkim district. The rock formations in the area are represented by the rocks of Daling group consisting of chlorite-sericite, phyllites, quartzites and metabasic rocks. The metabasics and chlorite schists which host the ore are highly folded and faulted. The sulphide mineralisation which occurs in the form of bands consists of chalcopyrite, pyrrhotite, sphalerite and galena.

3.2 BENEFICIATION

The copper content in sulphide ores is generally too low (0.3 to 2%) to permit direct smelting. The copper minerals are generally associated with worthless gangue constituents which, if not removed, will require large capacity smelting furnaces as well as enormous quantity of electrical and thermal energy. Besides, copper ores also contain some base metal minerals which need to be removed for ensuring smooth smelting and refining operations. Therefore, it is necessary to beneficiate copper ores to produce smelter grade concentrate. A diagramatic representation of principal production process is given at **Plate 3.IV.**

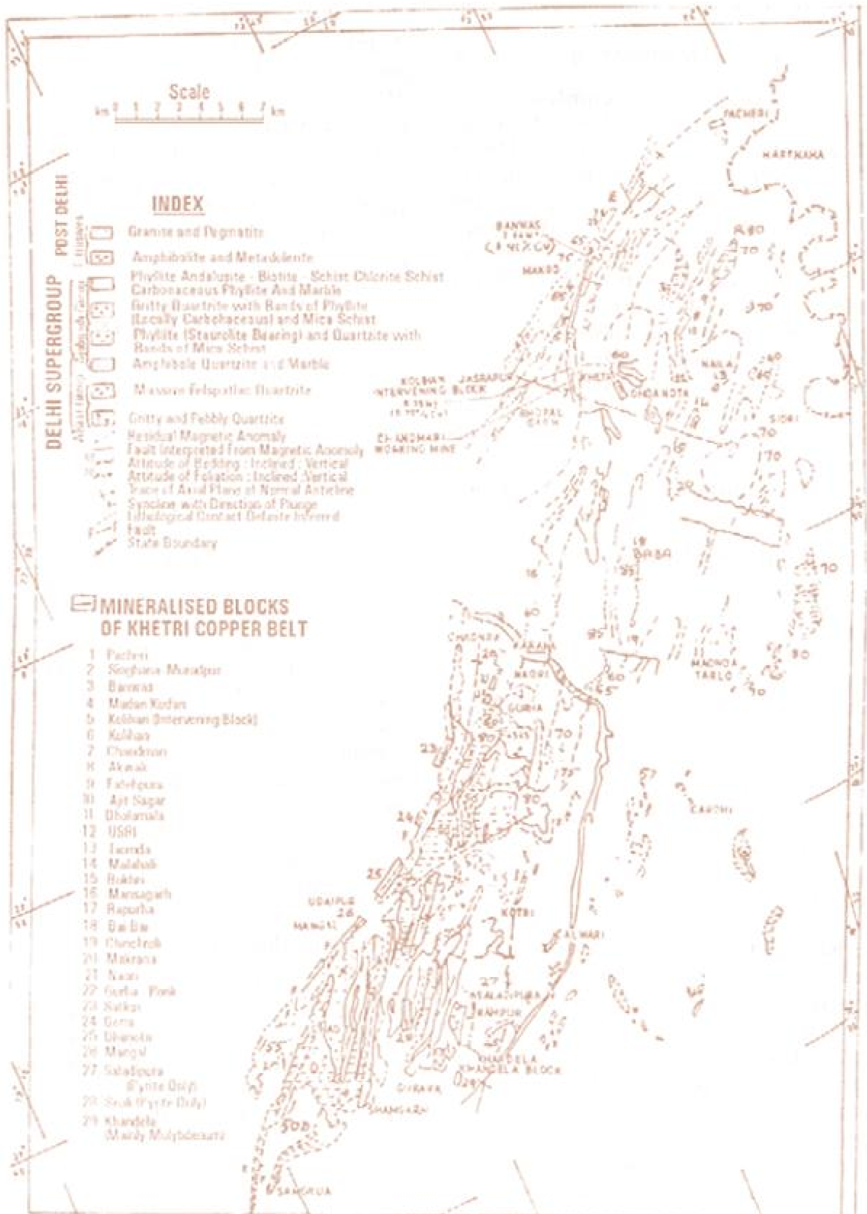
Plate 3.I

Geological Map of Singhbhum Copper Belt, Jharkhand



Source : Geological Survey of India

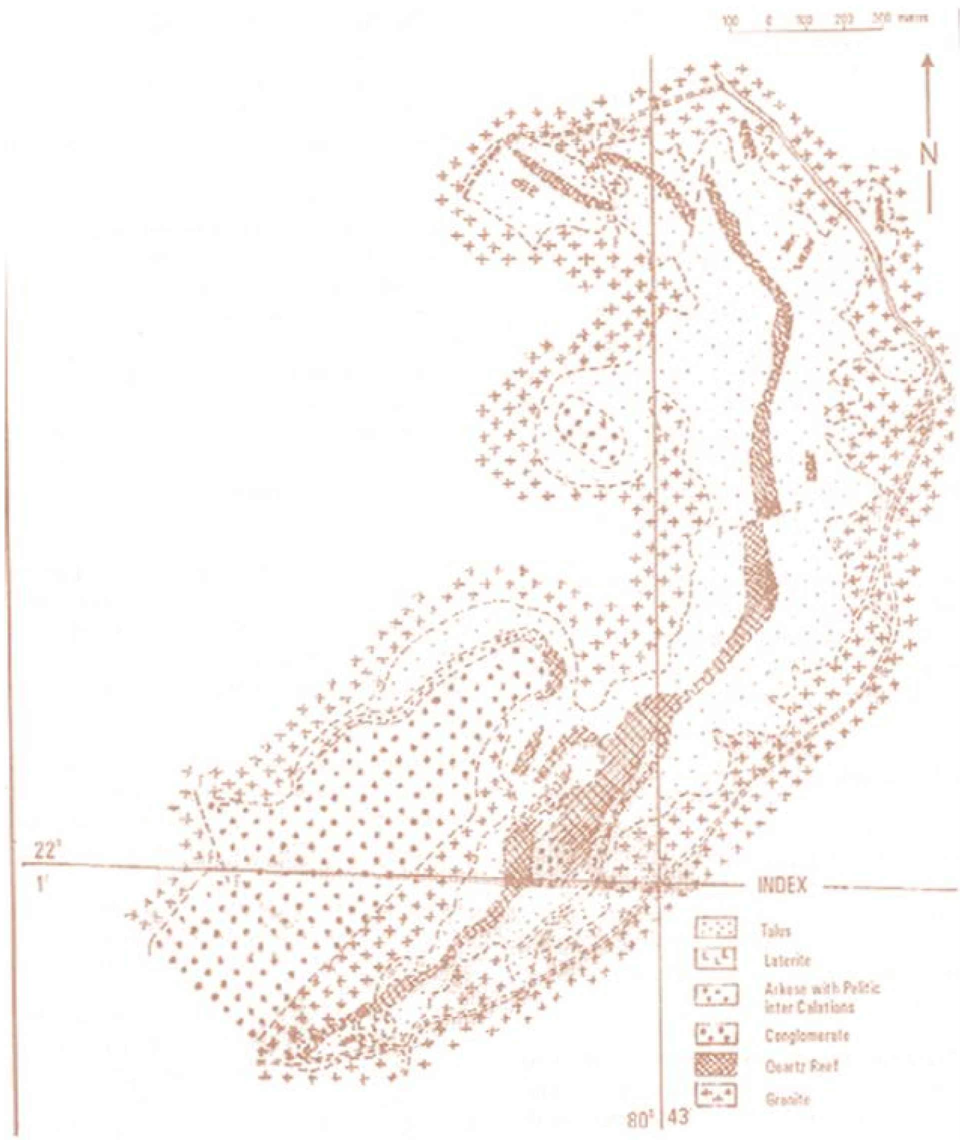
Geological Map of Khetri Copper Belt, Rajasthan



Source : Geological Survey of India

Plate 3.III

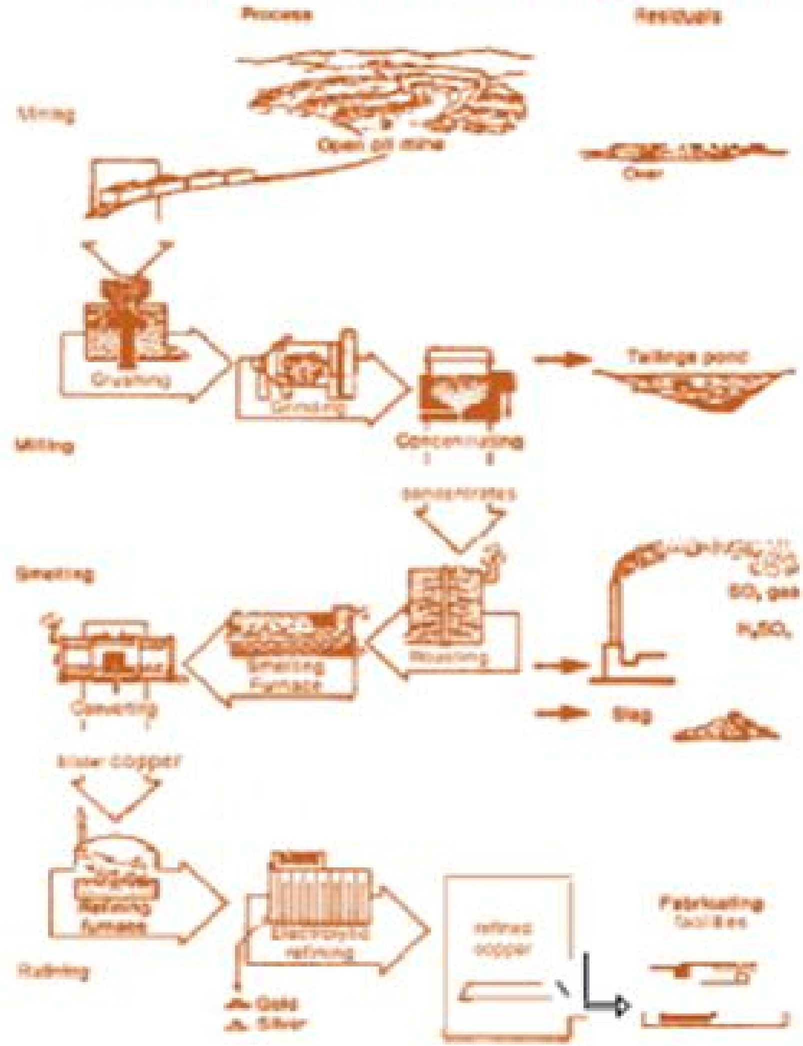
Geological Map of Malanjkhand Copper Deposit, Madhya Pradesh



Source : Geological Survey of India

Plate 3.IV

Principal Stages of the Copper Production Process



Source J.F. McDivitt and G. Manners, Minerals and Man (Baltimore, MD : The Johns Hopkins University Press, 1974)

Beneficiation of copper ore depends upon chemical, physical and mineralogical characteristics of the constituent minerals. Copper sulphide minerals are normally beneficiated by froth flotation.

3.2.1 Processing of Copper Ores

A) Comminution
B) Concentration
C) Dewatering

A) Comminution

Removal of gangue minerals from the copper minerals requires that first the ore should be comminuted (crushed and ground) to a size fine enough to ensure fair liberation of gangue minerals from copper minerals and other associated valuable sulphide minerals. Comminution is performed in two stages i.e. crushing and grinding.

(i) Crushing

Copper ores extracted from the mines are generally in the form of lumps of size up to 1000 mm. The feed to grinding mills is in the range of 10-20 mm size. Crushing of 1000 mm lumps to 10-20 mm size involves a reduction ratio of 50- 100 in multi-stage crushing. Depending upon the nature of the ore and capacity of the plant, jaw or gyratory crushers are employed for first stage of crushing (primary crushing). Clayey and plastic materials are crushed by jaw crushers whereas gyratory crushing is adopted for hard and abrasive ores. Gyratory crushers yield more cubical product from slabby lumps. The capacity of gyratory crusher is more than double the capacity of an equivalent size jaw crusher, that is why gyratory crusher are preferred for large capacity plants. crusher is a primary crusher used in copper industries. In designing, crushing circuit for hard ore, it is advisable to over-design the primary crushing plant to provide stockpiles of coarse product to ensure steady feed to secondary crushers. The size of the product from the primary crusher is in the range of 100-200 mm.

The second stage of crushing (secondary crushing) is usually carried out employing cone crushers and roll crushers for hard and soft ores, respectively. The cone crushers with mantle of diameter 1300 mm to 2150 mm are in operation in many plants. The secondary crushers discharge at 20-25 mm size. Third stage of crushing (tertiary crushing) is employed to obtain a product in the size range of 3-15 mm. Usually, short (mantle diameter up to 2 m) are employed in closed circuit to ensure that crushed product is of the desired size. The reduction ratio for primary, secondary and tertiary crushing must not increase beyond 8, 6-8 and 4-6 respectively.

(ii) Grinding

Fine grinding is usually done in rod mills in open circuit followed by ball mills in closed circuit with classifiers, cyclones, etc. In recent years, there is a trend to use Autogenous mills.

(a) Rod Mills: For many years the standard comminution circuits comprised two-three stage crushing followed by open circuit rod mills and then ball mills in closed circuit with classifiers. Now, many concentrators have dispensed with rod mills and use fine size feed (10 mm) for ball milling only.

(b) Ball Mills: Crusher product from ball milling must be finer for those concentrators who do not employ rod mills. A much greater amount of power is used in ball mills than in crusher or rod mills because the reduction is much greater. Power consumption is usually in 4-6 kW/h per tonne range, higher for those mills that use ball mills for primary grinding and lower for those that have rod mills.

(c) Autogenous Mills: This method of grinding is especially applicable when the ore is wet and sticky or contains a lot of fines. Paradoxically, it should also be considered when ore is tough & hard and blocky because the ore serves well as the grinding media. When the ore varies greatly in hardness, semi-autogenous grinding has been beneficial with capital and operating costs both being 10-20% lower than that could be obtained with conventional crushing and grinding. The ball charge in semi-autogenous mills varies from 6-8% of mill volume. In recent years, secondary and tertiary crusher or secondary crushers and rod mills have been substituted by autogenous mills which utilise coarse and hard pieces of ore itself as grinding media, so that rod and ball wear, a costly affair in conventional grinding is eliminated.

(iii) Sizing/Classification

An important step in grinding is to ensure that final discharge from the grinding circuit is fine enough to respond to flotation. Coarser material must be separated and returned to the grinding mill. Classification is usually done in hydrocyclones or mechanical classifiers. Cyclones utilise centrifugal force to accelerate setting rate of particles.

Presently, hydrocyclones have replaced mechanical classifiers as they are more efficient especially in fine size separation. They require less space and consume less power. Due to short residence time of particles in cyclones, oxidation of copper sulphides is minimised. They are almost universally used for classification between 150 and 5 microns, although coarse separation is also possible. The pulp (ground material) from grinding mills is pumped at high speed (5-10 m/second) into hydrocyclone through an opening tangential to the cylindrical wall so that pulp is given a rotational motion inside the cyclone. This results in a centrifugal force which accelerates the settling rate of ore particles. Faster settling particles move towards the wall of the cyclone where the velocity is lowest and migrate to the apex opening. Pressure drop across the cyclone and feed flow rate are the two most important operating variables in cyclone operation.

B) Concentration (Froth Flotation)

The copper minerals, particularly sulphides are intimately associated with gangue minerals necessitating fine grinding to bring about fair liberation. In addition, there is a little difference between specific gravity of sulphide minerals of copper and sulphide minerals of associated base metals. Concentration of copper ores can not be carried out by gravity separation technique. Under these circumstances, froth flotation becomes a suitable option for copper ore beneficiation.

Froth flotation as applied to copper ores, involves:

i) Conditioning of the ground ore pulp with flotation reagents to make copper minerals hydrophobic without affecting other accompanying minerals and

ii) Passing a dispersed stream of fine air bubbles up through the pulp causing air bubble attachment to copper minerals with which they rise to the top of the flotation cell in the form of mineral laden froth, other minerals being unaffected are rejected as tailings.

(a) Rougher and Scavenger Flotation

Commercial flotation is a continuous operation which is carried out in cells arranged in series. Overflow from classifiers/hydro cyclone forms feed to flotation. The pulp (overflow) conditioned with different flotation reagents enters the first cell where some valuable minerals are collected and the remaining pulp passes to the second cell and so on until barren tailings leave the last cell. The float from the last few cells is of comparatively lower grade containing interlocked particles or free coarse materials. The flotation of readily and rapidly floatable material is called rougher flotation whereas flotation of mixed particles, coarse particles and very fine particles from the last few cells is called scavenger flotation, i.e. in a commercial flotation circuit, the fast floating material is recovered by scavenging.

Both scavenger concentrates and cleaner tails contain essentially slow floating fine values as well as coarse mixed particles. Therefore, they are classified. The fine classified product is recycled to the rougher circuit or cleaned in a separate circuit and the coarse product is reground and returned to the system with new feed.

b) Cleaner Flotation

It goes with saying that rougher concentrates seldom conform to the smelters requirements as they are often contaminated with gangue minerals due to mechanical entrapments. In order to drop out these gangue minerals, rougher concentrate is cleaned number of times at lower pulp density.

c) Flotation Reagents

The most important reagents in copper ore flotation are collectors, frothers, pH regulators and depressants.

i) Collectors: The reagents which create the hydrophobic surfaces on minerals are called collectors. They are hetropolar organic compounds, i.e. collector molecule contains a non-polar hydrocarbon group and a polar (charged) group. The non-polar hydrocarbon radical has pronounced water-repellant properties whereas polar group has affinity for water. The collectors absorb on the mineral surface with non-polar end oriented outwards. It is this orientation which imparts hydrophobicity to the mineral particles.

The most widely used collectors for sulphide flotation are xanthates (sulphydryl type) which have polar bivalent sulphur. The other sulphur- bearing collectors are thiono carbonates, dithiophosphates (Aerofloat) and pthilocarbonitides. The dithiophosphates are not as widely used as xanthates, but are still important reagents in sulphide flotation. They have pentavalent phosphorus in polar group. Sodium ethyl xanthate has a typical structure.

The reaction of xanthate with oxidation product of sulphide surface through ion exchange process is considered to be a major adsorption mechanism for flotation of sulphides. However, a high degree of surface oxidation accompanied by formation of sulphates readily reacts with xanthates. As the metal xanthates so formed scale off the mineral surface, the solubility of copper, lead, silver and mercury in xanthate is very low whereas solubility of iron and zinc xanthates is much higher. There fore sphalerite activation by copper sulphate is necessary. The alkali earth metal xanthates (Ca, Ba, Mg) are very soluble and they have no collector action on the minerals of such metals nor on oxides, silicates or alumino-silicates. This phenomenon permits extremely selective flotation of sulphides from gangue minerals. Xanthates are normally used in weakly alkaline pulps, since they decompose in acid media and at high pH hydroxyl ions can displace xanthate ions from the mineral surface.

Sodium isopropyl xanthate is the universal collector used in the copper flotation plants. Sodium isopropyl xanthate is often replaced by amyl xanathate as it yields pyrite-rich copper concentrate suitable for flash smelting. The performance of combination of two or more xanthates/collectors has been found much superior to those of individual collectors and therefore copper flotation plants are employing combination of two to four collectors.

ii) Frothers: When the mineral surface has been rendered hydrophobic by the use of a collector, stability of bubble attachment especially at the pulp surface depends to a considerable extent on the efficiency of the frother. Frothers are generally surface-active hetropolar organic reagents capable of being adsorbed on air-water interface. When frother molecules react with water, the water dipoles combine readily with polar groups and hydrate them. But there is practically no reaction with the non-polar hydrocarbon group, the tendency being to force the latter into the airphase. Thus, hetropolar structure of frother molecule leads to its adsorption i.e. molecules concentrate in the surface layer with non-polar groups oriented towards the air and polar group towards the water. Frothing action is due to the ability of frother to adsorb on the air-water interface, because of its surface activity and to reduce the surface tension, thus, stabilising the air bubble. Frother must be to some extent soluble in water. The acids, amines and alcohols are the most widely used frothers since they have practically no collection properties.

Pine oil which contains aromatic alcohols has been widely used as frother in copper ore flotation plants. Cresol (cresylic acid: $CH_3C_6H_4OH$) is also widely used.

A wide range of synthetic frothers, based mainly on high molecular weight alcohols is now in use in many plants. A typical synthetic frother is Dowfroth-250, which is being widely used in copper flotation plants. Combination of two or more frothers is also reported to give better performance.

iii) Regulators: Regulators or modifiers are widely used in copper ore flotation to modify the action of collector either by intensifying or reducing its water repellent effect on the mineral surface. They, thus, make collector action more selective towards certain minerals. Regulators can be classified as activators, depressants, dispersants and pH modifiers.

iv) Activators: These reagents modify the mineral surfaces so as to make them hydrophobic and susceptible to collector action. Activators are generally soluble salts which ionize in solution and the ions then react with the mineral surface. Activators are occasionally used in copper flotation. Oxide minerals of copper like azurite, malachite, etc. sluggishly float with collectors and need large dosages. Such minerals are activated by use of sodium sulphide or sodium hydrosulphide. The sodium sulphide should be added in stages and its amount should be carefully controlled, as excess amount depresses even activated oxide minerals and also the sulphide minerals.

v) Depressants: Depressants are employed to ensure selective flotation by rendering certain minerals hydrophilic (water avid), preventing their flotation. There are many types of depressants and their actions are complex. Cyanides are widely used in copper-zinc and copper pyrite separation. Sodium cyanide is more commonly used depressant.

The depressing action of cyanide depends on its concentration, pH value and length of xanthenes hydrocarbon chain. Depressing effect of cyanide ion increases with pH. It is maximum (100%) at pH 13 and minimum (0.06%) at pH<6.

Cyanides are highly toxic and must be carefully handled. They are very expensive and they depress and dissolve gold and silver reducing the concentration of these metals in copper floats. When the ore contains gold and silver, sodium cyanide - ZnO complex should be used in place of cyanide alone.

The use of zinc sulphate reduces the consumption of cyanide and therefore many copper beneficiation plants use cyanide - $ZnSO_4$ combination as zinc depressant. Sometimes organic reagents, such as, starch, tannin, dyes, quebracho and dextrine are also used as depressants. These are used in small quantity to depress talc, graphite and calcite. Starch is used to depress molybdenite in copper-molybdenum separation.

vi) pH Modifiers : pH plays an important role in flotation of sulphides as well as non-sulphide. Lime, sodium hydroxide, sodium carbonate, sulphuric acid, etc. are used as pH modifiers.

Copper flotation is usually carried out in alkaline medium. Lime, being very cheap, is widely used to regulate/raise pulp alkalinity. It prevents the adverse effect of soluble salts on flotation by precipitating them as metal hydroxides. It is also used as depressant for pyrite and arsenopyrite in copper flotation. It has no depressing effect on copper minerals but does depress galena. Sulphuric acid is used to bring down pH below 7 which is required for flotation of pyrites.

As already stated, the beneficiation process may differ in the presence of a group of gangue as well as other metallic ores; therefore, use of collectors, frothers, activators, depressants, pH modifiers may differ from simple ores to complex ores.

C) Dewatering

Many of the mineral separation techniques involve use of substantial quantity of water. Final test product need to be dewatered to produce dry product required for shipment. Dewatering process can be broadly classified into three groups:

a) Sedimentation/thickening
b) Filtration
c) Drying

Dewatering in mineral processing is normally a combination of the above groups. The bulk of water (up to 80%) is removed by thickening which result in a thickened pulp up to 60% solid by weight. Filtration of the thickened pulp yields a moist cake containing 10 to 20% moisture which may require thermal drying to produce a dry product containing up to 5% moisture.

The filtration units in copper processing plants employ drum and disc filters with disc having slight edge. Filter capacity also varies considerably and ranges between 0.4 to 1.0 tpd per sq. ft. filter area. A large number of mills use driers to dry the copper concentrates. Dryers are used for many reasons - usually because the filter cake is too wet to strip or because the smelter requires a product with less moisture. Spray, rotary drum and multiple hearth dryers are used in copper mill. Rotary dryers are most common.

3.2.2 Smelting

Copper is extracted from its ores and concentrates either by

a) Pyrometallurgical Processes or **b) Hydrometallurgical Processes** depending upon ore type, economical and environmental consideration. The sulphide minerals of major importance for copper extraction are chalcopyrite and chalcocite. Production of copper from sulphide concentrates has been accomplished by pyrometallurgical techniques involving melting and oxidation to remove major impurities like silica, iron and sulphur.

Production of copper from sulphide concentrates by hydrometallurgical route has been investigated in recent years. Copper from oxide ores is produced mainly by hydrometallurgical process.

A brief description of processes are discussed below:

a) Pyrometallurgical Processes

The main pyrometallurgical processes by which copper is extracted from ore, mainly sulphide ores, are given below:

i) Conventional Copper Smelting Technology : Conventional smelting practice differs from smelter to smelter, but generally involves roasting, smelting converting and fire-refining.

ii) Roasting: Roasting, as applied to copper extraction, is partial oxidation of copper sulphide concentrates with air at 500-700^oC temperature. It is often employed prior to reverberatory smelting as heat generated from roasting is utilised to dry and heat the feed to smelter. It is not applicable to blast furnace or flash smelting as they encompass roasting reactions in smelting stage itself. It can however, be practised prior to electric furnace smelting. It is generally employed to ores high in sulphur.

The main reactions involved in roasting are oxidation of copper and iron sulphides to sulphates and oxides

$2CuS + 3SO_2 \longrightarrow CuO + CuSO_4 + SO_2$

$CuFeS_2 + 4O_2 \longrightarrow CuSO_4 + FeSO_4$

(Partial oxidation)

$2CuFeS_2 + 6SO_2 \longrightarrow 2CuO + Fe_2O_3 + 4SO_3$

(Complete oxidation)

Roasting gases have normally high SO_2 concentration (5-15% SO_2). Some volatile impurities are removed during roasting.

Many smelters do not use roasting as the difficulty in handling of hot roasted product (calcine) outweighs the roasting advantages. If moisture content is low, roasting can be performed autogenously at about 500-600^oC. High roasting temperature causes excessive oxidation of iron compounds leading to smooth operation of reverberatory operation. Magnetite increases the viscosity of slag during smelting affecting matte-slag separation leading to increased copper losses in slag.

Roasting is generally performed employing multiple hearth of fluid bed roasters. Fluid bed roasters are preferred because of their high production rates, excellent temperature and chemical control and high SO_2 concentration in effluent gases.

iii) Matte Smelting : Smelting or matte smelting consists of melting concentrates or partially roasted concentrates at 1,150 - 1,200^oC to produce the separable liquid phases known as copper matte (Cu 30-60% sp, gravity > 5) and slag (sp. gravity < 3). The matte (Cu_2S, FeS) form feed for production of blister copper. The slag are formed from the oxides in furnace charge (impurities in the concentrate: SiO_2, Al_2O_3, CaO, MgO and oxides from fluxing material) and iron oxides produced by oxidation during smelting. Smelting slag generally contains 30-40% iron oxides (FeO, Fe_2O_3), 35-40% SiO_2, 0-10% Al_2O_3 and 0-10% CaO.

The reaction between cuprous oxide (Cu_2O) and iron sulphide to produce copper sulphide (Cu_2S) proceeds rapidly and fully as sulphur has greater affinity for copper than iron. This is the main smelting reaction and this is the reason why copper is concentrated in matte and iron is partially slagged off.

Smelting operations are carried out in blast, reverberatory, electric and flash furnaces. As blast furnace requires lumpy feed, fine flotation concentrates are smelted in the other three furnaces only.

iv) Reverberatory Smelting : The reverberatory furnace is the most widely used unit for matte smelting. It is a fuel fired hearth furnace in which concentrates or roaster calcines are melted in presence of flux to produce separate layers of molten matte and slag. The heat for smelting is provided by burning fuel in the furnace and by passing hot combustion gases over the charge. All types of material (lumpy or fine, wet or dry) can be readily smelted. However, everything is not well with the reverberatory furnace. It requires large quantity of hydrocarbon fuel because it makes little use of the energy which is potentially available from sulphide oxidation. Thermal efficiency is in the range of 25 - 30% only. The reverberatory furnace gas presents serious pollution problem because SO_2 concentration is too low (0.5 to 1.5% SO_2) to form a feed for sulphuric acid manufacture, the minimum SO_2 concentration required is 5%. The principal products from reverberatory furnace are liquid matte (30-50% Cu; 1150^oC), which collects gold and silver, is sent forward for converting and a liquid slag (0.3 to 0.8% Cu: 1200^oC) which is discarded as effluent gas (1250^oC).

v) Electric Furnace Smelting : In the regions where abundant electricity is available at low price and fossil fuels are costly, electric furnaces are frequently used in place of reverberatory furnace for copper smelting. The advantages of electric furnace smelting are:

a) low capital and operating cost
b) high SO_2 concentration (8 to 15%) in the effluent gas and
c) high thermal efficiency and less air pollution.

About 375 to 425 kW/h electrical energy is required to smelt a tonne of calcined concentrates. Efficient operation of the furnace depends upon slag composition (35.5 - 38.5% SiO_2) as heat generated for smelting is proportional to slag.

vi) Flash Furnace Smelting : It is well-known that oxidation of sulphide is an exothermic reaction. Chalcopyrite oxidation can be represented by the following equation.

$$2CuFeS_2 + 2.5O_2 + SiO_2\ (flux) \rightarrow \underset{(matte)}{Cu_2S.\ FeS} + \underset{(slag)}{FeO.SiO_2)} + 2SO_2 + heat$$

It is this reaction which provides much or all of the heat required for smelting (heating and melting) forms the basis for flash smelting. Additional hydrocarbon fuel is needed when air is the combustant. SO_2 concentration in the effluent gas is high (>10% SO_2) and this can be profitably utilised for manufacture of H_2SO_4 and elemental sulphur. The major disadvantages of flash furnace smelting is higher copper losses in slag and fine dust necessitating additional treatment by flotation or electric furnace smelting.

vii) Converting: Molten matte from smelting contains copper, iron, sulphur as its predominant constituents with up to 3% dissolved oxygen. In addition, it contains minor impurities (As, Sb, Bi, Ni, Pb, Zn, etc.) and precious metals.

Converting is removal of iron and sulphur and other impurities from the matte by air oxidation which results in production of liquid metallic copper in crude (98.5-99.5% Cu) blister copper form.

$$Cu_2S + 1.5O_2 \rightarrow Cu_2O + SO_2$$

$$Cu_2S + 2Cu_2O \rightarrow 6Cu + SO_2$$

$$Cu_2S + O_2 \rightarrow Cu + SO_2$$

viii) Slag Making

$$FeS + O_2 \rightarrow Fe + SO_2$$

$$3FeO + 0.5O_2 \rightarrow Fe_2O_4$$

$$2FeO + 2SiO_2 \rightarrow 2FeO.SiO_2$$

Any Cu_2O formed is re-sulphidised to Cu_2S as per the following action, i.e.

$$Cu_2O + FeS \rightarrow FeO + Cu_2S$$

3.2.3 Copper Making/Refining

The minor impurities As, Bi, Cd, Ge, Hg, Pb, Sb and Sn are mainly volatilised and zinc along with iron joins the slag. Most of the precious metals viz. nickel and cobalt are present in blister copper from which they are recovered/removed during electro-refining.

3.2.3.1 Fire Refining

Blister copper normally contains too much sulphur and oxygen to form cast anodes for electro-refining, therefore, the last step in pyrometallurgy of copper is removal of remnant dissolved sulphur and oxygen by fire refining. Fire refining is done in an anode furnace but having only one or two tuyers and a pouring tap hole. Sulphur removal is done by air oxidation. Refining a 250-300 tonnes charge of blister copper requires one hour time to reduce sulphur content in the anode copper. Natural gas/reformed gas or propane is then blown through the dryer to reduce oxygen content 0.05 - 0.2%. At this point, molten copper is poured into anode moulds to produce anode copper.

3.2.3.2 Continuous Smelting Process

It is well established that production of blister copper by conventional route involves multistage operations, namely, roasting, smelting and converting. Of late, metallurgical and chemical engineers were striving to combine these three operations into a single continuous operation to produce blister copper directly from copper concentrates. Their efforts culminated into development of continuous smelting processes. The continuous smelting process incorporates continuous charging of concentrates onto slag surface, continuous melting (partial oxidation) of concentrates and continuous oxidation of matte by air/oxygen-enriched air to produce blister copper slag and pure-magnetite and continuous/intermittent tapping of blister copper and slag. In this process, slag layer is never completely removed and matte is continuously replenished with copper and iron sulphides by the continuous charging of the concentrate. These procedures ensure the simultaneous existence of slag, matte and blister copper. This entails simultaneous oxidation of iron sulphides into iron oxides and copper sulphides to blister copper.

The slag is saturated with magnetite and contains 20-30% magnetite and 7-8% Cu as Cu_2O and is highly viscous. Matte is also saturated with magnetite and contains 0.6 to 1.5% FeS. The blister copper may contain 0.2% Fe, 1.7% S and 0.03% oxygen. High copper content in the slag calls for additional recovery step.

The blister copper produced by continuous process contains higher percentage of Sb, As and Bi as compared to blister copper produced by conventional route. In conventional operations, these impurities are removed to a large extent by volatisation of their sulphides during slag forming stage of converting i.e. before metallic copper is formed. In continuous operations, since metallic copper is always present, these impurities get dissolved in copper before volatilisation can occur. The elimination of these impurities is difficult by further pyrometallurgical operations because of their low chemical activities. This is the reason why the anodes from continuous operation have higher level of As, Bi and Sb necessitating more careful electro-refining. Therefore, the continuous smelting route is restricted to smelting of concentrate with less content of these impurities.

3.2.4 New and Emerging Processes

3.2.4.1 Foam Smelting

A stationary furnace with water cooled side walls, similar to zinc fuming furnace is employed. A layer of slag-matte foam is maintained above a quiescent bath of slag and matte/metal. Concentrate, flux and carbonaceous fuel are fed into the foam layer maintained in a highly turbulent condition by oxygen-enriched air blown through tuyers. When blowing stops, the foam subsides exposing the tuyers directly above the bath. The slag and matte/metal continuously overflow from the furnace through weirs. Provision is made for cleaning the slag by reduction in a separate section of the furnace.

3.2.4.2 Electrolytic Refining

Electrolytic refining involves electrochemically dissolving copper from impure anodes and selectively plating the dissolved pure copper on to copper cathodes. During the process, it eliminates electrically and mechanically harmful impurities and at the same time separate valuable impurities which can be recovered as byproducts.

The principal impurities in a copper anode are As, Bi, Ni, Pb, Sb, Se, Te, Au, Ag and Pt. Gold and platinum do not dissolve in the sulfate electrolyte and hence they remain as anode residue/slimes. Silver partially dissolves but is precipitated from the electrolyte as AgCl by dissolving a small amount of NaCl or HCl in the electrolyte. Sulphur, selenium and tellurium being present as Ag_2Se, Cu_2Se, Ag_2Te_4 and Cu_2S are not dissolved in electrolyte and therefore report in anode residue/slimes in a similar fashion as noble metals. Lead and tin forming insoluble sulphates do not enter electrolyte to any appreciable extent. The other impurities (As, Bi, Co, Fe, Ni and Sb) being less noble than copper, dissolve in the electrolyte and therefore must be removed from the electrolyte to avoid contamination of cathode copper by occlusion.

Cleaning of electrolyte involves three main sequential steps:

a) Removal of copper from the electrolyte by electro-winning using inert antimonial lead anodes and normal copper starting sheets.

b) Removal of arsenic antimony and bismuth by electro-winning them into an impure copper cathode deposit.

c) Evaporation of water from the copper free electrolyte and precipitation of nickel, iron and cobalt as sulphates from the concentrated solution. The nickel sulphate is purified and sold for electroplating and other uses.

b) Hydrometallurgical Processes

Copper is most often found in form of sulphide minerals which undergo pyrometallurgical operation to produce crude copper (blister copper) metal. But the same is not true with copper oxide minerals. Oxide minerals when present in sufficient quantity in the ore deposits can be smelted in blast furnace economically as has been the practice in the past. However, oxide ores are too low in copper to permit economical hydrometallurgical extraction. In addition, many oxide minerals do not readily respond to froth flotation and therefore need to be treated by non-pyrometallurgical route, preferably, hydrometallurgical techniques. Hydrometallurgical extraction comprises leaching, cementation/solvent extraction and electro winning.

Hydrometallurgical techniques are applied mainly to oxidised copper ore, low grade oxide/sulphide mine wastes and roasted sulphide ores. Processes have been developed to extract copper hydrometallurgically from sulphide concentrates too.

Leaching Technology

Although leaching is a chemical process, physical factors play an important role. The most important factor is the ingress of leach solution into the ore. There are three types of voids in rocks - fractures, cleavage planes and fine pores. In most copper bearing rocks, copper minerals are concentrated in fractures and cleavage planes where solution can more readily come in contact with them than if they were disseminated through the entire rock.

Diffusion is an important action in leaching. As the solution penetrates the interior of the rock and dissolves copper minerals, a diffusion pressure is created and soluble salts diffuse to a less concentrated solution at the surface of the rock.

The actual rate of dissolution depends upon the type of leaching and the contacting conditions. Typical leaching cycles for oxidised ores are 5-12 hours for fine concentrate with agitation leaching, 5-10 days for crushed particles in vat leaching and 100-180 days in heap leaching. Factors favouring rapid leaching rates are high acid strength, elevated temperature (up to 60^o C), large contact area and good agitation.

Copper sulphide minerals dissolve mainly under extremely oxidising conditions provided by high oxygen pressure.

The best solvent for oxidised minerals is sulphuric acid. It is cheap and can be partly regenerated in leaching of sulphide/sulphite minerals. The best solvent for sulphide minerals is acidified ferric sulphate.

In some cases, ammonia and hydrochloric acid are used for nickel-copper sulphide ores/mattes. The leaching of sulphide ores with sulphuric acid as already indicated is a very slow process and that is why it is restricted mainly to long-term treatment (3-20 years) of oxide/sulphide mine wastes. Nevertheless, large quantity of copper is extracted by this long-term leaching technology. The principal sulphide minerals in leach dumps are chalcopyrite, chalcocite and pyrite. Pyrite, when leached converts to ferric sulphate which contributes to further leaching of copper minerals.

Leaching methods as applied for copper extraction are:

a) In situ leaching
b) Dump/heap leaching
c) Vat leaching/ percolation leaching
d) Agitation leaching
e) Bacterial leaching

a) In situ Leaching: In situ leaching involves the breaking of ore in situ by conventional mining method. This is practiced for low grade-surface deposits or worked out underground mines.

b) Dump/Heap Leaching: Dump leaching is applied to the low copper wastes from conventional mining methods, usually open pit operation. The waste rock is built into large dumps and the leachant is sprinkled over the surface and allowed to trickle down through the dump. Heap leaching is exactly the same as dump leaching except that surface oxide ore deposits rather than mine wastes are broken and piled into heaps of 1,00,000 to 5,00,000 tonnes. The solid material in the heaps is somewhat smaller (100 mm) than those in the dumps and leaching is faster. Copper recovery from sulphide heaps is low due to short leaching time (100-180 days). Leaching recovery seldom exceeds 60%. However, this method requires lowest capital cost.

c) Vat/Percolation Leaching: Vat leaching is a high production rate method employing concentrated sulphuric acid to produce a pregnant solution of sufficient copper concentration for electro-winning from oxidised copper ores (1.02% Cu). This technique, is based on batch principle. The ore crushed and sized to 10-20 mm containing no fines or with fines, agglomerated by moistening and rolling, is leached in large rectangular vats (28 m long x 15 m wide x 6 m deep) and is capable of treating 3,000 - 5,000 tonnes. The leaching usually takes place in sequence of four to seven reinforced concrete vats arranged side by side. The pregnant solution from the these vats are used as electrolyte (after purification) while the remaining solution (being more dilute in copper) is used to leach subsequent fresh batches of ore, continuous batch leaching is now being practised in several operations. The most prominent example of vat leaching has been the Chuquicamata (Chile) plant based on sulphate ores (antlerite). Chambishis (Zambia) vat leaching plant was based on carbonate copper ore. The total process cycle may last for 100-200 hours and recovery of copper up to 95% is possible from readily soluble oxide copper ores.

d) Agitation Leaching: It is rapid leaching of fine particles (usually 90% - 75 microns) of oxide copper concentrates/roaster calcines in strong acid solutions. It requires only 2-5 hours leaching time.

The leaching usually takes place continuously in a series of 3-4 tanks with agitation being provided by air or mechanical means. Rapid leaching is encouraged by high temperature (60^oC) operation. Existing plant use co-current or counter current leaching. Counter current washing is also practiced to ensure that pregnant solution is entirely recovered from the leach residue. This process yields the highest metal recovery in shortest possible time but requires the highest capital investment.

e) Bacterial Leaching: In certain cases, microbial leaching can be used for profitable copper recovery from low grade sulphide ore in heaps, dumps or in-situ in mines or deposits. The process is attractive because relatively little labour and capital investment are required compared with conventional techniques and commercial leaching operations.

f) Copper Recovery from Leach Solution: Pregnant solutions from leaching contain copper at sufficient concentration for direct electro-winning of high purity copper whereas solutions from in situ, dump and heavy leaching being weak, need additional treatment for copper extraction. Cementation and solvent extraction are important for recovering copper from weak solutions. Both strong and weak pregnant solutions contain impurities (iron, cadmium, lead and zinc) inherited from the ore and they require purification prior to further treatment. This is achieved by precipitating ferric iron from aerated solution with burnt lime at pH: 3-3.5 and by bleeding a portion of electrolyte from the circuit for decopperising the discard.

ii) Cementation: As practiced in copper industry, the pregnant solution flows through a pile of scrap steel and copper precipitates on the iron surfaces as per the following reaction

$$Fe + Cu^{2+} \rightarrow Cu + Fe^{2+}$$

(Scrap) (Solution) (Cement Copper) (Solution)

The copper precipitate detaches in flake or powder form under the influence of the solution flow. It is invariably contaminated with iron upon which it precipitates (typical analysis: 85-90% Cu, 0.2-2% Fe, 0.5% SiO_2 + Al_2O_3 and remainder oxygen). The cement copper is purified by melting in smelting furnaces/converters and therefore subjected to electro-refining.

iii) Electro Winning

Leaching operation and leaching solvent extraction produce solution with dissolved copper. The copper from these solutions is recovered in the form of copper cathode by electrowinning. This process involves application of an electrical potential between an inert anode (antimonial lead) and a copper cathode both immersed in copper-bearing solution. The electrowinning cathode reaction is identical to that in electro-refining but the anode reaction is different i.e. formation of oxygen gas takes place at anode. The electrowinning reaction is

$$Cu^{2+} SO_4^{2-} + H_2O \rightarrow Cu + O_2 + 2H^+ + SO_4^{2-}$$

For which standard cell potential is 0.89 V. The regenerated sulphuric acid is cycled to the leaching or solvent extraction stripping circuits.

The purity of electrowon cathodes (99.75 - 99.9% Cu) is inferior to that of electro-refined copper. However, they are suitable for all non-electrical uses. Lead is an especially difficult impurity to avoid because it originates from the anodes and affects annealing properties of copper wire.

3.2.5 Copper Segregation Process

The copper segregation process is designed to concentrate oxidized copper ores or mixed sulphide-oxide copper ores which are refractory to normal and cheaper beneficiation and hydrometallurgical (leaching) operations. Such ores contain copper minerals in dolomitic/calcitic gangue. Under these circumstances, neither flotation is possible nor leaching is economically viable.

A high temperature treatment (700-800 ^{0}C) of the ore in presence of small amounts of sodium chloride and finely divided carbon ensures transfer of metallic copper from the copper minerals to the carbon particles and copper is thereafter recovered by flotation. The reactions involved are :

Sodium chloride reacts with water vapours and acid gangue produces hydrogen chloride which reacts with copper leading to formation and volatilisation of cuprous chloride which is immediately reduced on coal particles by hydrogen emanating from the volatile matter of coal and from water gas reaction. Hydrogen chloride is regenerated and a new cycle of reaction begins. The sulphides, if present, are oxidised on heating and then react like oxides in segregation process. Silver, bismuth, arsenic and antimony can also be subjected to same reactions. Gold is usually recovered with copper as it floats well along with copper.

3.2.6 Copper Ore Processing in India (Concentrator plants)

Indian Copper industry was dominated by Hindustan Copper Ltd. (HCL) since 1967. It was incorporated as Indian Copper Corporation Ltd. in 1972 and in 1982 HCL expanded its operations in Madhya Pradesh by developing the Malanjkhand Copper Project. The activities relating to mining, processing of copper ore and production of copper metal was solely carried out by HCL. In the year 1992, the Indian Copper Industry was thrown open for private sector investment. Sterlite Industries Ltd. (SIL) and Indo Gulf Corporation set up plants at Tuticorin, Tamil Nadu at Dahej, Gujarat. The Dahej plant was subsequently taken over by Hindalco Industries Ltd. However, HCL is the only vertically integrated copper producer in India engaged in wide spectrum of activities ranging from mining, beneficiation, smelting, refining and continuous cast rod manufacturing.

A short write up in respect of ore processing and metal production is given below:

i) Khetri Copper Complex, Rajasthan

Khetri Copper Complex of Hindustan Copper Limited (HCL), a Government of India enterprise, was established in 1967. Khetri is located in Jhunjhunu district of Rajasthan, about 190 km southwest of Delhi and 180 km north of Jaipur. The complex houses concentrator, smelter and refinery.

Process Description

Crushing: ROM (-300 mm) skip hoisted from Khetri mines is conveyed to an open conical stockpile. Similar sized material from Kolihan and Chandmari mines is brought to worksite by aerial ropeway and delivered to a second stockpile; while recycled slag from smelter is conveyed to the third stockpile. The slag is processed separately.

Four Elliptex vibratory feeders from each stockpile draw off ore at variable rates and deliver to a double deck scalping screen. The oversize from both the decks is fed to standard cone crusher. The crushed material is sized on a single deck screen into +25 mm and -25mm fractions.

The + 25 mm material is conveyed to two surgebins (used for both ore and slag) from where it is delivered by feeders to two shorthead tertiary cone crushers. Tertiary crushed product is screened on two single deck screens (25 mm apertures), the oversize being returned to the surgebins, undersize from the various screens is conveyed to the fine ore bins ahead of grinding section. There are two parallel grinding circuits for ore, each having rod mill in open circuit and two ball mills in closed circuit with hydrocyclones. Cyclone overflow, from all four batteries of cyclones is delivered to a single distributor feeding pulp to the flotation section. Conventional flotation practice is followed. As described earlier, it involves roughing, cleaning and scavenging.

In entire operation measures are taken to control pollution such as, no water or slurry is allowed to go to the drains, catch pits have been constructed in the plant area whereas the drain material is collected and sent back to the tailing dam, water is reclaimed and recycled back to the operating plant.

The process control measures involve, electronic belt weigher to control feed rate, onstream XRF analyser, auto control of flotation cell level, metal detector/collector, auto lifting and leveling devices of rake in tailing thickener, autosampler, a part of onstream analyzer systems, and collect samples at 15 minutes interval.

ii) Malanjkhand Copper Project

The capacity of Malanjkhand Copper Project mine output is 2 million tpy. The average copper content in the ore is 1.2 to 1.5%.

Process Description

Crushing: ROM up to 1,200 mm size is crushed to 150 mm size in a gyratory crusher and the crushed product is conveyed to 18,000 tonnes capacity open stockpile. The coarse material is screened over double deck screens with (-) 90 mm and (-) 40 mm openings. The (-) 40 mm product goes to surgebin located above the Symon's cone tertiary crusher and screen oversize is crushed in secondary cone crusher. The crushed product is also taken to the surge bin. From the surge bin, the ore is drawn by belt feeders for feeding three single screens with 12 mm openings. The undersize is sent to fine ore bin (10,000 tonnes capacity) and oversize goes to surge bin.

Grinding : 12 mm product from fine ore bin drawn by eight belt feeders to conveyors for feeding four overflow type ball mill in closed circuit with eight hydrocyclones, i.e. each ball mill is in closed circuit with two cyclones. The cyclone overflow (30% solids) with 60% of 200 mesh fraction goes through distribution to flotation section.

Flotation : Flotation cell bank contains cells for rougher and scavenger flotation. The rougher tailing is scavenged. The rougher float is cleaned once and cleaner tails along with scavenger concentrate are recycled to rougher cells. The first cleaner concentrate is cleaned once more and second cleaner tailings are recycled to first cleaner cells. The second cleaner concentrate constitutes the final copper concentrate. The reagents used are 70 g/t of Methyl Isobutyl Carbinol (MIBC), 48 cells each of 8.5 m^3 capacity used in rougher and scavenger flotation. 24 and 16 cells each of 1.7 m^3 capacity are used in first and second cleaner flotation, respectively.

Thickening and Filtration: The second cleaner concentrate slurry is pumped to a 25 m diameter thickener. The thickener underflow is pumped to 2 disc filter units each having 6 discs with 2.7 m dia. The filter cake (concentrate) contains about 12 to 13% moisture and is sun dried. The dried concentrate is dispatched to Khetri and Ghatsila smelters. Copper content in the concentrate was 25.79% in 2008-09.

3.2.7 Copper Smelters in India

Till 1997, the only producer of primary refined copper in India was HCL. After economic liberalisation, Sterlite Industries Ltd. (SIL) and Birla Copper (Hindalco Industries Ltd.), started producing refined copper from imported/indigenous concentrates.

The smelters of HCL are located at Khetri in Rajasthan and Ghatsila in Singhbhum district Jharkhand, while the smelter of SIL is located at Tuticorin, Tamil Nadu and that of Birla Copper at Dahej, Gujarat.

The description of smelters of HCL, SIL, and Birla Copper is given below:

i) Hindustan copper Ltd. (HCL)

HCL has smelters and refineries at Khetri Nagar in Rajasthan and at Ghatsila in Jharkhand and a continuous cast wire rod plant at Taloja in Maharashtra. The total installed smelting capacity of the plants of HCL is about 51,500 tpy. The capacity of HCL's Continuous Cast Copper Wire Rod Plant (CCWR) at Taloja is 60,000 tpy.

(a) Khetri Copper Complex (KCC): This smelter with a capacity of 31,000 tpy is located at Khetri Nagar in Jhunjhunu district, Rajasthan. HCL has taken up technological upgradation and debottlenecking scheme of KCC Smelter leading to enhancements of the capacity from 31000 tpy to 45000 tpy.

Smelting takes place in Outokumpo Flash Furnace. Dried concentrate together with hot air (400^{o}C) and silica is fed into the vertical reaction shaft of the furnace via uptake shaft and pass on to a waste heat recovery boiler, electrostatic precipitator and finally to acid plant/main stack. The slag (1.5-2% Cu) after cooling is crushed in a jaw crusher and then recycled back to the concentrator. The matte (45% Cu) after cooling is crushed in a jaw crusher and then recycled back to the concentrator. The matte (45% Cu) is treated in two long Pierce Smith Converters, one of which is standby. Air is supplied by steam driven turbo-blowers and is oxygen enriched. The blister copper from converter is refined in two drum type anode furnaces employing oil reduction technology. The copper is cast into anodes on a casting wheel assaying 99.4% Cu and 1, 400 ppm oxygen. Some steam generated (45 kg/cm^2) in waste heat boiler is also used for cooling exhaust gases from flash furnace from a temperature of 1,350^{o}C to 360^{o}C. Cyclones and electrostatic precipitators are provided in both dryer and flash furnace exhaust gas circuits to recover copper bearing dust for recycling. The cleaned flash furnace gases containing over 4% SO_2 is sent to acid plant. Oxygen enrichment of air in the converter has led to effective control and generation/accumulation of secondaries.

Refining of anode copper to produce cathode copper is carried out by using conventional electro-refining technology. HCL has modernised its refining plant and has introduced different automatic process controls and operation systems to ensure quality output on sustained basis.

The Khetri Copper Complex, in addition, has a sulphuric acid and a phosphatic fertilizer plant with capacities of 1, 82,000 tonnes and 90,000 tonnes, respectively.

(b) Indian Copper Complex (ICC): It has a smelter of 20,500 tpy capacity located at Ghatsila, dist. East Singhbhum, Jharkhand and has planned to increase the capacity to 25,000 tpy. In addition to this the complex consists of a 8,400 tpy wire bar casting plant, a 54,000 tpy sulphuric acid plant and a brass rolling mill. There is also a precious metal recovery plant for recovery of gold, silver, selenium, tellurium, nickel sulphate, copper sulphate etc. The smelting and refining process is the same as is being practiced at KCC.

All mines at Indian Copper Complex (ICC), Jharkhand were earlier closed on economic considerations. Out of the closed mines at ICC, Company has since re-opened the mine at Surda in association with an Australian Mining Company, viz. M/s Monarch Gold CO. Ltd./ India Resources Ltd.(IRL). The mine has started production of Copper Ore and its beneficiation into Copper concentrate from January, 2008. The target of ore production from Surda mine during the year 2010-11 is 4.00 Lakh tonnes and has plans to scale-up production to achieve a futuristic target of 900,000 tonnes per annum via decline development. Copper concentrates production has also started at Mosabani Concentrator Plant from January 2008. All copper concentrate produced at Surda is sold to HCL to the nearby Maubhandar Works, a unit of ICC. The current production is limited only by existing shaft hoisting capacity and meets only 47% of the concentrator capacity.

(c) Continuous Cast Copper Wire Rod Plant, Taloja: The plant with a capacity of 60,000 tpy is located at Taloja in Maharashtra. It was commissioned in December, 1989 and commenced commercial production in April, 1991. The installed capacity is likely to be increased to its licensed capacity of 80,000 tpy.

(d) Leaching Facilities at Malanjkhand: In 1989, HCL created chemical-cum-bio-heap leaching and concentration facilities to produce 2.5 tonnes cement copper per day from oxides copper ore. Based on the experience acquired, the company has conducted field studies for the recovery of copper from lean chalcopyrite ore by bio-leaching SX-EW Route. The successful implementation of this project would augment resource base and metal production. Short description of chemical-cum-leaching process adopted since 1989, is as follows:

Oxide ore (1.25% Cu) containing over 80% oxide copper is crushed to (-) 150 mm and loaded on to HDP liners on the leach pad. The first layer is about 3 m thick. Concentrated H_2SO_4 is sprinkled over this layer followed continuously with dilute sulphuric acid sprinkling for about three months. A second layer of oxide is then deposited followed by another cycle of acid leaching. This continues up to a thickness of 10 m for each pad. The pregnant solution is collected and pumped to launders where the copper is precipitated by scrap iron in the form of cement copper. Cementation process is to be replaced by solvent extraction electro-winning (SX-EX) process.

(ii) Sterlite Industries Ltd.: The Sterlite's Copper smelter plant with an installed capacity of 4, 00,000 tpy of copper anodes, is located at Tuticorin in the coastal belt of Tamil Nadu. It was commissioned in November, 1996 and is based on 'Isasmelt' technology using imported concentrates. Sterlite Industries (India) Ltd. is the largest producer of continuous cast copper rods in India. Besides copper, the company also manufactures sulphuric acid & phosphoric acid, and recovers gold and silver as by-products. The smelting process adopted in the Sterlite Industries (India) Ltd., Tuticorin, Tamil Nadu is given below:

Smelting Process

Sterlite Copper smelter is custom smelter operating on imported concentrates on Isasmelt Technology. The Isasmelt Technology is based on submerged bath smelting, developed by Common Wealth Scientific and Industrial Research Organisation (CSIRO) and MIM Technologies Ltd., Australia.

Isasmelt Furnace is Shaft type with smelt set concentrates, operated at 1180-1200^{o}C. Oxygen enriched blast air with oil is passed through a Lance (Burner) into the molten bath where the concentrate is mixed with fluxes (river sand and limestone). The molten mass enriched from 30% Cu to 60% Cu.

The molten mixture of matte and slag is transferred to RHF-(Rotary Holding Furnace) through Launder where the matte and slag are separated due to differential density. The slag which floats on the top of the bath is discarded by granulation and the molten matte of 60% Cu is taken through pots with the help of the cranes.

The matte is further enriched in the converters to 98% Cu and taken to anode furnaces for further fire refining to remove traces of sulphur. After refining, copper is cast in the form of anodes and dispatched to refining at Silvassa refinery, Gujarat for electrolytic refining.

iii) Hindalco Industries Ltd, (Birla Copper) : The company's smelter commissioned in May, 1998 is located at Lakhigam Vaghera in Dahej Taluka of Bharuch District, Gujarat and is having a capacity of 5,00,000 tpy copper cathode . It is based on Outokumpu (Finland) technology. The plant is the largest of its kind in India. In the process of extraction of copper metal, sulphuric acid, phosphoric acid, di-ammonium phosphate, other phosphoric fertilizers, phosphogypsum, gold and silver are recovered as byproducts. The entire requirement of copper concentrate is being met through imports from other countries. Information on smelting process adopted in Birla Copper unit of M/s Hindalco Industries Ltd. is given below:

Smelting Process

At Birla Copper, various copper concentrates are blended to achieve desired copper concentrate & Sulphur/Copper ratio in the blend for efficient smelting. Concentrate blend is mixed with silica and dried from 6-8% moisture content to less than 0.2% moisture. The dried concentrate is smelted in a flash smelting furnace with oxygen enriched air. The furnace is preheated to 1,300^{o}C by means of furnace oil fired burners before cone feeding. Furnace oil fired burners are installed in the settler and reaction shaft of the Flash Smelting Furnace for maintaining smelting temperature.

Molten matte from the furnace containing about 65% copper is tapped from the furnace in ladles and transferred by means of Electrical Overhead Transport ladle crane to the Pierce Smith Converter. Furnace oil fired burner maintains the temperature of converter between two converter operations. In converter, air is blown through the liquid matte at a pressure through side blown tuyers and quartz is added as flux, resulting in production of blister copper (98%) and slag (containing about 5% Cu).

The slag from flash smelting furnace and converters is treated in a sub-merged arc slag cleaning furnace for reducing copper content in discard slag to below 0.7% Cu. The slag is allowed to settle in slag cleaning furnace where two layers of molten matte and slag are formed. Matte from slag cleaning furnace is treated in converters whereas slag is tapped, granulated and sent to the dump yard.

Blister copper from converters is poured into ladles and transferred to anode furnace by means of Electrical Overhead Transport crane for fire refining. Fuel used for the heating burner in the Anode Furnace is naphtha, which is low sulphur fuel suitable to maintain the quality of refined copper. Controlled air blowing first oxidises remaining sulphur to remove it as sulphur dioxide. However, in the process, a part of copper is also oxidized, which is reduced back by reduction with hydrocarbons available from cracking of propane injected under the metal bath. The fire refined copper containing 99.5% Cu poured on rotating anode casting wheel as anode and dispatched to refinery tank house for electro-refining to produce copper cathodes. Through this most efficient process, copper recovery of 98.5% and sulphur recovery of 95% is achieved.

Gases rich in sulphur dioxide are processed in Sulphuric Acid Plant (double conversion double absorption (DCDA) process) to produce sulphuric acid.

iv) Jhagadia Copper Ltd., (Formerly SWIL Ltd.) : SWIL Ltd. has been renamed as Jhagadia Copper Ltd. w.e.f. 05.01.2006. Its smelter is installed at Jhagadia in Bharuch district of Gujarat. It is a scrap based electrolytic smelter to make cathodes with a capacity of 50,000 tpy. The plant has an additional capacity of 20,000 tpy copper anodes. Out of the total capacity, 6000 tpy output is used for producing wires, strips, etc., 20,000 tpy are exported and 24,000 tpy are sold in domestic markets. The plant is set up in technical collaboration with Boliden Contech AB of Sweden.

3.3 PRODUCTION

3.3.1 Production of Ore

The history of production of base metals including copper is dated back to ancient times. The presence of extensive dumps near the old working, huge heaps of old slag are evidences of ancient copper mining in India particularly in Khetri and Singhbhum are the silent testimonies of once thriving mining activity. Both opencast and underground methods of mining were adopted. The sulphide ores are very important. The primary mineral chalcopyrite and the secondary mineral chalcocite account for lion's share of copper production in the world, following these, are bornite, covelite, tetrahedrite and enargite. Copper production from oxide ores emanates mainly from malachite, azurite, chrysocolla/dioptase, atacamite, brochanite and several rare minerals.

The production of copper ore in the Mosabani group of mines has been stopped and the mining lease was allowed to lapse from 15.06.2004 except Surda mine which was proposed to run through Workers Cooperative Society, in terms of decision taken in tripartite meeting with Ministry of Labour and Ministry of Mines, Government of India. However, the production activities in Surda mine were stopped since June, 2003 due to economic reasons. The mine has started production of copper ore and its beneficiation into copper concentrates from January 2008 in association with an Australian company through its Indian subsidiary India Resources Ltd. (IRL).

As mentioned earlier the content of copper in Indian copper ore is very low, when compared with the other major copper producing countries.

During the years 2000-01 to 2009-10 the average grade of copper content in the ore produced ranges from 0.92% Cu to 1.90% **(Table: 3.2)** while the grade of copper ore treated during the same period range in between 0.93% Cu and 1.22% Cu.

As it is seen from the table that the maximum production of copper ore was in 2000-01at 3.5 million tonnes and the lowest production of 2.64 million tonnes was recorded in 2005-06. The production in 2009-10 was at 3.23 million tonnes.

The major economic copper mineralisation is reported from the states of Rajasthan, Madhya Pradesh and Jharkhand. The major production of ore and concentrate comes from the state of Rajasthan, Madhya Pradesh and Jharkhand. The production of metal is from the states of Rajasthan, Jharkhand, Gujarat and Tamil Nadu. The details of ore, concentrates and metal production is given in **Tables: 3.2 to 3.4**.

The production of copper ore for the last 10 years is given in **Table: 3.2** and depicted in **Figure-3.2**.

Table: 3.2- Production of Copper Ore, 2000-01 to 2009-10

Year	Production(In tonnes)	Grade (%)
2000-01	3,498,270	1.07
2001-02	3,417,967	1.12
2002-03	3,071,293	1.07
2003-04	2,902,972	1.04
2004-05	2,929,074	1.00
2005-06	2,642,706	1.90
2006-07	3,273, 906	1.02
2007-08	3,242,371	1.02
2008-09	3,452,406	0.92
2009-10	3,227,667	N.A.

Presently, the production of copper ore is reported from 3 states namely: Madhya Pradesh (Malanjkhand Copper Project), and Rajasthan (Khetri copper

Complex), Jharkhand (Indian Copper Complex). Bhotang and Pacheykhani multi-metal mines in Sikkim produced copper ore till 2006-07, since then there was no production reported from these mines.

1. **Malanjkhand Copper Project (MCP):** This mining project is worked by HCL in Malanjkhand, district Balaghat, Madhya Pradesh. This is the largest open pit mine in the country which is having annual production capacity of 2.00 million tonnes.

2. **Khetri Copper Complex (KCC)** : The Khetri Copper complex is worked in four mining projects namely Khetri, Kolihan, Chandmari in Jhunjhunu district and Dariba in Alwar district. All these projects were commissioned within a span of two years from 1973 to 1975. Presently, Khetri and Kolihan are the only two projects in operation. The other two projects i.e. Chandmari and Dariba are not in operation since 2002. HCL is also considering a proposal to open a new mine at Banswara in Rajasthan. This project will be commissioned through contract mining with foreign partners.

3. **Indian Copper Complex (ICC):** Indian Resources Ltd. of Monarch Gold Company Ltd., Australia through its alliance with Hindustan Copper Ltd. has undertaken the mine development of Surda Copper Mine and the present mining capacity is 0.4 million tpy with the introduction of modern mining equipments.

3.3.2 Production of Copper Concentrates

The copper ore produced is then subjected to concentrator plants to produce copper concentrates. HCL has a total milling capacity of 5.57 million tpy copper ore for producing copper concentrates. This capacity is distributed in concentrator plants at (i) KCC, Khetrinagar, district Jhunjhunu, Rajasthan, (2.02 million tpy), (ii) ICC, Ghatsila, district East Singhbhum, Jharkhand, (1.55 million tpy) and (iii) MCP Malanjkhand, district Balaghat, Madhya Pradesh capacity 2.00 million tpy.

Besides, Sikkim Mining Corporation also has a small capacity to produce copper, lead & zinc concentrates in East Sikkim district however there was no production. The quantity and grade of copper ore treated to produce copper concentrates for last 10 years is given in **Table: 3.3**.

Table: 3.3 - Copper Ore Treated 2000-01 to 2009-10

Year	Copper ore treated (In tonnes)	Grade (%)
2000-01	3,558,028	1.16
2001-02	3,389,888	1.22
2002-03	3,238,347	1.15
2003-04	3,050,426	1.15
2004-05	3,315,524	1.05
2005-06	4,090,839	0.99
2006-07	3,257,540	1.026
2007-08	3,423,562	1.09
2008-09	3,644,796	0.93
2009-10	3,258,137	0.81

Figure : 3.2 - PRODUCTION OF COPPER ORE 2000-2001 TO 2009-10

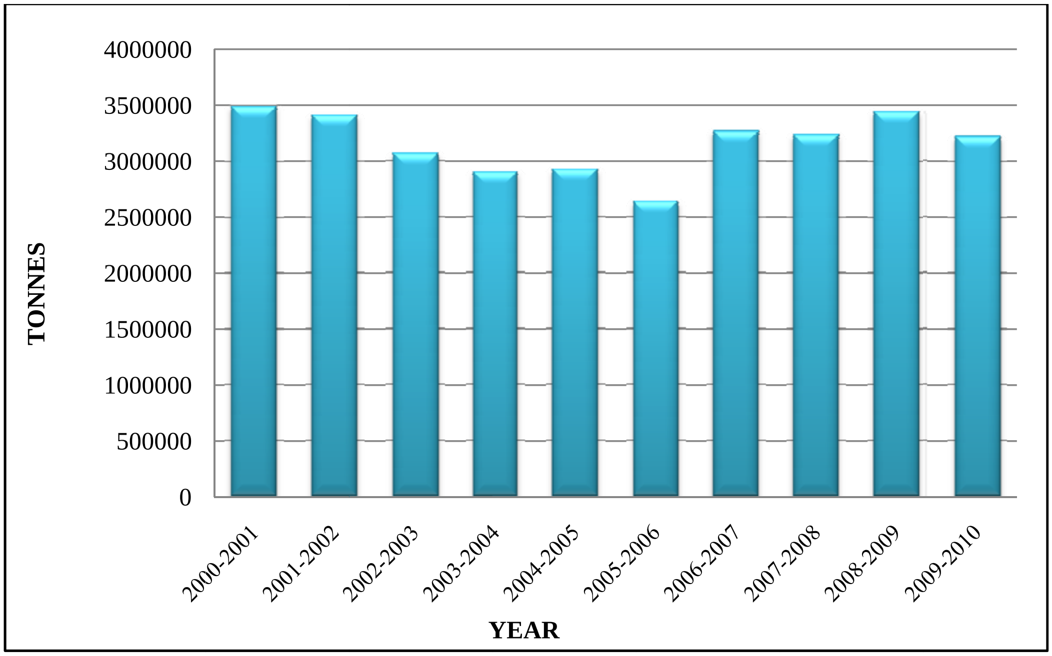
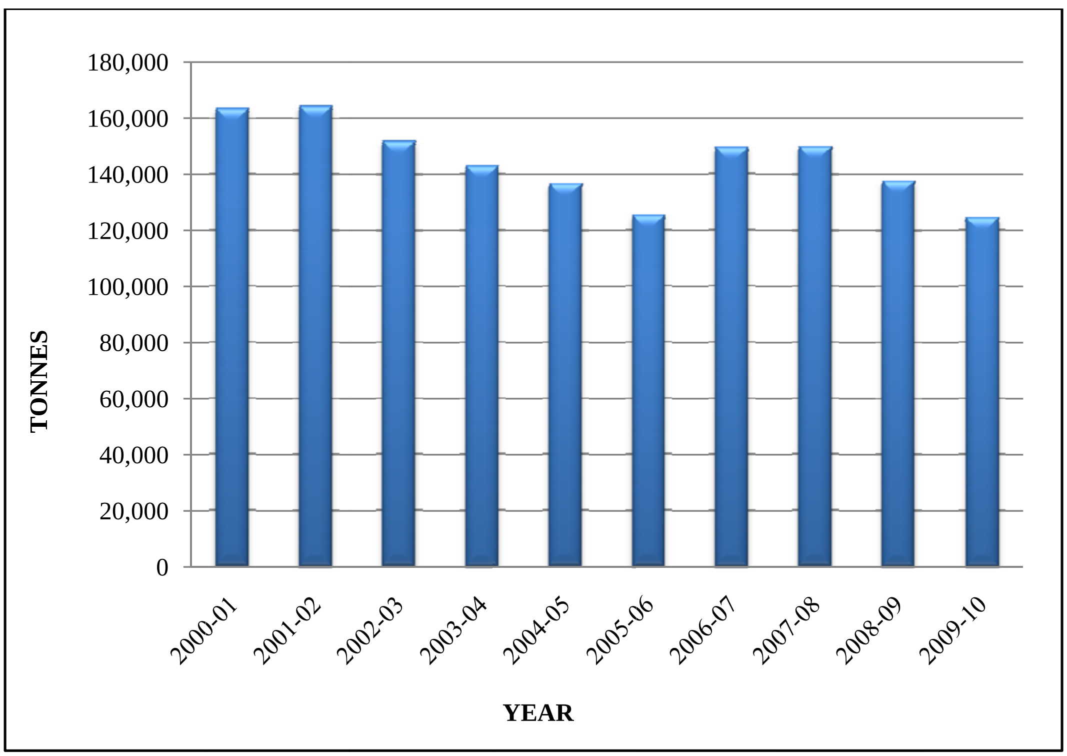


Figure : 3.3 - PRODUCTION OF COPPER CONCENTRATES, 2000-2001 TO 2009-10



Presently, the concentrator situated at ICC, Jharkhand is closed because the mines in Jharkhand which were supplying ore to this plant are closed due to uneconomic operations. The production of copper concentrates during 2000-01 to 2009-10 is given in **Table: 3.4** and depicted in **Figure-3.3.**

Table: 3.4- Production of Copper Concentrates, 2000-01 to 2009-10

(In tonnes)

Year	Copper concentrates produced	Grade (%)
2000-01	163,564	23.07
2001-02	164,469	23.03
2002-03	152,099	22.51
2003-04	143,135	20.63
2004-05	137,003	21.95
2005-06	125,392	22.84
2006-07	149,584	22.89
2007-08	150,187	21.79
2008-09	137,911	21.89
2009-10	124,471	N.A.

3.3.3 Production of Copper Metal

Hindustan Copper Ltd., a public sector enterprise, is the only producer of primary refined copper till 1997 with 2 integrated smelters at Khetri copper complex, Jhunjhunu district, Rajasthan and Indian Copper Complex, Ghatsila, East Singhbhum district, Jharkhand. Subsequently, two producers of primary refined copper namely, Hindalco Industries Ltd. (Birla Copper) at Dahej, Dist. Bharuch, Gujarat and Sterlite Industries at Tuticorin, Tamil Nadu, based on imported copper concentrates came on the scene. Besides, Jhagadia Copper Ltd. (formerly SWIL Ltd.) had started a scrap based plant at Jhagadia, Bharuch, district Gujarat. HCL has also a plant of CCWR (Continuous Cast Wire Rods) which is based on copper cathodes at Taloja, Raigad district, Maharashtra. The plantwise installed capacities of copper producers are given in **Table: 3.5** and depicted in **Figure-3.4.**

Table: 3.5- Plant wise Installed Capacities of Copper Smelters, 2008-09

(In tonnes)

Sl. No.	Name and location of the Smelters	Installed Capacity
1.	Khetri Copper Complex of M/s HCL, Khetri, Dist. Jhunjhunu, Rajasthan	31,000
2.	Indian Copper Complex of M/s HCL, Ghatsila, Dist. East Singhbhum, Jharkhand	20,500
3.	Sterlite Industries (India) Ltd., Tuticorin, Tamil Nadu	400,000
4.	Hindalco Industries Ltd. (Birla Copper) Dahej, Dist. Bharuch, Gujarat	500,000
5.	Jhagadia Copper Ltd. (formerly SWIL Ltd), Jhagadia, Dist, Bharuch, Gujarat	50,000
	Total Capacity	**1,001,500**

Figure : 3.4 - INSTALLED CAPACITIES OF COPPER SMELTERS, 2009-09

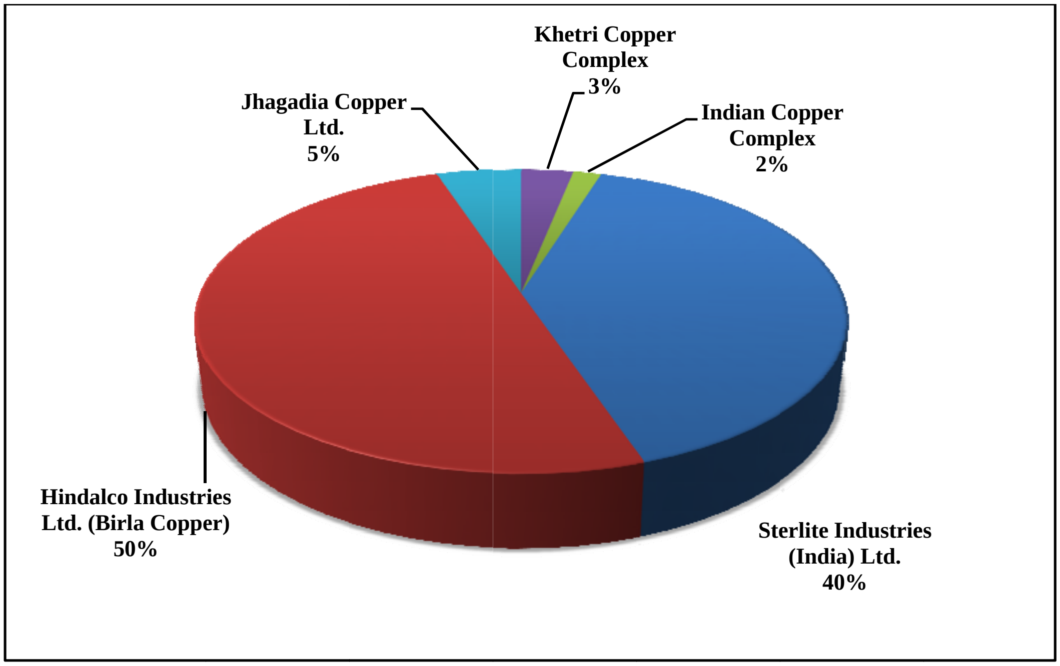
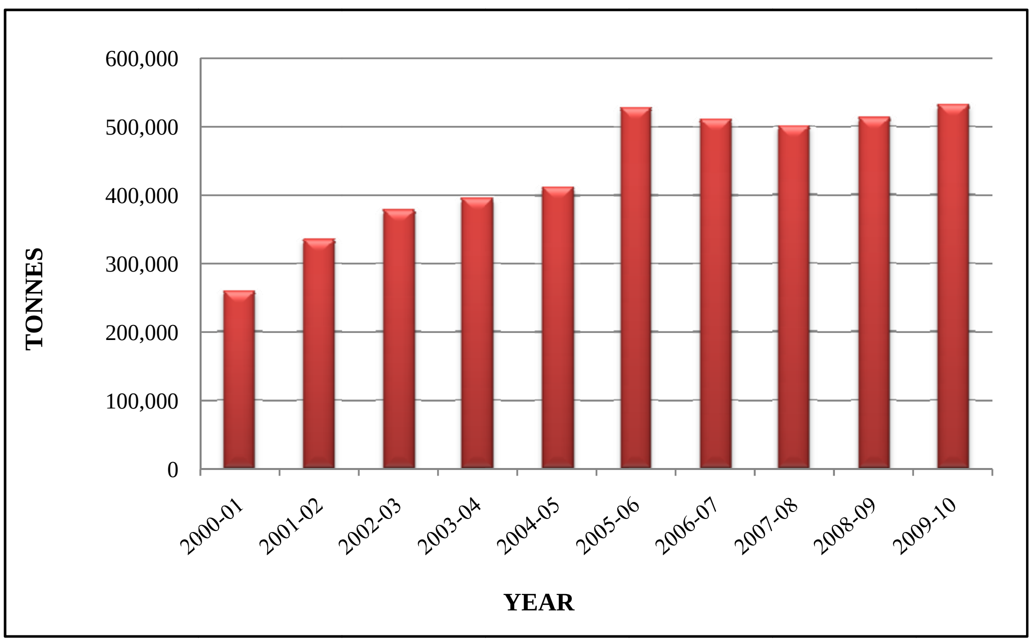


Figure : 3.5 - PRODUCTION OF COPPER CATHODES, 2000-2001 TO 2009-10



Out of these 5 plants, no plant is producing copper at its full capacity. There was an appreciable increase in the production of copper cathodes in the country mainly due to emergence of smelters of Hindalco Industries Ltd. and Sterlite industries Ltd. which produced copper cathodes from imported copper concentrates. The production of copper cathodes which was 2.60 lakh tonnes in 2000-01 rose to 5.33 lakh tonnes in 2009-10. The total production of copper cathodes in India for last 10 years is given in **Table: 3.6** and depicted in **Fig.3.5.**

Table: 3.6 - Production of Copper Cathodes in India
2000-01 to 2009-10

(In tonnes)

Year	**Production of Copper Cathodes**
2000-01	259,683
2001-02	335,769
2002-03	378,850
2003-04	395,967
2004-05	413,354
2005-06	529,248
2006-07	512,363
2007-08	501,485
2008-09	513,640
2009-10	532,865

3.4 SCRAP RECYCLING

Copper and copper alloys have been recycled since ancient times. In past it was common practice that after a war the cannons were melted down to make useful items and in the time of war many artifacts including church bells were used to produce cannons.

The entire economy of copper and copper alloys industry is dependent on economic recycling of any surplus products. However, the use of recycled copper does not necessarily fulfills the requirements of certain end-use industries without compromising the quality.

Even in some cases, scrap copper is associated with other materials, for example, after having been tinned or soldered it will be more economic to take advantage of such contamination than by removing it by refining. Many specifications for gun metals and bronzes require the presence of both tin and lead so this type of scrap is ideal feedstock.

In the Indian context, the collection of copper scrap is mostly in unorganised sector and the exact data on copper scrap generation is not readily available. The scrap is generated from various sources, major being the ship breaking, turning shavings, copper smelters, electric motors, radiators and from the fabrication industry.

New scrap is generated from the smelters, and from the fabrication industry in the form of cuttings and shavings. Used electric motors, cable wires and household utensils and cutlery form a sizeable quantity of scrap. In absence of authentic data, it is difficult to arrive at some percentage share for scrap type. Recycling is dependent on the efficiency of the scrap collection system, technological & economic factors , product design, social values as well as on the incentives and barriers introduced. Though the life expectancy of copper based equipments depends upon the actual end – use, it is seen that copper components of various engineering equipments come back for recycling after certain years:

(i) Small electric motors - <10 years
(ii) Medium sized transformers - 15 years
(iii) Heavy sized motors and generators - >25 years
(iv) Cable conductors - 30- 40 years

As per ICSG research the simplified route of recycled copper use is given at **Plate 3.V** and **Plate 3.VI**.

Even then attempts were made to arrive at some authentic data in respect of copper recycling. The generation of scrap within the country as well as imported scrap is reprocessed in the copper reprocessing units which have been registered with Central Pollution Control Board /Ministry of Environment & Forest.

As on 13.5.2010, there were 35 units operating in different states with a combined capacity of 242,321 tonnes/year for handling different types of scrap. The state wise list of different copper reprocessing units along with their capacities and type of scrap handling is given in **Annexure: 3 - I** and the state wise capacities of reprocessing units is given in following **Table: 3.7.**

Table: 3.7- State wise Capacities of Copper Reprocessing Units as Registered with CPCB/MOEF as on 13.5.2010

(Tonnes/Year)

Sl. No.	State	No. of Units	Capacity
1.	Andhra Pradesh	4	10,220
2.	Chhattisgarh	2	350
3.	Daman, Diu & Nagar Haveli	2	20,313
4.	Gujarat	7	47,868
5.	Haryana	2	11,100
6.	Jammu & Kashmir	6	56,450
7.	Maharashtra	4	8,090
8.	Rajasthan	2	480
9.	Sikkim	1	2,700
10.	Uttar Pradesh	1	1,500
11	West Bengal	4	83,250
	Total	**35**	**242,321**

Plate 3.V

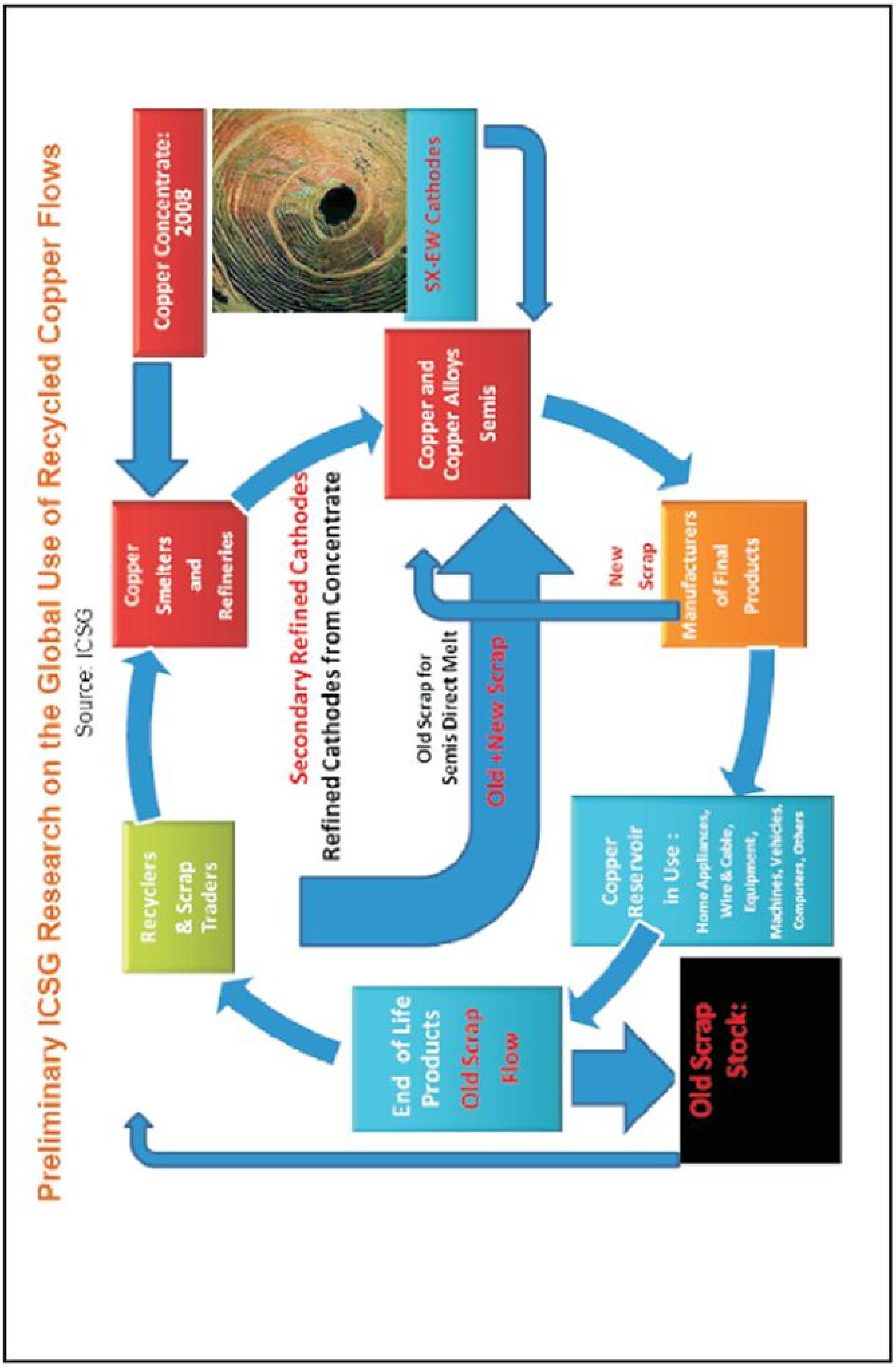
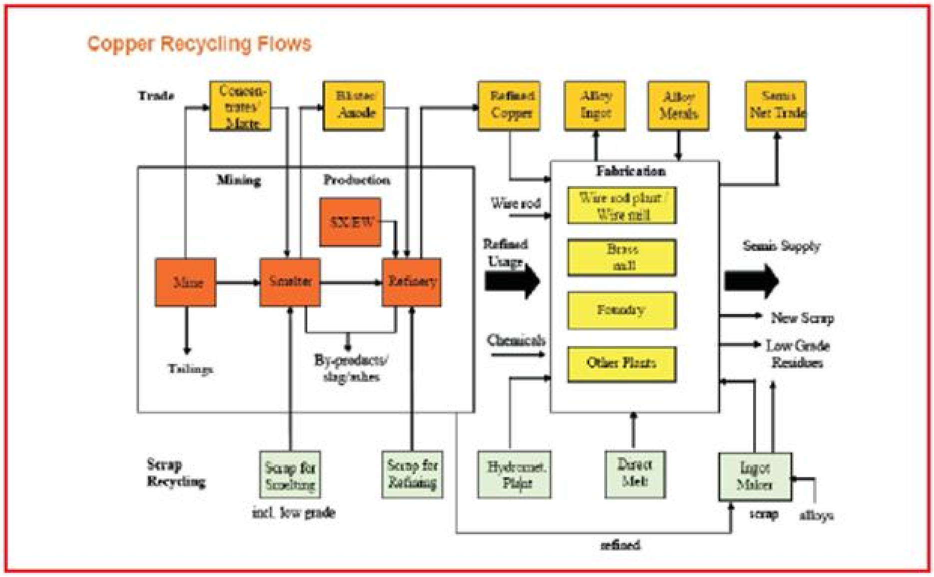
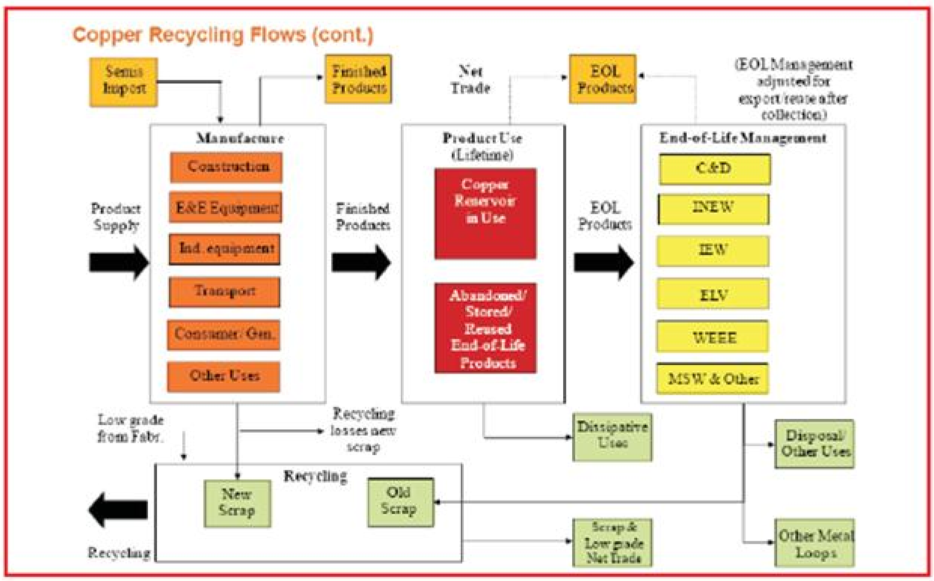

Preliminary ICSG Research on the Global Use of Recycled Copper Flows
Source: ICSG
Copper Concentrate: 2008
SX-EW Cathodes
Copper Smelters and Refineries
Secondary Refined Cathodes
Refined Cathodes from Concentrate
Copper and Copper Alloys Semis
New Scrap
Manufacturers of Final Products
Old Scrap for Semis Direct Melt
Old +New Scrap
Recyclers & Scrap Traders
Copper Reservoir in Use : Home Appliances, Wire & Cable, Equipment, Machines, Vehicles, Computers, Others
End of Life Products Old Scrap Flow
Old Scrap Stock:

Plate 3.VI





Source : International Copper Study Group

In addition to this there are some units registered with CPCB which reprocess copper with other nonferrous metals. The list of such units has been given at **Annexure 3-II** and also given in **Table: 3.8.**

Table: 3.8- State wise Capacities of Other Non ferrous Metals Reprocessing Units as Registered with CPCB/MOEF as on 13.5.2010

(Tonnes/Year)

Sl. No.	State	No. of Units	Capacity
1.	Andhra Pradesh	2	10,780
2.	Chhattisgarh	1	300
3.	Daman, Diu & Nagar Haveli	10	71,540
4.	Gujarat	43	104,096
5.	Haryana	4	18,115
6.	Jammu & Kashmir	6	46,960
7.	Karnataka	6	13,108
8.	Madhya Pradesh	5	9,960
9.	Maharashtra	26	76,981
10.	Punjab	3	18,870
11.	Rajasthan	10	46,775
12.	Tamil Nadu	2	21,000
10.	Uttar Pradesh	10	77,680
11	West Bengal	4	1,350
	Total	**132**	**517,515**

It is seen from the **Annexures: 3- I and 3- II** as well as **Table: 3.7 and Table: 3.8** that these units require substantial quantities of scrap. The data on the scrap which is generated indigenously is not available, however the availability of copper scrap is met by imports. The import of copper scrap is made under various trade names as approved by Institute of Scrap Recycling Industries Inc.(ISRI) in scrap specifications Circular, 2009. The same is given in **Annexure: 3 - III.**

As per the guidelines of ISRI, Scrap and Other Copper Commodity is also traded by India as per various H S Codes as given in **Annexure: 3 - IV (A) and Annexure: 3 - IV (B).**

3.4.1 Production of Recycled Copper:

India being net exporter of copper as well as in the production of virgin copper. However, as mentioned earlier, scrap is recycled to meet out the requirements of industries which require a little cheaper and less pure material.

The study in field as well as discussions with experts in the reprocessing industries as well as officials of CPCB and SPCB's it is understood that all the reprocessing units which are registered with the CPCB/MOEF are not in operation and the operating units are not utilising their full capacity.

As per the general opinion about 40% of the units are in operation and the capacity utilization is about 50%. The recovery of copper by these units is about 70%. Therefore the production of secondary copper by the copper scrap etc. processors comes out to be 33924 tonnes/year as shown in following **Table: 3.9.**

Table: 3.9- Production of Secondary Copper by Re-processors of copper Based on Registered Capacities with the CPCB, New Delhi & Recovery Percentage

(Tonnes/year)

Total Scrap intake Capacity	Limit in Operation 40%	Capacity utilisation 50%	Production of Secondary Copper at 70% recovery
242 ,321	96,928	48,464	33,924

In addition to the secondary production of copper by the copper re-processors there are units which recover secondary copper along with other metals.

As per the discussions in field as mentioned above that only 40% of these units are in operations and the capacity utilization by these units is about 50%. As copper is one of the metal recovered along with other metals such as zinc, nickel etc. the recovery factor of copper is taken as 30%. Based on these factors, the production of secondary copper by the processors of other non-ferrous metals and waste has been calculated. The production of secondary copper thus arrived at 31051 tonnes per year as shown in the **Table: 3.10.**

Table: 3.10 - Production of Secondary Copper by Re-processors of Other Non-Ferrous Metal Waste based on Registered Capacities with the CPCB, New Delhi & Recovery percentage

(Tonnes/Year)

Total Scrap intake Capacity	Units in Operation 40%	Capacity Utilisation 50%	Production of Copper at 30% recovery
517,515	207,006	103,503	31,051

3.4.2 Apparent Production

In view of the above discussion the total secondary copper production by copper re-processors and other non-ferrous metals and waste re-processors is arrived at 64,975 tonnes/year.

The production of virgin a primary copper cathodes during 2008-09 was 502,081 tonnes in comparison to 64,975 tonnes of secondary copper production which is about 13% of the primary production.

Copper is among the most efficiently recycled material in global commerce, China being the leader in the scrap utilisation. It is 100 percent recyclable without any loss in performance if properly refined. As per

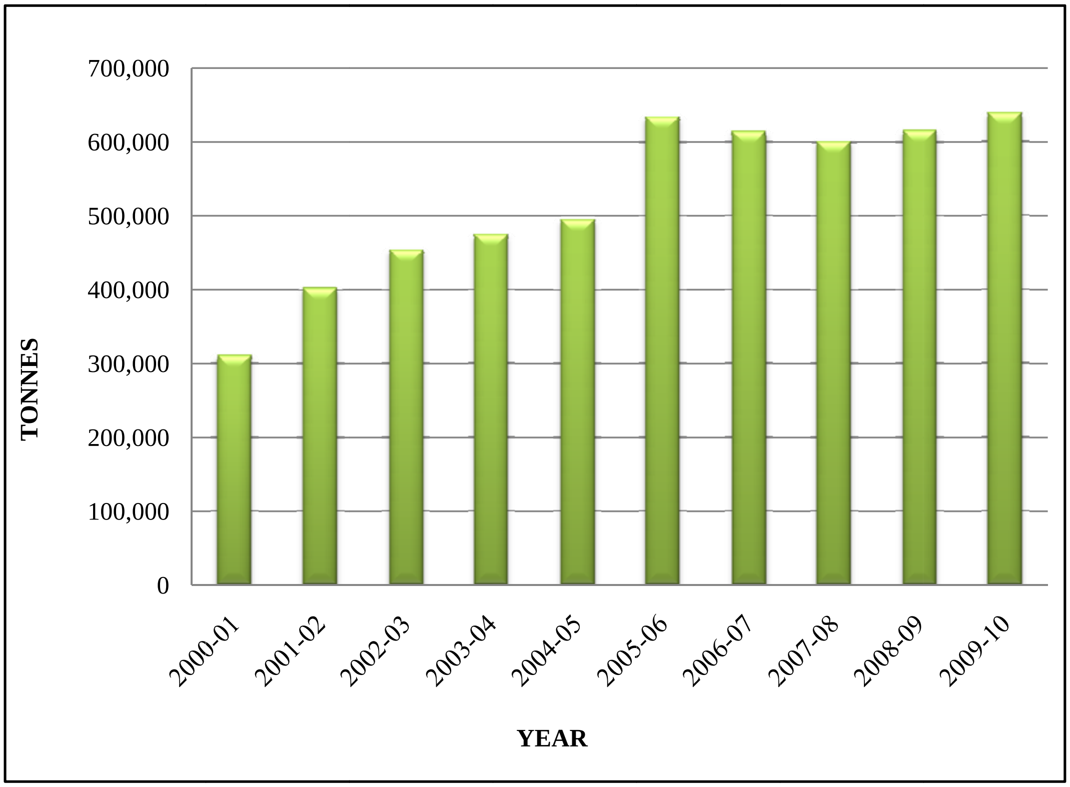
International Copper Association Ltd, 34% of global copper demand is met through recycling. A study conducted by Indian Copper Development Centre (ICDC), Kolkata for International Copper Study Group (ICSG), arrived at a figure of 35% to 49% of the scrap usage in India during the years 2000-01 to 2004-05. The study conducted in the field and based on the capacities of the reprocessors, about 13% of the secondary copper is being produced. Therefore a conservative figure of 20% of primary production is considered. Taking into consideration, the findings of ICDC and field study an average of 20% of secondary copper from scrap usage has been arrived at by adding 20% to the total copper production in Indian context. On this basis, the total apparent copper production in India has been arrived by adding 20% to the total copper cathode production. The same is given in **Table: 3.11** and also shown in **Figure –3.6.**

Table: 3.11- Apparent Production of Copper in India 2000-01 to 2009-10

(In tonnes)

Year	Production of Copper Cathodes	Apparent Production (adding 20% of secondary production)
2000-01	259,683	311,620
2001-02	335,769	402,923
2002-03	378,850	454,620
2003-04	395,967	475,160
2004-05	413,354	496,025
2005-06	529,248	635,098
2006-07	512,363	614,836
2007-08	501,485	601,782
2008-09	513,640	616,368
2009-10	532,865	639,438

Figure : 3.6 - APPARENT PRODUCTION OF COPPER, 2000-01 TO 2009-10



Chapter 4. Foreign Market

Since the dawn of new millennium the trading of copper has gathered momentum in the international market. The reason behind this was the brisk movement in the world economic activity supported by the improvement in the industrial production of most of the developed and developing countries. The heavy electrical industry and the telecommunication industry are the two sectors which triggered the demand of copper metal globally. Chile, Australia, USA, Indonesia etc. were the dominating countries in the trade of copper ores & concentrates, metal and alloys.

4.1 WORLD RESOURCES

As per the Mineral Commodity Summaries 2011, the world reserves of copper (in terms of copper contents) were 630 million tonnes. About 50% of these reserves are located in Chile, Peru, Mexico and USA. Chile has the largest reserves of 150 million tonnes, accounting for 24% of the total world reserves followed by Peru (14%), Mexico & USA (6% each). The remaining reserves were located in Poland, Australia, Indonesia, China, Zambia, Russia, Canada, Kazakhstan etc. The country wise reserves of copper in terms of metal content is given in **Annexure: 4 - I** and also depicted in **Figure: 4.1**.

4.2 WORLD PRODUCTION OF COPPER ORE

4.2.1 World Mine Production of Copper

In the last 21 years, mine production of copper in terms of metal content has almost doubled from 8.8 million tonnes in 1988 to 15.8 million tonnes in 2009. Copper is produced in about 50 countries. Five countries namely Chile, USA, Peru, Indonesia and China contribute about 62% of the world's total production in 2009. Each of these five countries produces nearly one million tonnes of copper every year.

Country-wise mine production of copper in terms of metal content from 2003 to 2009 is given in **Annexure: 4- II** and also shown in **Figure: 4.2.** The world mine production of copper which was 13.70 million tonnes in 2003 increases to and 15.80 million tonnes in 2009. The overall increase from 2003 to 2009 was 15.36 per cent.

Chile continued to be the largest producer of copper. The mine production in Chile was 5.39 million tonnes in the year 2009 contributing 34.11% of total world mine production of copper followed by Peru (8.03%), USA (7.59%) Indonesia (6.30%), China (6.08%) and Australia (5.50%).

World Production of Copper Ore

There are a number of countries producing copper ore. The leader in copper ore mining is Chile followed by Indonesia, Russia, Peru and USA. The list of top 10 copper mines with their capacities is given in **Table: 4.1.** The list of Copper Smelters and Copper Refineries along with their capacities is given in **Tables: 4.2 and 4.3** respectively. A comprehensive worldwide list of copper producing companies, copper producing countries, worldwide list of copper smelters, and worldwide list of copper mines are given at **Annexure:4- XV, Annexure:4 - XVI, Annexure:4 -XVII and Annexure:4 -XVIII.**

The details of important copper mines in the world is given at **Annexure 4-XIX.**

4.2.2 World Smelter Production of Copper

World smelter production of copper in terms of metal content from 2003 to 2009 is given in **Annexure: 4 - III** and also shown in **Figure: 4.3.** The world smelter production of copper which was 11.10 million tonnes in 2003 increased by 24.95% to 13.87 million tonnes in 2009.

China was the leader in smelter production of copper in the world contributing 2.63 million tonnes (18.96%) of the world production in 2009 followed by Japan with 1.54 million tonnes (11.10%) and Chile 1.52 million tonnes (10.96%). The smelter production of copper in Russia was 850 thousand tonnes (6.13%) followed by India at 729 thousand tonnes (5.26%). Remaining production was contributed by USA, Korea, Poland, and other countries.

4.2.3 World Production of Refined Copper

The production of refined copper is reported from a number of countries as given in **Annexure: 4-IV** and shown in **Figure: 4.4.** The total world production increased from 13.70 million tonnes in 2003 to 18.70 million tonnes in 2009 showing an increase of 36%including refined copper production from secondary sources. China and Chile are the two top most producers of refined copper and together produced about 40% of the total world production. In 2009 the production from China was 4.11 million tonnes (22.04%) followed by Chile with 3.27 million tonnes (17.53%). Japan with no resources of copper ore produced 1.44 million tonnes of refined copper (7.72%) followed by USA 1.16 million tonnes (6.22%). Other countries namely Russia, India, Germany, Zambia, Poland, Korea Rep. of, Australia, Canada and Kazakhstan together produced 28% in the world production.

4.2.4 Secondary Copper Production

Recycling of copper metal is a considerably large industry worldwide. The copper scrap is treated to manufacture secondary refined copper and in some industries the copper scrap is directly used in the manufacturing process.

The production of secondary refined copper showed an overall increasing trend since 2001, from 1.83 million tonnes in 2001 to 2.60 million tonnes in 2009 with little ups and downs. The direct usage of scrap has come down from 3.89 million tonnes in 2001 to 2.30 million tonnes in 2009. The reduction in direct usage of copper scrap can be attributed to the increased consciousness in respect of purity.

The heterogeneous nature of copper scrap calls for its refinement for imparting good quality in the end product. The details of production of secondary refined copper from 2001 to September 2010 and direct usage of copper by industries are given in **Annexures – 4 – IV (A) and 4 – IV(B).**

Figure : 4.1 - WORLD RESERVE OF COPPER, 2011
(By Principal Countries)

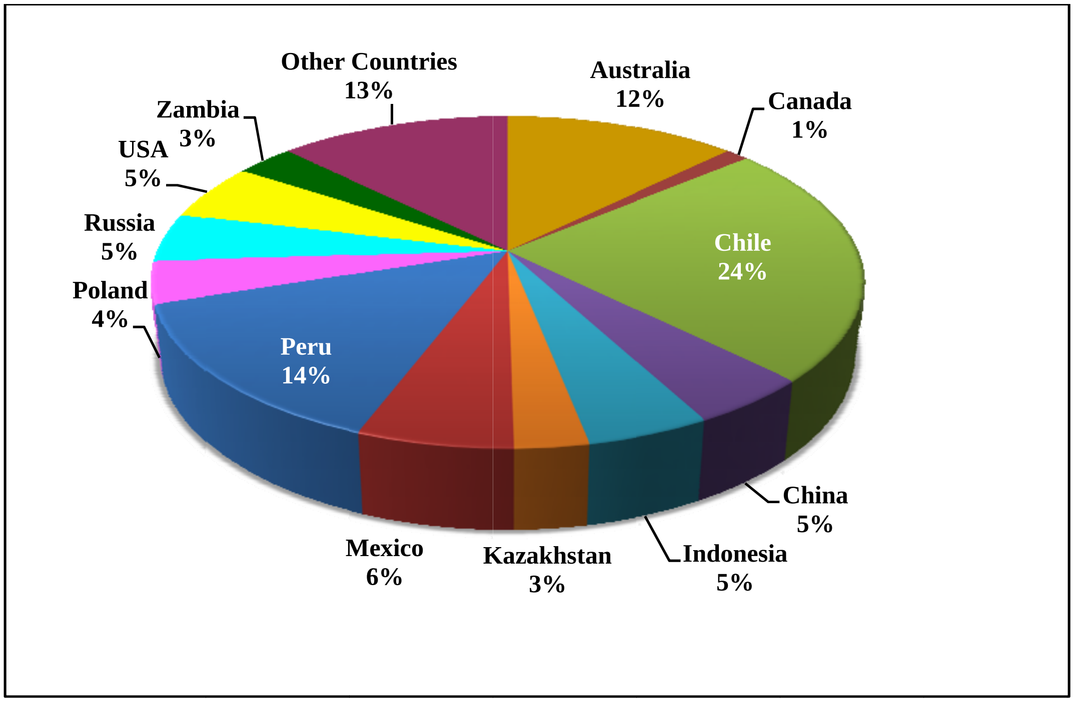


Figure : 4.2 - COUNTRY WISE MINE PRODUCTION OF COPPER, 2003 V/s 2009 (By Principal Countries)

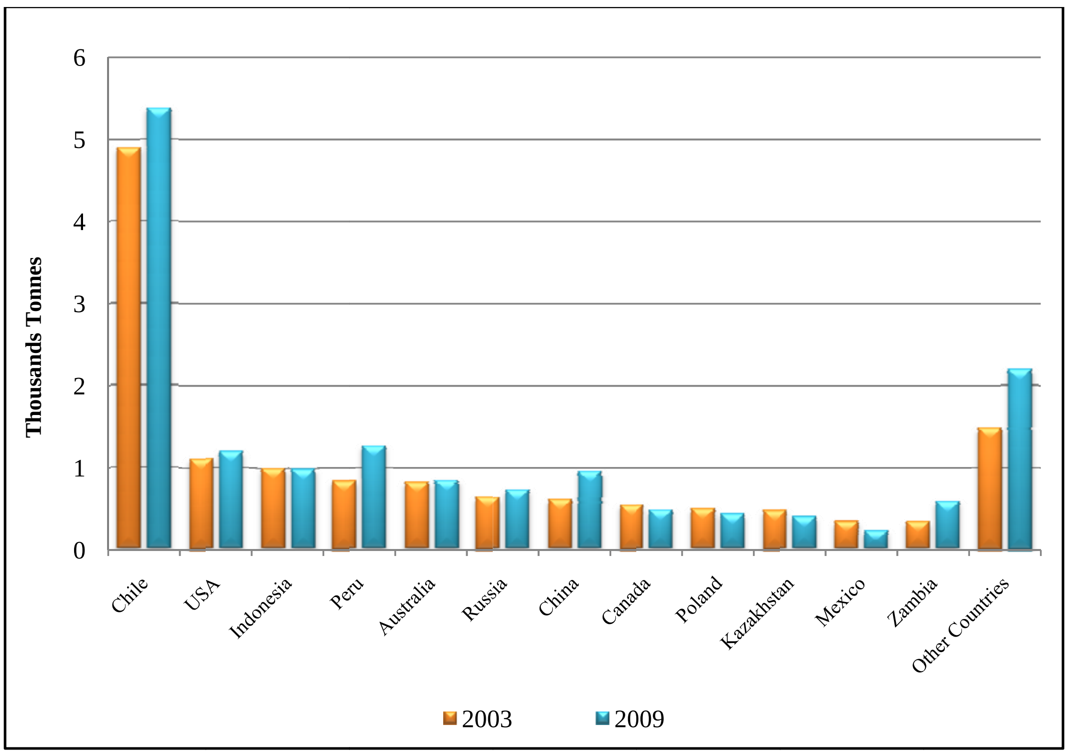


Figure : 4.3 - COUNTRY WISE SMELTER PRODUCTION OF COPPER, 2003 V/s 2009
(By Principal Countries)

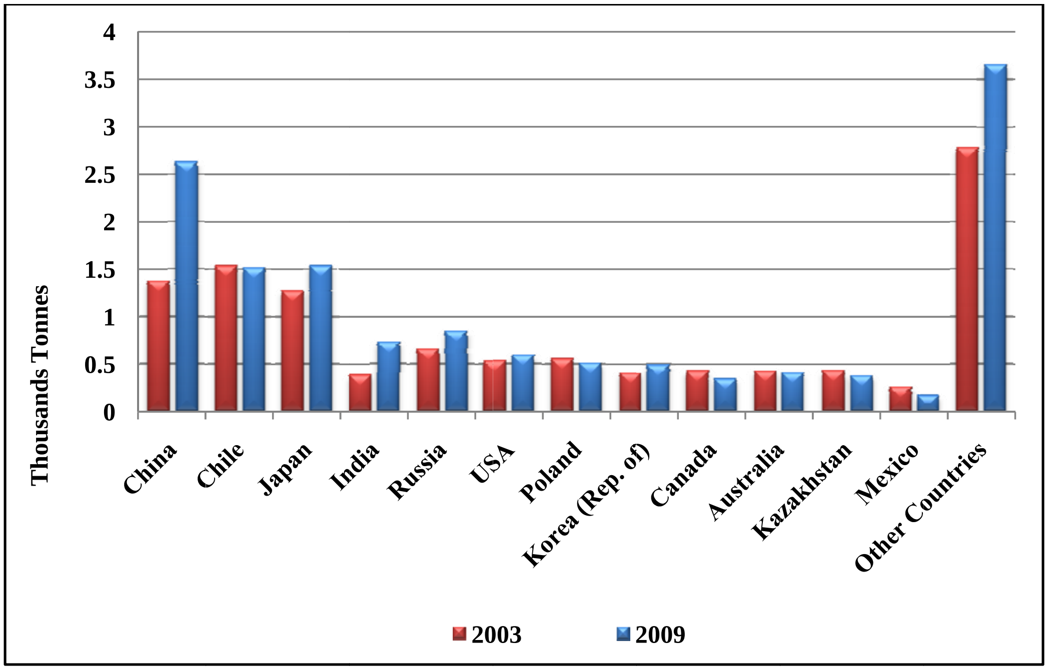


Figure : 4.4 - COUNTRY WISE REFINED PRODUCTION OF COPPER, 2003 V/s 2009
(By Principal Countries)

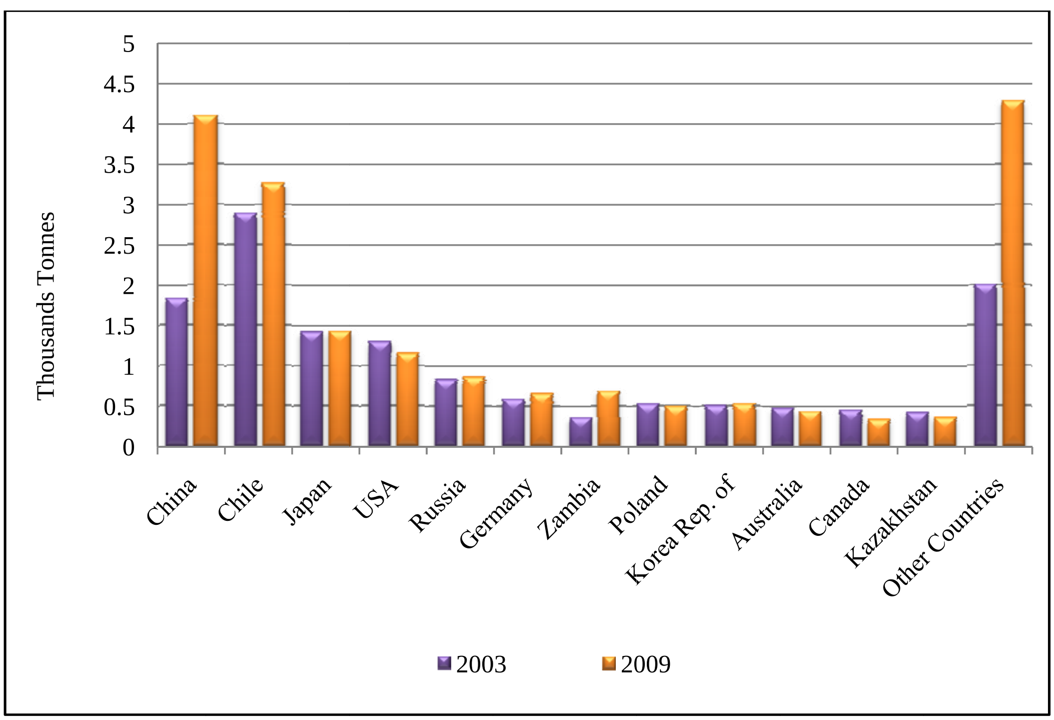


Figure : 4.5 - COUNTRY WISE EXPORTS OF REFINED COPPER, 2003 V/s 2009 (By Principal Countries)

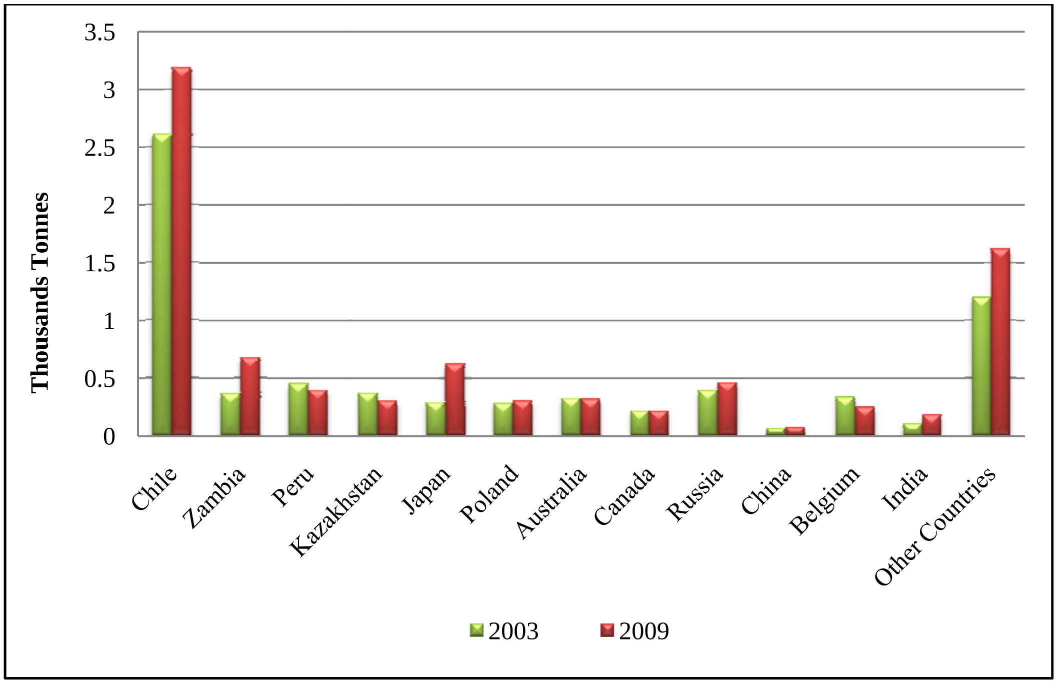
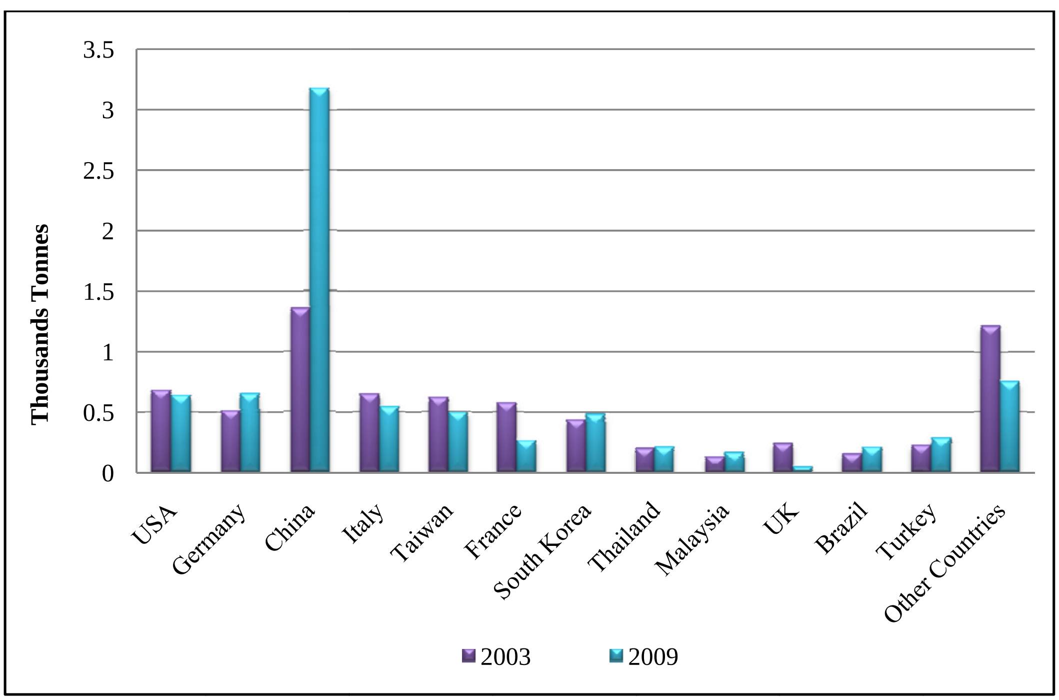


Figure : 4.6 - COUNTRY WISE IMPORTS OF REFINED COPPER, 2003 V/s 2009 (By Principal Countries)



4.3 TRADE

4.3.1 World Exports of Refined Copper

The world exports of refined copper were 8.64 million tonnes in 2009. The world exports of refined copper recorded an increasing trend since 2003, as shown in **Annexure: 4 -V** and **Figure: 4.5.** The exports which were 7.03 million tonnes in 2003 remained almost same in 2004. In 2005, there was a marked increase of 6.6% at 7.45 million tonnes. The same increasing trend was continued and exports reached 8.64 million tonnes in 2009.

Chile continued to be the top exporter of refined copper in the world with 3.19 million tonnes of exports in 2009, sharing 36.92% of the world exports. Other major exporting countries were Japan 0.63 million tonnes, Zambia 0.43 million tonnes, Peru 0.40 million tonnes, and Kazakhstan 0.31 million tonnes. Poland, Australia and Canada also contributed in exports of refined copper. India's contribution was only 0.18 million tonnes in the world exports. India's emergence in copper export is a recent phenomenon, which gained momentum since 2003. The exports reached to 0.18 million tonnes in 2009 from 0.10 million tonnes in 2003.

4.3.2 World Imports of Refined Copper

The quantum of world imports of refined copper in 2003 was 7.03 million tonnes which reached 7.45 million tonnes in 2005 showing an overall increase of 5.98% in two years. In 2006, the imports were slightly down at 7.05 million tonnes, and increased to 7.97 million tonnes in 2009. The data on world imports of refined copper is given in **Annexure: 4 -VI** and also shown in **Figure: 4.6.**

China and Germany are the major importers of refined copper. In 2009 China with 3.18 million tonnes contributed about 40% to the total world imports and Germany with 0.66 million tonnes contributed 8.27%. The imports in China also showed an increasing trend since last 4 years while the imports by Germany decreased from 881 thousand tonnes in 2003 to 660 thousand tonnes in 2009. The other major importing countries of refined copper were USA, Italy, Taiwan, South Korea etc.

India's imports of refined copper were very meager. India imported only 16 thousand tonnes of refined copper in 2006 and remained almost static at the same level since then.

Table: 4.1- Top 10 Copper Mines by Capacities, 2009

Position	Country	Name of Mine	Capacity '000 Tonnes
1	Chile	Escondida	1330
2	Chile	Codelco Norte	900
3	Indonesia	Grasberg	750
4	Chile	Collahuasi	498
5	Chile	El Teniente	440
6	Russia	Taimyr Peninsula (Norilsk/Talnakh Mills)	430
7	Peru	Antamina	420
8	USA	Morenci	400
9	Chile	Los Pelambres	360
10	USA	Bingham Canyon	280
10	Indonesia	Batu Hijau	280

Source: International Copper Study Group (ICSG)

Table : 4.2 - Top 10 Copper Smelters by Capacities, 2009

Position	Country	Name of Smelter	Capacity '000 Tonnes
1	China	Guixi	900
2	India	Birla Copper (Dahej)	500
3	Chile	Codelco Norte	460
4	Germany	Hamborg	450
4	Japan	Saganoseki/Ooita	450
4	Japan	Besshi/Ehime(Toyo)	450
7	Russia	Norilsk (Nikelevy,Medny)	400
7	Chile	El-Tenient(Caletones)	400
7	China	Jinchuan	400
10	Chile	Altonorte(La Negra)	390

Source: International Copper Study Group (ICSG)

Table : 4.3- Top 10 Copper Refineries by Capacities, 2009

Position	Country	Name of Refinery	Capacity '000 Tonnes
1	China	Guixi	900
2	India	Birla Copper	500
3	Chile	Chuquicamata	490
4	Chile	Codelco Norte(SX-EW)	470
5	Japan	Toyo/Niihama(Besshi)	450
5	USA	Amarillo	450
6	USA	El Paso	415
7	Chile	Ls Ventanas	400
8	China	Jinchuan	400
8	USA	Morenci (SX-EW)	400
9	Germany	Hamburg	395
10	Russia	Pyshma	390

Source: International Copper Study Group (ICSG)

4.4 COUNTRY WISE ANALYSIS

Australia, Brazil, Chile, China, Indonesia, Iran, Japan, Mexico, Peru, Russia, Kazakhstan, South Korea, USA and Zambia are the important producers of copper in the world. Their details are presented below.

Australia

Australia is an important country as far as non-ferrous metals are concerned. Australia with the reserves base of 24 million tonnes in terms of copper content is placed at 7^{th} position in the world tally. Australia's copper resources occur largely at Olympic Dam in the state of South Australia and at Mount Isa in the state of Queensland. Other important copper resources are located at the CSA and the North Parkes deposits in the state of New South Wales. The Ernest Henry, the Mammoth and the Osborne are the deposits located in Queensland. In the state of Western Australia, the Golden Groove and the Nifty are important copper deposits. The exploration activities in respect of copper in Australia have been accelerated since last 5 years. South Australia and Queensland are the two main provinces where the exploration activities are primarily concentrated. Telfer gold-copper mine of New Crest Mining Ltd. was further developed and as a result the production has increased to more than 55,000 tonnes per year. There were more than 12 copper projects in Queensland, New South Wales, South Australia and West Australia where feasibility studies have shown promising results. A pre-feasibility study of Prominent Hill Mine of Oxiana Ltd. has shown that an open pit mine could be developed with a production capacity of 90-100 thousand tpy of copper.

The Copper Co. Ltd.'s Lady Annie Copper deposit is located 100km. north-northwest of Mount Isa, Queensland. The construction of mine was completed in 2007. Copper Oxide ore is located near the surface. The resources of these mines were estimated at 11.3 million tonnes with an average grade of 1.0% copper. The beginning of production from the Lady Annie mines and the Leichardt mines is compensating the lower production from North Parkes and Olympic Dam mines.

Australia produced 854 thousand tonnes of copper ores and concentrates in 2009. The trend in production of ores and concentrates in Australia was fluctuating. The Mine production of copper which was 830 thousand tonnes in 2003 increased to 886 thousand tonnes in 2008 showing an increase of 6.75%. It again decreased to 854 thousand tonnes in 2009. The smelter production of copper which was 435 thousand tonnes which came to the level of 449 thousand tonnes in 2008 with lows in 2006 and 2007 and further decreased to 422 thousand tonnes in 2009.

As regards the foreign trade of copper metal, the exports of refined copper were around 300 thousand tonnes with little ups and downs for the last seven years. The imports of refined copper were very meager at 1.3 thousand tonnes in 2006 which were a little higher i.e. at 2 thousand tonnes in 2005. The imports of copper have suddenly increased to 236 thousand tonnes in 2009.

It is evident from the above discussion that the Australia is not only self sufficient in copper metal but a net exporter of copper metal and is placed at 7^{th} position in the list of copper exporting countries.

India's trade with Australia is mainly in the form of copper concentrates. Out of total imports of copper ores and concentrates in India the share of Australia was 22.52%. Hindalco Industries Ltd. and Vedanta Resources operates a number of mines in Australia and Tasmania and the concentrates are imported for their smelters in India.

Brazil

Brazil's copper ore production in terms of metal content was increasing since 2006 and reached a level of 222 thousand tonnes in 2008. In 2009 it showed a little decrease of 7% and was at 217 thousand tonnes. The major contributing company was Vale S A. The Vale S A has its mining operations at "Vale 118" and Sossego in Carajas, state of Para. The production from Sossego was 126 thousand tonnes in terms of copper content. The other major producer was Mineracao Caraiba S A with 23 thousand tonnes from its mine at Jaguarari in the State of Bahia.

Cariba Metals SA(CMSA) was the only electrolytic copper producer in Brazil which produced 220 thousand tonnes of Primary copper in 2009 which decreased by 12% in 2009 to reach 204 thousand tonnes. The annual demand of copper in the country was met with by imports of 217 thousand tonnes of copper of metal The major countries from which Brazil imported copper metal were Chile (75%) and Peru (25%).

In 2008, the Vale SA has included three more mining projects of sulphide ores namely the Salobo, the Alemao and Cristalino deposits and one oxidized ore deposit of project "Vale 118". All these projects are located in the mineral province of Carajas, State of Para. The Salova metals SA, a subsidiary company of Vale SA has plans to invest $ 1.2 billion to produce 129 thousand tpy by 2011 and 254 thousand tpy of copper by 2013. Valle SA is also planning to produce 10,000 tpy of copper cathode from the project 118 at an estimated cost of $ 235 million. Vale SA's another subsidiary Usina Hidrommetalurgica de Carajas SA (UHC) has plans to construct a semi-industrial scale copper processing plant with an estimated plan of $ 58 million. UHC would also produce copper concentrate at its Sossego project using hydometallurgical technology based on pressure oxidation followed by heap leaching, solvent extraction and copper electrowinning.

Feasibility study of Cristalino deposit for an estimated reserves of 312 million tonnes of copper ore (grading 0.77% Cu) is expected to produce 90,000 tpy of copper concentrates by the end of 2011.

Vale SA is also conducting intensive prospecting to identify new copper areas in Carajas district. Mineracao Maraca S A completed a feasibility study for Chapada Cu-Au-Ag project in Alto Horzonte, in the State of Goias with estimated reserves of 434 million tonnes. The Chapada mine is projected to produce 51,000 tpy of copper concentrate by 2012.

Keeping in view the present scenario and future plans of Brazil's copper industry, the country has a good future both in terms of production as well as trade.

India which is already in trade with Brazil can look forward for importing concentrate for fulfilling the demand for its smelters.

Chile

Chile is the most important country as far as copper is concerned. It holds the strategic position in the world copper scenario. Chile is at the top position in the world resources tally with huge reserves of 160 million tonnes of contained copper contributing about 30% of the world reserves. Most of the leading copper mines are located in the northern part of the country. There are four important deposits of copper in Chile namely, Chuquicamata, Portrerillos, Braden or El Teniente and El Salvador. Most of the copper deposits in Chile are porphyry copper deposits formed by hydrothermal replacement.

In 2008 many of the World's leading private mining companies, which included BHP Biliton plc., Rio Tinto plc., Japan Escondida Corp., Anglo American plc., Xstrata plc., Antofagsta plc., etc. were deeply involved in the copper mining in Chile. The important amongst them were BHP Biliton plc, and Japan Escondida Corp. These companies were involved in the Escondida open pit mine which was the largest copper mine in Chile with a capacity of 1.45 million tonnes. Corporation Nacional del Cobre (CODELCO), a Company wholly owned by Government was involved in the mining at Chuquicamata, Minerasur and Radomiro Tomic mines with a total capacity of 900 thousand tonnes per year. CODELCO was also involved in mining in El Teniente, Ventanas, Andina and El Salvador divisions. Another company Empressa Nacional de Mineria (ENAMI) wholly owned by Government was engaged in concentration plants at Manuel Antonio Matta, Paipotte Oswaldo Martinez etc. and Hernan Videla Lira smelter producing anodes and blister copper with an annual capacity of 340, 000 tonnes.

The production of ores and concentrates of copper in the country was around 5 million tonnes gross weight since last five years and has shown an increasing trend generally. In 2008 the production came down to 5.33 million tonnes from 5.56 million tonnes in 2007 owing to the decrease in production at CODELCO mine. The production at Escondida mine also decreased from 1.48 million tonnes in 2007 to 1.25 million tonnes in 2008. Chile was the top producer of copper ores and concentrates and produced 5.39 million tonnes in 2009.

The mine production of copper was 4.90 million tonnes in 2003 rose to the level of 5.39 million tonnes in 2009 contributing 34.39% in total world mine production of copper. There was a considerable decrease in smelter production since 2003. The smelter production of copper was 1.5 million tonnes in 2003 which came down to 1.37 million tonnes in 2008 and again increased to 1.52 million tonnes in 2009.

The production of blister and anode copper and refined copper was above 1.5 million tonnes and 2.8 million tonnes respectively since last seven years. Chile was at the top position in smelter production for copper till 2004 but since 2005 China has surpassed Chile in smelter production of copper and Chile now occupies third position. Codelco, the state mining company, Enami, Minera Escondida, etc. are the major contributors in Chile's production of copper.

The exports of refined copper were 3.19 million tonnes in 2009 as against 3.00 million tonnes in 2008 registering a slight decrease. The main destinations were Japan, China and India.

The import of copper ores and concentrates in India from Chile in 2008-09 was at 632 thousand tonnes contributing 28% in the total imports. It was the major supplier to India since last few years.

China

China was the main destination for a major share of copper metal produced in the world. This boom in demand of copper metal in China was attributed to rapidly increasing demand in consumer goods like air conditioners, refrigerators, automobiles along with building construction and other infrastructure facilities. The copper scenario in China has interestingly changed in a positive direction within the past few years. The mine production of copper, the smelter production of copper and exports of refined copper have increased sharply while the imports of refined copper have dropped down. The reason for this sudden spurt in activities in the field of copper in China is attributed to the overall economic and industrial growth in China particularly in the consumer goods sector.

China has large reserves of copper to a tune of 30 million tonnes of copper content but the overall grade is very low. There are many copper deposits in China but most of them are characterised by low grade. A few of them cannot be economically mined presently. The copper deposits in China are located in Hubei and Hunan Province and in the parts of adjoining provinces. The Dexing Copper deposit located in north eastern part of Jiangxi Province is the biggest one.

The production of copper ores and concentrates in China is very low as compared to the production of refined copper in the country. The country is mostly dependant on imports of copper ores and concentrates. The production of copper ores and concentrates was around one million tonnes since last three years.

There are four main copper processing units at Guixi in Jiangxi Province, with a capacity of 900 thousand tonnes, Yanggu in Shangdong and Jinchuan in Gansu Province each with a capacity of 400 thousand tonnes and Kuming in Unnan Province with a capacity of 250 thousand tonnes. Besides, there are 15 other copper processing units also. The mine production of copper which was 614 thousand tonnes in 2003 has increased to 1022 thousand tonnes in 2008 showing an increase of 66%. It came down by 6% to 961 thousand tonnes in 2009. The smelter production of copper in China which was 1379 thousand tonnes, in 2003 has increased to 2635 thousand tonnes in 2009, registering an increase of 91%. This whopping increase of copper production has taken China to the top position in the world tally of copper producing countries since 2005.

The refined copper production from China was 1836 thousand tonnes in 2003, and increased to 4109 thousand tonnes in 2009. There were negligible exports of copper ores & concentrates and blister & anode copper from China in the last few years.

China is the largest importer of copper ores & concentrates. China imported over 6.1 million tonnes (gross weight) of copper ores & concentrates in 2009 showing an increase of 17% over the previous year's imports of 5.20 million tonnes. China imported copper ores & concentrates mainly from Chile, Peru, Australia and USA. The imports of refined copper have also increased substantially since 2007 from 827 thousand tonnes and in 2009, it reached 3185 thousand tonnes showing an increase of 285% in just three years.

Indonesia

Indonesia with reserves of 31 million tonnes of contained copper is at the 5th position in world tally. There are 5 major deposits of copper in Indonesia. The average grade of Indonesian copper ore is 1.45% Cu. The Irian Jana Province in the country has important deposits of copper. Most important of which are Grasberg Erstberg mine worked by PT Freeport Indonesia Co. (PPFI) one of the major mines with reserves of the order of 267 million tonnes of copper ore with 1.53% Cu grade. The annual capacity of the mine is 800 thousand tonnes. The other important mine is West Nusa Tenaggara in the Sumbawa Island worked by PT Newmont Nusa Tenaggara Co. with a capacity of 300 thousand tonnes. There is a copper smelter in the country with an annual capacity of 210 million tonnes owned by PT Smelting Co. at Gresik, East Java.

Indonesia produced about one million tonnes of ores and concentrates in terms of copper content in 2009. The mine production of copper in Indonesia was 1006 thousand tonnes in 2003 which decreased to 997 thousand tonnes in 2009. The production of refined copper was 285 thousand tonnes in 2009 as against 253 thousand tonnes in 2008. The smelter production also increased from 247 thousand tonnes in 2003 to 305 thousand tonnes in 2009.

Indonesia is one of the major exporters of copper ores & concentrates. Indonesia exported 2330 thousand tonnes (Gross weight) of copper ores and concentrates in 2009 which was decreased by 43% as compared to 1627 thousand tonnes exported in 2005. Japan, Spain, South Korea and India were the main destination of Indonesian copper concentrates. India imported 333 thousand tonnes of copper ores & concentrates in 2006 from Indonesia. The exports of refined copper increased in 2009 to 197 thousand tonnes as compared to 143 thousand tonnes in 2008. There was no import of copper ores & concentrates in Indonesia. The imports of refined copper also were 104 thousand tonnes in 2009 as against 88 thousand tonnes in 2008.

Indonesia was a major source for imports of copper ores and concentrates but during 2008-09 the contribution of Indonesia was only 8% in the total imports.

Iran

Iran has estimated total reserves of 30 million tonnes of copper content distributed in 5 districts namely, Kerman Azerbaijan, Southern Khorasan, Northern Sistan, Baluchestan and Sabzever- Semnan belt. The important copper deposits of Iran are located in Sarcheshmeh, Miduk and Darrehzar all in Kerman locality; Songun, Mazraeh in Ahar; Darrehzereshk in Taft; Kali Kafi in Anarak; Ghale Zari in

East Iran and Lar in Zahedan locality. These deposits are having copper concentration from 0.4% Cu to 1.7% Cu. There are some major copper deposits where the exploratory work is going on. They are Anjerd in Aher; Taknar in Kashmar; Abhas Abad in Sharud and Ali Abad in Taft localities.

NICICO, National Iranian Copper Industries Co. (erstwhile Sarcheshmeh Copper Mines Joint Stock Company) is the only company producing copper in Iran. The company is working three major deposits namely i) Sarcheshmeh Copper Complex which is located 160 km south of Kermen and 50 km south of Rafsanjan. It is a porphyry copper deposit having one of the biggest open pits in the world. The mine has estimated reserves of 1200 million tonnes of sulphide copper ore with an average grade of 0.7% Cu. ii) The Miduk Copper Complex is located 42 km northeast of Shahr-Babak town, 132 km northwest of Sarcheshmeh copper mines in Kerman Province. The estimated reserves of the mine are 178 million tonnes with an average grade of 0.83% Cu and iii) Sungun Copper Complex which is located 130 km north of Tabriz, in East Azerbaijan province. Based on the latest evaluation, estimated reserves are 806 million tonnes with an average grade of 0.61% Cu.

The annual production capacity of copper concentrates of NICICO is 970,000 tonnes. The company has plans to increase the capacity to 1,366,000 tonnes. The company has smelters and refineries located at Sarcheshmeh and Khatoonabad with electrowinning and elctrorefining facilities. The present production capacity of copper cathodes of the company is 225,000tonnes which is expected to reach 480,000 tonnes in the near future. The company also operates 2 small mines namely Qaleh Zari in Khorasan province with a capacity of 10,000 tonnes and Chah Musa & Qaleh Sukhteh mine in Samnan province with a capacity of 5,000 tonnes.

Iran is one of the major exporters of copper ores & concentrates to India. India imported copper ores & concentrates from Iran to a tune of 34,000 tonnes in 2006-07 which rose by 166% in 2007-08 at 91,000 tonnes. In 2008-09 the imports from Iran were 125,000 tonnes a rise of 37% over the previous year. With the growing copper smelter capacities in India, there are good prospects for importing copper ores & concentrates from Iran to feed the Indian copper smelters.

Japan

There are no economical copper ore deposits in Japan. Hence there is no production of copper ores & concentrates in Japan. The country depends wholly upon the imports of copper ores and concentrates. Japan imports copper ores and concentrates mainly from Chile, Indonesia, Australia, Canada and Peru. The imports of copper ores & concentrates in the country are showing an increasing trend. The imports which were 4.5 million tonnes (gross weight) in 2004 decreased marginally to 4.32 million tonnes in 2005 and increased again in 2006 to 4.63 million tonnes and further to 5.05 million tonnes in 2007. The imports were 4.77 million tonnes in 2009.

Japan has a good capacity to produce refined copper. The total capacity of refined copper production in the country is approximately 1.68 million tonnes. The Pan Pacific Copper Co. Ltd. has two plants at Saganosiki smelter & refinery and

Hitachi refinery & Tamano smelter and refinery with a total capacity of 710 thousand tonnes. The other major smelters are Besshi/Toyo (Saijyo) refinery of Sumitomo Metal Mining Co. Ltd., Onahama refinery of Onahama Refining and Smelting Co. Ltd. and Naoshima Refinery of Mitsubishi Materials Corporation.

Japan is the third major producer of refined copper in the world. The production of refined copper in 2003 was 1430 thousand tonnes increased to 1540 thousand tonnes in 2008 and decreased to 1440 thousand tonnes in 2009.

Japan is a major exporter of refined copper after, Chile, Zambia, Peru and Kazakhstan. Japan contributed to world's total refined copper exports with 627 thousand tonnes of exports. The main destination of Japan's refined copper export was China, Taiwan and South Korea.

Mexico

The principal copper deposits of Mexico are located in an extension of Arizona belt of North America. These deposits are situated at about 61 km South West of Bisbec, Arizona. The area forms one of the largest copper bearing districts. The deposits are associated with fairly good quantity of gold and silver. The major deposits amongst these are Cananea, Carided and Nacozar and the major mining companies are MEDIMESA and Min-Maria working in La Girded EW and Mariquitarw mines respectively. Major Mexican copper production comes from these deposits and remaining is contributed by lead-zinc, copper deposits as a byproduct.

Grupo Mexico was the major producer of copper ore having two mines namely, La Caridad and another mine at Cananea both located in Son. Other producers are Minera Maria S.A. and Cobre de Mexico.

Mexico has reserves of 38 million tonnes of copper content claiming 3rd position in the world and the mine production of copper is 238 thousand tonnes of contained copper in 2009. The smelter capacity of Mexico was about 500 thousand tonnes. As far as smelter production of copper is concerned, Mexico produced 261 thousand tonnes in 2003 in terms of copper content which came down to 169 thousand tonnes in 2009.

The exports of copper ores & concentrates from Mexico are showing a decreasing trend. However there was an increasing trend in the exports of refined copper. The exports of refined copper which were at 23 thousand tonnes in 2004 increased to 62 thousand tonnes in 2007 and then started decreasing to reach33 thousand tonnes in 2009.

Peru

Peru enjoys a very strategic position in the field of copper. The reserves of copper are 63 million tonnes of contained copper, second in the entire world. There are 4 important deposits of copper in Peru namely, Cerro-de-Pasco, Moracocha, Cuajone and Toquepala. Cerro-de-Pasco is the largest deposit in Peru. The reserves of copper ore in Cerro-de-Pasco deposit were estimated at 731 million tonnes with an average grade of 0.66% Cu. The Moracocha deposit has comparatively low ore reserves of the order of 4.23 million tonnes but a fairly good grade of 1.3% Cu. The Cuajone deposit has estimated ore reserves of 346 million tonnes with an average grade of 1.1% Cu and the Toquepala deposit is rich with 149 million tonnes of ore reserves with an average grade of 0.85% Cu. Compania Minera Antamina S.A. and Southern Copper Corporation (SCC) are the 2 major companies involved in the production of copper in Peru. Sociedad Minera Cerro Verde S.A.A, Glencore International A.G. etc. are other companies involved in the copper industry in Peru.

The Cerro Verde mine of Sociedad Minera Cerro Verde S.A.A. with an annual capacity of 270 thousand tonnes and Cujone, Toquepala, Cocotea mines of Southern Copper Corporation with a total annual capacity of 430 thousand tonnes are the major producing mines in Peru.

The mine production of copper has increased in 2009 to 1.27 million tonnes from 843 thousand tonnes in 2003. The production of refined copper in Peru decreased to 423 thousand tonnes in 2009 from 517 thousand tonnes in 2003.

The exports of copper ores & concentrates from Peru were 3.03 million tonnes (gross weight) in the year 2009 which decreased from 3.10 million tonnes in 2008. The main destinations of Peruvian copper ores & concentrates were China, Japan, Canada, Germany etc. India also imported 80 thousand tonnes of copper ore & concentrates from Peru in 2009.

Peru also exports refined copper to various countries namely USA, Italy, Netherlands, Taiwan, China, Japan etc. The total exports of refined copper from Peru in 2009 were 401 thousand tonnes which were down by about 4.3% at 419 thousand tonnes in 2008.

Russia

Russia has 20 million tonnes of copper reserves in terms of copper content. The annual mining capacity of Russia is around 800 thousand tonnes. The major mining activity is reported from Noril'sk region in Kola Peninsula and Ural Mountains. The mine production of copper in Russia increased to 742 thousand tonnes in 2009 from 650 thousand tonnes in 2003. Russia produced 850 thousand tonnes of smelter copper in 2009 as against 662 thousand tonnes in 2003. The general trend in the production of refined copper in Russia was increasing with a slight decrease to 874 thousand tonnes in 2009 from 913 thousand tonnes in 2008.

Major producers of ore and metal are MMC Noril'sk Nickel, Russian Copper Company (RCC) and Ural Mining and Metallurgical Company (UMMC). The capacity of refined metal production of Russia is about 980 thousand tonnes.

In the world trade Russia imported 133 thousand tonnes (gross weight) of copper ores & concentrates in 2009 as against 125 thousand tonnes in 2008 mainly from Kazakhstan showing a slight increase. Russia also imported a small amount of 1.5 thousand tonnes of refined copper in 2009. The exports of copper ores and concentrates (gross weight) also were very low at 30 thousand tonnes in 2009. The exports of refined copper from Russia recorded a decreasing trend upto 2008. The exports which were 397 thousand tonnes in 2003 have gradually come down to 207 thousand tonnes in 2008. In 2009 Russia exported 466 thousand tonnes of refined copper to various countries mainly to Sweden, Netherlands, Turkey and other countries.

Kazakhstan

In Kazakhstan, four major copper ore deposits are located in Altay, Boshekul, Dzhezkhazgan and Kounarl of which Dzhezkhazgan is the largest. In Dzhezkhazgan Province Nikolayevka, Orlovka, Sayak and Balkhash are the important deposits. As in the other countries in CIS, Kazakhstan also has large reserves of copper ore with a grade of 1.1% Cu. Kazakhstan has 18 million tonnes of reserves in terms of copper content.

The resources of copper in Kazakhstan are distributed in South central, Eastern and north central parts of the country. In Zhezkazgen complex Orlovskoe mine in eastern Kazakhstan, East and South mine in north central Kazakhstan are owned by Kazakhmys plc. with annual capacities of 86,200, 65,800 and 71,600 tonnes of copper content respectively. Besides, Maleevsky mine owned by Kazzinc JSC (Glencore International Ltd. AG) in East Kazakhstan with annual capacity of 62,100 tonnes is also producing copper. Nikolaevskoe mine, Stepnoy mine are the other important mines producing copper in Kazakhstan.

The Kazakhmys plc. has a concentrator plant and a smelter at Balkhash complex with annual capacities of 145 thousand tonnes and 250 thousand tonnes respectively. Kazakhmys plc. also owns a smelter and a refinery in Zhezkazgen complex with a capacity of 215 thousand tonnes and 250 thousand tonnes per year.

Kazakhstan showed a decreasing trend in the mine production of copper. The mine production of copper which was 484 thousand tonnes in 2003, decreased to 420 thousand tonnes in 2008 and further to 406 thousand tonnes in 2009. A similar trend was observed in the smelter production of copper in Kazakhstan. In the 2003 the smelter production was 432 thousand tonnes which came down to 380 thousand tonnes in 2009. The production of copper ores and concentrates (gross weight) was around 400-450 thousand tonnes during the last 5 years.

The export of refined copper from Kazakhstan showed an increasing trend up to 2005. It increased to 401 thousand tonnes in 2005 from a level of 376 thousand tonnes in 2003 and since then it is around 350 thousand tonnes upto 2009. The exports were mainly to Italy and China. A small quantity was exported to Germany and other countries.

South Korea

Despite having no production of copper ores and concentrates, South Korea has large capacities of blister, anode and refined copper which are based wholly on imported ores and concentrates. The total capacity of primary copper in the country is 590 thousand tonnes in 2008. The LS-Nikko Copper Inc. has two plants at Changhang and Onsan with a total capacity of 570 thousand tonnes and one plant operated by Korea Zinc Company Ltd. has a capacity of 20 thousand tonnes. Korea's smelter production of copper is steadily increasing since 2004. The smelter production of copper in 2009 was 495 thousand tonnes as against 410 thousand tonnes in 2003. The refined copper production in 2003 was 510 thousand tonnes which rose to the level of 532 thousand tonnes in 2009.

South Korea imported 1.60 million tonnes (gross weight) of copper ores & concentrates in 2009. The imports of copper ores & concentrates which were 1.40 million tonnes in 2007 increased to 1.59 million tonnes in 2009. South Korea also imported 488 thousand tonnes of refined copper in 2009 as against 406 thousand tonnes in 2008.

USA

The USA with 35 million tonnes of reserves in terms of copper content occupies fourth position in the world. The grade of copper ore in USA is fairly good. The Jerome, Copper deposit, Arizona has the highest grade; Ray Pit deposit near the city of Miami has nearly 85 million tonnes of ore with a grade of 1.65% Cu. Liberty and Veteran deposits near Montana Miser chest deposit near Lordsberg, Arimetco, Cyprus Amax, Kennecoh, and Leaching Tech. etc. are the other major deposits in USA.

The mine production of copper in USA showed a mixed trend during last 5 years the production remained around 1 million tonnes. In the year 2008 the mine production was 1.3 million tonnes. It however decreased slightly to 1.2 million tonnes in 2009. The smelter production of copper was 597 thousand tonnes in 2009 as against 574 thousand tonnes in 2008. The production of copper ores and concentrates in terms of copper content in USA which was 1.31 million tonnes in 2008 decreased to 1.20 million tonnes in 2009. Production of refined copper in 2007 was 1.33 million tonnes and decreased to 1.16 million tonnes in 2009.

Though USA imported negligible quantity of copper ores and concentrates, it was the world's largest importer of refined copper with an import of 1.08 million tonnes in 2006 replacing China which was the largest importer of refined copper in 2005. Since 2007 China has surpassed USA and is the top importer of refined copper since then. The exports of refined copper from USA were 38 thousand tonnes in 2008 and increased to 86 thousand tonnes in 2009.

Zambia

Zambia has 19 million tonnes of reserve in terms of copper contents. the important copper deposits in Zambia are located in Solwezi, Em, Nadola, Pet, Cem Kabwa etc. The Zambia Consolidate Copper Mines (ZCCM) owns important mines like Mindola, Muflira, Konkola, Nchanga, Nkana, Chingola and Luanshya. The mining at two major mines, namely Konola and Chingola were affected due to poor ground condition and lower grade respectively. Vedanta Resource Plc. has earmarked US$ 400 million for the development of Konkola Deep Mining Project (KDMP), to enhance the capacity from 1.5 million tonnes to 6 million tonnes per year. A modern copper smelter with 300,000 tpy capacity after expansion is under construction at Nchanga mine.

Zambia is a major country in the mine production of copper. The total capacity of ore mining in Zambia in 2007 was around 52.5 million tonnes of ore (the copper content in the ore are not available). The Lumwana mine (Malundwe Pit) being the largest mine with a capacity of 20 million tonnes of ore is operated by Lumwana Mining Co. Ltd. The Kansanshi operated by Kansanshi Mining plc. (12 million tonnes) Vedanta Resources plc. with 51% stake alongwith Zambia Copper Investments Ltd. and Zambia Consolidated Copper Mines Investments Holding plc. formed a joint venture company named as Konkola Copper Mines Ltd. and is operating three mines namely Nchanga (open Pit and Underground), Konkola Underground and Fitwaola open pit with a total capacity of about 10 million tonnes of copper ore.

The smelter and refinery capacity of the country is around 1.14 million tonnes. The major producer Konkola copper mines plc. has a total capacity of 500 thousand tonnes of blister, anode and cathode copper operating plants at Nchanga and Chingola. The other players are Mopani Copper Mines plc., Chambishi Metals plc. etc.

The mine production of copper recorded an increasing trend. The production which was from 347 thousand tonnes in 2003 increased gradually to 601 thousand tonnes in 2009. The production of Copper ores and concentrates in terms of Copper content was increasing since last three years. It was 441 thousand tonnes in 2005 and increased by 36% to 601 thousand tonnes in 2009.

The exports of copper ore and concentrates (in terms of Cu contents) from Zambia is recorded an increasing trend since last 3 years and reached to 402 thousand tonnes in 2009. The exports of refined copper from Zambia are also increasing since last 5 years. The exports of refined copper which were 363 thousand tonnes in 2003 increased by 86% to 675 thousand tonnes in 2009. There were no imports of copper ores & concentrates and refined copper during the last few years.

4.5 INDIA'S TRADE

The past few years saw the Indian copper industry taking remarkable strides towards the goal of self sufficiency. The HCL was able to meet the 25 to 30% of the country's demand before economic liberalization. After 1992 the private domestic producers boosted the production of copper metal based on imported ores and concentrates and now India exports copper to various countries. The details of exports of copper and other related items are given in **Annexures: 4 -VII to 4 - X**.

India also imports sizable quantities of copper ores and concentrates to feed the smelters as well as copper metal is also imported in the form of copper and alloys, copper scrap and cement copper (precipitated). The details of imports of copper as above are given in **Annexures: 4 - XI to 4 - XIV**. However, for the sake of analysis in this Market Survey the data on exports of refined copper has been taken from World Metal Statistics (BGS).

4.5.1 Exports

India plays an important role in the world export market. India stands 11th in the tally of refined copper exporting countries. India's export of refined copper shows an increasing trend since last few years. The exports of refined copper which was only 105 thousand tonnes in 2003 increased to 236 thousand tonnes in 2006 and came down to 185 thousand tonnes in 2009. The main destinations of Indian copper alloys were mainly to China (36%) was followed by Saudi Arabia 17%. Besides, 27 thousand tonnes of copper ores & concentrates was also exported mainly to Germany, and China. A small quantity of cement copper (precipitated) was also exported. India also exports copper scrap and scrap of brass and bronze.

4.5.2 Imports

India is one of the major importers of copper ores & concentrates. India imported 1.91 million tonnes of copper ores & concentrates in 2007-08 but in the year 2008-09 the imports were increased to 2.26 million tonnes. The major countries from which India imports copper ores and concentrates are Chile, Australia, Indonesia, Brazil, Iran etc. India imported 633 thousand tonnes of copper ores & concentrates from Chile, contributing 28% to the total Indian imports followed by Australia (22%) and Indonesia (8%). The India's imports of refined copper stood at 15,496 tonnes in 2009 which decreased from 15,744 tonnes in 2008. In the 2008-09, India also imported 23,245 tonnes of copper scrap, 321 tonnes of cement copper precipitated.

4.6 EXPORT- IMPORT POLICY:

The export import (Exim) policy of copper metal is decided by the Ministry of commerce, Government of India. The gist of the policy is given below.

4.6.1 Export Policy

As per the export policy 2009-14 Copper/lead/zinc metal and their alloys are freely exportable without conditions.

4.4.2 Import policy:

The import policy for years 2009-14 is given in **Table: 4.4.**

Table: 4.4 - Import Policy for Copper 2009-14

Exim Code	Policy	Policy Condition	Basic duty	Pref. duty	CVD+E. Ed.Cess	Custom Ed.Cess	Spl. CVD	Total Duty %
Items of copper under Exim Code 7401 to 7410 (Except the following)	Free	-	5	-	8.24	2+1	4	18.62402
Exim Code Nos. 7404 00 11, 7404 00 19, 7404 00 29, 7404 00 21	Restricted	-	5	-	8.24	2+1	4	18.62402
Items of copper under Exim Code 7411 to 7412	Free	-	7.5	-	8.24	2+1	4	21.52269
Items of copper under Exim Code 7415 to 7419	Free	-	10	-	8.24	2+1	4	24.42136

4.7 FUTURE SCENARIO

Copper is an important non ferrous metal used in the industries such as Electrical, telecommunications, alloys, die-casting etc. India has good capacities to produce copper metal but the production of ores and concentrates is not sufficient to cater to the demand of the refineries. India's demand of copper ores & concentrates is mostly met with by imports India produces about 150 thousand tonnes of copper concentrates whereas imports about 2000 thousand tonnes of copper ores & concentrates. The major smelting plants such as Hindalco industries Ltd., Sterlite Industries (India) Ltd. and Jhagadia Copper Ltd. which depend upon the imported copper concentrates and scrap are not running with their full capacity. The major overseas markets from which India is importing copper ores & concentrates are Chile, Australia, Indonesia, Brazil, Peru etc. Out of these Chile has got good capacities to produce ores and concentrates followed by Indonesia, Australia, Brazil, Kazakhstan, Peru etc. The new developments in the Zambian copper mining industry are showing good prospects of revival. India may look forward to import copper ores & concentrates from Chile, Indonesia, and Zambia in the future. As regards the exports of copper metal, India exports its copper metal to Asian Countries such as Saudi Arabia, China, Malaysia, Thailand etc. If the production of copper metal in India with the help of imported copper concentrates is increased, India can extend its export destinations to some of European and African countries which are good consumers of copper metal but do not have capacities to produce the metal.

The internal demand of copper in India is also increasing due to positive changes in the industrial production and economy. The growth in the infrastructure sector also has a positive effect on India's internal demand of copper. The internal demand of copper has been discussed in **Demand and Supply Chapter**. Keeping in view the overall growth of Indian industry the demand of copper is expected to increase in the future.

World Future Scenario Beyond 2010

It has already been mentioned in the **Foreign Markets Chapter** that forecasting copper scenario in the entire world in respect of production and trade is difficult owing to fast development in respect of closing down of mines & companies and switching over, merger & acquisition of companies. The International situation is full of uncertainty.

It has now become a set practice that entrepreneurs acquiring mines world-wide to feed their smelters situated in different countries. Therefore to forecast the copper demand in the world and in various regions, the basis of consumption of refined copper as reported in World Mineral Statistics have been adopted.

The consumption data of refined copper from 2001-2010 has been compiled and analysed to find out rise and fall in consumption on year- to - year basis in respect of World as a whole and Europe, Africa, Asia, America and Oceania, to arrive at the CAGR based on data for 10 years.

The countries included under various regions namely Europe, Africa, Asia, America and Oceania are given in **Tablel-4.5.**

As it will be seen from the **Table-4.5** that, countries included under various regions are different in number and there is a vast difference in their economic conditions. Therefore by applying a CAGR of each area, it is difficult to arrive at a clear picture of refined copper consumption. Hence, the CAGR of entire world has been calculated and future world consumption has been arrived at.

Table-4.5: Countries Included in Different Regions

EUROPE	**ASIA**
Albania	China
Austria	Hong Kong
Belgium	India
Bulgaria	Indonesia
Czech Republic	Iran
Denmark	Japan
Finland	Kazakhstan
France	Kuwait
Germany	Malaysia
Greece	North Korea
Hungary	Pakistan
Ireland	Philippines
Italy	Saudi Arabia
Netherlands	Singapore
Norway	South Korea
Poland	Taiwan
Portugal	Thailand
Romania	Turkey
Russia	Uzbekistan
Serbia	Vietnam
Slovakia	Other Asia
Spain	
Sweden	**AMERICA**
Switzerland	Argentina
Ukraine	Brazil
United kingdom	Canada
Other Europe	Chile
	Colombia
AFRICA	Mexico
Egypt	Peru
South Africa	U.S.A.
Tunisia	Venezuela
Zambia	Other America
Zimbabwe	
Other Africa	**OCEANIA**
	Australia
	New Zealand

The details of consumption pattern from 2001 to 2010 is given in **Table-4.6** and the CAGR calculated on the basis of year to year rise and fall in consumption is given in **Table-4.7**

Table -4.6: World Refined Consumption of Copper, 2001 to 2010

(000'tonnes)

Year	World	Europe	Africa	Asia	America	Oceania
2001	14765.6	4341.8	142.0	6159.5	3861.0	171.3
2002	15052.5	4326.6	148.3	6946.9	3441.3	189.3
2003	15365.5	4278.9	147.1	7304.0	3451.1	184.3
2004	16345.4	4546.2	163.3	7737.4	3729.9	168.6
2005	16638.8	4539.6	194.6	8249.5	3497.6	157.5
2006	17007.0	4995.3	222.4	8338.6	3307.0	143.7
2007	18142.5	4793.3	230.5	9754.4	3216.4	147.9
2008	18152.6	4624.7	334.3	9913.7	3125.9	154.0
2009	18243.0	3578.9	218.4	11668.8	2646.5	130.5
2010	19444.2	4088.4	117.9	12342.1	2793.0	102.9
CAGR%	**3.20**	**(-)0.13**	**1.78**	**8.18**	**(-)3.28**	**(-)5.04**

Table -4.7: Compounded annual Growth Rate (CAGR) of Refined Copper Consumption, 2001 to 2010

	CAGR (%)
World	3.20
Europe	(-)0.13
Africa	1.78
Asia	8.18
America	(-)3.28
Oceania	(-)5.04

It will be seen from the above **Table-4.7** that the CAGR in respect of world has been arrived at 3.20% although as per world bank data the GDP growth of the world has been given as 3.3% in 2010, as against (-) 2.1% in 2009. The CAGR calculated on the basis of consumption of refined copper from 2001to 2010 has been adopted for forecasting the consumption in 2025, the maximum CAGR has been arrived at in respect of Asia at 8.18% mainly driven by higher level of consumption in China, Korea and India where as the lowest CAGR has been arrived at in respect of Africa 1.78% which is the positive sign though most of the African countries are having status of under developed and developing countries. In Europe, America and Oceania most of the countries are in developed categories hence there is a negative CAGR of (-) 0.13%, (-) 3.28 % and (-) 5.04% respectively.

On the basis of CAGRs given in **Table -4.8** the World Consumption of Refined Copper has been calculated for the years from 2011 to 2025. The same is given at **Table-4.9.**

Table -4.8: Estimated Region wise World Refined Consumption of Copper, 2011 to 2025 (Base year 2010)

(000'tonnes)

Year	**Europe** (CAGR- (-) 0.13%)	**Africa** (CAGR- 1.78%)	**Asia** (CAGR- 8.18%)	**America** (CAGR- (-) 3.28%)	**Oceania** (CAGR- (-) 5.04%)	**World Total***
2010	4088.4	117.9	12342.1	2793.0	102.9	19444.3
2011	4083.1	120.0	13351.7	2701.4	97.7	20353.9
2012	4077.8	122.1	14443.9	2612.8	92.8	21349.4
2013	4072.5	124.3	15625.4	2527.1	88.1	22437.4
2014	1067.2	126.5	16903.6	2444.2	83.6	23625.1
2015	4061.9	128.7	18286.3	2364.0	79.4	24920.3
2016	4056.6	131.0	19782.1	2286.5	75.4	26331.6
2017	4051.3	133.3	21400.3	2211.5	71.6	27868.0
2018	4046.0	135.7	23150.8	2139.0	68.0	29539.5
2019	4040.7	138.1	25044.5	2068.8	64.6	31356.7
2020	4035.4	140.6	27093.1	2000.9	61.3	33331.3
2021	4030.1	143.1	29309.3	1935.3	58.2	35476.0
2022	4024.9	145.6	31706.8	1871.8	55.3	37804.4
2023	4019.7	148.2	34300.4	1810.4	54.5	40331.2
2024	4014.5	150.8	37106.2	1751.0	49.8	43072.3
2025	4009.3	153.5	40141.5	1693.6	47.3	46045.2

**On the basis of CAGR of Europe (-)0.13%, Africa 1.78%, Asia 8.18%, America (-)3.28%, Oceania(-)5.04%*

It will be seen from the **Table-4.9** that on the basis of CAGR of 3.20 % for the entire world the consumption of refined copper comes to 31 million tonnes in 2025. However on the basis of CAGRs of different areas, the total consumption of refined copper comes to 46 million tonnes. There is a difference of 15 million tonnes which is mainly due to the negative CAGR in respect of Europe, America and Oceania as well as robust positive growth in Asia supported by Africa.

Therefore, the overall CAGR of 3.20% calculated in respect of world seems to be more realistic as it is also supported by overall world's GDP growth of 3.3% in 2010 from (-)2.1% in 2009 and further forecast of 3.3% in 2011 and 3.5% in 2012 by World Bank .

As far as the area-wise analysis in concerned, the CAGR of (-) 0.13% in Europe is given an indication that the copper consumption is nearing saturation in the developing countries and in 2025, the refined copper consumption will be 4 million tonnes and the consumption of refined copper during 2025 in America will be 1.7 million tonnes calculated on the basis of CAGR (-) 3.28%.

The CAGR in respect of Oceania has been calculated at (-) 5.04% and the consumption of refined copper has been calculated at 0.047 million tonnes.

The positive CAGR of 8.18% estimated in respect of Asia is mainly due to increased consumption in China, Korea and India, hence the world consumption of refined copper in 2025 is 40 million tonnes which is more than the world's consumption of 31 million tonnes calculated on the basis of CAGR of 3.2%. On the basis of positive CAGR of 1.78% in Africa, consumption of refined copper in 2025 has been arrived at 0.15 million tonnes.

The consumption in Asia seems to be on higher side and hence is not accepted for long term forecasting, and the forecast made on the basis on 3.2% CAGR which comes to 31 million tonnes has been accepted.

Table -4.9: Comparison of Estimated World Refined Consumption of Copper, 2011 to 2025

(000'tonnes)

Year	World Total Consumption (As per CAGR-3.20%)	Total Consumption estimated on the basis of Area wise CAGRs*
2011	20066.4	20353.9
2012	20708.5	21349.4
2013	21371.2	22437.4
2014	22055.1	23625.1
2015	22760.8	24920.3
2016	23489.1	26331.6
2017	24240.7	27868.0
2018	25016.4	29539.5
2019	25816.9	31356.7
2020	26643.0	33331.3
2021	27495.6	35476.0
2022	28375.5	37804.4
2023	29283.5	40331.2
2024	30220.6	43072.3
2025	31187.7	46045.2

**As given in Table-2 World-3.20%, Europe (-) 0.13%, Africa 1.78%, Asia 8.18%, America (-)3.28%, Oceania(-)5.04%*

Chapter 5. Prices

Copper metal is traded in the forms of copper cathodes, copper anodes, blister copper wire bars, wire rods, cement copper and scrap. Copper ores and concentrates are also traded in the market. Copper scrap is traded in the forms like heavy scrap, utensil scrap etc. as per the norms laid down by ISRI. The norms of ISRI are given in **Annexure: 3 - III.** The copper alloys such as brass, bronze and other alloys are also traded in the form of articles and artifacts.

There are many factors which affect the prices of copper amongst which purity of copper, and percentages of deleterious constituents are very important. Another important factor which influences the prices of copper is economic growth of the major consuming countries such as China, USA, Japan, Germany etc. and growth and development in the infrastructure, real estate, telecom and electrical industries. The demand and supply position of copper is another factor which decides the trend in copper prices. Transportation cost, export and import duties also have influence on copper prices.

Copper as any other merchandise, is traded between producers and consumers. Producers sell their present and future production to buyers. Copper is traded in two ways. One of the very important ways of trading copper is the settlement price for the present day which is known as 'Spot Price' and the other way of trading is settlement of price for future days. The commodity exchanges play an important role in the trading of copper. These exchanges facilitate to make a transparent settlement of prices. There are many international commodity exchanges where copper is traded. Among them the London Metal Exchange (LME) is the most important.

In the exchanges prices are settled by bid and offer. These prices reflect the perception of demand and supply of copper on a particular day. The London Metal Exchange is the most important exchange. In LME copper is traded in lots of 25 tonnes and the prices are quoted in US dollars per tonne. The exchanges also provide facilities to trade in future contracts. The future contract defines the size of lot quality of the product, delivery dates and other important details of the trading process.

Copper is also traded directly between the manufacturer and the consumer of copper. Consumers directly place their requirements to manufacturers and the price is negotiated between the two parties.

5.1 DOMESTIC MARKET PRICES:

Copper is also traded in the domestic markets. There are two major markets of copper on domestic front namely Delhi and Mumbai. The prices in both these markets are quoted in Rupees per quintal and the grades are named as wire rod, wire bar, cathode etc. scrap is traded as wire scrap and utensil scrap. The prices of all grades of copper for last ten years in the domestic market are given in **Table: 5.1.** The average monthly prices of Copper Wire, Rods and Wire Bars (BME) and average monthly prices of copper Heavy Utensils Scrap (BME) are given at **Annexure:5-I** and **Annexure: 5-II** respectively.

Table: 5.1- Annual Average Prices of Copper in Domestic Markets, 1999-2000 to 2008-09

(In Rs per Quintal)

Grade	Market	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
Wire rod	Mumbai	12,379	13,798	13,234	12,987	13,083	18,820	25,881	32,209	39,442	20,929
Wire bar	Mumbai	11,879	14,008	13,481	12,664	17,876	21,160	28,110	34,736	39,553	26,033
Birch	Mumbai	10,026	11,446	11,128	10,987	11,000	16,155	24,114	31,950	NQ	NQ
Red Berry	Mumbai	10,627	12,026	11,940	11,887	11,900	16,185	23,400	31,859	NQ	NQ
Cathode	Mumbai	11,270	12,368	12,231	12,074	12,100	15,513	26,690	29,418	39,479	17,224
Utensil Scrap	Mumbai	9,123	10,164	10,620	10,472	13,571	15,740	23,762	30,064	32,921	21,586
Wire Scrap	Mumbai	10,4 83	11,674	11,506	11,387	11,000	15,310	25,957	32,391	34,895	21,333
Wire rod	Delhi	12,318	13,900	13,046	12,465	13,600	18,205	24,538	NQ	NQ	NQ
Wire bar	Delhi	11,824	13,598	12,703	12,161	15,757	18,120	26,738	33,195	37,400	21,119
Wire	Delhi	12,635	14,333	13,408	12,861	12,600	17,095	24,262	31,636	33,374	18,195
Wire Scrap	Delhi	10,378	11,613	11,167	10,770	14,881	16,775	26,067	31,709	34,900	20,271
Mixed Scrap	Delhi	9,143	10,412	10,223	9,928	13,440	15,510	23,533	29,200	32,411	23,010

NQ: Not Quoted; Source: Indian Minerals Yearbook

The comparison of copper prices is during 2003-04 and 2008-09 given in **Table: 5.2.**

Table: 5.2 - Comparative Study of Prices of Copper, during 2003-04 & 2008-09

(In Rs. per Quintal)

Sl. No.	Commodity	Market	Prices		Percentage increase/ decrease
			2003-04	2008-09	
1.	Wire Rod	Mumbai	13,083	20,929	(+) 59.97
2.	Wire Bar	Mumbai	17,876	26,033	(+) 45.46
3.	Birch	Mumbai	11,000	NQ	-
4.	Red Berry	Mumbai	11,900	NQ	-
5.	Cathode	Mumbai	12,100	17,224	(+) 42.35
6.	Utensil Scrap	Mumbai	13,571	21,586	(+) 59.06
7.	Wire Scrap	Mumbai	11,000	21,333	(+) 93.94
8.	Wire Rod	Delhi	13,600	NQ	-
9.	Wire Bar	Delhi	15,757	21,119	(+) 34.02
10.	Wire	Delhi	12,600	18,195	(+) 44.40
11.	Wire Scrap	Delhi	14,881	20,271	(+) 36.22
12.	Mixed Scrap	Delhi	13,440	23,010	(+)71.21

In the endeavour of this market survey study the consumers of copper in all sectors were contacted through correspondence for data on various aspects including prices.

5.2 INTERNATIONAL PRICES:

The prices of copper in the International Market were also on upsurge. The reason for this upsurge is obviously the imbalance in demand supply scenario in the overseas market. China, Japan and Germany were the main driving forces in increasing the demand of copper in the overseas market. The London Metal Exchange prices of copper (highest, lowest and average) are given in **Table: 5.3** for the last twenty years.

Table: 5.3 - London Metal Exchange Prices of Copper, 1991 to 2010

(In $ per tonne)

Sl. No.	Year	Highest	Lowest	Yearly Average
1.	1991	1500.00	1149.00	1325.11
2.	1992	1506.00	1111.00	1297.09
3.	1993	2009.00	1101.50	1578.15
4.	1994	3088.00	1720.00	2312.73
5.	1995	3235.00	2716.00	2936.52
6.	1996	2841.00	1830.00	2290.46
7.	1997	2720.00	1699.00	2275.70
8.	1998	1880.00	1438.00	1652.88
9.	1999	1846.00	1354.00	1573.66
10.	2000	2009.00	1607.00	1814.26
11.	2001	1837.00	1319.00	1577.77
12.	2002	1689.00	1421.00	1557.50
13.	2003	2321.00	1544.50	1779.67
14.	2004	3287.00	2337.00	2868.34
15.	2005	4650.00	3072.00	3683.64
16.	2006	8788.00	4537.00	6730.60
17.	2007	8301.00	5225.50	7126.35
18.	2008	8985.00	2770.00	6955.88
19.	2009	7346.00	3050.50	5149.74
20.	2010	N.A.	N.A.	7539.32

It will be seen from the table above that the yearly average prices of copper which were at a level of $ 1325 in 1991 increased to $ 2275 in 1997. Again in the year 2004, there was a sharp rise in LME prices of copper and touched a level of at $ 2868 from a level of $ 1779 in 2003. Since then, every year there was a sharp increase in prices till the year 2010. Prices of copper reached upto $ 7539, in 2010.

It will be seen from the **Annexure 5-III** that there is no regular pattern in the price rise in a particular month. However it will be noted that the escalation in prices of the copper was noticed from October 2003 onwards and the escalation of prices reached up to $ 9147 in December 2010.

The average monthly settlement LME prices of copper for the years 2001 to 2010 are presented in **Annexure 5-III** and also depicted in **Figure 5.1** and the comparative prices during 2007 to 2010 is depicted in **Figure – 5.2.**

Figure : 5.1 - Month Wise LME Prices of Copper 2001 to 2010

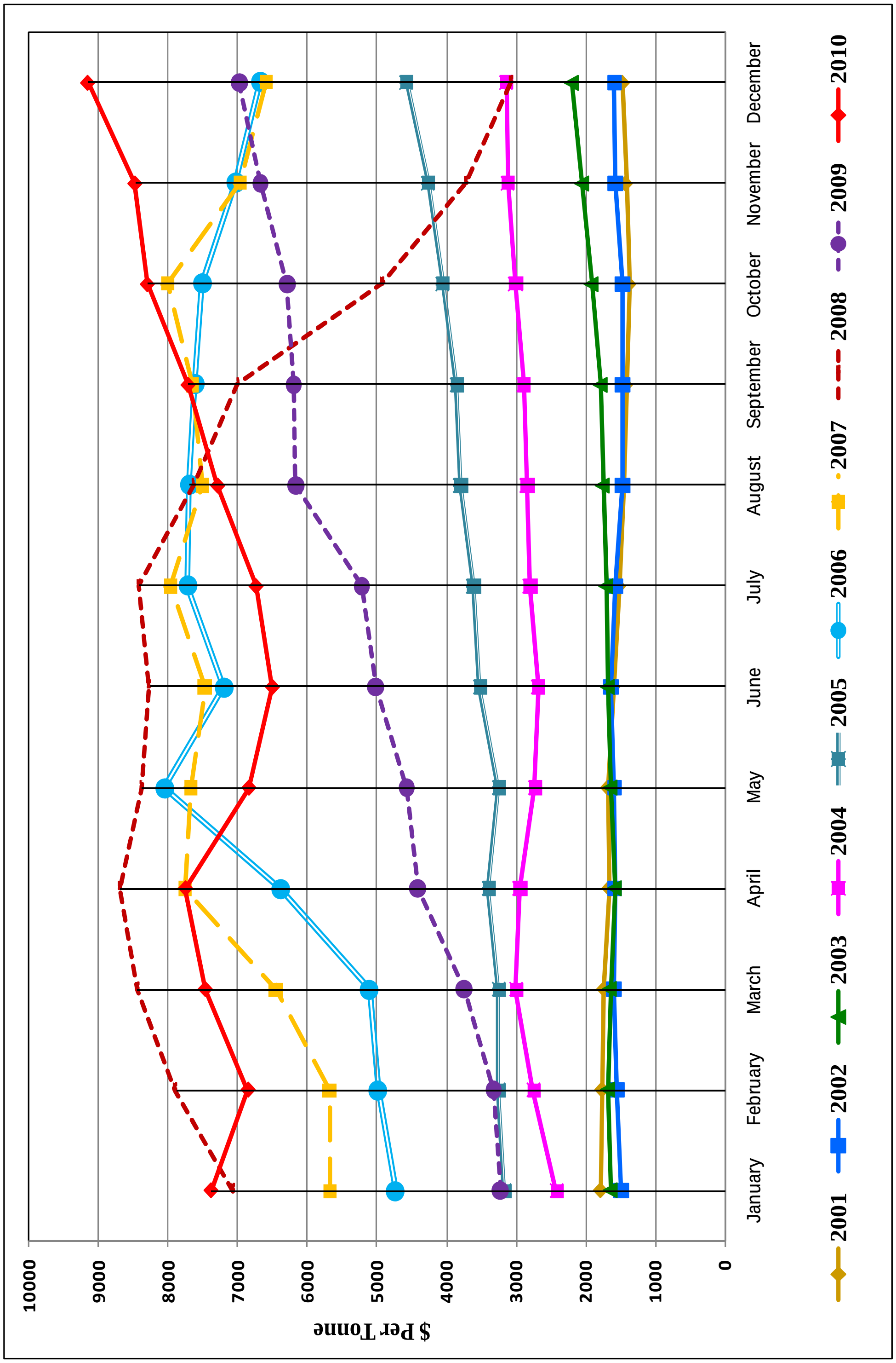
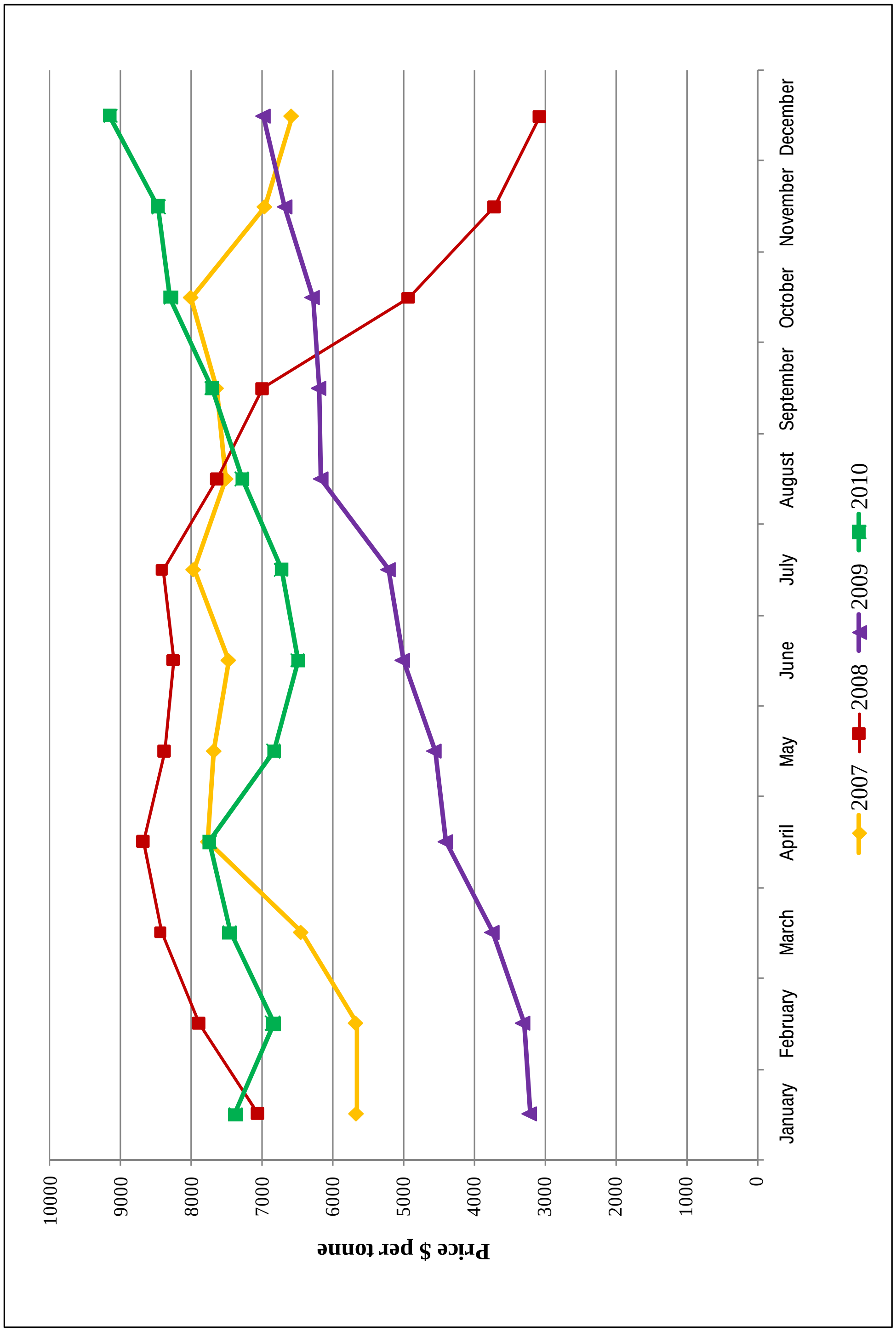


Figure : 5.2 - Month Wise LME Prices of Copper, 2007 to 2010



5.3 ROYALTY AND OTHER TAXES

5.3.1 Royalty

In exercise of the powers conferred by Subsection (3) of the Section 9 of the Mines and Minerals Development and Regulation (MMDR) Act, 1957, the Government of India notifies rates of royalty in respect of minerals applicable in all states of and Union Territories (Except in the State of West Bengal). The holder of the mining lease is liable to pay royalty in respect of all minerals removed or consumed from the leased area at the rates specified in the Second Schedule of MMDR Act, 1957. The Central Government is empowered to increase or reduce the rates of royalty, but it can not increase the rate in respect of a mineral more than once during a period of three years. The royalty is to be paid at such a time and in such a manner as the State Government may prescribe. The rates of royalty of zinc are levied on the basis of contained copper metal in the ore produced. The royalty rate applicable is "Four Point two percent of London Metal Exchange “Copper Metal Price chargeable on the Contained Copper Metal in the ore Produced.

5.3.2 Dead Rent

The holder of a mining lease must pay to the State Government dead rent annually at such a rate as may be specified in the MMDR Act, 1957, for areas included in the mining lease.

(1) Presently the rate of dead rent applicable to the leases granted for low value minerals are as under

Rates of Dead Rent in Rupees per Hectare per Annum

From 2nd year of lease	3rd & 4th year	Fifth year onwards
200/-	500/-	1000/-

(2) Two times the rate specified in paragraph (1) above in the case of lease granted for medium value minerals.

(3) Three times the rate specified in paragraph (1) above in the case of lease granted for High Valued Minerals

(4) Four times the rate specified in paragraph (1) above in the case of lease granted for precious metals and stones.

Copper being included in the list of High Valued Minerals the rate of dead rent chargeable for copper is three times the above rates i.e. Rs. 600/- per hectare per annum for second year of lease and Rs. 1500/- per hectare per annum in 3rd & 4th year and 5th year onwards Rs. 3000 per hectare.

5.3.3 Surface Rent

The lessee is required to pay surface rent for the surface area used for mining operation at a rate not exceeding the land revenue as may be specified by the State Government in the Mining Lease. The rates of surface rents are specified by the State Governments and hence vary from state to state.

5.3.4 Future Forecast of Copper Prices

The unprecedented volatility in copper market makes it very difficult to forecast the future price range. However analyst worldwide forecast the prices. The same are given in **Annexure: 5-IV.**

Chapter 6. Demand and Supply

Forecast for demand and supply of a commodity or mineral has always been an intricate and interesting part. The present Market Survey on copper metal is a maiden attempt in respect of metals. All the previous Market Surveys were mostly covered the industrial minerals as well as metallic minerals such as iron ore.

The very nature of use of metals, especially copper, starting from metallic use in different forms such as wires, bars, sheets, pipes, plates and in manufacture of chemicals and alloys made it more challenging for arriving at an acceptable forecast.

In the following paragraphs the Internal Demand (present and future) of copper metal has been attempted. Demand-Supply analysis of copper metal in the country has been carried out.

6.1 INTERNAL DEMAND

6.1.1 Present Demand

i) Reported Consumption

Copper is an important metal as far as electrical industry is concerned. The electrical industry has to some extent replaced copper with aluminium in transmission of electricity in the form of transmission lines, underground cables, as well as wires for household fittings. However, the durability of copper, conductivity, ductility and long life made copper the most sought after material in motor winding, power cables and wires and electronic products. Copper is also used in building and construction industry, transport, ordnance and in making copper compounds.

The industry wise consumption of copper is given in **Table: 6.1** based on the data collected from consuming industry on non-statutory basis and hence the coverage is not complete.

Table: 6.1- Industry wise Consumption of Copper Metal, 2004-05 to 2008-09

(In tonnes)

End use Industry	**2004-05**	**2005-06**	**2006-07**	**2007-08**	**2008-09**
Cable & Winding Wires	72,845	74,392	78,775	80,855	125,746
Semis & Alloys	41,391	42,625	52,716	50,724	41,129
Electricals	13,355	10,908	13,436	13,415	15,762
Auto Ancillary	2,754	5,597	3,731	3,539	3,023
Others	8,969	9,355	9,362	9,194	8,729
Total Metal (A)	139,314	142,875	158,019	157,727	194,389
Total Scrap (B)	35,936	70,320	74,052	74,702	73,358
Grand total (A+B)	**175,250**	**213,196**	**232,071**	**232,428**	**267,747**

The consumption given in above table relates to units in the organized sector only and more pertinent to the units responding to our queries. It is thus implied that substantial amount of metal is consumed in un-organised sector for which there is no record available and hence it is not possible to realistically assess the demand based on reported consumption.

ii) Apparent Consumption:

In absence of authentic industry/sector wise consumption data of copper an apparent consumption based on production, imports and exports is tabulated and presented in **Table: 6.2.** The production of copper considered includes secondary production from scrap recycling industry as discussed in **Supply Chapter.**

Table: 6.2 -Apparent Consumption of Copper, 2004-05 to 2009-10

(In tonnes)

Year	**Apparent Production of copper metal** (inclusive of estimated production from secondary sources)	**Imports**	**Total availa-bility**	**Exports**	**Apparent consumption**	**% Growth/ fall**
1	**2**	**3**	**2+3 =4**	**5**	**4-5=6**	**7**
2004-05	496025	32259	528284	132842	395442	
2005-06	635098	36810	671908	162749	509159	(+) 28.76
2006-07	614836	12793	627629	254717	372912	(-) 26.75
2007-08	601782	15804	617586	204585	413001	(+) 10.75
2008-09	616368	17452	633820	138001	495819	(+) 20.05
2009-10	639438	11542	650980	199842	451138	(-) 9.01

From the above Table it may be seen that the apparent consumption of copper which was 3.95 lakh tonnes in 2004-05 rose to 5.09 lakh tonnes in 2005-06 and settled at 4.50 lakh tonnes in 2009-10. The compounded annual growth rate of apparent copper consumption from 2004-05 to 2009-10 was 4.76% or say 5% per annum. The CAGR as per XI plan of 6.6% per annum seems to be in tune with the CAGR shown by apparent consumption.

6.1.2 Future Demand

Sectorial analysis of consumption indicates that the industry-wise consumptions of copper is maximum in the production of copper wires to be used in electrical industry as household wiring, winding wires, automobile wiring as well as in many other ways.

There is an overall increase in the production of various goods namely electric motors, fans, automobiles, wiring and winding wires, transmission cables, refrigeration and air-conditioning plants, air conditioner, washing and laundry machines etc. The details of compounded annual growth rates (CAGR) of various copper consuming machines/equipments is given in **Annexure:6-I.** Considering the apparent consumption as given in **Table 6.2** from 2004-05 to 2008-09 a CAGR of 12.2% have been arrived and used for forecasting the apparent consumption till 2024-25 as given in **Table 6.3**. The apparent consumption during 2009-10 has not been considered as it shows a negative growth and not representing the factual position.

1) Demand Forecast of Copper on CAGR & GDP

Electrical industry is by far the largest industry consuming copper to a tune of 50% of the total consumption in the country. Copper is used in making wires of different diameter to suit the requirements such as making cables, transmission and winding wires for household as well as industrial purposes.

Production of copper has seen an unprecedented growth in recent years because of the smelting capacity came up in private sector on the basis of imported concentrates. In addition to this the recovery of copper from scrap is gaining importance and contributing about 20% of the total primary production.

Therefore, on the basis of primary and secondary production of copper, an estimated production of 639 thousand tonnes has been arrived at in 2009-10. Although the country exports sizeable quantities of copper presently it also imports some quantities of copper. By adding the apparent production of copper and imports and deducting the exports, the demand of copper has been calculated at 496 thousand tonnes in 2008-09 and 451 thousand tonnes in 2009-10. **Table-6.2.**

The demand of copper is increasing at a CAGR of 12.2%, calculated on the basis of data from 2004-05 to 2008-09. This has been utilized to forecast the demand beyond 2009-10 till 2024-25 and is given in **Table-6.3.** During 11th Plan period, Planning Commission has calculated a GDP growth of 8.2% and for 12th Plan period GDP growth has been estimated at 9-9.5%. Taking into consideration the GDP growth of 9% for 12th plan (2012-17), the demand forecast till 2024-25 has been made, the same is given at **Table-6.3.**

Table-6.3: Internal Apparent Demand Forecast of Copper 2010-11 to 2024-25
(Base Year 2008-09demand of 496 thousand tonnes)

(In '000 tonnes)

Year	Apparent Demand at CAGR 12.2%	Apparent Demand at GDP 9%
2009-10	556	541
2010-11	624	590
2011-12	700	643
2012-13	785	701
2013-14	881	764
2014-15	988	833
2015-16	1109	908
2016-17	1244	990
2017-18	1396	1079
2018-19	1566	1176
2019-20	1757	1282
2020-21	1971	1397
2021-22	2211	1523
2022-23	2481	1660
2023-24	2784	1809
2024-25	3124	1972

From the above discussion it will be seen that the demand forecast attempted by different methods gives different results. In the year 2024-25, the demand forecast considering CAGR of 12.2% comes to about 3.1 million tonnes and applying GDP growth of 9% as forecasted in 12th plan the demand comes to about 2.0 million tonnes.

2) Demand Projection Based on Sector wise Growth

With the liberalised policies of the Government, the Indian copper sector has registered a quantum rise in production. The present installed capacity of refined copper has reached at around ten lakh tonnes per year. India's position has shifted from being a net importer of copper to a net exporter. The main demand for refined copper is in the electrical and electronic sectors, construction sector, consumer durables and transport sector. The per capita consumption of copper in the country is low at about 0.5 kg compared to the usage of 10 kg copper in developed countries, 4.6 kgs in China and 2.4 kgs in the entire world. It has been forecasted that there will be an increase in consumption of copper and in 2025, the per capita consumption in India will be about 3kg. There are certain potential upcoming areas like infrastructure development and railways, power sector, especially rural electrification and information technology sector which may boost the internal demand for copper.

The growth of copper industry is highly dependent on the performance of and demand for products like power and telecommunication cables, transformers, generators, radiators and other ancillary components. Hence, its growth is closely linked with the country's economic and industrial growth. The growth in these industries has been calculated on the basis of production from 2004-05to 2009-2010. The same is given in **Annexure:6-I** which indicates that there is a positive growth in almost all the copper consuming industries.

As per ICSG the share of Electrical and Telecommunication industry in total consumption is 56%, followed by Transport (8%), Consumer Durables (7%) Building and Construction (7%), General Engineering Goods (6%), and Other Industries including Process Industries (16%).

A short write up in respect of various consuming sectors is given below:

A. Growth in Electrical and Telecommunication Industry

i) Tele Density & IT industry : The Government has, by allowing Foreign Direct Investment in telecommunication sector ranging from 49% to 100% from basic telephony to providing gateways has accelerated the tele-density from 0.4% to 9% in the span of the last 10 years. This growth was always been supported by continuously evolving policies & thus a drastic reduction in the cost per consumer. In view of this success, mainly achieved with private sector participation for the tele density & broadband connectivity subscribers will create a huge opportunity for copper in the last mile in the form of structured wiring and coaxial cables in India. The expected density of usage could be lower in developed countries as the lower prices of competing technologies like wireless & fiber optic cables will reduce the share of copper even in the last mile.

ii) Energy : To support the average GDP growth of approx. 7% during the last 3 years there has been a considerable increase in primary energy demand. The growth in a secondary source such as electricity was more than 10%. This has increased the peak load shortage. Therefore the country has set a priority to:

a) Increase availability by adding additional generation capacity by 2012.

b) Strengthening the inter-regional power transmission back-bone with 30 GW capacities by 2012 from the existing capacity of 8.1 GW & inviting a private partnership to achieve this target.

c) Improve supply side efficiency by strengthening the distribution system & reducing the system efficiency by creating an incentive mechanism for distribution utilities & adopting an open access policy along with 100% private participation in distribution business. In addition to this, 100% rural electrification will result in an increase in the distribution network in rural areas. All this will result in an increase in demand for copper in the power generation, transmission & distribution sectors such as magnet wire used in generators, instrument transformers, power & distribution transformers, busbars, power & control cables & switch gears. The density of the usage is also expected to grow due to the focus on supply side efficiency.

iii) Energy Conservation : After establishing the national energy conservation office (BEE) under energy conservation act; government has set a target of saving the equivalent of 23,700 MW in power generation capacity by investing in energy conservation initiatives. Under this the focus is on Indian Industry Programmes for Energy Conservation, Demand Side Energy Management, Standards and Labeling Programme, Energy Efficiency in Buildings and Establishments, Energy Conservation Building Codes, green building, Professional Certification and Accreditation, Manuals and Codes, Energy Efficiency, Policy Research Programme, Delivery Mechanisms for Energy Efficiency Services. This will create additional demand for copper used in products, systems & appliances.

iv) Renewable Energy : With an installed capacity of 4,200 MW till date, wind power installed capacity has grown by 12 times in 10 years. With the strong driver from wind mill manufactures the central & state governments have created policies that will keep up a similar growth trend. As per the new & renewable policy statement 2005, Ministry of Non – conventional Energy Sources is targeting wind, solar, biomass, Hydro & nuclear power sources to achieve the targets defined in the Kyoto protocols.

v) New Electric Connections in Rural Areas : As per government statistics 56% of rural houses are still deprived of access to electrical energy . The Government of India has targeted 100% electrification of all rural houses by 2012.This will drive additional growth in the building wire segment; though the density of usage in rural houses will be lower than in urban houses.

vi) Off – Grid Connections : In order to achieve 100% rural electrification target & by creating a open access policy it is expected to create the growth in off – grid connections based on oil as the primary source of energy & renewable energies like wind, solar cell, co-generation & mini or micro hydel power plants.

The share of copper consumption in Electrical and Telecommunication Industry has been taken as 56 % of the total all India consumption of copper.

B. Transport Sector

i) Automobiles : The automobile sector in India is growing at a fast rate. It is expected to have similar growth in the future. The increase in sophistication and size of Passenger vehicles will give rise to a higher density of Auto-wiring harnesses. Further, the swapping of fuel from imported Petroleum Oil derivatives to locally available Natural gas will create more opportunities for copper tubes in this sector.

ii) Mass Rapid Transport & Railway Network : Conversion from oil fuel to electricity has created a niche for copper in railway sector. The railway electrification will continue in next 5 years. Additional copper demand will be created in urban mass rapid transport to reduce the traffic jams in crowded cities. This will create opportunity for copper in underground trains & sky train projects announced recently.

The share of copper consumption in Transport Sector has been taken as 8 % of the total all India consumption of copper.

C. Appliances and Consumer Durables

The penetration of air-conditioners & refrigerators in India's households is very low as compared to other countries in the region. With the increase in per-capita earnings in the country it is expected to be similar other countries in the region. The current trend in appliances market is growing and it is expected to grow further for the next 5 years. Today, Chinese & Korean brands entering in the market are creating healthier competition by reducing the market prices which may lead to increase in market growth of appliances industry. There is a large potential for improvement in the levels of Energy Efficiency which would increase the density of Copper usage.

The share of copper consumption in Appliances and Consumer Durables has been taken as 7 % of the total all India consumption of copper.

D. Growth in Building and Construction Industry

The average expected growth of the construction industry of approx 7% - 9% PA will continue to drive the demand for copper building wires. In view of the growth in per capita disposable income the standard of living will improve; that will increase the density of copper usage in building wires. The share of copper consumption in Building and Construction Industry has been taken as 7% of the total all India consumption of copper.

E. General Engineering

For last 3 years the industry production is growing at average rate of 7% to 8%. It is expected to have a similar growth rate in the future. Indian industry is also gearing itself to demonstrate global competitiveness by improving efficiency in the core sector of industry. The energy conservation act 2001 has created special focus on energy conservation in the industry sector. As industry needs more electricity at cheaper cost, and also to improve the overall efficiency there will be growth in the captive co-generation capacity using fossil fuel & waste as a source of energy.

This will create demand for more & energy efficient motor driven systems, transformers, power cables & wires, bus-bars. There could be additional potential in heat exchanger products as well. The share of copper consumption in General Engineering has been taken as 7% of the total all India consumption of copper.

F. Others Industries Including Process Industries

Others industries including process industries consumes about 16% of the total copper consumption in the country. The process industry uses copper in making different types of chemicals, alloys, compounds etc. and the making decorative and utility items.

i) Cooking Gas : Due to discoveries of large Natural Gas deposits within the country, the Government is pursuing a policy of substitution of Liquified Petroleum Gas which is imported. With this, the method of delivery would change from Cylinders to Piping, giving opportunities for Copper tubes in the last mile.

In addition to this, copper and its alloys having anti microbial properties. This should be exploited fully and completely and now emerging applications of copper may further be explored.

On the basis of above discussion, the projection of demand have been attempted by assuming the growth in sectors namely Electrical and Telecommunications as 9% followed by General Engineering (8%), Transport(8%), Consumer Durables (7%), Building and Constructions (7%) and Other Industries including Processing Industries as (7%). The growth has been calculated considering an apparent consumption in 2008-09 at 496 thousand tonnes as base year. The same is given in **Table 6.4.**

Table 6.4: Demand Forecast of Copper Metal as per Sector-wise Growth, 2010-11 to 2024-25 (Base Year 2008-09 Apparent Demand of 496 thousand tonnes)

(In thousand tonnes)

Year	Industry						Total
	Electrical & Telecommunication at 9% growth	General Engineering at 8% growth	Transport at 8% growth	Consumer Durables at 7% growth	Building& Construction at 7% growth	Process Industries & Others at 16% growth	
2010-11	330	35	46	40	40	107	598
2011-12	360	38	50	43	43	124	658
2012-13	392	41	54	46	46	144	723
2016-17	553	56	73	60	60	261	1063
2020-21	780	76	99	78	78	472	1583
2024-25	1101	104	135	102	102	853	2295

Note: *Based on Sector wise share of Electrical and Telecommunication-56%, General Engg.-6%, Transport-8%, Consumer Durables-7%, Building & Construction-7% and Process Industries and Others-16%.*

It is seen from the **Table 6.4** that the apparent demand has increased from 496 thousand tonnes in 2009-10 to 1 million tonnes in 2016-17, the terminal year of 12th Five Year Plan and with the same growth rate it has reached 2.3 million tonnes in 2024-25.

As seen from the above table, the total apparent demand of copper will be 723 thousand tonnes in 2012-13. The present capacity of about one million tonnes is able to cater to the demand upto 2012-13 if all the plants start production with their full capacity. There will be demand of concentrates which are presently being met by imports by Sterlite and Hindalco from their captive sources abroad as well as from open markets. HCL is also importing concentrate to feed its smelter.

3. Judgmental Analysis

In all the three cases the demand forecast during 2024-25 of 3.1 million tonnes is on higher side and is not considered. However, the demand based on the sectorial growth of 2.3 million tonnes is realistic and hence considered. This demand is also having implications from sectoral growth of copper consuming industries. Whereas on the basis of GDP growth of 9%, the demand of 2.0 million tonnes is slightly on lower side hence not considered. Moreover it is expected that the GDP growth of the country may increase from 9% to two digit in near future.

6.2 FUTURE SUPPLY SCENARIO

1. Resources

Resources of copper in the country are mainly located in the states of Rajasthan, Madhya Pradesh and Jharkhand which together accounted for about 93% of the total resources available at 1394 million tonnes with a metal content of 11.40 million tonnes.

2. Production of Copper Ore

HCL is the only company in the country producing copper ore from its mines located in Rajasthan, Madhya Pradesh and Jharkhand. In the year 2000-01, the production of copper ore was 3.49 million tonnes with a grade of 1.07% Cu, with wide fluctuation during the period 2000-01 to 2007-08 the production reached up to 3.45 million tonnes in 2008-09 with a grade of 0.92% Cu. However, there was a fall in production in 2009-10 by 6.50% at 3.23 million tonnes as compared to the previous year.

The GSI, MECL and other agencies are exploring the possible locations of copper mineralisation.

As per Hindustan Copper Limited estimates the total copper mineralisation area in the country is spread over an area of 60,000 sq.km, out of which only 20,000 sq.km. area has been explored till date and balance 40,000 sq.km area is awaiting exploration.

It is presumed that the exploration in the balance area will ease out the pressure in indigenous supply of ore. A comprehensive scheme is to be re-drawn for re-exploration of the existing deposits as well as exploring new and virgin areas for establishing copper resource.

The HCL has planned a number of green field projects. It has applied for 20 new concessions (RP/PL &ML) for Baniwali Ki Dhani and Dhani Basri area in Rajsthan, Sitalpani Block and Jatta Block in Balaghat district of Madhya Pradesh; and Tamrapahar-Dhaboni deposit in Singhbhum district of Jharkhand. The HCL has also projected that the production of ore will increase at a CAGR of 21.35% from 2010 onwards. The production of ore which was 3.2 million tonnes in 2010 will reach to 12.4 million tonnes in 2017.

The details of projection in respect of production of copper ore from 2010 to 2017 are given in **Table-6.5**.

Table -6.5: Production of Copper Ore, 2010 to 2017 by applying CAGR 21.35% by HCL

Year	Production (Million tonnes/annum)
2010	3.22
2011	3.66
2012	4.71
2013	5.72
2014	6.94
2015	8.42
2016	10.22
2017	12.40

In the wake of rise in prices of copper the HCL has decided to revive operations of the closed Chitradurga Copper mine of Hutti Gold Mines Ltd. (HGML) in Chitradurga district Karnataka. A joint inspection and technical evaluation by HCL and HGML was taken and decision was taken to revive the mine.

The non-operational underground mine has an estimated deposit of ore to a tune of 2.62 million tonnes with an average grade of 1.13% Cu and in addition to this the mine has deposits of 2.796 tonnes of recoverable gold.

The company is also planning to bid for copper mines in Afganistan which is under developmental stage.

HCL plans to invest Rs.3677 crore to increase the mine production capacity from 3.2 million tonnes to 12.41 million tonnes by 2016-17. It would spent a total of Rs.297 crores in next fiscal year for expansion of the Khetri, Kolihan, Banwas and Singhbhum mines and reopening of the Rakha and Kendadih mine. HCL plans to invest Rs. 174 crore for expansion of the Khetri mines from 0.5 mtpa to 1 mtpa. In the Kolihan mines, it would invest Rs. 275 crore for expanding the capacity from 0.5 mtpa to 1.5 mtpa. It will also spend Rs. 91 crore to develop the Banwas mine with a capacity of 0.6 mtpa. The Surda mine’s capacity will be expanded to 0.9 mtpa from 0.42 mtpa at a total cost of Rs. 216 crore. It would also invest Rs. 347 crore to reopen the closed Rakha mine and Rs. 87 crore fro enhancing the capacity of the Kendadih mine to 0.21 mtpa.

The HCL has plans to outsource the 25 million tonne Banwas deposits in Rajasthan for ore extraction to Byrnecut Mining of Australia on a risk-sharing model. HCL is opt for a joint venture to re-commission the Chapri Sideshwar mine in Jharkhand with 80 million tonne resources.

3. Production of Copper Cathodes

As already mentioned that there is only one integrated producer of copper cathodes in the country namely HCL. However, other producers namely, Sterlite Industries (India) Ltd. and Hindalco Industries Ltd. produce copper cathodes from imported copper concentrates. There is one more producer of copper cathode namely Jhagadia copper which produces copper cathodes from Scrap and also uses about 15% of copper concentrates. The share of HCL in total cathode production is very small at about 9% only. The major contribution comes from Hindalco Industries Ltd.'s Birla Copper at 64% and Sterlite Industries at 26%. Jaghadia's contribution is only 1% in total cathode production.

The production of copper cathode in the country during 2000-01 was 259 thousand tonnes only, however, with the economic liberalization and emergence of private players there has been unprecedented increase in the production of copper cathodes. The production of copper cathode reached to 2036 thousand tonnes in 2024-25. On the basis of yearly increase in the production of cathodes from 2000-01 to 2009-10 an impressive CAGR of 9.35% has been calculated and the same has been utilized to forecast the production of cathode till 2025, the same has been given in **Table -6.6.**

Table-6.6: Estimated Production of Copper Metal, 2009-10 to 2024-25 by applying CAGR 9.35% and Apparent Production Copper

(In '000 tonnes)

Year	Production Copper cathode (9.35%)CAGR	Estimated Production	Remarks
2009-10	533	639	By adding 20% secondary production
2010-11	582	699	
2011-12	637	765	
2012-13	697	836	
2013-14	762	914	
2014-15	833	1083	By adding 30% secondary production
2015-16	911	1184	
2016-17	996	1295	
2017-18	1089	1416	
2018-19	1191	1548	
2019-20	1302	1823	By adding 40% secondary production
2020-21	1424	1994	
2021-22	1557	2180	
2022-23	1703	2384	
2023-24	1862	2607	
2024-25	2036	2851	

In earlier chapter it has already been described that there is a production of secondary copper from scrap to a tune of 20% of the total primary production and by adding 20% of secondary production with the primary production an apparent production of 312 thousand tonnes was estimated in 2000-01 which reached to 639 thousand tonnes in 2009-10.

It has been presumed that this trend of 20% of secondary production will continue till 2013-14. However, it has also been estimated that there will be increased availability of secondary copper hence the percentage of secondary copper production has been increased to 30% till 2018-19 and 40% till 2024-25. The same has been given in **Table-6.6**. It is seen from the table that the total production of copper in 2024-25 will be 2851 thousand tonnes.

6.3 DEMAND SUPPLY ANALYSIS

The future demand of copper is envisaged at 2.3 million tonnes in 2024-25. This is considered keeping in view the sectoral break up of future demand which is more realistic as compared to CAGR and projected GDP growth.

To fulfill the demand the production of copper is also projected with due justification. The projected production of copper in 2024-25 comes to 2.8 million tonnes. This includes the production contributed by secondary source in addition to primary. The primary production will contribute 2.0 million tonnes whereas secondary production will be 0.85 million tonnes. This is justifiable production which will meet the future demand.

Chapter 7. Summary

Copper a Non-Ferrous Metal is of utmost importance to the industry since ancient times. Copper was known to be used since the advent of human civilization for making utensils, artifacts, tools as well as cannons and other warfare equipments. Copper in association with zinc makes alloys namely brass and bronzes. Brass look alike gold was sought by the nobles in ancient past and bronze was used to cast statues and other articles as it bears the vagaries of atmosphere better than other metals. Copper is an essential component of energy efficient electrical motors & transformers.

The copper scenario in the country dates back to ancient times. The copper metal forms the basis of electrical industry where it is used in the form of copper wire. About 50% of Indian consumption of copper is attributed to electrical and electronic industry.

The industries require metals in its purest form as per BIS specifications laid down for various industries. India is endowed with the resources of these metals and the production of ores, concentrates and metals is being done in varying proportions.

India is not self sufficient in the resources of copper ore. The occurrences of copper ore have been reported from number of states but the resources are mainly occurring in the states of Rajasthan, Madhya Pradesh and Jharkhand. These three states are the only producer of copper ore in the country. However, the Birla copper of Hindalco Industries Limited and Sterlite Industries Limited produces copper metal from the imported concentrates in the States of Gujarat and Tamil Nadu, respectively. There is a thriving industry of recycling of copper metal which is contributing to the total refined production.

In the copper scenario, the average percentage of copper content in ore is very low and in 2008-09 the average metal content in copper ore mined was 0.92% Cu. India also imports sizeable quantities of copper concentrates to meet out the domestic demand of copper smelters. The copper metal production from imported concentrates is able to meet the ever increasing demand of industries as well as exports. The production of copper cathodes has reached to 533 thousand tonnes in 2009-10 from a level of 260 thousand tonnes in 2000-2001.

Worldwide, copper is being produced in a number of countries. In the case of mine production of copper Chile is the leader but the copper metal production is maximum in China.

There is a thriving trade of copper metal in various forms throughout the world. Chile with exports of 3191 thousand tonnes was the largest exporter of refined copper in 2009 contributing 37% in the total world's export, while China was leading in total world's imports to a tune of 3185 thousand tonnes having a share of 40%.

India's trade of copper is mainly focused on the imports of copper ore & concentrates as two smelters of Sterlite Industries Ltd and Birla Copper are totally based on imported concentrates. India also imported copper scrap, alloys of copper and refined copper.

The imports of copper ores & concentrates during 2008-09 were 2265 thousand tonnes as compared to 1914 thousand tonnes in 2007-08 an increase of 18% mainly from Chile and Australia. The exports of refined copper from India reached to a maximum at 236 thousand tonnes in 2006 but in 2009 the exports of refined copper was decreased to 185 thousand tonnes. The exports of refined copper were mainly to China and Saudi Arabia.

The worldwide trading of base metals has resulted in wide fluctuation in prices. As per LME prices, the copper prices peaked to $ 8985 per tonne in 2008 from a low of $ 1101 per tonnes in 1993 and settled at an average price of $ 7539.32 in 2010.

There are industries based on copper in the country. The demand of copper is increasing day by day with the expansion in electrical, electronic and telecommunication industries. The recycling of copper is adding to the total production of copper in the country. There was only one producer of copper namely HCL, based on indigenous copper concentrates. Now the production of primary copper is by Sterlite Industries Ltd. & Birla Copper from imported concentrates. This has changed the entire scenario by emerging India as self sufficient and exporter country of copper. Against an apparent production of 639 thousand tonnes in 2009-10, there was an apparent consumption of 451 thousand tonnes by all industries in 2009-10, leaving a balance of 200 thousand tonnes for exports. The apparent consumption of 496 thousand tonnes in 2008-09 has been considered to forecast the demand.

The total demand forecast for copper in 2024-25 has been estimated at 2.3 million tonnes on the basis of sectorial growth which is below the projected copper metal production at 2.8 million tonnes from both primary and secondary sources. Hence there seems to be no problem in the availability of copper metal.

World Future Scenario beyond 2010

The forecast in respect of copper consumption in world have been arrived by calculating the compounded annual growth rate of refined copper consumption from the year 2001 to 2010 in respect of World, Europe, America, Africa, Asia and Oceania. It has been observed that the average growth of refined copper consumption is 3.20% while area-wise growth rates are negative in Europe, America and Oceania. The growth rates in the developing and under developed countries are on the positive side and in Asia there is a healthy growth rate of 8.18% and in Africa it is 1.78%.

The World Bank projected a GDP growth of 3.3% in 2010 and 2011 while in 2012 the forecast is 3.5% from a level of negative growth of (-) 2.1% in 2009.

On the basis of these growth rates the consumption of refined copper in the World has been arrived at 31 million tonnes (CAGR 3.2%) in respect of entire World while on the basis of growth rates in different areas the consumption of refined copper have been estimated at 46 million tonnes in 2025.

The abrupt rise in consumption from China, Korea and India the demand of 46 million tonnes in 2025 seems to be higher side hence the demand of 31 million tonnes calculated on the basis of CAGR 3.2% for the entire World has been adopted in this report.

Annexure: 3 - I

LIST OF THE UNITS REGISTERED WITH MOEF/CPCB AS RECYCLERS/REPROCESSORS HAVING ENVIRONMENTALLY SOUND MANAGEMENT FACILITIES COPPER METAL WASTE RE-PROCESSORS

(As on 13.5.2010)

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
I	**ANDHRA PRADESH**		
1.	Hitec Smily, Shed No. 23, Phase-I, IDA, Cherlapally – 500 051, Hyderabad, Andhra Pradesh.	720	Insulated Copper Wire Scrap/ Copper with PVC Sheathing including ISRI code material namely 'Druid' Jelly filled copper cable only.
2.	Surya Udyog, Plot No. 9, Phase-I, IDA, Cherlapally, Hyderabad-500 051, Andhra Pradesh.	3000	Insulated Copper Wire Scrap/ Copper with PVC Sheathing including ISRI code material namely 'Druid' Jelly filled copper cable only.
3.	Raghavendra Industries, Plot No. 305 to 307 & 311 to 323, Bouppal Village,Ghatkesar Mandal, Hyderabad -500 039, Andhra Pradesh.	3000	Insulated Copper Wire Scrap/ Copper with PVC Sheathing including ISRI code material namely ' Druid' Jelly filled copper cable only.
4.	India Extrusion, P-9/13/1, I.D.A, Nachanam, Rangareddy Distt.- 500 076, Andhra Pradesh.	3500	Copper scrap only.
	Total	**10,220**	
II	**CHATTISGARH**		
1.	Power Pack Industries, 32/D, Light Industrial Area, Bhilai, Durg, Chhattisgarh -490 026.	150	Copper Scrap.
2.	Fabritech Engineers, 740-C, Sector- B, Urla Industrial Area, Raipur – 493 221, Chhattisgarh.	200	Waste Copper & Copper Alloys.
	Total	**350**	
III	**DAMAN DIU & DADRA NAGAR HAVELI (UNION TERRITORY)**		
1.	Metal Link Alloys Ltd. Plot No. 67, Panchal Udyog Nagar, Bhimpore, Daman – 396 210	5313	Copper Scrap, Brass Scrap, Brass Dross, Copper Druid, Copper Skimming & Oxide Mill Scale Copper, Reverts, Cake & Residues
2.	Metal Gems, 113-120, Panchal Udyog Nagar, Bhimpore, Daman.	15000	Copper Druid.
	Total	**20,313**	

Contd….

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
IV	**GUJARAT**		
1.	Tarunkumar Industries, Plot No. 132, 133 & 134, Gozariya GIDC, Tal & Dist.-Mehsana, Gujarat	450	Copper Scrap Copper Dross & Copper Oxide Mill Scale
2.	Choksi Metal Refinery, Road No.11, Udhana, Udyognagar, Udhana Distt.Surat, Gujarat	2000	Copper Druid, Copper Residues, Copper Reverts & Cakes
3.	R.J.Industries, Plot No.233, Road No.6/E, New Industrial Estate, Udhana, Distt.Surat-394 210, Gujarat	750	Copper Dross, Copper Oxide Mill Scale, Copper Reverts Cakes & Residues
4.	Krishna Chemicals, Survey No.3/1-P, Village-Sanghpur Tq-Vijapur, Distt.Mehsana, Gujarat	90	Copper Reverts, Cakes & Residues,Waste,Copper Copper Alloys in dispersible form
5.	Jay Bhawani Metal Industries, Plot No.211-212, Road No.6F, New Estate, Udyognagar, Udhana, Surat, Gujarat	9290	Copper Druid
6.	Jhagadia Copper Ltd., 747, GIDCIndustrial Estate , Jhagadia Distt.Bharuch-393 110, Gujarat	35000	Copper Dross, Copper Oxide, Mill Scale Copper Reverts Cakes & Residues Copper Druid & Waste Copper & Copper Alloys in dispersible form
7.	Dyelon, 38-39, Soma Kanjini Wadi, Main Road, Khatodara, Surat, Gujarat	288	Copper Dross, Copper Oxide Mill Scale, Copper Reverts, Cake & Residues, Waste Copper & Copper Alloy and Slag from Copper Processing.
	Total	**47,868**	
V	**HARYANA**		
1.	Shree Ganpati Metal Industries, 07-B M.I.E., Part-II, Red Cross Road, Bahadurgarh-124 507, Dist. Jhajjar, Haryana.	9900	Copper Druid
2.	Namo Alloys Pvt. Ltd., 14/1, Mile Stone, Main Mathura Road, Faridabad, Haryana	1200	Copper Druid, Copper Dross and Copper Residue
	Total	**11,100**	
VI	**JAMMU & KASHMIR**		
1.	Verma Metal Industries, Industrial extension Area, Opp. DIC Office, Hatli Morh, Kathua ,(J &K	7450	Copper Reverts, Waste Copper, Copper Dross, Copper Druid and Copper Cable Scrap

Contd….

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
2.	Ess Vee Udyog, 178, SIDCO Industrial Area, Kathua,Jammu (J &K)	14500	Copper Scrap.
3.	Rajdhani Industries Industrial Growth Centre (IGC) Jammu (J &K)	10000	Copper Scrap/Waste Copper.
4.	K. N. K. Chemicals, Industrial Growth, Centre, Phase-I Samba (J&K)	3600	Copper Scrap.
5.	Vrinda Copper Industries Lane No. 4, SIDCO Industrial Complex Phase – II, Bari Brahmana, Jammu(J&K)	4900	Copper Scrap/Copper Waste/Copper Reverts.
6.	Metal Extrusion, 154, SICOP Industrial Estate, Kathua, (J & K)	3000 6000 5000 2000	Copper Druid. Copper Scrap. Waste Copper & Copper Alloys. Brass Scrap.
	Total	**56,450**	
VII	**MAHARASHTRA**		
1.	Hamirani Metals P. Ltd., 10/3/4, Village Kiwale, New Mumbai Bangalore Highway, Kiwale, Maharashtra-412 101	3000	Copper Druid.
2.	Accent Metals Pvt. Ltd., Plot No. C-46, TTC Industrial Area, MIDC-Pawane, Navi Mumbai - 400 708	4900	Copper Druid, Copper Dross and Brass Dross
3.	Parag Sulpha Chemicals, Tech Shed No.-18, Chemical Zone, MIDC, Ambernath, Dist-Thane, Maharashtra	90	Spent Catalyst containing Copper Scrap, Copper Oxide, Mill Scale and Copper Residues
4.	Rohini Metal Alloys, B-56, Kagal Hatkanangale Industrial Area, Kolhapur, Maharashtra	100	Copper Scrap
	Total	**8,090**	
VIII	**RAJASTHAN**		
1.	P. R. Enterprises, G-23, RIICO Industrial Area, Gudli, Dist. Udaipur, Rajasthan.	240	Copper Cakes & Residues.
2.	Raj Industries, G-1/201, RIICO Industrial Area, Gudli Distt-Udaipur, Rajasthan.	240	Copper Cakes and Residues
	Total	**480**	
IX	**SIKKIM**		
1.	Promising Export Ltd., Manpur Village, South Sikkim -737 128	2700	Copper Scrap
	Total	**2700**	

Contd….

Concld….

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
X	**UTTAR PRADESH**		
1.	Lohia Brass Pvt. Ltd., Lakri Fazalpur Delhi Road Moradabad-244 001, U.P.	1500	Insulated Copper wire scrap Copper with PVC Sheathing including Druid, Jelly filled Copper Cables and Waste Copper and Copper Alloys
	Total	**1500**	
XI	**WEST BENGAL**		
1.	Ranichem Industrial Corporation, 188, Manicktala Main Road, Kolkata-700 054, West Bengal	250	Copper Scrap/Copper Oxide Mill Scale/Copper Residue/ Waste Copper and Copper Alloys Copper Slag and Copper Dross.
2.	Eastern Dye Chem (P)Ltd., East Udayrajpur, Madhyamgram, Kolkata-700 129, West Bengal	500	Copper Dross, Copper Oxide Mill Scale, Copper Cake and Residues, Waste Copper & Copper Alloys.
3.	Infinity Electric Private Limited, Shed No.III & I/III, Sector-2, S.E.Z., Falta, PO : Falta, PS : Ramnagar, Distt:24 Parganas(South)	22500	Copper Druid.
4.	Vedik Vanijya Private Limited, 68, Palm Village, Bhasam, P.O. & P.S : Bishnupur, Distt.24, Parganas(South), West Bengal	60000	Copper Druid
	Total	**83,250**	
	Grand Total	**2,42,321**	

Annexure: 3 - II

LIST OF THE UNITS REGISTERED WITH MOEF/CPCB AS RECYCLERS/REPROCESSORS HAVING ENVIRONMENTALLY SOUND MANAGEMENT FACILITIES
OTHER NON-FERROUS METAL WASTE RE-PROCESSORS
(As on 13.5.2010)

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
I	**ANDHRA PRADESH**		
1.	Magus Metals Pvt. Ltd., Lingojigudesm (Village), Chowtuppal (Mandal), Nalgonda Dist, Andhra Pradesh.	10000	Brass dross/Scrap, Copper Scrap, Copper dross, Copper Oxide, Mill Scale Copper & Reverts, Cake, residues spent catalyst containing Copper & Zinc, Zinc Scrap/Ash Dross, Zinc Skimming, Waste Copper & Cu Alloys Slags from Copper processing only.
2	Lakshmi Venkateshwara Metals & Chemicals, K-1 IDA, Gooty Road, Guntakal, Ananthpur, Andhra Pradesh - 515 803.	240 300 240	Spent Catalyst containing Copper Copper Oxides Mill Scales, Reverts, Cake Residues Zinc Ash /Skimming.
	Total	**10,780**	
II	**CHATTISGARH**		
2.	Shreyansh Industries, 14-A, Light Industrial Area, Bhilai, Dist. Durg, Chhattisgarh	300	Brass dross/Scrap, Copper Scrap/ Copper dross/Copper Oxide, Copper Cakes/Copper residues spent Copper Druid.
	Total	**300**	
III	**DAMAN DIU & DADRA NAGAR HAVELI (UNION TERRITORY)**		
1.	Dhakad Metal Corporation, 341/4, Bharat Industrial Estates, Bhimpore- Nani, Daman-396 210	2700	Brass Dross Copper dross, Copper Oxide, Copper Scrap & Brass Scrap.
2.	Raja Zinc Pvt. Ltd., Plot No. 3, 4 &5, Bharat Industrial Estates, Bhimpore, Nani, Daman-396 210	4350	Copper Druid, Copper Ash, Residues and cakes, Copper Dross, Copper Oxide Mill Scale Copper Skimmings, Copper Reverts, Brass Dross, Zinc Dross, Zinc Ash and Zinc Residues.
3.	Nissan Copper (P) Limited Sr. No. 168/2/1, Village Rudana, Dadra Nagar Havelli	4600	Copper Dross, Copper Druid, Copper Scrap, Copper Residues, Brass Dross & Brass Scrap.

Contd...

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
4.	Sunland Metal Recycling Industries, S. No. 89/1/2, Village Karajgan, Dadar & Nagar Haveli, Silvasa- 396230	12000	Brass Dross/Copper Druid Copper Cakes & Residues, Copper Oxide Mill Scale Brass Dross Zinc Ash & Skimmings & Zinc Dross.
5.	B.N. Industries, Plot No. 75/80, Bharat Industrial Estate, Bhimpore,Nani , Daman.	6360	Brass Scrap, Brass Dross, Copper Scrap, Copper Dross, Copper Reverts, Cakes & Residues Waste Copper and Copper Alloys, Copper Druid, Zinc Drops and Zinc Scrap.
6.	Spring Merchandisers P. Ltd., Survey No. 170(1) & (02), Shed No. 1, Panchal Udyog Nagar, Bhimpore, Daman	9000	Brass Dross, Copper Oxide, Mill Scale Reverts, Cakes, Residues, Copper Dross, Copper Druid & Zinc Ash.
7.	RHJ Metals Private Limited, S. R. No. 47/1/1/3 & 47/1/4, Village Kherdi, D&NH Silvaasa	1200 5400	Copper Oxide, Mill Scale Copper Reverts, Cakes & Residue, Waste Copper & Copper Alloys in dispersible form, Slag from copper processing and spent cleared Metal Catalyst containing Copper. Brass Dross, Zinc Dross, Copper Dross, Zinc Residues, Zinc Ash & Zinc Skimmings.
8.	Shri Singhal Commodities Pvt.Ltd. 47/1/1/1, 47/1/2 & 47/1/3, Amboli, Kherdi, Silvaasa	5670 5500	Copper Dross,Brass Dross and Zinc Dross. Zinc Ash and Residues, Copper Reverts, Cakes & Residues.
9.	NICO Extrusion Pvt.Ltd. Survey No.678/1/3, Plot No.4, Bhilad-Silvaasa Main Road, Naroli, Silvaasa , Daman – 396 235	5760 3600	Brass Dross, Copper Dross, Copper Residues, Copper Oxide Mill Scale and Copper Druid Zinc Dross, Zinc Ash and Skimming of Hazardous Waste containing zinc

Contd...

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
10.	Transalloy India Pvt.Ltd., Survey No.71/3, P.B.No.39, Village - Samarvarni, Opp. Krishna Knitwear Technology Ltd, Silvaasa–396230	5400	Brass Dross, Copper Dross, Waste Copper & Copper Alloy and Zinc Ash.
	Total	**71,540**	
IV	**GUJARAT**		
1.	Dadbhawala Fertilizers & Chemicals Pvt. Ltd., Plot No. 103/104, GIDC Area, Trolley Road, Wadhwan City, Gujarat – 363 035	1440	Copper Oxide, Mill Scale Copper Dross, Brass Dross, Copper Reverts, Cakes & Residues, Zinc Dross, Zinc Ash & Residues .
2.	Shanti Agro Products, Plot No. C1-B-13, Old GIDC, Kabilpore Navsari - 396 445 Gujarat	7776	Copper Scrap, Zinc Ash, Zinc Skimmings, Copper Oxide, Mill Scale Copper Cakes and Residues, Zinc Bearing Wastes arising from smelting & Re-Refining.
3.	Madhav Extrusion, Plot No. C-1/298 & 301, Phase-2 GIDC, Dared –Jamnagar-361004, Gujarat	1080	Brass Scrap.
4.	Ambica Recycling, Plot No. 621-622, GIDC Phase-II, Dared Jamnagar - 361 004 Gujarat	1080	Copper Scrap, Zinc Scrap, Brass Scrap, Zinc Dross & Copper Druid.
5.	Siyaram Metal Pvt. Ltd., Plot No. 12 & 14, Village – Lakhabaved, Post – Khodiyar Colony, Jamnagar – 361 005	5400	Brass Scrap, Brass Dross, Copper Scrap & Zinc Scrap.
6.	Deep Recycling Industries, Plot No. 773 GIDC, Phase-II, Jamnagar-361 004	4860	Brass Scrap, Copper Scrap & Zinc Scrap & Copper Druid.
7.	Zinco Chemical Industries, Plot No. 22/2, 23, GIDC Estate, Kalol Dist. Gandhi Nagar, Gujarat.	3000	Zinc Ash, Zinc Scrap and Brass Scrap.
8.	S. J. Coating Industries, Block No. 227, Vill. Ukharla, Dist. Bhavnagar, Gujarat.	750	Spent Catalyst containing Nickel, Spent Catalyst containing Copper Dross, Copper cakes and Residues, Spent Catalyst containing Zinc, Zinc Ash Skimmings and Residues.

Contd...

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
9.	Shree Super Industries, A-20, GIDC, Shankar Tekri, Jamnagar – 361 004, Gujarat	270	Brass Scrap.
10.	Viom Impex, Plot No.3003-3007, Phase-III GIDC Estate, Dared, Jamnagar Gujarat	8400	Brass Scrap, Copper Scrap, Zinc Scrap, Brass Dross, Copper Dross, Zinc Dross and Copper Druid.
11.	Kissan Agro Fertilizers, Shed No.A-2/2219, Phase-III, GIDC, Vapi-396 195 Gujarat.	450	Zinc Ash, Zinc Skimmings & Other Zinc Bearing Wastes, Copper Oxide, Mill Scale and Waste Copper & Copper Alloys.
12.	D&G Metal Inc., Plot No. 109/110, Phase-II GIDC Estate, Jamnagar – 361 005 Gujarat	1250	Brass Scrap, Copper Scrap and Zinc Scrap.
13.	Senor Metals Pvt. Ltd., Plot No.353, GIDC Phase-II Dared, Jamnagar-361 004 (Gujarat)	600	Brass Scrap, Copper Scrap and Zinc Scrap.
14.	Mahalaxmi Extrusions, SPL 431, Shanker Tekri, Udyognagar, Jamnagar-361 004, Gujarat	2160	Brass Scrap, Copper Scrap, Zinc Scrap, Brass Dross, Copper Dross, Zinc Dross and Copper Druid
15.	Marvel Metal Corporation, Plot No. 771, GIDC Estate, Phase –II Dared, Jamnagar – 361 005, Gujarat	600	Brass Scrap and Brass Dross
16.	Sterling Enterprises, 408/4, GIDC, Shankar Tekri, Jamnagar-361 004, Gujarat	600	Brass Scrap, Copper Scrap and Zinc Scrap
17.	Suraj Recycling Pvt. Ltd., 656/566,GIDC Phase-II, Dared, Jamnagar -361 004, Gujarat	840	Brass Scrap, Copper Scrap and Zinc Scrap
18.	Pranami Metal, Plot No. 240, Phase-II GIDC Estate, Dared, Jamnagar, Gujarat	900	Brass Scrap, Copper Scrap and Zinc Scrap

Contd...

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
19.	Monarch Metals Pvt. Ltd., Plot No. 260, GIDC Phase-II Wadhwan City- 363025, Gujarat	300	Copper Scrap, Brass Scrap & Zinc Scrap
20.	Hindustan Impex, B-23/24, M.P. Shah Udhyognagar, Saru Section Road, Jamnagar-361002, Gujarat	750	Brass Scrap
21.	Bravo Agro Tech., Plot No. 200, Phase-II, GIDC Estate, Vadhwan, Dist. Surendranagar, Gujarat	1800	Brass Dross, Zinc Dross, Zinc Scrap & Zinc Ash
22.	Padmavati Impex Pvt. Ltd., Shed No. 781 GIDC, Phase-II, Dared, Jamnagar - 361 004 , Gujarat	1850	Brass Scrap, Copper Scrap, Zinc Scrap, Copper Dross, Zinc Dross, Brass Dross & Copper Druid
23.	Rozy Metals Extrusions, Plot No. 194 GIDC, Phase-II Dared, Jamnagar – 361 005, Gujarat	2520	Brass Scrap, Zinc Scrap, Copper Scrap and Waste Copper & Copper Alloys
24.	Akshar Exports, Shed No. 250 GIDC Phase II, Dared, Jamnagar – 361 005	3600	Brass Scrap, Zinc Scrap, Copper Dross, Copper Scrap, Waste Copper & Copper Alloys
25.	Indu Overseas Pvt. Ltd., Sp. Shed No. 23/1/A, GIDC Shankar Tekri, Udyognagar, Jamnagar – 361 004	1600	Brass Scrap, Zinc Scrap & Copper Scrap
26.	Siyaram Impex Pvt. Ltd., Plot No. 6-7, Naghedi, P.O. Khodiyar Colony, Village Lakhabavad, Distt-Jamnagar – 361 006, Gujarat	7000	Brass Scrap, Brass Dross, Copper Scrap, Waste Copper, Copper Alloys & Zinc Scrap
27.	Meridian Impex, Plot No. 2980 – 81 GIDC, Phase – III Near Dared, Jamnagar, Gujarat	1800	Brass Scrap, Copper Scrap, Copper Druid & Zinc Scrap
28.	Maheshwari Overseas, Spl. Shed No. 430 GIDC, Udyognagar Shanker Tekri, Jamnagar – 361 004, Gujarat	1350	Brass Scrap Copper Scrap Zinc Scrap

Contd...

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
29.	Raj Metallurgical Industries, Plot No. 661-662, Raj Marg, Phase – II GIDC Estate, Dared, Jamnagar, Gujarat	1080	Brass Scrap, Copper Scrap including Scrap & Copper Reverts
30.	Divine Impex, Plot No. 440/441, GIDC Phase II Dared, Jamnagar – 361 004, Gujarat	240	Brass Scrap, Copper Scrap, Zinc Scrap
31.	Conex Metal (International), Plot No. C-1/451/452, Phase-II, GIDC Estate Dared, Jamnagar, Gujarat	1350	Brass Scrap, Copper Scrap ,Zinc Scrap
32.	Meet Industries, Plot No. 2, Sub Plot No. 2A + 2C/2 GIDC Udhyognagar, Jamnagar – 361 004,Gujarat	500	Brass Scrap, Copper Scrap, Zinc Scrap
33.	Ghanshyam Metal Udyog Survey No.36/1, Kuha Road Village- Singarva, Ta: Dascroi Dist - Ahmedabad ,Gujarat	1500	Brass Scrap, Copper Scrap, Zinc Scrap
34.	Sanginita Chemicals Pvt.Ltd.(Unit-II) , Block No.1133, Near Laxmi Chemicals, Nr. Phase-IVGIDC, Chhatral Tq-Kalol Distt.Gandhinagar ,Gujarat	2220	Copper Oxide, Mill Scale Copper Reverts Cakes & Residues, Waste Copper & Copper Alloys in dispersible form, spent catalyst containing nickel & Zinc
35.	Sara Chemicals, Plot No.3205/B GIDC, Ankleshwar – 393 002, Distt.Bharuch, Gujarat	3000	Zinc Ash & Residues, Copper Residues, Spent Catalyst containing Copper Spent Catalyst containing Zinc
36.	Sairam Industries, Plot No.316, Phase-1, GIDC Estate, Chhatral, Distt.Gandhinagar, Gujarat.	1200	Zinc Ash, Zinc Skimming, Zinc bearing wastes arising from smelting and refining, Copper Oxide, Mill Scale Copper Reverts Cakes & Residues
37.	Khandelwal Brass Industries, B-37, GIDC, Shankar Tekari Indl. Area, Post Box No.607, Jamnagar-361 004, Gujarat.	3000	Brass Dross, Copper Dross and Copper Druid

Contd...

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
38.	Shyam Chemical, Survey No.222, At: Ramgadh, Post-Derol, Tq:Himmatnagar, Distt. Sabarkantha, Gujarat.	1500	Zinc Ash & Skimmings, Copper Cakes and Residues
39.	Raj Agro, Plot No.3-4, Gojariya GIDC, Taluka – Vijapur, Distt. Mahesana, Gujarat.	6500	Zinc Ash, Brass Dross & Zinc Dross, Zinc Residue Copper Residue
40.	Madhu Processor, Block No.227, Talaja Highway, Opp.Sartanparx Road, Village – Ukharala, Tehsil – Gogha, District Bhavnagar, Gujarat.	4200	Zinc Ash, Zinc Residue, Spent Catalyst containing Zinc Nickel, Copper Residues, Copper Cakes, Copper Ash, Copper Dross and Zinc Dross.
41.	Rubamin Limited, 23-Shree Laxmi Industrial Estate, Village – Duniya, Halol Tehsil, District – Panchmahal, Gujarat.	6000	Spent Catalyst containing Nickel, Zinc, Copper Cobalt, Vanadium and Cadmium.
42.	G.G.Manufacturer, Plot No.439/6, GIDC Odhav, Near Neptune Textile Mill, Ahmedabad, Gujarat-382 415	5880	Zinc Dross, Zinc Skimming, Zinc Ash, Copper Dross, Copper Reverts, Copper Oxide, Mill Scale, Copper Residue, Copper Cake, Spent Catalyst containing Copper and Zinc.
43.	Abbey Chemical (P) Ltd., S.R.No.1088/B-1, Lamdapura Road, Manjusar, Taluka – Savli, Distt.Vadodara, Gujarat.	350 1000 550	Zinc Dross, Zinc Skimming, Zinc Ash and Residues. Copper Dross, Copper Oxide, Mill Scale, Copper Cake and Residue Waste Copper and Copper Alloys Slag from Copper processing. Spent Catalyst containing Nickel
	Total	**104,096**	
V	**HARYANA**		
1.	Gupta Metal Sheets(P)Ltd., Post Box No.1559, Delhi Road, Rewari, Haryana	7500	Copper Scrap, Brass Scrap, Zinc Scrap, Zinc Dross, Copper Dross and Brass Dross

Contd...

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
2.	Shiv Metals, Gulab Nagar Chowk Bilaspur Road Jagadhari, Yamunanagar Haryana-135 003	200 70 30	Brass Dross Zinc Ash Zinc Ash Copper Dross.
3.	Shree Narayan Industries, V.P.O.Thana Chapper, Shahbad-Adhoya Road, Jagadhari, Dist. Yamunanagar, Haryana	2455 2505 2355	Brass Dross. Copper Dross, Copper Slag and Copper reverts Zinc Ash & Zinc Dross
4.	Soorajmull Baijnath Industries (Pvt.)Ltd. E-4, Industrial Area, Sonepat – 131 001, Haryana	3000	Zinc Ash, Zinc Skimming, Zinc Dross, Brass Dross, Copper Dross and Copper Reverts.
	Total	**18,115**	
VI	**JAMMU & KASHMIR**		
1.	Vimco Alloys, 163-164, SICOP Industrial Estate, Kathua, Jammu (J &K) -184 104	5400 5300	Copper Scrap/Copper. Dross/Waste Copper and Copper Alloys/Brass Scrap and Brass Dross. Zinc Scrap./Zinc Dross.
2.	Jammu Metallic Oxides Pvt. Ltd,. Logate More, Village Logate, Tehsil & Dist. Kathua – 184 104, (J &K)	4860	Copper Scrap/Copper Dross/ Copper Reverts/Waste Copper/Brass Scrap/Zinc Scrap/Zinc Dross.
3.	Shri Ganga Metals Plot No. 38, Phase-III SICOP Indl. Area Extension, Gangyal, Jammu (J&K)	10800	Copper Scrap/Nickel Scrap.
4.	Vardhman Extrusion Pvt. Ltd., Lane No.4, Bari Brahmma, Phase-II Industrial Complex, (J & K)	3600	Copper Scrap, Zinc Scrap and Brass Scrap.
5.	Shree Shub Laxmi Enterprises, Lane No.3, SIDCO Industrial Complex, Bari Brahmna, Jammu, (J&K)	7000	Copper Reverts, Copper Druid Zinc Ash and Zinc Skimming.
6.	Shivangi Metal Industries Pvt. Ltd., Plot No. 13-14, IID Centre Battal Balian Udhampur -182 101, (J&K)	10000	Zinc Skimming, Zinc Residues Zinc Dross Brass Dross, Copper Mill Scale, Copper Dross and Copper Druid.
	Total	**46,960**	

Contd...

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
VII	**KARNATAKA**		
1.	Alchemist Processors, A-150 2nd 'C' Main PIE, 2nd Stage, Bangalore, Karnataka-560 058	720	Spent Catalyst (Ni,Cu,Cd, Zn,As).
2.	MSR Chemicals & Fertilizers Pvt. Ltd., No. 380, 6th Cross, 2nd Block RMV, 2nd Stage, Bangalore-560 094.	750 198	Zinc Ash /Dross /Residue/ Skimming. Copper Scrap/Residue/ Dross .
3.	Metcorp, No.175, Nagappa Garden, Kothanur Dinaye, Off.B.G.Road, Behind Meenakshi Temple, Bangalore Karnataka-560 083	3500	Copper Scrap Copper dross Brass Scrap/Dross Zinc ScrapDross/Ash Skimmings insulate Copper wise Scrap.
4.	Balaji Smelters and Alloys, Sy. No. 138/P9, Hulimangala Hoskote, Village Lakkur, Hobli Malur (TK), Kolar District, Karnataka	480 480 240	Brass Scrap. Copper Scrap. Zinc Scrap.
5.	Rajeshwari Copper Products, Shed No. D-79, Industrial Suburb Yeshwantpur, Bangalore, Karnataka-560 022	3600 860	Copper Scrap Insulated Copper Cable Scrap, Copper Dross, Copper with PVC Sheathing as Copper Druid. Zinc Ash/Skimmings.
6.	Moogambigai Metal Refineries, 89 & 90, Industrial Area , Baikampady, Mangalore, Karnataka – 575 011	760 760 760	Zinc Dross. Brass Dross. Copper Dross.
	Total	**13,108**	
VIII	**MADHYA PRADESH**		
1.	Jhaveri Overseas Pvt. Ltd., Plot No. 193/1, Navada Panth Dhar Road, Indore, Madhya Pradesh	1000	Zinc Dross/Zinc Ash/ Spent Catalyst containing Zinc Copper Scrap/Copper Dross, Spent Catalyst containing Copper & Spent Nickel Catalyst.
2.	Cable Processors India Pvt. Ltd., Plot No. 14, Sector – A Maneri Industrial Area Dist. Mandla Madhya Pradesh	6300	Brass scrap/ Copper scrap/ Zinc Scrap, Brass Dross and Zinc Dross.

Contd...

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
3.	Siddharth Wires Pvt. Ltd., A.B.Road, Biaora-465 674, Distt.Rajgarh, Madhya Pradesh	1800	Zinc Dross and Zinc Ash.
4.	Metachem Industries, 16/17, Industrial Growth Centre, Maneri, Distt.Mandla, Madhya Pradesh	105 105 350	Copper Scrap. Brass Scrap. Zinc Scrap.
5.	Savitri Enterprises, Plot No.22-B, Laxmibai Nagar, Fort Industrial Area, Indore-452 006 Madhya Pradesh	300	Brass Dross, Copper Dross, and Zinc Dross.
	Total	**9,960**	
IX	**MAHARASHTRA**		
1.	Aashumi Chemicals P. Ltd., 169-B, Village Mangathane, Tal. Wada, Dist. Thane,Maharashtra	2000	Copper Druid, Copper slag, Zinc Scrap, Brass Dross, Brass Scrap and spent Catalyst Containing Copper.
2.	Bharti Rubber Lining and Allied Service P. Ltd., Plot No. C-49, TTC Indl. Area, Pawane,Village & Dist. Thane, Maharashtra	10000	Copper Druid, Copper Dross Copper Residues, Copper Oxide Mill Scale, Brass Dross, Zinc Ash, Brass Scrap, Copper Scrap and Zinc Dross.
3.	Beetachem Industries, W-177,TTC Industrial Area, Pawana Village, Thane Belapur Road, Navi Mumbai, Maharashtra	60	Spent Catalyst Containing Copper & Spent Catalyst Containing Nickel.
4.	Astron Engineers (I) Pvt. Ltd., GAT No. 131, Near Lavale Phata Tal. Mulshi, Dist. Pune, Maharashtra.	4500	Copper Scrap, Brass Scrap, Zinc Scrap and Copper Druid.
5.	Namdev Silicates & Chemicals (P) Ltd., Shed No. W-73(II), MIDC Taloja, Raigarh-410 208, Maharashtra.	300 1350 900	Zinc Ash. Spent Nickel Catalyst. Copper Scrap and Spent Catalyst Containing Copper.
6.	Rajkob Industries, Plot No. N-41, MIDC Tarapur, Boisar, Dist. Thane, Maharashtra – 401 506	720	Copper Scrap, Copper Dross, Spent Catalyst containing Copper, Copper Oxide Mill Scale, Nickel Scrap, Spent Catalyst Containing Nickel Zinc Dross and Zinc Scrap

Contd...

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
7.	Nizalco Metals P. Ltd., Plot No.C-353, TTC Industrial Area, MIDC Turbe, Navi Mumbai, Maharashtra	3600	Copper Druid, Copper Dross, Brass Dross & Zinc Scrap
8.	S. K. Naik & Sons, Sr. No. 50/15, Naregaon Road, Dharygaon, Dist. Pune – 411 041,Maharashtra	2160	Copper Scrap, Zinc Scrap & Brass Scrap
9.	Monika Metal Corporation, S. No. 79, Plot No.B, Opp. Bhairav Nath Temple, Kudulwadi, Chikali, Pune – 412 114,Maharashtra	2400	Copper Dross, Copper Druid, Copper Residues, Copper Reverts, Copper Cakes, Zinc Skimmings, Brass Scrap & Brass Dross.
10.	Metal Press India, 146 BCD, Industrial Estate, Charkop, Kandivli West, Mumbai – 400 067 Maharashtra	450	Copper Scrap, Brass Scrap & Zinc Scrap.
11.	Arjandas Metals Industries Pvt. Ltd., Saki Vihar Road, Arjandas House, Sakinaka, Mumbai-400 072	8100	Brass Scrap Brass Dross Copper Scrap and Copper Dross.
12.	Vineeth Precious Catalyst (P) Ltd., 9 & 10, Estate No. 3, 15 to 18, Building, No. 8, Agarwal Udyog Nagar, Sativali Road, Vasai(E), Dist. Thane- 401 208, Maharashtra	250 150	Spent Nickel Catalyst & Nickel Scrap. Copper Scrap and Zinc Scrap.
13.	R. K.Manufacturing Company, Plot No. A-395, TTC MIDC, Mahape, Navi Mumbai-400 710, Dist. Thane, Maharashtra	2700	Copper Druid, Copper Dross, Copper Scrap, Copper Oxide, Mill Scale Copper Reverts, Cakes, and Residues Brass Scrap Brass Dross Zinc Scrap and Zinc Dross.
14.	Bharat Industries, Plot No. 46, Phase-II, Ramtekadi Industrial Estate, Hadapsar, Pune-411013, Maharashtra	500	Brass Scrap & Copper Scrap.
15.	HSR Enterprises, GAT No. 799, Pawar Vasti, Vishnu Nagar, Near Kohinoor Weigh Bridge, Chikali, Dist. Pune- 412 114, Maharashtra	2520	Copper Scrap, Brass Scrap & Copper Druid.

Contd...

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
16.	Aryavart Chemicals Pvt. Ltd., Plot No.G-14/3, MIDC Taloja, Tal-Panvel, Dist-Raigad, Maharashtra	300 100	Spent Nickel Catalyst. Copper Reverts & Cakes.
17.	Aditya Industries, 474, Naigaon Road, At Shinde Village Nashik-422 002, Maharashtra	1600	Copper Scrap, Zinc Ash & Zinc Dross
18.	Maurya Metal Pvt. Ltd., Plot No. A-762, TTC Industrial Area, MIDC, Khairane, Navi Mumbai – 400 709, Maharashtra	4800	Brass Scrap, Brass, Dross Copper Scrap, Copper Dross, Copper Residues, Copper Druid, Zinc Scrap, Zinc Dross, Zinc Ash & Skimmings and Zinc Residues
19.	Shri Hari Extrusion Ltd., Ashok Nagar, A.C.Road, Near Bank of Baroda, Kandivili(East) Mumbai, Maharashtra	9000	Brass Dross, Copper Dross, Zinc Dross and Copper Cable i.e. Druid, Copper Residues, Zinc Scrap and Zinc Ash & Skimmings.
20.	Shree Metals(Mujbi)Private Limited, Plot No.312/2, At.Mujbi, P.Bela, Tah. & Dist.Bhandara - 441 904, Maharashtra	655 560	Zinc Dross, Zinc Ash & Zinc Residues. Brass Dross.
21.	B.R.Steel Products Pvt. Ltd., Plot No.C-39(B&C), Near Krishna Steels, Pawane Village TTC Industrial Area, Mhape Turbhe, Navi Mumbai-400 705 Maharashtra	1300	Copper residue Cakes. Copper Dross, Brass, Dross Zinc Dross Zinc Skimming, Zinc Ash and Spent Catalyst containing Nickel.
22.	R.T.Jain & Co., Plot No.F-1/19, MIDC, Tarapur, Boisar, District Thane, Maharashtra	1800	Brass Dross, Copper Dross, Copper Druid, Copper Slag, Zinc Dross, Zinc Ash.
23.	Om Balaji Inorgo Metal Pvt.Ltd., W-71/B, MIDC Chikhloli, Ambernath, District Thane, Maharashtra – 421 505	350 100	Spent Nickel Catalyst. Spent Catalyst containing copper.

Contd...

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
24.	Kam-Vit Chemicals Pvt.Ltd., Gut No.45-46 & 47, Village:Kambre, Wada, Distt.Thane, Maharashtra-421 303	2880	Spent Catalyst containing Nickel, Copper, Copper Reverts, Cakes and Residue, Waste Copper and Copper Alloys in dispersible forms, spent cleared metal catalyst containing copper
25.	Govind Metal Industries, Khasra No.60/1, Station Road, Bhandara, Maharashtra	876	Brass Dross, Copper Dross, Zinc Dross and Zinc Ash.
26.	Rishabh Meta Process, Gut No.27/1, Village: Jamni(Dhaba), Station Road, Tah & Distt. Bhandara, Maharashtra	10000	Zinc Ash, Zinc Dross, Copper Dross, Brass Dross, Copper Oxide Mill Scale, Waste Copper.
	Total	**76,981**	
X	**PUNJAB**		
1.	D. D. Agro Industries Ltd., Industrial Area-C, Dhandari Kalan, Ludhiana, Punjab	7300 4300	Zinc Ash/Skimming & Zinc Scrap Copper Druid/Copper Scrap/ Copper Dross/ Copper Oxide Mill Scale/Reverts/ Cakes and residue.
2.	Randeep Paper Board Mill, Chemical Division, Village-Chabba, Tarantaran Road, Amritsar, Punjab	520	Zinc Ash, Zinc Skimming and Brass Dross.
3.	Gupta Smelters Pvt.Ltd., C-48, Industrial Focal Point, Sangrur – 148 001, Punjab	4500 2250	Zinc Dross and Zinc Skimming. Brass Dross.
	Total	**18,870**	
XI	**RAJASTHAN**		
1.	Rose Zinc Ltd., Airport Road, Post Gundli, Distt. Udaipur, Rajasthan	21200	Zinc Ash and Skimmings, Brass Dross, Copper Dross, Copper Oxide Mill Scale, Brass Scrap, Copper Scrap, Copper Reverts Cakes and Residues, Waste Copper & Copper Alloys, Zinc Scrap, Zinc Dross & Slag from Copper processing for further processing or refining.

Contd...

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
2.	Siyarco Industries, F-540, B Marudhar Industrial Area, 2nd Phase, Basni, Jodhpur-342 005, Rajasthan	3600	Zinc Dross, Zinc Ash & Skimmings, Brass Dross, Brass Scrap, Copper Dross, Copper Scrap Reverts, Cakes & Residues, Copper Mill Scale and Copper Druid.
3.	B.M.A. Zinc Pvt. Ltd., F-449, Industrial Area, Bhiwadi, Alwar, Rajasthan	2000 1275	Zinc Ash/Skimmings. Brass Dross.
4.	West India Chemicals, F-24 -25, Mewar Indl. Area, Road No. 4, Madri, Udaipur – 313 003, Rajasthan.	1080	Zinc Ash Zinc Skimmings & Brass Dross.
5.	Goel Meta Chem. P. Ltd., A-114(A), Indraprastha Industrial Area, Kota, Rajasthan.	650	Spent Catalyst Containing Copper, Spent Catalyst Containing Nickel, Copper Residues, Copper Oxide Mill Scale, Copper Scrap and Nickel Scrap.
6.	Barium International Ltd., A-114, Indraprastha Industrial Area, Kota, Rajasthan – 324 005.	650	Spent catalyst containing Zinc & Copper, Zinc Ash, Zinc Skimming, Zinc Residues
7.	Resource Recycling Industries, G 35, RIICO Industrial Area, Manpura, Distt. Chittorgarh, Rajasthan.	6300	Spent Catalyst containing Copper Zinc & Nickel
8.	G.L. Metallica Pvt. Ltd. (Unit II), G-1/38, RIICO Industrial Area, Bassi, Jaipur, Rajasthan.	4320	Brass Scrap, Copper Scrap, Zinc Scrap Copper Druid, Waste Copper & Copper Alloys, Copper Reverts, Zinc Ash & Skimmings
9.	M/s Alcobex Metals Ltd., 24/25, HIA Area, Jodhpur, Rajasthan	700 1500	Brass Dross Waste Copper and Copper Alloys
10.	Swastik Zinc Pvt. Ltd., F-268, Mewar Industrial Area, Road No.12, Madri, Udaipur, Rajasthan – 313 001	1700	Zinc Ash, Zinc Skimming, other Zinc bearing waste arising from smelting & refining, Zinc Dross, Bottom Dross, Spent cleared metal catalyst containing

Contd...

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
		1800	Copper & Zinc Copper Dross, Brass Dross, Copper Oxide Mill Scale, Contd... Copper Reverts, Cake & Residue, Waste Copper alloys and slags
	Total	**46,775**	
XII	**TAMIL NADU**		
1.	Pondy Oxides & Chemicals, G-47, SIDCO Industrial Estate, Kakkalur Village-602 003, Distt.Thiruvallur, Tamil Nadu.	4000	Copper Dross, Brass Dross, Zinc Ash, Copper Druid, Copper Scrap, Brass Scrap, Zinc Scrap and Zinc Dross
2.	Hydromet (India) Ltd., Vedal Village, Rajakulam Post, Kanchipuram, Tamil Nadu.	12000 3600 1400	Copper Dross, Brass Dross, Copper Zinc Spent Catalyst, Copper residue, Copper Cakes, Copper reverts, Copper Skimmings, Copper Druid, Copper Scrap/Copper alloys/Zinc Scrap & Brass Scrap Zinc Ash/Dross, Skimming Spent Zinc Catalyst, Spent Nickel Catalyst
	Total	**21,000**	
XIII	**UTTAR PRADESH**		
1.	Kay Em Enterprises, F 29 -31, Masuri Gulawali Road, Industrial Area P. O., Masuri, Dist – Ghaziabad, UP - 201 302.	2500 4500	Copper Druid Brass Dross/Copper Dross/Zinc Ash/Residue/Copper Oxide/ Mill Scale/Brass Scrap/Copper Scrap/Zinc Skimmings
2.	Aditya Recycling Industries, Vill. –Bharona, Varanasi Road, Mirzapur – 231 001, U.P.	6000	Brass Dross, Copper Dross, Copper Druid, Copper Cake & Residues, Zinc Ash, Zinc Dross and Zinc Skimming
3.	Sagun Udyog Pvt. Ltd., Rajdeopur Dehati, P.O. Rauza, Ghazipur-233 001, U.P	1000 750 500 750	Zinc Ash/Skimming Brass Dross Zinc Dross Brass Scrap

Contd...

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
4.	Gold Star Inc., Vill. Ahraula Mafi, P.O. Chaudharpur, Via: Pakbara, Dist. Moradabad- 244 001, U.P	6000	Copper Scrap/Druid/Dross/ Residue Zinc Scrap /Dross /Skimming/ Residue and Brass Scrap/Dross
5.	Agrasen Metal Works, Shed No. D-3, Industrial Estate, Mirzapur-231 001, U.P	300 200 220	Brass Scrap/Brass Dross Copper Scrap/Copper Dross Zinc Scrap/Zinc Dross
6.	Metal Alloy, E-46, Industrial Area, Ram Nagar, Chandauli, Varanasi – 221 110 U.P	1080 540 540	Copper Oxide Mill Scale, Copper Reverts, Waste Copper and Copper Alloys, Insulated Copper Wire Scrap, Copper with PVC Sheathing, Jelly filled Copper Cables Brass Dross Zinc Dross – hot dip galvanizers Slab, Zinc Dross – Bottom Dross
7.	Chadha Brass Limited, 26, Madhubani Kanth Road, Moradabad-245 372, U.P	1800	Zinc Scrap/Brass Scrap/ Copper Scrap
8.	S.D.M Metalloys Limited, 16/1, A-5 Site-IV, Sahibabad Industrial Area, Ghaziabad-201 010,U.P.	6500	Brass Dross, Copper Dross, Copper Druid, Zinc Dross and Zinc Ash.
9.	Met Trade India Ltd., Village – Bheel Akbarpur, G.T Road, Dadri, Distt.Gautam Budh Nagar, U.P.	22000 22000	Zinc Ash, Zinc Dross, Zinc Skimming and spent cleared Metal Catalyst containing Zinc Copper Dross, Copper Oxide Mill Scale, Copper Reverts, Copper Cake & Residue, Waste Copper & Copper Alloys, Copper Slag, insulated Copper wire scrap, Copper with PVC Sheathing including Druid; Spent cleared Metal Catalyst containing Copper & Jelly filled Copper Cable.

Contd...

Concld…

Sl. No.	NAME OF THE UNIT	CAPACITY (tonnes/year)	WASTE PERMITTED FOR RECYCLING
10.	Sheo Kumar Sunil Kumar, Bharuhna, Varanasi Road, Mirzapur, Uttar Pradesh	500	Copper Dross, Brass Dross and Zinc Dross.
	Total	**77,680**	
XIV	**WEST BENGAL**		
1.	A.R. Engineering Works Unit-II, 36/2, Hara Chand Mukherjee Lane, Howrah-711 101 West Bengal	132 60 12	Copper Scrap, Waste Copper, Copper Alloys Brass Scrap. Zinc Scrap.
2.	Vinod Metal Industries, Mouza & Vill. Argori (NH-6), PO Argori P.S. Sankrail, Dist. Howrah - 711 302, West Bengal	420	Copper Cable/ Copper Scrap/ Copper Dross/Brass Scrap/ Brass Dross
3.	Golden Metal Industries, 265/A/1/A G.T. Road, Liluah, Howrah-711 204, West Bengal	78 36 12	Copper Scrap. Brass Scrap. Zinc Scrap
4.	Arjun Enterprise, Dakshin Duttapara Bazar, P.O.Haripukaria, P.S.Haringhata, Distt.Nadia-741 257, West Bengal	600	Insulated Copper Wire Scrap, Copper with PVC Sheathing including 'Druid', Jelly filled Copper Cables, Copper Dross & Waste Copper and Copper Alloys, Zinc Dross, Zinc Ash & Zinc Skimmings & Brass Dross.
	Total	**1,350**	
	Grand Total	**5,17,515**	

Annexure: 3 - III

Guide lines for Nonferrous Scrap, 2009, Institute of Scrap Recycling Industries Inc. (ISRI)

BARLEY

No.1 Copper: Wire Shall consist of No. 1 bare, uncoated, unalloyed copper wire, not smaller than No. 16 B & S wire gauge. Green copper wire and hydraulically compacted material to be subject to agreement between buyer and seller.

BERRY

No.1 Copper Wire: Shall consist of clean, untinned, uncoated, unalloyed copper wire, and cable, not smaller than No. 16 B & S wire gauge, free of burnt wire which is brittle. Hydraulically briquetted copper subject to agreement.

BIRCH

No.2 Copper Wire: Shall consist of miscellaneous, unalloyed copper wire having a nominal 96% copper content (minimum 94%) as determined by electrolytic assay. Should be free of the following: Excessively leaded, tinned, soldered copper wire, brass and bronze wire, excessive oil content, iron and non-metallics, copper wire from burning, containing insulation; hair wire; burnt wire which is brittle and should be reasonably free of ash. Hydraulically briquetted copper subject to agreement.

CANDY

No.1 Heavy Copper: Shall consist of clean, unalloyed, uncoated copper clippings, punching, bus, bars, commutator segments, and wire not less than 1/16 of an inch thick, free of burnt wire which is brittle, but may include clean copper tubing. Hydraulically briquetted copper subject to agreement.

CLIFF

No. 2 Copper: Shall consist of miscellaneous, unalloyed copper scrap having a nominal 96% of copper content (minimum 94%) as determined by electrolytic assay. Should be free of the following: Excessively leaded, tinned, soldered copper scrap, brasses and bronzes, excessive oil content, iron and non-metallics; copper tubing with other than copper connections or with sediment, copper wire from burning, containing insulation; hair wire; burnt wire which is brittle and should be reasonably free of ash. Hydraulically briquetted copper subject to agreement.

CLOVE

No.1 Copper Wire Nodules: Shall consist of No.1 bare, uncoated, unalloyed copper wire scrap nodules, chopped or shredded, free of tin, lead, zinc, aluminium, iron, other metallic impurities, insulation, and other foreign contamination. Minimum copper 99%. Gauge smaller than No. 16 B & S wire and hydraulically compacted material subject to agreement between buyer and seller.

Contd...

Concld….

COBRA

No.2 Copper Wire Nodules: Shall consist of No. 2 unalloyed copper wire scrap nodules, chopped or shredded, minimum 97% copper. Maximum metal impurities not to exceed 0.50% aluminium and 1% each of other metals or insulation. Hydraulically compacted material subject to agreement between buyer and seller.

COCOA

Copper Wire Nodules: Shall consist of unalloyed copper wire scrap nodules, chopped or shredded, minimum 99% copper Shall be free of excessive insulation and other non-metallics. Maximum metal impurities as follows :

Aluminium 0.05%, Antimony 0.01%, Tin 0.25%, Iron 0.05%, Nickel 0.05%.

Hydraulically compacted material subject to agreement between buyer and seller.

DREAM

Light Copper: Shall consist of miscellaneous, unalloyed copper scrap having a nominal 92% copper content (minimum 88%) as determined by electrolytic assay and shall consist of sheet copper, gutters, downspouts, kettles, boilers and similar scrap. Should be free of the following; Burnt hair wire; copper clad; plating racks; grindings; copper wire from burning, containing insulation; radiators and fire extinguishers, refrigerator units, electrotype shells; screening; excessively leaded, tinned, soldered scrap; brasses and bronzes, excessive oil, iron and non metallics; and should be reasonably free of ash. Hydraulically briquetted copper subject to agreement. Any items excluded in this grade are also excluded in the higher grades above.

DRINK

Refinery Brass: Shall contain a minimum of 61.3% copper and maximum 5% iron and to consist of brass and bronze solids and turnings and alloyed and contaminated copper scrap. Shall be free of insulated wire, grindings, and electrotype shells and non-metallics. Hydraulically briquetted material subject to agreement.

DROVE

Copper Bearing Scrap: Shall consist of miscellaneous copper containing skimmings grindings, ashes, irony brass and copper, residues and slags. Shall be free of insulated wires, copper chlorides, unprepared tangled material, large motors, pyrophoric material, asbestos brake linings, furnace bottoms, high lead materials, graphite crucibles, and noxious and explosive materials. Fine powdered material by agreement. Hydraulically briquetted material suject to agreement.

DRUID

Insulated Copper Wire Scrap: Shall consist of copper wire scrap with various types of insulation. To be sold on a sample or recovery basis, subject to agreement between buyer and seller.

Annexure: 3 - IV (A)

Imports of Copper & Other Items as per H S Codes

Sl.No.	HSCode	Commodity
1.	26030000	COPPER ORES & CONCENTRATES
2.	26203090	OTHER ASH & RESIDUES CONTG MAINLY COPPER
3.	74011000	COPPER MATTES
4.	74012000	CEMENT COPPER(PRECIPITATED COPPER)
5.	74020010	BLISTER COPPER FOR ELECTROLYTIC REFINING
6.	74020090	OTHER UNREFINED COPPER;COPPER ANODES FOR ELECTROLYTIC REFINING
7.	74031100	CATHODS & SECTNS OF CATHODS OF REFINED COP
8.	74031200	WIRE-BARS OF REFINED COPPER
9.	74031300	BILLETS OF REFINED COPPER
10.	74031900	OTHER REFINED COPPER,UNWROUGHT
11.	74040012	COPPER SCRAP COVERED BY ISRI CODE BARLEY, BERRY ,BIRCH,CANDY,CLIFF,CLOBE,COBRA,COCOADREAM AND PALMS
12.	74040019	OTHER COPPER SCRAPS
13.	74061000	COPPER POWDERS OF NON-LAMELLAR STRUCTURE
14.	74062000	COPPER POWDERS OF LAMELAR STRUCTURE,FLAKES
15.	74061000	COPPER POWDERS OF NON-LAMELLAR STRUCTURE
16.	74062000	COPPER POWDERS OF LAMELAR STRUCTURE,FLAKES
17.	74071010	ELECTROLYTIC COPPER RODS OR BLACK COPPER RODS(INCLUDING COILS),WROUGHT
18.	74071020	COPPER RODS OTHR THAN ELECTROLYTIC,WROUGHT
19.	74071030	COPPER BARS(SOLID),WROUGHT
20.	74071040	HOLLOW BARS OF COPPER WROUGHT
21.	74071051	HOLLOW PROFILES OF REFINED COPPER
22.	74071059	OTHER PROFILES OF REFINED COPPER
23.	74071090	OTHER REFIEND COPPER BARS & RODS
24.	74091900	OTHER PLATES,SHEETS ETC OF REFINED COPPER
25.	74101100	FOIL OF REFINED COPPER,NOT BACKED
26.	74102100	FOIL OF REFINED COPPER,BACKED
27.	74111000	TUBES & PIPES OF REFINED COPPER
28.	85441110	WINDING WIRE OF ENAMELLED COPPER
29.	85441190	OTHER WINDING WIRE OF COPPER

Annexure: 3 - IV (B)

Exports of Copper & Other Items as per HS Code

S.No.	HSCode	Commodity
1.	26030000	COPPER ORES & CONCENTRATES
2.	26203090	OTHER ASH & RESIDUES CONTG MAINLY COPPER
3.	74011000	COPPER MATTES
4.	74012000	CEMENT COPPER(PRECIPITATED COPPER)
5.	74020010	BLISTER COPPER FOR ELECTROLYTIC REFINING
6.	74020090	OTHER UNREFINED COPPER;COPPER ANODES FOR ELECTROLYTIC REFINING
7.	74031100	CATHODS & SECTNS OF CATHODS OF REFIND COP
8.	74031200	WIRE-BARS OF REFINED COPPER
9.	74031300	BILLETS OF REFINED COPPER
10.	74031900	OTHER REFINED COPPER,UNWROUGHT
11.	74040012	COPPER SCRAP COVERED BY ISRI CODE BARLEY, BERRY, BIRCH, CANDY, CLIFF, CLOBE, COBRA, COCOADREAM AND PALMS
12.	74040019	OTHER COPPER SCRAPS
13.	74061000	COPPER POWDERS OF NON-LAMELLAR STRUCTURE
14.	74062000	COPPER POWDERS OF LAMELAR STRUCTURE,FLAKES
15.	74071010	ELECTROLYTIC COPPER RODS OR BLACK COPPER RODS(INCLUDING COILS),WROUGHT
16.	74071020	COPPER RODS OTHR THAN ELECTROLYTIC,WROUGHT
17.	74071030	COPPER BARS(SOLID),WROUGHT
18.	74071040	HOLLOW BARS OF COPPER,WROUGHT
19.	74071051	HOLLOW PROFILES OF REFINED COPPER
20.	74071059	OTHER PROFILES OF REFINED COPPER
21.	74071090	OTHER REFIEND COPPER BARS & RODS
22.	74091100	PLATES,SHEETS ETC OF REFIND COPR IN COILS
23.	74091900	OTHER PLATES,SHEETS ETC OF REFINED COPPER
24.	74101100	FOIL OF REFINED COPPER,NOT BACKED
25.	74102100	FOIL OF REFINED COPPER BACKED

Annexure: 4 - I

World Reserves of Copper
(By Principal Countries)

(In '000 tonnes)

Country	Reserves
Australia	80,000
Canada	8,000
Chile	150,000
China	30,000
Indonesia	30,000
Kazakhstan	18,000
Mexico	38,000
Peru	90,000
Poland	26,000
Russia	30,000
USA	35,000
Zambia	20,000
Other Countries	80,000
Total (rounded)	**630,000**

Source: Mineral Commodity Summaries 2011.

Note: Reserve base estimates were discontinued in 2009.

Annexure: 4 – II

World Mine Production of Copper by Principal Countries, 2003 to 2009

(In '000 tonnes of Metal Content)

Sl. No.	Name of Country	2003	2004	2005	2006	2007	2008	2009
1	Chile	4904	5412	5320	5361	5557	5330	5390
2	USA	1116	1160	1140	1197	1169	1310	1204
3	Indonesia	1006	840	1064	818	797	650	997
4	Peru	843	1036	1010	1048	1190	1268	1275
5	Australia	830	854	935	878	871	886	854
6	Russia	650	630	640	675	690	785	742
7	China	614	754	776	889	946	1076	961
8	Canada	557	563	595	603	596	608	494
9	Poland	504	531	512	497	452	429	439
10	Kazakhstan	484	462	402	446	406	420	406
11	Mexico	356	406	429	334	338	247	238
112	Zambia	347	410	465	516	523	568	601
13	Other Countries	1489	1542	1612	1815	1953	2093	2203
	Total	**13,700**	**14,600**	**14,900**	**15,100**	**15,500**	**15,670**	**15804**

Source: World Metal Statistics

Annexure: 4 – III

World Smelter Production of Copper by Principal Countries, 2003 to 2009

(In '000 tonnes)

Sl. No.	Name of Country	2003	2004	2005	2006	2007	2008	2009
1	China	1379	1503	1751	1917	2111	2543	2635
2	Chile	1542	1518	1558	1565	1514	1369	1522
3	Japan	1278	1220	1266	1362	1383	1625	1542
4	India	386	400	482	610	700	656	729
5	Russia	662	662	695	635	650	850	850
6	USA	539	542	523	501	621	574	597
7	Poland	560	547	556	556	518	537	515
8	Korea (Rep. of)	410	392	437	449	475	478	495
9	Canada	430	446	441	485	471	485	346
10	Australia	435	443	410	377	399	449	422
11	Kazakhstan	432	445	405	425	393	392	380
12	Mexico	261	299	340	299	295	200	169
13	Other Countries	2786	2883	3036	2865	2770	3776	3664
	Total	**11100**	**11300**	**11900**	**12046**	**12300**	**13844**	**13866**

Source: World Metal Statistics

Annexure: 4 – IV

World Production of Refined Copper by Principal Countries, 2003 to 2009

(In '000 tonnes)

Sl. No.	Name of Country	2003	2004	2005	2006	2007	2008	2009
1	China	1836	2199	2607	3002	3499	3795	4109
2	Chile	2902	2837	2824	2811	2936	3060	3272
3	Japan	1430	1380	1395	1532	1577	1540	1440
4	USA	1306	1306	1255	1250	1311	1280	1160
5	Russia	842	919	935	943	949	913	874
6	Germany	598	653	639	662	666	690	669
7	Zambia	360	409	446	497	523	612	698
8	Poland	530	550	560	557	533	527	502
9	Korea Rep. of	510	496	527	561	566	538	532
10	Australia	484	498	469	429	442	503	446
11	Canada	455	527	515	500	453	442	336
12	Kazakhstan	432	446	419	430	408	400	368
13	Other Countries	2015	3580	4009	4026	3937	4200	4294
	Total	**13700**	**15800**	**16600**	**17200**	**17800**	**18500**	**18700**

Source: World Metal Statistics

Annexure 4 – IV (A)

World Production of Secondary Refined Copper, 2001-2010

(In 000' tonnes)

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010 (Jan-Sept.)
Total	**1,833**	**1740**	**1766**	**1923**	**2108**	**2347**	**2512**	**2657**	**2605**	**1970**
Austria	69	65	65	59	52	46	55	67	96	85
Belgium	220	216	200	108	97	96	96	113	113	85
Finland	2	2	10	10	10	10	10	10	10	8
Germany	365	355	370	369	399	350	364	389	379	295
Italy	29	29	27	34	40	36	29	24	7	8
Poland	15	15	15	15	15	15	15	15	15	11
Russia	232	180	150	150	160	160	160	160	160	120
Serbia	-	-	-	-	-	29	17	18	11	2
Spain	50	40	35	35	45	45	45	45	45	34
Sweden	37	47	39	61	55	64	55	65	58	39
Yugoslavia	17	17	8	7	21	-	-	-	-	-
Egypt	4	4	4	4	4	4	4	4	4	3
China	307	280	426	620	744	999	1136	1196	1196	897
Iran	24	24	24	24	24	24	24	24	24	18
Japan	140	182	173	195	199	219	245	259	244	188
South Korea	45	50	60	60	70	70	70	70	70	53
Turkey	10	10	10	16	20	20	20	20	20	15
Argentina	16	16	16	16	16	16	16	16	16	12
Brazil	36	23	20	24	25	27	24	27	27	20
Canada	43	25	27	30	31	36	46	42	30	24
Mexico	1	-	35	35	35	35	35	35	35	26
U.S.A.	172	70	54	51	47	45	46	54	46	28

Source: World Metal Statistics

Annexure 4 – IV (B)

Country-wise Usage of Direct Scrap by Manufactures, 2001-2010

(In '000 tonnes)

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010 (Jan-Sept.)
Total	**3888**	**3814**	**3862**	**3561**	**3505**	**3563**	**3484**	**3349**	**2301**	**1815**
Austria	20	20	20	20	20	20	20	20	20	15
Benelux	32	33	36	36	36	36	36	36	36	27
France	52	57	57	57	57	57	57	57	57	14
Germany	234	234	234	234	234	234	234	234	234	176
Greece	12	12	12	12	12	12	12	12	12	9
Italy	482	482	482	482	482	482	482	482	482	362
Scandinavia	57	57	57	57	57	57	57	57	57	43
Serbia	-	-	-	-	-	36	36	36	36	27
Spain	24	24	24	24	24	24	24	24	24	18
Switzerland	29	29	29	29	29	29	29	29	29	22
U. K.	127	120	120	120	120	120	120	120	120	90
Yugoslavia	36	36	36	36	36	-	-	-	-	-
South Africa	24	24	24	24	24	24	24	24	24	18
Other Africa	9	9	9	-	-	-	-	-	-	-
Japan	1167	1034	1079	1082	1033	1074	1040	976	743	676
Other Asia	360	360	360	360	360	360	360	360	360	270
Brazil	66	66	66	66	66	66	66	66	66	50
U.S.A.	1039	1099	1099	922	914	932	887	816	-	-
Other America	117	117	117	-	-	-	-	-	-	-

Source: World Metal Statistics

Annexure: 4 – V

World Exports of Refined Copper by Principal Countries, 2003 to 2009

(In '000 tonnes)

Sl. No.	Name of Country	2003	2004	2005	2006	2007	2008	2009
1	Chile	2614	2954	2799	2606	2910	3004	3191
2	Zambia	363	393	423	476	491	587	675
3	Peru	459	318	514	449	365	419	401
4	Kazakhstan	376	391	401	357	348	344	309
5	Japan	290	195	248	320	428	423	627
6	Poland	283	280	290	288	239	297	306
7	Australia	323	323	315	286	295	356	316
8	Canada	222	289	297	279	298	290	222
9	Russia	397	359	301	262	275	207	466
10	China	64	124	140	243	126	96	73
11	Belgium	337	170	241	237	201	260	248
12	India	105	125	149	236	215	169	185
13	Other Countries	1201	1108	1337	1433	1395	1387	1625
	Total	**7034**	**7029**	**7455**	**7472**	**7586**	**7839**	**8644**

Source: World Metal Statistics

Annexure: 4 - VI

World Imports of Refined Copper by Principal Countries, 2003 to 2009

(In '000 tonnes)

Sl. No.	Name of Country	2003	2004	2005	2006	2007	2008	2009
1.	USA	687	704	977	1076	832	721	644
2.	Germany	517	585	625	881	844	843	659
3.	China	1357	1200	1222	827	1496	1458	3185
4.	Italy	651	700	652	774	746	617	544
5.	Taiwan	621	692	640	647	615	585	498
6.	France	578	590	517	507	432	434	266
7.	South Korea	441	488	428	380	420	406	488
8.	Thailand	204	224	234	268	245	265	216
9.	Malaysia	133	186	246	186	201	167	171
10.	UK	246	214	182	184	47	48	45
11.	Brazil	151	154	168	175	218	252	209
12.	Turkey	229	217	224	150	288	288	290
13	Other Countries	1219	1075	1340	996	745	693	755
	Total	**7034**	**7029**	**7455**	**7472**	**7129**	**6777**	**7970**

Source: World Metal Statistics

Annexure: 4 - VII

India's Exports of Copper Ores & Concentrates, 2003-04 to 2008-09 (By Countries)

(In tonnes)

Sl. No.	Name of Country	2003-04	2004-05	2005 - 06	2006-07	2007-08	2008-09
1.	Belgium	-	-	-	26000	-	-
2.	Japan	-	-	-	18200	-	-
3.	USA	-	-	-	340	-	1
4.	Bahrain	24	-	-	50	-	-
5.	Australia	-	270	-	-	-	-
6.	China Peoples Rep. of	-	16260	-	-	368	10507
7.	Kuwait	-	-	-	-	-	3
8.	Maldives	-	-	-	-	-	98
9.	Mexico	224	-	-	-	-	-
10.	Nepal	-	-	-	-	-	3
11.	UAE	52	-	-	55	-	-
12.	Sri Lanka	-	20	-	-	-	-
13.	Germany	-	-	-	-	110	16000
14.	Bangladesh	-	-	-	-	80	-
15.	Zambia	-	-	-	-	7	-
16.	UK	-	-	-	-	++	1
17.	Other Countries	-	-	-	-	++	-
	Total	**300**	**16550**	**-**	**44645**	**565**	**26613**

Source: DGCI&S

Annexure: 4 – VIII

India's Exports of Copper & Alloys, 2003-04 to 2008-09 (By Countries)

(In tonnes)

Sl. No.	Name of Country	2003-04	2004-05	2005 -06	2006-07	2007-08	2008-09
1.	UAE	31774	40697	82138	50487	46483	45471
2.	Thailand	21322	32132	20580	17547	25877	17164
3.	China, Peoples Rep.of	13506	18610	26696	72652	76216	33531
4.	Chinese Taipei	14314	33118	17185	25043	18281	2982
5.	Saudi Arabia	14327	23336	36846	24780	55858	50649
6.	USA	8435	5479	-	-	-	-
7.	Sri Lanka	7857	6343	-	-	-	-
8.	Philippines	6442	-	-	-	-	-
9.	Indonesia	5607	5993	10781	8482	8565	5019
10.	Singapore	4444	16211	13782	24598	19140	-
11.	Syria	3235	-	-	-	-	-
12.	UK	3788	-	-	-	-	-
13.	Korea, Rep. of	4007	10947	-	-	-	-
14.	Turkey	3506	-	-	-	-	-
15.	Vietnam	4406	6510	-	-	-	-
16.	Oman	4043	9549	12750	24387	21481	3828
17.	Kuwait	3095	6212	-	-	-	-
18.	Malaysia	2917	-	9745	20179	39416	-
19.	South Africa	2204	-	-	-	-	-
20.	Germany	2018	-	-	-	-	-
21.	Japan	2259	-	-	-	-	-
22.	Egypt	2134	-	-	-	-	-
23.	Hong Kong	-	-	3399	10327	9893	7006
24.	Other countries	22956	22863	66278	65213	53612	35862
	Total	**188596**	**238000**	**300180**	**343695**	**321210**	**245683**

Source: DGCI&S

Annexure: 4 – IX

India's Exports of Copper (Scrap) 2003-04 to 2008-09 (By Countries)

(In tonnes)

Sl. No.	Name of Country	2003-04	2004-05	2005 -06	2006-07	2007-08	2008-09
1.	Sri Lanka	963	922	487	-	-	-
2.	UAE	767	302	388	41	68	++
3.	China, Peop. Rep. of	336	336	385	71	79	-
4.	Chinese Taipei	334	106	105	-	-	-
5.	Malaysia	206	-	-	-	-	-
6.	Hong Kong	186	25	36	-	-	-
7.	Korea Rep. of	106	-	-	17	19	-
8.	Singapore	132	106	51	-	-	-
9.	Japan	50	-	45	-	-	-
10.	USA	26	-	-	8	35	3
11.	Korea, DPR	37	-	-	-	-	-
12.	Kenya	-	++	3	-	-	-
13.	Portugal	-	-	41	51	60	67
14.	Spain	-	-	-	-	124	331
15.	Belgium	-	-	-	-	20	2
16.	Canada	-	-	-	3	2	-
17.	Germany	-	-	-	7	1	182
18.	Sweden	-	-	-	146	-	-
19.	Philippines	-	-	-	-	-	99
20.	Denmark	-	-	-	-	-	22
21.	Other countries	121	127	27	90	35	62
	Total	**3264**	**1924**	**1568**	**434**	**443**	**768**

Source: DGCI&S

Annexure: 4 - X

India's Exports of Cement Copper (Precipitated) 2003-04 to 2008-09 (By Countries)

(In tonnes)

Sl. No.	Name of Country	2003-04	2004-05	2005 -06	2006-07	2007-08	2008-09
1.	USA	-	++	1	10	18	14
2.	UK	-	-	++	-	-	-
3.	Other Countries	++	2	-	-	-	-
	Total	**++**	**2**	**1**	**10**	**18**	**14**

Source: DGCI&S

Annexure: 4 - XI

India's Imports of Copper Ores & Concentrates, 2003-04 to 2008-09 (By Countries)

(In tones)

Sl. No.	Name of Country	2003-04	2004-05	2005 -06	2006-07	2007-08	2008-09
1.	Chile	188293	312204	332458	940501	774494	632940
2.	Australia	90893	196863	315820	562767	477708	510019
3.	Indonesia	165939	89809	235832	395526	115179	191101
4.	Brazil	-	32704	20854	116400	101738	184862
5.	Iran	10260	-	-	34338	91205	124794
6.	Papua New Guinea	-	31456	33000	128106	59484	79503
7.	Peru	-	-	4000	54684	57761	169100
8.	Canada	-	22822	22541	43809	42211	-
9.	Argentina	20000	21339	29084	66893	41048	-
10.	South Africa	-	-	5290	-	-	89479
11.	Ghana	11500	-	-	-	-	-
12.	Chinese Taipei	-	306	-	-	-	-
13.	Zambia	-	-	-	-	-	117678
14.	Congo, Peop. Rep. of	-	-	-	-	-	98956
15.	Unspecified	-	-	-	93531	-	-
16.	Other Countries	133611	66656	74026	270814	153350	66300
	Total	**620496**	**774159**	**1702905**	**2707369**	**1914178**	**2264732**

Source: DGCI&S

Annexure: 4 - XII

India's Imports of Copper & Alloys, 2003-04 to 2008-09 (By Countries)

(In tonnes)

Sl. No.	Name of Country	2003-04	2004-05	2005 - 06	2006-07	2007-08	2008-09
1.	Sri Lanka	35356	31639	31436	9577	3790	-
2.	Korea Rep. of	3627	6179	8777	4043	3627	6752
3.	Malaysia	3643	6013	5438	4399	5519	8160
4.	Japan	2027	1164	-	-	-	-
5.	Thailand	2682	2695	2909	2888	3845-	3492
6.	USA	2679	1155	1738	-	-	-
7.	Oman	3201	1114	-	-	-	-
8.	Philippines	815	-	-	-	-	-
9.	UK	1796	-	-	-	-	-
10.	Chinese Taipei	827	-	-	-	-	
11.	China, Peop. Rep. of	1282	3814	6125	8921	10822	11792
12.	France	1335	2340	-	-	-	-
13.	Singapore	2435	-	-	-	-	-
14.	Germany	794	1636	2880	3085	4932	13698
15.	Bhutan	1670	3409	7283	9105	8500	1996
16.	Sweden	1446	-	-	-	-	-
17.	Sierra Leone	1531	-	-	-	-	-
18.	Russia	1281	2940	15720	9322	15713	11219
19.	Australia	1276	3769	-	1724	6710	11695
20.	Switzerland	274	-	-	-	-	-
21.	Nepal	1104	-	-	-	-	-
22.	Peru	1080	-	-	-	-	-
23.	Iran	1076	-	-	-	-	-
24.	Zambia	-	629	3968	-	-	-
25.	Bulgaria	-	-	-	-	10009	2020
26.	Congo Peop. Rep. of	-	-	-	-	5488	5014
27.	Other Countries	4024	13696	26321	24583	32617	30579
	Total	**77261**	**82192**	**112595**	**77647**	**107782**	**106417**

Source: DGCI&S

Annexure: 4 - XIII

India's Imports of Copper (Scrap) 2003-04 to 2008-09 (By Countries)

(In tonnes)

Sl. No.	Name of Country	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
1	UAE	15054	15563	18706	8435	8353	7997
2	Saudi Arabia	3101	9458	7734	4283	2743	5020
3	UK	4142	4922	2945	2143	1618	1227
4	Singapore	2477	4269	3726	1121	744	639
5	USA	5350	4058	1530	844	760	633
6	Malaysia	1827	4051	4200	2900	2135	969
7	Belgium	5565	4739	-	-	-	-
8	Germany	1937	3068	4212	887	1232	-
9	Spain	406	-	-	-	-	-
10	Australia	3006	-	-	-	480	258
11	Kuwait	996	1677	2124	1167	497	438
12	Sweden	736	-	-	-	-	-
13	Iran	434	435	-	-	-	-
14	Sri Lanka	760	-	400	1126	319	420
15.	Italy	233	364	-	-	-	-
16	Bahrain	-	373	654	645	755	759
17.	Jordan	-	974	-	-	-	-
18	Other countries.	6340	12219	12700	7653	5096	4886
	Total	**52364**	**66170**	**58931**	**31204**	**24252**	**23245**

Source: DGCI&S

Annexure: 4 - XIV

India's Imports of Cement Copper (Precipitated) 2003-04 to 2008-09 (By Countries)

(In tonnes)

Sl. No.	Name of Country	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
1.	Indonesia	1	-	-	-	-	-
2.	Philippines	2	-	-	-	-	-
3.	Hong Kong	++	-	-	-	-	-
4.	Korea, Rep. of	1	-	-	-	-	-
5.	USA	++	-	-	-	-	3
6.	Peru	-	-	1005	-	-	-
7.	Malaysia	-	-	70	85	46	43
8.	Singapore	-	-	-	20	63	48
9.	Zaire/Congo Dem. Rep.	-	-	-	-	18	96
10.	Congo, Peop. Rep. of	-	-	-	-	-	72
11.	Tanzania	-	-	-	-	-	40
12.	Unspecified	-	-	-	-	23	19
13.	Other Countries	-	48	-	-	-	-
	Total	**4**	**48**	**1075**	**105**	**150**	**321**

Source: DGCI&S

Annexure: 4 - XV

Worldwide List of Companies Producing Copper

Company Name	Operations	Countries
(Governments)	Chibuluma, Kansanshi, Konkola, Konkola Deep, Mufulira, Nchanga and Nkana	Zambia
(Private)	Cerro Corona, Cerro Verde, Grasberg and Santa Barbara (Mantos Blancos)	Chile, Indonesia, and Peru
(Privately Held)	Alumbrera, Dikulushi, Highland Valley and Los Pelambres	Argentina, Canada, Chile, and Congo (DRC)
(Public Shareholders)	Cerro Verde	Peru
(Various)	Cayeli, Continental, Escondida, Los Pelambres, Mantoverde, Michilla, Quebrada Blanca, Rapu Rapu and Tintaya	Chile, Peru, Philippines, Turkey, and USA
(Workers)	Cananea, La Caridad and Tintaya	Mexico, and Peru
Aditya Birla Minerals	Mount Gordon and Nifty	Australia
AMP Limited	El Tesoro	Chile,
Anglo American plc	Collahuasi, El Soldado, Konkola, Konkola Deep, Los Bronces, Mantos Blancos, Mantoverde, Mufulira, Nchanga, Nkana, Palabora, Salobo and Santa Barbara (Mantos Blancos)	Brazil, Chile, South Africa, and Zambia
AngloGold Ashanti Limited	Boddington	Australia
Antofagasta PLC	El Tesoro, Esperanza, Los Pelambres and Michilla	Chile
Anvil Mining Limited	Dikulushi, Kinsevere and Kulu	Congo (DRC)
ASARCO LLC	Continental, Cuajone, Mission Complex, Ray and Toquepala	Peru, and USA
Barrick Gold Corporation	Osborne and Zaldivar	Australia, and Chile

Contd…..

Company Name	Operations	Countries
BHP Billiton Limited	Alumbrera, Cerro Colorado (Chile), Escondida, Highland Valley, Ok Tedi, Olympic Dam, Pinto Valley, Robinson, San Manueln (CLOSED), Spence and Tintaya	Argentina, Australia, Canada, Chile, Papua New Guinea, Peru, and USA
Boliden AB	Aitik, Gibraltar and Lomas Bayas	Canada, Chile, and Sweden
Brazilian Development Bank	Vale '118'	Brazil
Buenaventura Mining Company Inc	Cerro Verde	Peru
Capstone Mining Corp.	Minto	Canada
CDC Capital Partners	Konkola, Konkola Deep and Nchanga	Zambia
China Minmetals Corporation	Sepon Copper	Laos
China NonFerrous Metal Mining (Group) Co., Ltd.	Luanshya & Baluba	Zambia
Codelco	Andina, Chuquicamata, El Abra, El Teniente, Radomiro Tomic and Salvador	Chile
Compania Minera Milpo S.A.A.	Ivan-Zar	Chile
Constellation Copper Corporation	Lisbon Valley	USA
Copper Co Limited	Lady Annie	Australia
Dowa Holdings Co Ltd	Huckleberry	Canada
Empresa Nacional de Mineria	Andacollo Cobre and Quebrada Blanca	Chile
Equinox Minerals Ltd	Lumwana	Zambia
Erdenet Mining LLC	Erdenet	Mongolia
Eti Mine Works	Cayeli	Turkey
Exxon Mobil Corporation	El Soldado and Los Bronces	Chile
First Quantum Minerals Ltd	Bwana M`kubwa/Lonshi, Frontier, Guelb Moghrein, Kansanshi, Kolwezi Tailings, Mufulira and Nkana	Congo (DRC), Mauritania, and Zambia

Contd…..

Company Name	Operations	Countries
Forrest Group	Kinsenda	Congo (DRC)
Forte Energy NL	Mount Cuthbert	Australia
Freeport-McMoRan Copper & Gold Inc	Bagdad, Candelaria, Cerro Verde, Chino, El Abra, Grasberg, Miami, Morenci, Morenci (Conc Leach & EW), Ojos del Salado, Safford, Sierrita, Tenke Fungurume and Tyrone	Chile, Congo (DRC), Indonesia, Peru, and USA
Furukawa Co. Ltd.	Huckleberry	Canada
Gecamines	Frontier, Kamoto, Kolwezi Tailings, Kulu, Ruashi and Tenke Fungurume	Congo (DRC)
Glencore International AG	CSA (Cobar), Mufulira and Nkana	Australia, and Zambia
GM Mines d'Akjoujt SA	Guelb Moghrein	Mauritania
Gold Fields Ltd	Cerro Corona and Tsumeb/Otjihase/Kombat	Namibia, and Peru
Goldcorp Inc	Alumbrera	Argentina
Governments	Khanong, Kinsevere, Kolwezi Tailings, Konkola & Phu Kham	Congo (DRC), Laos, and Zambia
Grupo Carso S.A.de C.V.	Maria	Mexico
Highlands Pacific Limited	Frieda River	Papua New Guinea
Iberian Minerals Corp	Aguas Teñidas	Spain
Imperial Metals Corporation	Huckleberry and Red Chris	Canada
Indago Resources Ltd.	Mount Gordon	Australia
Industrial Development Corporation of South Africa	Kolwezi Tailings	Congo (DRC)
Industrias Peñoles SA de CV	Milpillas	Mexico
Inmet Mining Corporation	Cayeli, Las Cruces, Ok Tedi and Pyhäsalmi	Finland, Papua New Guinea, Spain, and Turkey
International Finance Corporation	Escondida, Kolwezi Tailings, Konkola, Konkola Deep and Nchanga	Chile, Congo (DRC), and Zambia

Contd…..

Company Name	Operations	Countries
Ivanhoe Mines Ltd	Monywa and Turquoise Hill (Oyu Tolgoi)	Mongolia, and Myanmar
Company Name	Operations	Countries
Kagara Limited	Thalanga	Australia
Kazakhmys PLC	Balkhash Complex, East Region, Karaganda Region and Zhezkazgan Complex	Kazakhstan
KGHM Polska Miedz	Lubin, Polkowice-Sieroszowice and Rudna	Poland
Korea Resources Corporation	Rapu Rapu	Philippines
Leucadia National Corporation	Las Cruces	Spain
LG International Corp	Rapu Rapu	Philippines
Lundin Mining Corporation	Tenke Fungurume	Congo (DRC)
Malaysian Resources Corporation Berhad	Mamut	Malaysia
Marubeni Corporation	El Tesoro, Esperanza and Huckleberry	Canada, and Chile
Matrix Metals Limited	Mount Cuthbert	Australia
Mercator Minerals Ltd	Mineral Park	USA
Metorex Limited	O'okiep and Ruashi	Congo (DRC), and South Africa
Mitsubishi Corporation	Chino and Escondida	Chile, and USA
Mitsubishi Materials Corporation	Batu Hijau, Chino, Escondida, Huckleberry and Los Pelambres	Canada, Chile, Indonesia, and USA
Mitsui & Co Ltd	Collahuasi and Silver Bell	Chile, and USA
Montana Resources Inc	Continental	USA
Newcrest Mining Limited	Boddington	Australia
Newmont Mining Corporation	Batu Hijau, Boddington and Golden Grove Copper	Australia, and Indonesia
National Iranian Copper Industries Corporation	Sarcheshmeh, Miduk, Sungun, Qaleh Zari, Chah Musa, Qaleh Sukhteh	Iran

Contd…..

Company Name	Operations	Countries
Nippon Mining Holdings Inc.	Collahuasi, Escondida and Los Pelambres	Chile
No. 1 Mining Enterprise	Monywa	Myanmar
Other - Public Companies, Governments, Minor Parties	Batu Hijau, Cerro Verde, Cuajone, Ernest Henry, Escondida, Highland Valley, Huckleberry, Ok Tedi, Palabora, Pyhäsalmi, Quebrada Blanca, Tintaya and Toquepala	Australia, Canada, C Contd... Finland, Indonesia, New Guinea, Peru, and South Africa
Outokumpu Oyj	Zaldivar	Chile
OZ Minerals Limited	Golden Grove Copper, Khanong, Prominent Hill and Sepon Copper	Australia, and Laos
PanAust Limited	Phu Kham	Laos
Papua New Guinea Government	Ok Tedi	Papua New Guinea
Quadra Mining Ltd.	Carlota and Robinson	USA
Rio Tinto Group	Alumbrera, Bingham Canyon, Escondida, Grasberg, Northparkes and Palabora	Argentina, Australia, Chile, Indonesia, South Africa, and USA
Sociedad Minera Corona S.A.	Cerro Corona	Peru
Societe de Developement Industriel et Minier du Congo	Kinsenda	Congo (DRC)
Southern Copper Corporation	Cananea, Continental, Cuajone, La Caridad, Minto, Mission Complex, Ray, Silver Bell and Toquepala	Canada, Mexico, Peru, and USA
Sterlite Industries India Limited (59.9% owned by Vedanta Resources plc)	Mission Complex, Mount Lyell and Thalanga	Australia, and USA
Straits Resources Limited	Nifty, Tritton and Whim Creek	Australia
Sumitomo Corporation	Batu Hijau, Candelaria, Cerro Verde, Morenci, Morenci (Conc Leach & EW) and Northparkes	Australia, Chile, Indonesia, Peru, and USA

Contd…..

Concld.……

Company Name	Operation	Countries
Sumitomo Metal Mining Co. Limited	Batu Hijau, Candelaria, Cerro Verde, Morenci, Northparkes and Ojos del Salado	Australia, Chile, Indonesia, Peru, and USA
Taseko Mines Limited	Gibraltar and Prosperity	Canada
Teck Resources Limited	Andacollo Cobre, Cerro Colorado (Panama), Highland Valley, Maria, Quebrada Blanca and Red Chris	Canada, Chile, Mexico, and Panama
Tiomin Resources Inc.	Cerro Colorado (Panama)	Panama
Vale S.A	Salobo, Sossego and Vale '118'	Brazil
Vedanta Resources PLC	Konkola and Nchanga	Zambia
Weatherly International Plc	Tsumeb/Otjihase/Kombat	Namibia
Western Copper Corporation	Carmacks	Canada
Western Mining Co. Ltd	Xitieshan	China
Xstrata plc	Alumbrera, Collahuasi, Ernest Henry, Las Bambas, Lomas Bayas and Tintaya	Argentina, Australia, Chile, and Peru
Yamana Gold Inc.	Agua Rica, Alumbrera and Chapada	Argentina, and Brazil

Source: 2010, AME Mineral Economics.

Annexure: 4 - XVI

Worldwide List of Countries Producing Copper

Country	Operations	Companies
Argentina	Agua Rica and Alumbrera	(Privately Held), BHP Billiton Limited, Goldcorp Inc, Rio Tinto Group, Xstrata plc, and Yamana Gold Inc.
Australia	Boddington, CSA (Cobar), Ernest Henry, Golden Grove Copper, Lady Annie, Mount Cuthbert, Mount Gordon, Mount Lyell, Nifty, Northparkes, Olympic Dam, Osborne, Prominent Hill, Thalanga, Tritton and Whim Creek	Aditya Birla Minerals, AngloGold Ashanti Limited, Barrick Gold Corporation, BHP Billiton Limited, Copper Co Limited, Forte Energy NL, Glencore International AG, Indago Resources Ltd., Kagara Limited, Matrix Metals Limited, Newcrest Mining Limited, Newmont Mining Corporation, Other - Public Companies, Governments, Minor Parties, OZ Minerals Limited, Rio Tinto Group, Sterlite Industries India Limited (59.9% owned by Vedanta Resources plc), Straits Resources Limited, Sumitomo Corporation, Sumitomo Metal Mining Co. Limited, and Xstrata plc
Brazil	Chapada, Salobo, Sossego and Vale '118'	Anglo American plc, Brazilian Development Bank, Vale S.A, and Yamana Gold Inc.
Canada	Carmacks, Gibraltar, Highland Valley, Huckleberry, Minto, Prosperity and Red Chris	(Privately Held), BHP Billiton Limited, Boliden AB, Capstone Mining Corp., Dowa Holdings Co Ltd, Furukawa Co. Ltd., Imperial Metals Corporation, Marubeni Corporation, Mitsubishi Materials Corporation, Other - Public Companies, Governments, Minor Parties, Southern Copper Corporation, Taseko Mines Limited, Teck Resources Limited, and Western Copper Corporation
Chile	Andacollo Cobre, Andina, Candelaria, Cerro Colorado (Chile), Chuquicamata, Collahuasi, El Abra, El Soldado,	(Private), (Privately Held), (Various), AMP Limited, Anglo American plc, Antofagasta PLC, Barrick Gold Corporation, BHP Billiton Limited,

Contd…..

Country	Operations	Companies
	El Teniente, El Tesoro, Escondida, Esperanza, Ivan-Zar, Lomas Bayas, Los Bronces, Los Pelambres, Mantos Blancos, Mantoverde, Michilla, Ojos del Salado, Quebrada Blanca, Radomiro Tomic, Salvador, Santa Barbara (Mantos Blancos), Spence and Zaldivar	Boliden AB, Codelco, Compania Minera Milpo S.A.A., Empresa Nacional de Mineria, Exxon Mobil Corporation, Freeport-McMoRan Copper & Gold Inc, International Finance Corporation, Marubeni Corporation, Mitsubishi Corporation, Mitsubishi Materials Corporation, Mitsui & Co Ltd, Nippon Mining Holdings Inc., Other - Public Companies, Governments, Minor Parties, Outokumpu Oyj, Rio Tinto Group, Sumitomo Corporation, Sumitomo Metal Mining Co. Limited, Teck Resources Limited, and Xstrata plc
China	Xitieshan, Shenyang, Liaoning Wusong	Western Mining Co. Ltd
Congo (DRC)	Dikulushi, Frontier, Kamoto, Kinsenda, Kinsevere, Kolwezi Tailings, Kulu, Ruashi and Tenke Fungurume	(Privately Held), Anvil Mining Limited, First Quantum Minerals Ltd, Forrest Group, Freeport-McMoRan Copper & Gold Inc, Gecamines, Governments, Industrial Development Corporation of South Africa, International Finance Corporation, Lundin Mining Corporation, Metorex Limited, and Societe de Developpement Industriel et Minier du Congo
Finland	Pyhäsalmi	Inmet Mining Corporation, and Other - Public Companies, Governments, Minor Parties
Indonesia	Batu Hijau and Grasberg	(Private), Freeport-McMoRan Copper & Gold Inc, Mitsubishi Materials Corporation, Newmont Mining Corporation, Other - Public Companies, Governments, Minor Parties, Rio Tinto Group, Sumitomo Corporation, and Sumitomo Metal Mining Co. Limited
Iran	Sarcheshmeh, Miduk, Sungun, Qaleh Zari, Chah Musa, Qaleh Sukhteh	National Iranian Copper Industries Corporation (NICICO)
Kazakhstan	Balkhash Complex, East Region, Karaganda Region and Zhezkazgan Complex	Kazakhmys PLC

Contd…..

Country	Operations	Companies
Laos	Khanong, Phu Kham and Sepon Copper	China Minmetals Corporation, Governments, OZ Minerals Limited, and PanAust Limited
Malaysia	Mamut	Malaysian Resources Corporation Berhad
Mauritania	Guelb Moghrein	First Quantum Minerals Ltd, and GM Mines d'Akjoujt SA
Mexico	Cananea, La Caridad, Maria and Milpillas	(Workers), Grupo Carso S.A. de C.V., Industrias Peñoles SA de CV, Southern Copper Corporation, and Teck Resources Limited
Mongolia	Erdenet and Turquoise Hill (Oyu Tolgoi)	Erdenet Mining LLC, and Ivanhoe Mines Ltd
Myanmar	Monywa	Ivanhoe Mines Ltd, and No. 1 Mining Enterprise
Namibia	Tsumeb/Otjihase/Kombat	Gold Fields Ltd, and Weatherly International Plc
Panama	Cerro Colorado (Panama)	Teck Resources Limited, and Tiomin Resources Inc.
Papua New Guinea	Frieda River and Ok Tedi	BHP Billiton Limited, Highlands Pacific Limited, Inmet Mining Corporation, Other - Public Companies, Governments, Minor Parties, and Papua New Guinea Government
Peru	Cerro Corona, Cerro Verde, Cuajone, Las Bambas, Tintaya and Toquepala	(Private), (Public Shareholders), (Various), (Workers), ASARCO LLC, BHP Billiton Limited, Buenaventura Mining Company Inc, Freeport-McMoRan Copper & Gold Inc, Gold Fields Ltd, Other - Public Companies, Governments, Minor Parties, Sociedad Minera Corona S.A., Southern Copper Corporation, Sumitomo Corporation, Sumitomo Metal Mining Co. Limited, and Xstrata plc
Philippines	Rapu Rapu	(Various), Korea Resources Corporation, and LG International Corp
Poland	Lubin, Polkowice-Sieroszowice and Rudna	KGHM Polska Miedz
South Africa	O'okiep and Palabora	Anglo American plc, Metorex Limited, Other - Public Companies, Governments, Minor Parties, and Rio Tinto Group

Contd…..

Concld..…..

Country	Operations	Companies
Spain	Aguas Teñidas and Las Cruces	Iberian Minerals Corp, Inmet Mining Corporation, and Leucadia National Corporation
Sweden	Aitik	Boliden AB
Turkey	Cayeli	(Various), Eti Mine Works, and Inmet Mining Corporation
USA	Bagdad, Bingham Canyon, Carlota, Chino, Continental, Lisbon Valley, Miami, Mineral Park, Mission Complex, Morenci, Morenci (Conc Leach & EW), Pinto Valley, Ray, Robinson, Safford, San Manueln (CLOSED), Sierrita, Silver Bell and Tyrone	(Various), ASARCO LLC, BHP Billiton Limited, Constellation Copper Corporation, Freeport-McMoRan Copper & Gold Inc, Mercator Minerals Ltd, Mitsubishi Corporation, Mitsubishi Materials Corporation, Mitsui & Co Ltd, Montana Resources Inc, Quadra Mining Ltd., Rio Tinto Group, Southern Copper Corporation, Sterlite Industries India Limited (59.9% owned by Vedanta Resources plc), Sumitomo Corporation, and Sumitomo Metal Mining Co. Limited
Zambia	Bwana M`kubwa/Lonshi, Chibuluma, Kansanshi, Konkola, Konkola Deep, Luanshya & Baluba, Lumwana, Mufulira, Nchanga and Nkana	(Governments), Anglo American plc, CDC Capital Partners, China NonFerrous Metal Mining (Group) Co., Ltd., Equinox Minerals Limited, First Quantum Minerals Ltd, Glencore International AG, Governments, International Finance Corporation, and Vedanta Resources PLC

Source: 2010, AME Mineral Economics.

Annexure: 4 - XVII

Worldwide List of Mines Producing Copper

Mine Name	Country	Owners
Agua Rica	Argentina	Yamana Gold Inc.
Aguas Teñidas	Spain	Iberian Minerals Corp
Aitik	Sweden	Boliden AB
Alumbrera	Argentina	(Privately Held), BHP Billiton Limited, Goldcorp Inc, Rio Tinto Group, Xstrata plc, and Yamana Gold Inc.
Andacollo Cobre	Chile	Empresa Nacional de Mineria, and Teck Resources Limited
Andina	Chile	Codelco
Bagdad	USA	Freeport-McMoRan Copper & Gold Inc
Balkhash Complex	Kazakhstan	Kazakhmys PLC
Batu Hijau	Indonesia	Mitsubishi Materials Corporation, Newmont Mining Corporation, Other - Public Companies, Governments, Minor Parties, Sumitomo Corporation, and Sumitomo Metal Mining Co. Limited
Bingham Canyon	USA	Rio Tinto Group
Boddington	Australia	AngloGold Ashanti Limited, Newcrest Mining Limited, and Newmont Mining Corporation
Bwana M`kubwa/Lonshi	Zambia	First Quantum Minerals Ltd
Cananea	Mexico	(Workers), and Southern Copper Corporation
Candelaria	Chile	Freeport-McMoRan Copper & Gold Inc, Sumitomo Corporation, and Sumitomo Metal Mining Co. Limited
Carlota	USA	Quadra Mining Ltd.
Carmacks	Canada	Western Copper Corporation
Cayeli	Turkey	(Various), Eti Mine Works, and Inmet Mining Corporation
Cerro Colorado (Chile)	Chile	BHP Billiton Limited
Cerro Colorado (Panama)	Panama	Teck Resources Limited, and Tiomin Resources Inc.
Cerro Corona	Peru	(Private), Gold Fields Ltd, and Sociedad Minera Corona S.A.
Cerro Verde	Peru	(Private), (Public Shareholders), Buenaventura Mining Company Inc, Freeport-McMoRan Copper & Gold Inc, Other - Public Companies, Governments, Minor Parties, Sumitomo Corporation, and Sumitomo Metal Mining Co. Limited

Contd…..

Mine Name	Country	Owners
Chapada	Brazil	Yamana Gold Inc.
Chah Musa	Iran	National Iranian Copper Industries Corporation
Chibuluma	Zambia	(Governments)
Chino	USA	Freeport-McMoRan Copper & Gold Inc, Mitsubishi Corporation, and Mitsubishi Materials Corporation
Chuquicamata	Chile	Codelco
Collahuasi	Chile	Anglo American plc, Mitsui & Co Ltd, Nippon Mining Holdings Inc., and Xstrata plc
Continental	USA	(Various), ASARCO LLC, Montana Resources Inc, and Southern Copper Corporation
CSA (Cobar)	Australia	Glencore International AG
Cuajone	Peru	ASARCO LLC, Other - Public Companies, Governments, Minor Parties, and Southern Copper Corporation
Dikulushi	Congo (DRC)	(Privately Held), and Anvil Mining Limited
East Region	Kazakhstan	Kazakhmys PLC
El Abra	Chile	Codelco, and Freeport-McMoRan Copper & Gold Inc
El Soldado	Chile	Anglo American plc, and Exxon Mobil Corporation
El Teniente	Chile	Codelco
El Tesoro	Chile	AMP Limited, Antofagasta PLC, and Marubeni Corporation
Erdenet	Mongolia	Erdenet Mining LLC
Ernest Henry	Australia	Other - Public Companies, Governments, Minor Parties, and Xstrata plc
Escondida	Chile	(Various), BHP Billiton Limited, International Finance Corporation, Mitsubishi Corporation, Mitsubishi Materials Corporation, Nippon Mining Holdings Inc., Other - Public Companies, Governments, Minor Parties, and Rio Tinto Group
Esperanza	Chile	Antofagasta PLC, and Marubeni Corporation
Frieda River	Papua New Guinea	Highlands Pacific Limited
Frontier	Congo (DRC)	First Quantum Minerals Ltd, and Gecamines
Gibraltar	Canada	Boliden AB, and Taseko Mines Limited
Golden Grove Copper	Australia	Newmont Mining Corporation, and OZ Minerals Limited
Grasberg	Indonesia	(Private), Freeport-McMoRan Copper & Gold Inc, and Rio Tinto Group

Contd…..

Mine Name	Country	Owners
Guelb Moghrein	Mauritania	First Quantum Minerals Ltd, and GM Mines d'Akjoujt SA
Highland Valley	Canada	(Privately Held), BHP Billiton Limited, Other - Public Companies, Governments, Minor Parties, and Teck Resources Limited
Huckleberry	Canada	Dowa Holdings Co Ltd, Furukawa Co. Ltd., Imperial Metals Corporation, Marubeni Corporation, Mitsubishi Materials Corporation, and Other - Public Companies, Governments, Minor Parties
Hushamu	Canada	
Ivan-Zar	Chile	Compania Minera Milpo S.A.A.
Kamoto	Congo (DRC)	Gecamines
Kansanshi	Zambia	(Governments), and First Quantum Minerals Ltd
Karaganda Region	Kazakhstan	Kazakhmys PLC
Khanong	Laos	Governments, and OZ Minerals Limited
Kinsenda	Congo (DRC)	Forrest Group, and Societe de Developpement Industriel et Minier du Congo
Kinsevere	Congo (DRC)	Anvil Mining Limited, and Governments
Kolwezi Tailings	Congo (DRC)	First Quantum Minerals Ltd, Gecamines, Governments, Industrial Development Corporation of South Africa, and International Finance Corporation
Konkola	Zambia	(Governments), Anglo American plc, CDC Capital Partners, Governments, International Finance Corporation, and Vedanta Resources PLC
Konkola Deep	Zambia	(Governments), Anglo American plc, CDC Capital Partners, and International Finance Corporation
Kulu	Congo (DRC)	Anvil Mining Limited, and Gecamines
La Caridad	Mexico	(Workers) and Southern Copper Corporation
La Granja	Peru	
Lady Annie	Australia	CopperCo Limited
Las Bambas	Peru	Xstrata plc
Las Cruces	Spain	Inmet Mining Corporation, and Leucadia National Corporation
Lisbon Valley	USA	Constellation Copper Corporation
Lomas Bayas	Chile	Boliden AB, and Xstrata plc
Los Bronces	Chile	Anglo American plc, and Exxon Mobil Corporation

Contd…..

Mine Name	Country	Owners
Los Pelambres	Chile	(Privately Held), (Various), Antofagasta PLC, Mitsubishi Materials Corporation, and Nippon Mining Holdings Inc.
Luanshya & Baluba	Zambia	China NonFerrous Metal Mining (Group) Co., Ltd.
Lubin	Poland	KGHM Polska Miedz
Lumwana	Zambia	Equinox Minerals Limited
Mamut	Malaysia	Malaysian Resources Corporation Berhad
Mantos Blancos	Chile	Anglo American plc
Mantoverde	Chile	(Various), and Anglo American plc
Maria	Mexico	Grupo Carso S.A. de C.V., and Teck Resources Limited
Miami	USA	Freeport-McMoRan Copper & Gold Inc
Michilla	Chile	(Various), and Antofagasta PLC
Miduk	Iran	National Iranian Copper Industries Corporation
Milpillas	Mexico	Industrias Peñoles SA de CV
Mineral Park	USA	Mercator Minerals Ltd
Minto	Canada	Capstone Mining Corp., and Southern Copper Corporation
Mission Complex	USA	ASARCO LLC, Southern Copper Corporation, and Sterlite Industries India Limited (59.9% owned by Vedanta Resources plc)
Monywa	Myanmar	Ivanhoe Mines Ltd, and No. 1 Mining Enterprise
Morenci	USA	Freeport-McMoRan Copper & Gold Inc, Sumitomo Corporation, and Sumitomo Metal Mining Co. Limited
Morenci (Conc Leach & EW)	USA	Freeport-McMoRan Copper & Gold Inc, and Sumitomo Corporation
Mount Cuthbert	Australia	Forte Energy NL, and Matrix Metals Limited
Mount Garnet Copper Circuit	Australia	
Mount Gordon	Australia	Aditya Birla Minerals, and Indago Resources Ltd.
Mount Lyell	Australia	Sterlite Industries India Limited (59.9% owned by Vedanta Resources plc)
Mowana	Botswana	
Mufulira	Zambia	(Governments), Anglo American plc, First Quantum Minerals Ltd, and Glencore International AG
Nchanga	Zambia	(Governments), Anglo American plc, CDC Capital Partners, International Finance Corporation, and Vedanta Resources PLC
Nifty	Australia	Aditya Birla Minerals, and Straits Resources Limited

Contd…..

Mine Name	Country	Owners
Nkana	Zambia	(Governments), Anglo American plc, First Quantum Minerals Ltd, and Glencore International AG
Northparkes	Australia	Rio Tinto Group, Sumitomo Corporation, and Sumitomo Metal Mining Co. Limited
O'okiep	South Africa	Metorex Limited
Ojos del Salado	Chile	Freeport-McMoRan Copper & Gold Inc, and Sumitomo Metal Mining Co. Limited
OK Mine	USA	
Ok Tedi	Papua New Guinea	BHP Billiton Limited, Inmet Mining Corporation, Other - Public Companies, Governments, Minor Parties, and Papua New Guinea Government
Olympic Dam	Australia	BHP Billiton Limited
Osborne	Australia	Barrick Gold Corporation
Palabora	South Africa	Anglo American plc, Other - Public Companies, Governments, Minor Parties, and Rio Tinto Group
Phu Kham	Laos	Governments, and PanAust Limited
Piedras Verdes	Mexico	
Pinto Valley	USA	BHP Billiton Limited
Polkowice-Sieroszowice	Poland	KGHM Polska Miedz
Prominent Hill	Australia	OZ Minerals Limited
Prosperity	Canada	Taseko Mines Limited
Pyhäsalmi	Finland	Inmet Mining Corporation, and Other - Public Companies, Governments, Minor Parties
Qaleh Sukhteh and Qaleh Zari	Iran	National Iranian Copper Industries Corporation
Quebrada Blanca	Chile	(Various), Empresa Nacional de Mineria, Other - Public Companies, Governments, Minor Parties, and Teck Resources Limited
Radomiro Tomic	Chile	Codelco
Rapu Rapu	Philippines	(Various), Korea Resources Corporation, and LG International Corp
Ray	USA	ASARCO LLC, and Southern Copper Corporation
Red Chris	Canada	Imperial Metals Corporation, and Teck Resources Limited
Rio Tinto	Spain	
Robinson	USA	BHP Billiton Limited, and Quadra Mining Ltd.
Ruashi	Congo (DRC)	Gecamines, and Metorex Limited
Rudna	Poland	KGHM Polska Miedz
Safford	USA	Freeport-McMoRan Copper & Gold Inc
Salobo	Brazil	Anglo American plc, and Vale S.A
Salvador	Chile	Codelco

Contd…..

Concld…..

Mine Name	Country	Owners
San Manueln	USA	BHP Billiton Limited (Closed)
Santa Barbara (Mantos Blancos)	Chile	(Private), and Anglo American plc
Sarcheshmeh	Iran	National Iranian Copper Industries Corporation
Selwyn	Australia	
Sepon Copper	Laos	China Minmetals Corporation, and OZ Minerals Limited
Sierrita	USA	Freeport-McMoRan Copper & Gold Inc
Silver Bell	USA	Mitsui & Co Ltd, and Southern Copper Corporation
Skouriotissa	Cyprus	
Sossego	Brazil	Vale S.A
Spence	Chile	BHP Billiton Limited
Sungun	Iran	National Iranian Copper Industries Corporation
Tenke Fungurume	Congo (DRC)	Freeport-McMoRan Copper & Gold Inc, Gecamines, and Lundin Mining Corporation
Thalanga	Australia	Kagara Limited, and Sterlite Industries India Limited (59.9% owned by Vedanta Resources plc)
Tintaya	Peru	(Various), (Workers), BHP Billiton Limited, Other - Public Companies, Governments, Minor Parties, and Xstrata plc
Tonopah	USA	
Toquepala	Peru	ASARCO LLC, Other - Public Companies, Governments, Minor Parties, and Southern Copper Corporation
Tritton	Australia	Straits Resources Limited
Tsumeb/Otjihase/Ko mbat	Namibia	Gold Fields Ltd, and Weatherly International Plc
Turquoise Hill (Oyu Tolgoi)	Mongolia	Ivanhoe Mines Ltd
Tyrone	USA	Freeport-McMoRan Copper & Gold Inc
Vale '118'	Brazil	Brazilian Development Bank, and Vale S.A
Whim Creek	Australia	Straits Resources Limited
Xitieshan	China	Western Mining Co. Ltd
Zaldivar	Chile	Barrick Gold Corporation, and Outokumpu Oyj
Zhezkazgan Complex	Kazakhstan	Kazakhmys PLC

Source: 2010, AME Mineral Economics.

Annexure: 4 - XVIII

Worldwide List of Copper Smelter & Refineries

Sl.No.	Country	Company	Location	Annual Capacity
Australia				
1.	Smelter	Mount Isa Copper Smelter	Mount Isa	0.25 MT
2.	Smelter	Olympic Dam Copper Smelter	Roxby Down	0.07 MT
3.	Smelter	Port Kembla Copper Smelter	Port Kembla	0.12 MT
4.	Refinery	Olympic Dam Copper Refinery	Roxby Down	0.235 MT
5.	Refinery	Port Kembla Copper Refinery	Port Kembla	0.120 MT
6.	Refinery	Townsville Copper Refinery	Townsville	0.30 MT
Burma				
1.	Refinery	Ivanhoe Myanmar Holding Ltd.	SX-EW Plant Monywa	0.039 MT
China				
1.	Smelter	Jinchang Smelter	Anhui, Tongling	0.17 MT
2.	Smelter	Jinlong Smelter	Anhui, Tongling	0.40 MT
3.	Smelter	Wuhu Smelter	Anhui, Wuhu	0.060 MT
4.	Smelter	Guixi Smelter	Jiangxi,Guixi	0.70 MT
5.	Smelter	Yunnan Smelter	Yunnan,Kunming	0.25 MT
6.	Refinery	Baiyin Nonferrous Metal Co.	Gansu, Baiyin	0.05 MT
7.	Refinery	Jinchuan Nonferrous Metal Co.	Gansu,Jinchuan	0.20 MT
8.	Refinery	Luoyang Copper Processing Factory	Henan, Luoyang	0.050 MT
9.	Refinery	Daye Nonferrous Metal Co.	Hubei,Daye	0.20 MT
10.	Refinery	Zhangjiayang United Copper Co.	Jiangsu,Zhangjiayang	0.20 MT
11.	Refinery	Dongfang Copper Co.	Liaoning, Huludao	0.10 MT
12.	Refinery	Chifeng Jinseng Copper Co.Ltd.	Nei Mongol,Chifeng Hargin Banner	0.10 MT
13.	Refinery	Dongying Fangyuan Nonferrous Metals Co.	Shandong,Dongying	0.10 MT

Contd…..

Sl.No.	Country	Company	Location	Annual Capacity
14.	Refinery	Shandong Jinseng Non Ferrous Metal Co.	Shandong, Linyi	0.10 MT
15.	Refinery	Shandong Yanggu Xiangguang Co.Ltd.	Shandong,Yanggu	0.20 MT
16.	Refinery	Yantai Penghui Copper Industry Co.Ltd.	Shandong,Yantai	0.06 MT
17.	Refinery	Taiyuan Copper Industries Co.Ltd.	Shanxi,Taiyuan	0.03 MT
18.	Refinery	Zhongtiaoshan Nonferrous Metal Co.	Shanxi,Yuangu	0.10 MT
19.	Refinery	Tianjin Datong Copper Co.Ltd.	Tianjin	0.20 MT
India				
1.	Smelter	Hindalco Industries Ltd.	Birla Copper Complex, Dahej,Gujarat	0.07 MT
2.	Smelter/ Refinery	Hindustan Copper Ltd.	Indian Copper Complex,Ghatsila, Jharkhand	0.02 MT
3.	Smelter/ Refinery	Hindustan Copper Ltd.	Khetri Copper Complex,Khetri, Rajasthan	0.045 MT
4.	Smelter	Sterlite Industries Ltd.	Tuticorin Smelter, Tamilnadu	0.4 MT
5.	Smelter	Sterlite industries Ltd.	Silvasa Refinery, Gujarat	0.18 MT
Indonesia				
1.	Concentrates	PT Freeport Indonesia Co.	Ertsberg & Grasberg,Papua	0.80 MT
2.	Concentrates	PT Newmont Nusa Tenggara	Sumbawa Island	0.30 MT
3.	Smelter	PT Smelting Co.	Gresik,East Java	0.210 MT
Iran				
1.	Concentrator	National Iranian Copper Industries Corporation	Khatoonabad, Kerman	0.080MT
2.	Refinery	National Iranian Copper Industries Corporation	Sercheshmeh, Kerman	0.225MT
3.	Smelter	National Iranian Copper Industries Corporation	Sercheshmeh, Kerman	0.15MT
Japan				
1.	Refinery	Mitsubishi Material Corp.	Naoshima Kagawa, Prefecture	0.226 MT
2.	Refinery	Onahama Smelting & Refining Co.Ltd.	Onahama,Fukushima	0.258 MT

Contd…..

Sl.No.	Country	Company	Location	Annual Capacity
3.	Refinery	Pan Pacific Copper Co.Ltd.	Saganoseki Oita Prefecture	0.710 MT
			Hitachi,Ibaraki,Tamano Okayama Prefecture	
4.	Refinery	Sumitomo Metal Mining Co .Ltd.	Besshi/Toyo (Saijyo), Ehime Prefecture	0.410 MT
5.	Refinery	Kosaka Smelting & Refining Co. Ltd.	Kosaka,Akita Prefecture	0.072 MT
Republic of Korea				
1.	Metal Primary	Korea Zinc Co. Ltd.	Onsan	0.02 MT
2.	Metal Primary	L.S.Nikko Copper Co.	Changhang	0.06 MT
3.	Metal Primary	L.S.Nikko Copper Co	Onsan	0.51 MT
Laos				
1.	Refinery	Lane Xang Material Ltd.	Sepon,Vilabouly District	0.67 MT
Mangolia				
1.	Concentrator	Erdenet Mining Corp.	Bulgan Province, Erdenet	0.13 MT
Pakistan				
1.	Metal	Saindak Metal Ltd.	Chagai,Baluchistan	0.022 MT
Philippines				
1	Smelter	Glen core International AG	Isabel,Leyte Island	0.25 MT
2.	Refinery	Glen core International AG	Isabel, Leyte Island	0.173 MT
Thailand				
1.	Refinery	Thai Copper Industries PCL	Rayong	0.165 MT
Vietnam				
1.	Concentrates	Vietnam National Mineral Corporation	Tang Loong Long Commune	0.010 MT
Algeria				
1.	Copper Cathode	Societe Algerieme Due Zinc	Ghazaoyet	NA
Congo (Kinshasa)				
1.	Smelter	La Generale des	Lubumbashi	0.15 Blister MT
2.	Concentrates	La Generale des Corrierers	Kambove	1.5 MT

Contd…..

Sl.No.	Country	Company	Location	Annual Capacity
3.	Refinery	La Generale Sihituru EW Plant	LIKASI	0.15 MT Cathodes
4.	Refinery	La Generale Panda Reverberatory Furnace	Sihituru	0.15 MT Wire bar
5.	Concentrates	Gecamines West Group	DIMA-Kamota Concentratrors at Kolwezi	8 MT ore
6.	Refinery	Gecamines, Luilu Hyudrometallurgical Refinery & Leach Plant near Kolwezi		0.175 MT
7.	Tailing	Ruashi Mining SPRL	Ruashi Tailing Project	0.01 MT
Morocco & Western Sahara				
1.	Concentrates	Societe Miniere de bou Gaffer	Bleida	0.05 Mt
2.	Concentrates	Campaigne mininere de Guemassa	Douar Hajaj Mine,Guemassa	0.018 MT
3.	Concentrates	Societe de development du Cuivede	Tiouit	4500 Tonnes
Namibia				
1.	Concentrates	Ongopolo Mining & Processing Ltd.	Otjihase Windhoek	0.023 MT
2.	Concentrates	Ongopolo Mining & Processing Ltd.	Kambat Mine Windhoek	0.023 MT
3.	Smelter	Ongopolo Mining & Processing Ltd.	Tsumeb	0.003 MT
South Africa				
1.	Smelter	Palabora Mining Co.Ltd.	Phalaborwa	0.135 MT Anode
2.	Refinery	Palabora Mining Co.Ltd.	Phalaborwa	0.135 MT Cathode
3.	Refinery	Anglo American Platinum Corp.Ltd.	Rustenberg Basemetal Refineries	0.012 MT Refined
4.	Refinery	Lonmin Platinum	Marikana Mine Basemetal Refineries	0.003 MT Refined
5.	Refinery	Impala Platinum Ltd.	BaseMetal Refinery	NA
Tanzania				
1.	Concentates	Bulyanhulu Gold Mine Ltd.	Bulyanhulu Gold Mine, Kahama	6300 Tonnes

Contd…..

Concld….

Sl.No.	Country	Company	Location	Annual Capacity
Zambia				
1.	Smelter & Refinery	Konkola Copper Mine	Tailing Leach Plant at Chingola	0.08 MT cathodes
2.	Smelter	KCM (Smelterco) Ltd.	Nana Copper Smelter	0.24 MT blister/ Anode
3.	Refinery	KCM (Smelterco) Ltd.	Nkana Copper Smelter	0.18MT Cathode
4.	Smelter	Mopani Copper Mines Co.	Mufulira Insitu and SXEW plant	0.017MT cathode
5.	Smelter	Mopani Copper Mines Co.	Mufulira	0.2 MT Anode
6.	Refinery	Mopani Copper Mines Co.	Mufulira	0.275 MT Cathode
7.	Refinery	Mopani Copper Mines Co.	Nkana heap Leach	0.038 Cathodes
8.	Refinery	Chambishi Metal Co.	Chambishi Cobalt Plant	0.027 MT cathode
9.	Refinery	First Quantum Mineral Ltd.	Bwana Mkubwa SXEW Plant	0.052 MT Cathode
10.	Smelter/ Refinery	Sable Zinc Kobwe Ltd.	Copper Leach and Electro winning Plant, Kabwe	0.014 MT
11.	Smelter/ Refinery	Sino Metal Leach Zambia Ltd.	Chambishi	0.008 MT Cathode
Zimbabwe				
1.	Refinery	Empress Nickel Refinery	Eiffel Flats	0.006 MT
Oman				
1.	Refinery	Oman Mining Co.	Lasail	0.025MT

Source: USGS Area Reports

Annexure: 4 – XIX

Details of Important Copper Mines in the World

1. Escondida Copper Mine, Chile

The Escondida copper-gold-silver mine is located in the arid, northern Atacama Desert of Chile about 160km southeast the port of Antofagasta, at an elevation of 3,050m above sea level. The mine is a joint venture between BHP-Billiton (57.5%), Rio Tinto (30%), a Japanese consortium (10%) and the International Finance Corporation (2.5%). It came on-stream in late 1990 and its capacity has since been increased by phased expansions to the current level of 230,000t/d ore throughput. The mine employs around 2,200 people.

Production at the mine was cut back during the period 2003 on account of the weak world market conditions for copper. The partners in the project decided to mine lower-grade ores while maintaining the concentrator throughput, thus reducing the impact on per-ton-treated costs. Output was subsequently ramped up again, and during 2004 the mine handled 377Mt of ore and waste, and processed 82.4Mt of sulphide ore grading 1.51% copper (up from 70.3Mt at 1.43% copper in 2003).

During the year ending June 2006, the mine handled 368.3Mt of ore and waste and processed 87.7Mt of sulphide ore grading 1.61% copper. Total mill output was 1,207,100 tons. Payable copper production was 1.17Mt of copper, electrowon copper cathode output was 116,300 tons, payable gold in concentrate was 139,000oz and payable silver in concentrate was 5.9Moz.

In 2007, the copper mine boosted output by 18.2% after producing 1.245 million tons of copper contained in concrete and 238,357 tonnes in cathodes. However, during the first nine months of 2008, Escondida experienced a 10.4% production rate compared to the same period a year ago.

Geology and reserves

Escondida is related geologically to three porphyry bodies intruded along the major Chilean west fissure fault system. Primary hydrothermal sulphide ore grades at between 0.2% and 1% copper. Subsequent weathering and uplifting created a barren, leached cap, up to 180m thick, over a high grade supergene enriched ore, both overlying the primary sulphides. Primary sulphide mineralisation includes pyrite, chalocopyrite and bornite, with covellite and chalcocite in the enriched zone.

The combined proven and probable ore reserves of Escondida and Escondida Norte as at mid-2004 were: 2,018Mt of copper sulphide ore at 1.24% total copper; 1,701Mt of low-grade copper sulphide ore at 0.55% total copper; and 290Mt of copper oxide ore at 0.73% acid-soluble copper.

Escondida's proved and probable reserves are currently 3,900Mt, including the addition of 1,200Mt from the Escondida Norte project. Current mine operations are projected for 34 years.

Contd…..

Production and expansions

1993 and 1994 expansion increased capacity from the initial level of 320,000t/y of copper-in-concentrates to 480,000t/y. Further expansion in 1996 took output capacity to 800,000t/y. In November 1998, concentrator expansion was completed, increasing capacity to 127,000t/d of ore. A new oxide ore processing plant then began operation, reaching its design rate of 125,000t/y of electrolytic copper metal in mid-1999. The $1.044bn 110,000t/d Phase 4 concentrator was completed in September 2002 using retained earnings.

Escondida's proved and probable reserves are currently 3,900Mt; including the addition of 1,200Mt from the Escondida Norte project.

The project partners have invested $400m for opening the new Escondida Norte pit, 5km north of the existing mine. By the end of 2004, 126Mt of material had been moved during pre-stripping operations.

Meanwhile, the Escondida sulphide leach project, designed to produce 180,000t/y of cathode copper cathode, is costing $870m to commission. The process will use bacterially assisted leaching on low-grade run-of-mine ore from both the Escondida and Escondida Norte pits, with solvent-extraction and electrowinning to produce the copper. Production at the plant began in 2007.

Open-pit mining

Escondida is a conventional open-pit operation processing sulphide and oxide ores. Run-of-mine ore is hauled to two semi-mobile, in-pit crushers for primary reduction before being conveyed to the coarse ore stockpiles. The stripping ratio will average around 1.7:1 over the full life of the project. In-pit truck dispatching and monitoring is handled by a system from Wenco International Mining Systems, while project materials, maintenance and costing control is achieved using Mincom's mine information management system.

Ore processing

The sulphide concentrator employs crushing, milling and flotation circuits. 12m-high, 4m-square column cells are used for cleaning the bulk sulphide concentrate. The new concentrator uses 94 Wemco 160m³ cells for rougher and cleaner flotation. The separate oxide ore plant uses solvent extraction-electrowinning technology to produce cathode copper metal directly from leached ore. Oxide ore is crushed and sized then heap leached, the dissolved copper being recovered directly by electrolysis.

Concentrate transport and handling

Copper concentrates from the Escondida mill are pumped through a 170km-long, nine-inch-diameter pipeline to the coastal port of Coloso where concentrates are dewatered and dried for export. Concentrate dewatering employs three Larox style PF and four ceramic hyperbaric filters, which reduce the moisture content to an average of 9% after arrival at the pipeline discharge. Effluent is treated before discharge deep into the Pacific Ocean.

Contd…..

2. Corporacion Nacional del Cobre de Chile (Codelco) or National Copper Corporation of Chile

Codelco Norte

Codelco Norte is a division of Codelco that is made of the Chuqicamata and Radomiro Tomic mining areas.

i) Chuquicamata

Copper has been mined for centuries at Chuquicamata as was shown by the discovery in 1898 of "Copper Man", a mummy dated at about 550 A.D. which was found trapped in an ancient mine shaft by a fall of rock. However mining on any scale did not start until the later years of the XIX Century and these early operations mined the high grade veins (10-15% copper) and disregarded the low grade disseminated ore.

The Modern Mine

Chilex (The Chile Exploration Company) then went ahead with the development and construction of a mine on the eastern section of the Chuquicamata field - it acquired the remainder gradually over the next 15 years - and a 10,000 tons per day leaching plant which was planned to produce 50,000 tons of electrolytic copper annually.

Production from the capping of oxidised minerals, which required mere leaching in sulphuric acid to dissolve the copper and the recovery of the copper by electrolysis was the sole means of production until the 1950s. However their gradual depletion forced the construction of a mill and flotation plant in 1961 to treat the underlying secondary sulphides. These have been steadily expanded until recently the pit was producing over 600,000 tonnes of copper annually, though this has now fallen with the lower grades as the richer secondary mineralisation is also depleted in the three porphyries that make up the orebody.

The present mine is a conventional truck and shovel operation, with a large proportion of the ore crushed in-pit and transported by underground conveyors to the mill bins. The 182,000 tonnes p.a. concentrator is also conventional and is primary crushing followed by SAG mills and ball mills with cyclone classification. The flotation section produces both copper and molybdenum concentrates. The 1.65 million tonnes p.a. of concentrate are smelted in one Outokumpu flash smelter and one Teniente converter with electric furnace and cylindrical slag cleaning followed by four Pierce Smith converters. The blister copper goes to six anode furnaces which feed three anode casting wheels. The anodes go on to the 855,000 tonnes p.a. electrolytic refinery.

The Future of Chuquicamata

Plans to go underground and mine the rest of the Chuquicamata orebody by block caving are now well advanced. At the SIMIN conference in 2007 in Santiago Codelco engineers detailed a possible future mining plan. The open pit is becoming gradually uneconomic and it was estimated that mining would slow down and stop by

Contd…..

2020. In the meantime the mill will be kept up to its 182,000 tonnes per day capacity with sulphides from Radomiro Tomic and Alejandro Hales. The underground mine will start up in 2018 and when it reaches full capacity of 120,000 tonnes per day in 2030, the balance of the tonnage will come from the Alejandro Hales underground mine. It is estimated that extractable underground reserves below the present pit total 1,150 million tonnes of ore gradeing 0.76% copper and 0.052% molybdenum.

This remarkable mine was for many years the world's largest annual producer until overtaken recently by Escondida and it is one of the largest ever copper mining excavation. It has produced over 29 million tonnes of copper in total, far more than any other mine.

ii) Radomiro Tomic

The Radomiro Tomic deposit, 5 km north of the main pit, was discovered in 1952 after an extensive churn drilling programme to explore for oxidised ore to the north of the Chuquicamata pit. It was named Chuqui Norte but they did not develop it, largely because the technology had not been developed, particularly SX/EW. Two smaller areas of interest were found and the overall results showed that the Chuquicamata complex of mineralised porphyries is no less than 14 km long.

The deposit is covered with some 100 metres of alluvium and in 1993/94 Codelco estimated a resource base for the operation of 802 million tonnes of oxide ore grading 0.59% copper and 1,600 million tonnes of refractory (sulphide) ore. The deposit covers an area of 5 km x 1.5 km.

Mining started in 1997 and is again a conventional truck and shovel operation followed by crushing, pre treatment and stacking before acid leaching. Copper is extracted by SX/EW. Leached ore is removed by bucket wheel excavator followed by secondary leaching. It is likely that the 'refractory' sulphide ore will be mined and used to keep the Chuquicamata mill full during the changeover to underground mining.

Northern Expansion of Mina Sur

Between the main pit and Mina Sur there remains a substantial tonnage of so-called exotic copper in the channel of paleogravels (ancient gravels) between the two and which were mined in Mina Sur. The minerals, thought to be deposited by colloidal copper solutions leached from the main deposit, included manganese bearing copper pitch and copper wad, along with other impurities which made the ore difficult to leach in the original vats and produced a substandard cathode. The 'exotic' ore is now being heap leached and the copper extracted by SX/EW which leaves the impurities behind in the leach solution. It is expected that this operation will produce 129,000 tonnes of good quality copper cathode annually.

Secondary Waste Dump Leach

This is the leaching of certain copper bearing waste dumps and is expected to produce 26,000 tonnes of copper annually.

Contd…..

Ministro Alejandro Hales (formerly Mansa Mina)

This is a major discovery that was made between Chuquicamata and Calama. It was initially estimated to have reserves of over 500 million tonnes grading over 1% copper but was found to be geologically complex and have a high arsenic content and work was stopped on it for some years. Work resumed in 2000, as a result of the development of a process to treat high arsenic ores, the need for sulphide ore feed to the mill when Chuquicamata's mining goes underground and to test bioleaching technology. It is also possible that it may enable an expansion of the sulphide mill's capacity.

Pollution

For many years Chuquicamata, particularly its smelter, was a byword for pollution and the inhabitants of the Chuquicamata camp and Calama had serious amounts of arsenic in their blood. This has changed drastically. The camp at Chuquicamata has been closed and the inhabitants moved to Calama, away from the dust and general pollution close to the mine.

The off gasses from the flash smelter, Teniente converter and Pierce-Smith converters have a high enough sulphur dioxide content to allow sulphuric acid production in a single absorption sulphuric acid plant which has improved sulphur capture to 98%. The Corporation also planned some years ago to reduce arsenic emissions by 97% but there have been no recent reports. Pollution of the River Loa, which flows through Calama is a problem which is being addressed but little has been reported.

3. Grasberg Open Pit, Indonesia

Located some 60 miles north of Timika, at Tembagapura in Irian Jaya – the most easterly of Indonesia's provinces – on the western half of the island of New Guinea, the Grasberg mine has the world's single largest known gold reserve and the second largest copper reserves.

Copper is the primary commodity, with a proven and provable reserve of 2.8 billion tonnes of 1.09%. The reserve also contains 0.98g/t gold and 3.87g/t silver.

Ownership belongs to Freeport McMoran Copper & Gold (67.3%), Rio Tinto (13%), Government of Indonesia (9.3%) and PT Indocopper Investama Corporation (9.3%). Around 18,000 people work at the mine, which is operated by PT Freeport Indonesia, a subsidiary of Freeport McMoran Copper & Gold.

The mine stands at the collision of the Indo-Australian and the Pacific tectonic plates. Two distinct phases of intrusion have led to the production of nested coaxial porphyry ore bodies and sulphide rich skarn at the margins, while sedimentary strata includes Eocene clastic carbonate limestone with siltstones and sandstones near the base.

Contd…..

The Dalam Diatreme (DD) forms the first intrusive stage, being highly fragmental and characterised by clasts and a matrix of dioritic composition.“The open pit mine is a high-volume low-cost operation, producing more than 67 million tonnes of ore.”Mineralisation is largely disseminated and chalcopyrite dominant, having average grades of 1.2% copper and 0.5 g/t gold.

The second intrusive stage, the Main Grasberg Stock (MG), is composed of non-fragmental, porphyritic monzodiorites, forming a quartz-magnetite dilational stockwork with veinlet controlled copper-gold mineralisation. This is a high-grade resource, with averages of 1.5% copper and 2 g/t gold.

There is also a third intrusive stage, associated with the South Kali Dykes, which was the final intrusion and the most weakly mineralised.

Mining

The workings comprise an open pit mine, an underground mine and four concentrators. The open pit mine – which forms a mile-wide crater at the surface – is a high-volume low-cost operation, producing more than 67 million tonnes of ore and providing over 75% of the mill feed in 2006.

Designed to be fully mechanised, using $6.2m^3$ Caterpillar R1700 load-haul-dump vehicles (LHDs) at the extraction level with a truck haulage level to the gyratory crusher, the Deep Ore Zone (DOZ) block cave mine is one of the largest underground operations in the world.

After 2004, when the DOZ mine averaged 43,600 tonnes/day a second underground crusher and additional ventilation were installed to increase daily capacity to 50,000 tonnes.Ore from both operations is transported by conveyor to centralized mine facilities, feeding a combined daily average total of some 225,000t of ore to the mill and 135,000t to the stockpiles.

Production equipment includes $30m^3$–$42m^3$ buckets, a 170-strong fleet of 70t–330t haul trucks, together with 65 dozers and graders, with radar, GPS and robotics used in the mine’s state-of-the-art slope-monitoring system.

Processing

Ore undergoes primary crushing at the mine, before being delivered by ore passes to the mill complex for further crushing, grinding and flotation. Grasberg’s milling and concentrating complex is the largest in the world, with four crushers and two giant semi-autogenous grinding units processing a daily average of 240,000t of ore.“This is a high-grade resource, with averages of 1.5% copper and 2 g/t gold.”

A flotation reagent is used to separate concentrate from the ore. Slurry containing 60-40 copper concentrate is drawn along three pipelines to the seaport of Amamapare, over 70 miles away, where it is dewatered. Once filtered and dried, the concentrate – containing copper, gold and silver – is shipped to smelters around the world.

Contd…..

The Future

With the open pit heading to be exhausted in 2015, arrangements are well underway for the planned transition to fully underground production. The geology includes nine ore bodies – the Deep Ore Zone, which is located immediately below the now depleted Intermediate Ore Zone, the underground Grasberg, Kucing Liar, Mill Level Zone, Deep Mill Level Zone, Ertsberg Stockwork Zone and Big Gossan.

"The Deep Ore Zone block cave mine is one of the largest underground operations in the world."

Since 2004, a Common Infrastructure project has been in progress to create access to these large and undeveloped underground ore bodies through tunnels some 400m deeper than the currently existing system. This will both enable the known ore to be exploited and allow the potential of associated prospective areas to be explored in the future.

Open stoping at Big Gossan was scheduled to begin production in 2008, followed by the Ertsberg Stockwork Zone block cave mining in 2009.Grasberg and Mill Level Zone block caving is expected to start in 2016, with exploitation of Kucing Liar and the Deep Mill Level Zone commencing in 2024 and 2027 respectively.

4. Collahuasi Copper Mine, Chile

Collahuasi copper mine is situated in northern Chile, about 180km southeast of the port of Iquique, at an altitude of 4,000m. The mine is 44%-owned by Xstrata plc (following its acquisition of Falconbridge Ltd in 2006) in joint venture with Anglo American (44%) and a Japanese consortium (12%) comprising Japan Collahuasi Resources BV, Mitsui & Co. Ltd., Nippon Mining & Metals Co. Ltd. and Mitsui Mining & Smelting Co. Ltd. The operating company is Cia. Minera Doña Ines de Collahuasi.

Lying in an area of historical copper mining, the deposit was outlined in 1991 after exploration by Shell, Chevron and Falconbridge in the late 1980s. The mine was commissioned in April 1999 at a cost of US$1.76bn. During 2004, the project partners completed a $584m expansion programme at the mine, giving it a long-term capacity of 500,000t/yr of copper.

Geology and reserves

Collahuasi is based on a typical low-grade copper porphyry, comprising three ore zones: the major Ujina and Rosario deposits consisting of secondary, enriched sulphides and oxides and the Huinquintipa oxide deposit.

The major ore minerals are chalcocite, chalcopyrite and bornite. Oxide mineralisation occurs mainly as chrysocolla with minor brochantite, native copper, and copper-iron-manganese oxides and hydroxides.

Contd…..

Open-pit mining

The Ujina and Huinquintipa zones were mined first, with a transition to the Rosario orebody completed during 2004. Stripping at Rosario began in 2002. The stripping ratio at Ujina averages 4.4:1 (waste: ore) with a 15m bench height. Huinquintipa is somewhat smaller. The design mining rate of 360,000t/d of rock was achieved in Year 1, involving the blasting of 750,000t of material every two days.

In 2008, Xstrata Copper announced a 28% increase in the total estimated mineral resource at the mine, representing the equivalent of an additional 11 million tons of contained copper metal from 2007 resources.

Processing

The processing area consists of both oxide and sulphide plants. Oxide and mixed ores are treated by heap-leaching, solvent-extraction and electro-winning (SX-EW). Sulphide ore is crushed, ground and treated by flotation.

Run-of-mine sulphide ore enters the primary gyratory crusher prior to transport to two parallel grinding circuits, each consisting of a Semi Autogenous Grinding mill and a ball mill. Secondary closed circuit grinding includes cyclone classifiers, from which the overflow feeds the flotation circuit. Flotation concentrate is thickened to 50% solids for slurry transport in a 200 km-long pipeline to Punta Patache, 65km south of Iquique, where it is thickened and filtered before shipment worldwide. An expansion to the concentrator was completed during 2004.

Run-of-mine oxide ore is reduced to -10mm by three-stage crushing. The fine ore is agglomerated with sulphuric acid and water before being conveyed to the leach pads. Copper is recovered from the pregnant leach solution in the solvent-extraction plant, where the copper is stripped using organic solutions; the stripped liquor is then returned to the leach pads for re-use.

The strip solution is cleaned using dilute acid and flotation, and is filtered prior to the electro-winning phase, where the copper is plated onto electrolysis cathodes. These are stripped by the Kidd process on a seven-day cycle, the cathode copper being transported by road to Iquique for export.

Production

In 2005, Cia Minera Doña Inés de Collahuasi produced 488,600t of copper in concentrate, plus 68,600t of cathode copper. In December 2005, the company commissioned a US$36m molybdenum recovery plant that has a capacity of 7,500t/y of contained molybdenum.

In January 2008, the company announced an upgraded mineral resource of 5.19 bn tons at an average grade of 0.83% copper, including, for the first time, 746 m tons at a grade of 1.06% from the Rosario Oeste deposit.

This compares to the previous mineral resource of 4.05 bn tons at an average grade of 0.80% copper. The mineral resource includes ore reserves of 2.20 bn tons at

Contd…..

a grade of 0.82% copper, a 25% increase in tonnage from ore reserves of 1.76 bn tons at 0.89% copper from December 2006.

Environment

As the environment at Collahuasi is harsh and fragile, ecological issues have a top priority. Collahuasi is a zero-discharge operation, with much of its water being recycled. An extensive environmental monitoring system is in place along with research projects in high altitude operations.Collahuasi achieved its ISO 14001 environmental management certification in 2000.

5. El Teniente

Situated 44 km east of Rancagua and 75 km south of the capital, Santiago, El Teniente claims to be the largest underground copper mine in the world (see below). The El Teniente orebody has been known and worked on a small scale for many years.

Work started on establishing a mine in 1905 after Government permission had been acquired but progress was slow because of difficulty of access and a hard winter climate. A small gravity plant was soon erected but it was not until 1912 that a flotation plant was erected at Sewell. Control passed to Kennecott in 1915 and it ran the mine until nationalisation in 1971.

The Present Mine

The porphyry orebody consists of a stockwork (a network of narrow veins) of mineralised veinlets, mainly in andesitic lavas and tonalite, superimposed by a leached zone and a substantial zone of secondary enrichment, both of very variable thickness. It surrounds a narrow, almost circular ring of tourmaline breccia which in turn surrounds the Braden Chimney, an inverted cone of breccia which was emplaced after the main mineralisation. Reserves and resources are substantial. At the end of 2007 reserves and resources in the mining plan totalled 4,204 million tonnes grading 0.91% copper or 38.3 millionn tonnes of contained copper. In addition the mine has identified additional resources of 15,827 million tonnes grading 0.46% copper or nearly 73 million tonnes of contained copper though there is no indication how much of this may prove economic. Production in 2007 was 404,728 tonnes copper and 5,053 tonnes molybdenum.

Mining is gradually moving lower and removing the ore between the barren country rock and the Braden Chimney. Access is through adits (horizontal tunnels) to shafts and other services cut in the Braden Chimney. Mining methods include panel caving, panel caving with pre-undercut, and block caving, which have been adapted to overcome the serious rockburst problem which stopped mining some years ago on level 6 and threatened the future of the mine. A new level, Level 8, is now in operation and another, lower, level is being studied which will give access to 1.5 billion tonnes of ore grading 0.96% copper and extend the life of the mine by many years.

Contd…..

All ore is now treated in the lower Colón mill, the original Sewell mill being closed. Capacity is now 130,000 tonnes per day, split equally between SAG and conventional milling, followed by flotation, thickening and filtration. The recent increase in mill capacity has been necessary to compensate for the gradual move of mining into the lower grade primary ore zone. The concentrate goes to the Caletones smelter further down the valley. This is equipped with two Teniente converters with slag furnaces, three Pierce Smith converters and six anode furnaces feeding two anode and one fire refined casting wheels. Tailings are flumed down the valley to dams on flatter ground. An independent company, Minera Valle Central, retreats old and current El Teniente tailings and extracts some 12,000 tonnes p.a. of copper in concentrate.

6. Antamina Copper-Zinc Mine, Peru

The Antamina copper-zinc mine is located in the Andes Mountains of Peru, approximately 285km north of Lima in the Department of Ancash. The elevation of the mine is 4,300m above sea level. The mine was brought into production by a joint venture comprising the Canadian companies, Noranda Inc (33.75%) and TeckCominco Ltd. (22.5%), Australian-UK-based BHP Billiton (33.75%) and the Japanese firm, Mitsubishi Corp. (10.0%). The subsequent merger between Noranda and its subsidiary, Falconbridge, and the acquisition of Falconbridge during 2006 by Xstrata has brought Noranda's holding into Xstrata's portfolio.

During the mid-1990s, the Antamina deposit was considered to be the largest undeveloped copper/zinc orebody in the world.

Construction began following the completion of a feasibility study in 1998, with Bechtel being appointed as the principal engineering contractor for the project.

Following construction of the concentrator and other infrastructure, together with pre-production stripping of overburden (around 161Mt of waste was moved during 2001 alone), the mine was commissioned in December 2001, under budget and ahead of schedule.

The mine employed a maximum of 8,500 people during construction, and now has a workforce of around 900.

Geology

Antamina is a polymetallic skarn orebody with a regional structural trend parallel to the Andean Cordillera Trend. Major geological faulting and associated jointing was intruded by a multi-phased quartz-monzonite porphyry about 9.8Ma, resulting in a large area of intrusives being in contact with the older Jumasha limestone Formation.

The calcic skarn thus produced was mineralised by extensive hydrothermal solutions, forming at least six distinctive ore zones. Adjacent to the limestone contact, copper occurs mainly as chalcopyrite. Zinc and bismuth occur in any rock type but are generally found in the green garnet contacts with limestone, marble and hornfels,

Contd…..

where lead is also present. Molybdenum is present in the intrusive core, with silver found in any of the skarn lithologies.

By mid 2008, proven reserves at Antamina were 100Mt graded at 1.14% copper, 0.17% zinc, 8.7g/t silver and 0.036% molybdenum. Reserves of copper sulphide ore are 454Mt at 1.05% copper, 0.17% zinc, 9.7g/t silver and 0.031% Molybdenum. Measured, indicated and inferred resources during the same time stood at 132Mt, 579Mt and 489Mt, respectively.

Silver is associated with both ore types, while copper ore also contains molybdenum. In 2007, a three-year programme of regional exploration began, together with an ore resource enhancement drilling project. As part of the project, drilling was conducted to a depth of 101,000m in 2007. An additional 115,000m of resource definition drilling was carried out in 2008.

Mining

In 2007 a three-year programme of regional exploration began, together with an ore resource enhancement drilling project. Mining is done by conventional truck-and-shovel open-pit methods, with the ore being processed by grinding and flotation. Crushed ore is conveyed through a 2.7km-long tunnel to the concentrator stockpiles. The concentrator has a milling rate of 70,000t/d and is the largest single-circuit SAG-milling operation in the world. The SAG mill provides feed for ball milling to produce flotation feed, with the ball mills featuring variable-speed drives to enable the mills to handle the range of different ore hardness found at Antamina.

Ore-control procedures are designed to allow mining of several ore types simultaneously but enabling one type to be sent to the concentrator at a time in order to maximise recoveries.

Before production began, ore grade-control guidelines were also established to include the definition of blasthole logging and sampling procedures, as well as daily geostatistical modelling of the active mining areas.

In November 2006 an incremental expansion to the concentrator was approved to provide a 10% increase in throughput capacity. By the first half of 2007, coarse ore conveying enhancements were completed and new pulp filters were installed in the SAG mill. A new pebble crusher, intended to increase production by around 10%, was commissioned in mid 2008 at an investment of $42.m.

By late 2008, a feasibility study to expand milling capacity by 38% was completed. The expansion was started following the approval of the plan in January 2010. The expansion will require an investment of $1.3bn and will boost production to 130,000t/d. The project is due for completion by the end of 2011.

Environment

Antamina is situated in an area of high rainfall (approximately 1.5m annually). A surface water-management system has been set up for the principal Quebrada Antamina drainage. This receives discharge from pit dewatering, waste-rock dump

Contd…..

runoff and seepage, and from the low-grade stockpiles as well as general runoff. An appropriate method for removing any dissolved metals is being researched and implemented.

Mine Production

Antamina is noted for the high variability in the contents of individual metals in its ores. Thus in 2004, the mine came into an area of higher copper and molybdenum grades, with less zinc than in 2003. Metal production during for 2004 was 362,100t of copper, 190,100t of zinc and 3,600t of molybdenum.

In calendar 2005, a total of 30.1Mt of sulphide ore was processed, at average grades of 1.36% copper and 1.15% zinc. This involved the movement of 128Mt of material in total, and led to the production of 361,500t of copper, 156,100t of zinc, 9.1Moz of silver and 6,720t of molybdenum. In 2004, the mine came into an area of higher copper and molybdenum grades, with less zinc than in 2003.

In 2006, ore production dropped by around 8% as a result of the need to use longer haulage distances than had been originally planned. In addition, although the total concentrator throughput remained much the same as 2005, its relative composition showed some changes.

Zinc concentrate production fell by around 15% due to a lower grade feed and harder rock forced a drop in the throughput for copper-zinc ores, although this was offset by higher milling-rates for copper-only ore.

In total, 2006 saw the production of 384,200t of copper, 156,100t of zinc and 7,730t molybdenum, from 30.25Mt of ore. Copper and molybdenum head grades together with copper recovery rates have shown slight improvements year on year. Sales volumes of both these metals increased, benefiting from strong commodity pricing in 2006 with improved recoveries – some 8% higher than that in the previous year – helping to drive molybdenum sales up by nearly 10%.

However, 2007 has seen lower-grade ore cause a decrease in the mine's copper output; with the price of this metal having rallied by 25% over the year, it is planned to focus heavily on the production of copper from October through to the start of 2008.

In 2009, approximately 11.3Mt of zinc ore was processed at Antamina, an increase of 10% over the previous year. Approximately 35Mt of ore and 370Kt of concentrate copper were produced during the same year. Production of zinc metal in concentrate was 154,000t, an increase of 31% over 2008.

7. Minera Los Pelambres Copper Mine, Chile

The Los Pelambres deposit, located 200km north of Santiago and 45km east of Salamanca in Choapa Province, was discovered by one of Chilean copper's founding fathers, William Braden,in the 1920s. Today's project, the world's fifth-largest copper mine, was started by Antofagasta Holdings in the 1990s.

Contd…..

In late 1997, Antofagasta sold a 25% stake in Minera Los Pelambres to one Japanese consortium and a 15% holding to another. With partner project finance loans secured, mine development started immediately, and production began in December 1999. Fresh water supply is drawn from three mountain streams but is carefully recycled. Electricity is taken from the grid via a dynamically controlled DC-link.

Antofagasta plc now owns 60% and manages the operation, which employs 521 people, via Antofagasta Minerals SA. One partner consortium comprises Nippon Mining and Metals Co. Ltd (15%), Marubeni Corp. (8.75%) and Mitsui & Co. Ltd (1.25%), while Mitsubishi Materials Corp. (10%) and Mitsubishi Corp. (5%) make up the other. Nippon Mining & Metals and Mitsubishi Materials planned to take delivery of approximately half the concentrate output.

Reserves

Porphyry copper mineralisation – chalcopyrite, chalcocite, bornite, covellite and molybdenite – makes up a resource of 3,000Mt grading 0.65% Cu and 0.014% molybdenum. By end-2005, the reserves figures were: proven – 831Mt grading 0.68% Cu, 0.019% Mo, 0.034g/t Au and 1.2g/t Ag; probable – 655.9Mt grading 0.67% Cu, 0.016% Mo, 0.032g/t Au and 0.93g/t Ag; and possible – 525.2Mt at 0.59% Cu, 0.0138% Mo, 0.033g/t Au and 0.57g/t Ag.

By 2008, a two-stage exploration programme to identify additional reserves was completed. The drilling programme identified an additional 1.9 billion tons of resources.

Mining

The mine is an open pit sized 2.5km x 2.2km at surface, which is at an altitude of 3,100m above sea level (asl). Three Ingersoll-Rand electric rotary rigs drill blastholes, the initial two P&H 4100AS mining shovels and a LeTourneau L-1800 wheel loader, plus a 4100XPB shovel added later, work with a haulage fleet of five 329t-capacity Caterpillar 797 haul trucks to shift waste and ore in equal proportions. The mine works two 12-hour shifts.

Processing

Trucks feed an FFE Minerals 60” x 110” in primary gyratory crusher and a sophisticated overland conveyor system engineered by Thyssen Krupp takes the ore 13km to the stockpile at the concentrator, which is down at 1,620 m. In its first full year, 2000, Los Pelambres processed 34 Mt of ore to produce 298,900t of copper-in-concentrate and 5,450t of molybdenum.

Two 17,000 hp FFE Minerals 36ft x 19ft SAG mills work with four 9,500hp FFE Minerals 21ft x 33.5ft ball mills, giving a throughput of about 85,000t/d. In 2001 Los Pelambres decided to install pebble crushing to improve the SAG mill performance, and Bechtel designed an upgrade programme to raise the throughput to 114,000t/d. FFE supplied a redesigned SAG discharge system for this project. The pebble crusher was installed in August 2003 and had an immediate positive effect.

Contd…..

Concentration and separation involves two steps, carried out in a bulk flotation plant and a molybdenum plant. Bulk flotation involves rougher, scavenger and cleaner flotation with associated concentrate regrind stages and is optimised by the Metso Minerals VisioFroth system. Bulk copper-moly concentrate goes to a thickener prior to treatment in the molybdenum plant. Flotation tails go to tailing thickeners. About 70% of process water is recycled.

The concentrate slurry is piped via Salamanca and Illapel to the purpose-built port of Los Vilos (Punta Chungo) where it is dewatered for shipment. Los Pelambres treats the water extracted for use in irrigating a nearby eucalyptus plantation.

In April 2004, the Chilean government approved an Environmental Impact Statement covering a second tailings disposal site, Mauro. Construction would allow Los Pelambres to mine an additional 2,000Mt over the life of mine and extend that life from 22 to 47 years at the current processing rate of 114,000t/d. Alternatively, the concentrator capacity could be increased to 175,000t/d, possibly in stages. Construction of the Mauro tailings dam was completed in December 2008 at a cost of $600m.

Production

In its first full year, 2000, Los Pelambres processed 34Mt of ore to produce 298,900 tonnes of copper-in-concentrate and 5,450 tonnes of molybdenum. In 2003, the plant treated an average of 113,300 t/d of ore grading 0.91% copper, with average recovery 89.9%, to produce a total of 826,500 t of concentrate grading 40.9% copper. Payable copper-in-concentrate totalled 326,700 t and payable molybdenum, 8,700 tonnes.

2004 saw a 7.3% increase in output to 350,600 t payable copper-in-concentrate despite a lower average ore grade of 0.88% Cu, mainly because of the pebble crusher added to the grinding circuit during 2003. However, the payable molybdenum tonnage fell to 7,900 t. In 2005, the copper ore grade fell again to 0.80% and payable copper-in-concentrate output dropped to 322,800 t as the mine focused on maximising molybdenum production, which rose to the 2003 level of 8,700 t.

A $192 m expansion project that was completed in 2007, boosting production capacity of the mine to 130,000 t/d. By the end of 2008, the mine produced 136,000 t of ore per day, graded at 0.76% ore. A plan for further plant expansion was approved in July 2008. The expansion will boost copper production to 90,000 t a year from early 2010. By June 2009, the project was 47% complete and within the allotted $1bn budget.

8. Morenci Copper Mine, Arizona, USA

The Detroit Copper Company started mining at Morenci, 16km south of Silver City, Arizona, in 1872. Copper Queen Consolidated Mining bought the property in 1885, with the company name being changed to Phelps Dodge in 1917.

Contd…..

Ninety years later, Phelps Dodge is merging with Freeport McMoRan Copper & Gold, whose principal asset is the massive Grasberg copper-gold mine in Indonesia, in an agreed $25.9bn takeover by Freeport, the smaller of the two companies.

Morenci is the largest copper producer in North America and remains a major contributor to Phelps' copper output, which is second only to that of Chile's Codelco. In 1986, Phelps Dodge Morenci, Inc. was established as a partnership between Phelps Dodge Mining Company (85%) and Sumitomo Metal Mining Arizona Inc. The latter belongs to Sumitomo Corp. (75%) and Sumitomo Metal Mining Co Ltd.

Morenci is the largest copper producer in North America and remains a major contributor to Phelps' copper output. For many years as an integrated mine-concentrator-smelter operation, Morenci pioneered the large-scale hydrometallurgical treatment of mined copper ore by dump leaching, solvent extraction (SX) and electrowinning (EW) during 1985, in parallel with conventional treatment.

In 1999, Phelps Dodge started a $220m Mine-For-Leach (MFL) conversion project, and from mid-2001 until 2006 produced all its copper this way. However, in 2005 the company announced the go-ahead for a $210m project to create the world's first commercial copper-concentrate leaching/direct electrowinning operation at Morenci, a proprietary technology that allows primary sulphide ore treatment by leaching in combination with secondary ore processing.

As well as new leach-electrowin capacity, the project required re-opening the mothballed Morenci concentrator. This programme was accelerated in 2006 to provide copper-in-concentrate for treatment at Phelps' Miami smelter, also in Arizona, before completion of the hydrometallurgical facilities at Morenci.

The Morenci mine and largely company-owned town are located at an elevation of 3,100m above sea level. The operation employs approximately 2,000 people who work eight- or 12-hour shift rotations.

Geology and Reserves

Copper mineralisation, identified by a regiment of California Volunteers in 1865, turned out to

.5Mt of be part of a major porphyry copper orebody extending across a dissected mountain terrain. Both sulphide and oxide ores occur, pyrite and chalcocite being the main sulphide minerals, and chrysocolla and malachite the predominant oxides. Molybdenite, galena and sphalerite are also present.

At the end of 2006, the reserves figures were 245.7Mt of millable ore averaging 0.52% Cu, 470crushed ore for leaching at 0.57% Cu, and 2,268.9Mt of leachable run-of-mine ore at 0.19% Cu.

Mining

Phelps mined underground until the 1930s depression, converting to an open-cut operation with rail haulage in 1937. The topography prevented development as a

Contd…..

single pit: today the working area extends across 2.5km x 2.2km but is worked as three pits: the Metcalf (within the original Morenci pit), the NWX (Northwest Extension) and the Coronado.

Electric rotary rigs, mainly made by Bucyrus, drill blastholes and P&H 4100 and 2800 series electric rope shovels load the truck fleet. This includes more than 60 Caterpillar units, both 793 (218t capacity) and 797 (272t) models.Waste is mainly used to backfill the Morenci pit, while the ore, which averaged 0.29% Cu in 2004, is hauled to in-pit primary crushers. The new leaching-electrowinning capacity will be incorporated into the existing complex, which is already the world's largest.

Processing

The Morenci and later Metcalf conventional concentrators supplied the operation's own smelter until it shut down in 1984, and thereafter other Phelps smelters. When hydrometallurgical processing started these two mills worked in parallel with two leaching / solvent extraction operations and one electrowinning tankhouse. The MFL conversion required an expansion of the hydrometallurgical facilities to yield 365,000t/y of cathode copper, but led to the Metcalf concentrator being closed and the Morenci unit being placed on care-and-maintenance until 2006.

While high-grade ore is conveyed to leach pads within the pit, the bulk of the primary crusher output (63,500t/d of ore) is secondary crushed and conveyed to the Stargo dump-leaching site. This ore is agglomerated for spreading by two Rahco mobile stacking units. Leaching is bacterially assisted, with air blown into alternate lifts.

The total heap and dump leach-liquor yield is 16,500m^3/hr; copper recovery was 58.5% in 2003. Four SX plants – Central, Metcalfe, Stargo and Modoc – feed three tankhouses (Central, Southside and Stargo). The new leaching-electrowinning capacity will be incorporated into the existing complex, which is already the world's largest.

Production

During 2006, Morenci mined 247Mt of ore, milled 4.1Mt grading 0.56% Cu, placed 230.70Mt of ore onto leach pads, recovered 14,993t copper in concentrate and electrowon 355,574t of copper cathode.

9. Bingham Canyon Copper Mine, USA

Located near Salt Lake City, Utah, USA, Bingham Canyon celebrated its 100th anniversary in June 2003. The Bingham Canyon mine, Copperton concentrator and Garfield smelter comprise one of the largest and most up-to-date integrated copper operations in the world: major investments during the past 15 years have ensured economically and environmentally sound operation. Cumulative copper output is now about 17Mt, more than any other mine.

For much of its life, Bingham Canyon was owned by Kennecott Copper Corp. However, during the post-1973 oil crisis shake-out, the company was acquired by British Petroleum, then sold on to Rio Tinto, which operates Bingham Canyon

Contd…..

through its 100% subsidiary, Kennecott Utah Copper Corp. The facilities employ about 2,400 people.

In early 2005, Rio Tinto committed $170m to the East 1 pushback project, which will extend the life of the open pit at Bingham Canyon until 2017. Rio revealed in 2008 it was studying deepening the 1.2km pit to shore up an extra 2.83 million tons of copper resources.

Following research from analysts and investors, Rio revealed in 2008 it was studying deepening the 1.2km pit to shore up an extra 2.83 million tons of copper resources.

A major molybdenum deposit was discovered in 2008. Additional porphyry mineralisation was identified beneath the southern wall of the pit. The resources were studied for extraction by open pit mining methods. However, because of the economic downturn, the option to expand the underground operations was suspended.

Rio hoped to begin the project in 2009 and produce copper valuing about $22.67bn at the prevailing prices. A major molybdenum deposit was discovered in 2008. Beneath the southern wall of the pit, additional porphyry mineralisation has been identified. The resources are being studied for extraction by open pit mining methods.

In August 2010, Rio announced its Cornerstone project, which is expected to extend the life of the mine to 2034. Rio is seeking permission from the regulators to push the south wall back by approximately 1,000ft and deepen the mine by another 300ft in order to reach more than 700Mt of copper ore.

Rio would need to generate or source 100MW of electricity to power the Cornerstone expansion project. It will also require obtaining 25 of the 70 primary environmental permits relating to air, water and land.

Geology and Reserves

The classic copper porphyry orebody is not only huge but also enjoys a fairly uniform distribution of sulphide mineralisation, mainly chalcopyrite. The existing pit will be worked out by 2013, but open pit and then underground mining will continue after that. As of end-2009, proven and probable open-pit reserves totalled 524Mt grading 0.47% copper, 0.044% molybdenum, 0.25g/t gold and 2.08g/t silver. Total mineral resources were 647Mt at 0.477% copper, 0.18g/t gold, 0.034% molybdenum and 2.1g/t silver.

Mining

The Bingham Canyon pit is now 2.5 miles wide and very deep. Mining uses a rotary drilling/blasting – shovel/truck – in-pit crushing system, with two to four blasts per day. To contain costs, management has been quick to utilise the most cost-effective drilling, loading and haulage equipment and management tools available.

Contd…..

One of the first of the recent series of major investments was an in-pit, semi-mobile gyratory crushing unit linked to the Copperton Concentrator by an 8km conveyor system. This reduced haulage distances from the working faces substantially but even so the mine needs a large fleet of Caterpillar mechanical drive and Komatsu electric-drive trucks, mostly of 218t-capacity, to service ten P&H electric rope shovels.

Dispatching is by the Modular Mining computerised system and Bingham also utilises Thunderbird Pacific's drill monitoring and logging systems. Both GPS and Glonass are used for precise drill positioning. Germany's MAN Takraf has upgraded and relocated the semi-mobile in-pit crushing plant and conveyor system to keep trucking distances down.

Processing

The Copperton concentrator was expanded in 1992 and fitted with some of the world’s largest SAG and ball mills, and large flotation cells. There are four grinding and flotation lines, sequentially yielding a copper and molybdenum concentrate. The copper concentrate is piped about 27km to the smelter. Until its closure in mid-2001, the older North plant supplied about 20% of the copper concentrate for smelting. Rio produces approximately 8% of the world's molybdenum.

The current smelting facilities are the result of major investment, comprising a new primary flash smelter and flash converter system, designed by Outokumpu with input from Kennecott, plus a slag treatment plant. The converter treats matte that has been granulated and powdered. The 98.6% copper from the new converter is refined to 99.5% copper in two anode furnaces.

Cast anodes are railed about 3km to the refinery’s electrolytic tankhouse, where marketable high-purity copper is produced and the gold and silver content of the concentrate is also recovered.

Production

Having been regarded as a minor contributor to income at Bingham Canyon, increased world demand for molybdenum has now made it very important. Income from moly sales was just $30m in 2002, but rose to $700m in 2005. The 2008 mine plan was modified to include areas of higher moly content, even at the expense of copper, while the concentrator has also been fine-tuned to optimise moly recoveries, with a second expansion of the moly-recovery circuit commissioned in mid-2006.

Rio produces approximately 8% of the world's molybdenum and expects to produce 60 million pounds by 2015. In order to improve efficiency, it is constructing an autoclave process in Magna to produce molybdenum instead of outsourcing. The plant is estimated to cost $340m and is scheduled to be completed by 2012. Operations are expected to begin in 2013.

Contd…..

Concld…..

10. Andina Copper Mine, Chile

Situated some 50 km northeast of the capital, Santiago, the Andina mine was discovered in 1920 but production did not start until 1970. It consists of the Rio Blanco underground (block cave) mine and the Sur Sur open pit and an underground concentrator. Unlike other Codelco mines, it does not have its own smelter. Geologically it consists of about half the Los Bronces-Rio Blanco complex of mineralised breccias, the other half being owned and mined by the Los Bronces mine of Compania Minera Disputada de la Condes which is in turn owned by Anglo American.

Originally owned by the American Cerro De Pasco Corporation, who brought the mine to production, it has been gradually built up by Codelco and is now the subject of a major expansion scheme. At the end of 2007, reserves and resources in the mining plan totalled 5,698 million tonnes grading 0.78% copper containing 44.3 million tonnes of metal and additional identified resources of 11,342 tonnes grading 0.52% copper containing 59.6 million tonnes of metal.

The orebodies are at considerable heights, between 3,000 and 4,200 metres and operations can be severely affected by the weather. Originally the mine was only the underground block cave and an underground concentrator with an 'hotel'/bunkhouse where the workers live when the Rio Blanco valley is impassable in the winter. Now the Sur Sur and Don Luis breccias above and to the south of the underground mine are being worked as open pits. Production in 2007 was 218,322 tonnes of extractable copper and 2,525 tonnes molybdenum in concentrate from the 72,000 tonnes per day concentrator.

Work is now under way on the Andina Phase I Development Project which aims to raise mill capacity to 92,000 tonnes per day and is expected to be complete by November 2009.

Pre feasibility studies on raising mill capacity to over 200,000 tonnes per day by 2014 should be complete this year. Deep drilling to prove up resources to sustain such a production rate continues. No estimates of the likely copper output at a milling rate of 200,000 tonnes per day have been given and cannot be until the deep drilling campaign is complete.

One of the mysteries of Andina is why it did not buy Compania Minera Disputada de las Condes when Peñarroya was prepared to sell it for a very low price in 1972. It went to Enami who subsequently sold it for a handsome profit to Exxon Minerals for US$97 million. It would have given Codelco complete control of the district. When Exxon finally did decide to sell in 2002, Codelco expressed interest but were not prepared to match the US$1.3 billion that Anglo American were prepared to give for it

Rock glaciers have been seriously intervened by Andina since the late 1980s, when it started to deposit several million tons of waste rock on top of rock glaciers, resulting in their acceleration and partial destabilisation. Since then, 2.1 km^2 of rock glaciers with a water equivalent of more than 15 million cubic metres have been affected by Andina, including the partial removal of rock glaciers.

Annexure: 5 - I

Average Monthly Prices of Copper Wire Bars (Bombay Metal Exchange)

(Rates in Rs. Per quintal)

Sl. No.	Month	Average Prices			
		2006	**2007**	**2008**	**2009**
1	January	N.A.	N.A.	36,869	N.A.
2	February	N.A.	33,438	N.A.	24,386
3	March	28,104	35,525	39638	26,117
4.	April	34,822	39,634	40,168	29,965
5	May	41,035	39,108	40,396	29,916
6	June	37,646	37,992	41,072	N.A.
7	July	40,683	38,750	41,626	N.A.
8	August	41,374	N.A.	N.A.	N.A.
9	September	40,924	38,423	N.A.	35,217
10	October	40,969	38,988	N.A.	N.A.
11	November	38,769	N.A	28,226	N.A.
12	December	37,713	36,638	23,289	N.A.

Source: Metal World (Monthly) *N.A.: Not Available*

Annexure: 5 - II

Average Monthly Prices of Copper Heavy & Utensil Scrap (Mumbai Metal Market)

(Rates in Rs. Per quintal)

Sl. No.	Month	Average Prices							
		2006		**2007**		**2008**		**2009**	
		Heavy Scrap	**Utensil Scrap**	**Heavy Scrap**	**Utensil Scrap**	**Heavy Scrap**	**Utensil Scrap**	**Heavy Scrap**	**Utensil Scrap**
1	January	N.A.	N.A.	N.A.	N.A.	33,604	31,454	N.A.	N.A.
2	February	N.A.	N.A.	30,152	28,414	N.A.	N.A.	21,409	20,005
3	March	25,954	23,788	32,167	29,958	36,271	32,883	23,096	21,671
4.	April	32,917	29,909	36,020	33,016	36,704	32,956	26,904	25,174
5	May	38,723	33,919	35,491	32,115	36,892	33,108	26,848	25,220
6	June	30,865	29,732	34,828	31,116	37,628	33,572	N.A.	N.A.
7	July	N.A.	N.A.	35,331	31,835	38,237	35,074	N.A.	N.A.
8	August	37,522	32,374	34,625	31,208	N.A.	N.A.	N.A.	N.A.
9	September	37,088	32,488	35,100	31,764	N.A.	N.A.	31,757	29,013
10	October	37,069	32,655	35,723	32,327	N.A.	N.A.	N.A.	N.A.
11	November	35,145	31,596	N.A.	N.A.	25,078	23,130	N.A.	N.A.
12	December	34,279	31,392	33,300	31,231	20,244	18,893	N.A.	N.A.

Source: Metal World (Monthly) *N.A.: Not available*

Annexure: 5 - III

Average Monthly Settlement Prices of Copper, London Metal Exchange, 2001 to 2010

(In $ per tonne)

Sl. No.	Month	Average Prices									
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	January	1787.50	1503.95	1647.66	2423.57	3170.00	4734.33	5669.66	7061.02	3220.69	7380.25
2	February	1765.65	1561.90	1683.80	2759.53	3253.70	4982.40	5676.45	7887.69	3314.73	6848.18
3	March	1738.77	1604.88	1658.98	3008.72	3253.70	5102.85	6452.48	8439.29	3749.75	7462.83
4.	April	1664.16	1590.33	1587.48	2948.73	3394.48	6387.78	7766.51	8684.93	4406.55	7745.08
5	May	1682.21	1595.68	1648.28	2733.50	3249.10	8045.86	7682.17	8382.75	4568.63	6837.68
6	June	1608.45	1647.53	1686.50	2686.70	3524.07	7197.61	7475.88	8260.60	5013.95	6499.30
7	July	1525.20	1589.46	1710.00	2808.43	3614.21	7712.10	7973.91	8414.04	5215.54	6735.25
8	August	1464.43	1479.55	1760.28	2846.10	3797.75	7695.66	7513.50	7634.70	6165.30	7283.95
9	September	1426.33	1478.71	1789.52	2894.86	3857.44	7602.36	7648.98	6990.86	6196.43	7709.30
10	October	1377.28	1483.76	1920.54	3012.24	4059.76	7500.39	8008.43	4925.70	6287.98	8292.40
11	November	1427.73	1582.29	2055.43	3122.80	4269.34	7029.18	6966.70	3717.00	6675.60	8469.89
12	December	1471.74	1595.68	2201.29	3145.45	4576.78	6675.11	6587.67	3071.98	6981.71	9147.26

Source: World Metal Statistics

Annexure: 5-IV

Copper Prices Forecast by Various Analysts, 2011 to 2014 **(In $ per tonne)**

Forecast Date	Analyst/ Desk	2011				2012				2013				2014			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
02.02.11	MB Research	9720	9900	9500	9100	9400	10000	10200	98000	8800	8800	8800	8800	-	-	-	-
17.01.11	Societe Generale, David Wilson	10040	9640	9620	10720	11550	11550	11550	11550	10000	10000	10000	10000	8800	8800	8800	8800
02.02.11	Goldman Sachs*	10229	10229	10229	10229	10891	10891	10891	10891	9370	9370	9370	9370	8267	8267	8267	8267
11.11.10	BAML, Michale Widmer	10000	12000	11000	12000	12000	12000	12000	12000	-	-	-	-	-	-	-	-
11.02.11	Barclays Capital	9900	11000	12000	13100	11500	11500	11500	11500	-	-	-	-	-	-	-	-
11.01.11	RBCCM Fraser Philips	8267	8267	8267	8267	8267	8267	8267	8267	8818	8818	8818	8818	8818	8818	8818	8818
15.02.11	Natixis, Nic Brown	9000	9000	9000	9000	9500	9500	9500	9500	8500	8500	8500	8500	8000	8000	8000	8000
17.01.11	Macquarie	9260	10582	12125	12125	11023	11023	11023	11023	7716	7716	7716	7716	6614	6614	6614	6614
01.02.11	Standard Bank Leon Westgate	9150	8900	9300	9450	10000	10000	10000	10000	-	-	-	-	-	-	-	-
16.02.11	BNP Paribas, Stephen Briggs	10000	11000	11500	11500	10500	10500	10500	10500	-	-	-	-	-	-	-	-
14.01.11	Credit Agricole, Robin Bhar	9000	9500	10000	10500	10750	11000	10500	9750	-	-	-	-	-	-	-	-
14.01.11	MF Global, Ed Meir	9300	8750	10200	9500	-	-	-	-	-	-	-	-	-	-	-	-
05.01.11	CISA, Ian Roper	9921	10472	10472	11023	9921	9921	9921	9921	8818	8818	8818	8818	6173	6173	6173	6173
14.01.11	Numis	8267	8267	8267	8267	8818	8818	8818	8818	6614	6614	6614	6614	6063	6063	6063	6063
18.01.11	VM Group / Abn Amro*	9113	9113	9113	9113	8880	8880	8880	8880	8896	8896	8896	8896	7950	7950	7950	7950
14.02.11	Citigroup	9920	9920	9920	9920	10000	10000	10000	10000	9026	9026	9026	9026	8051	8051	8051	8051
21.12.10	Commerzbank	9350	9350	9350	9350	-	-	-	-	-	-	-	-	-	-	-	-
13.01.11	Credit Suisse, Matt Hope	10362	10362	10362	10362	9921	9921	9921	9921	8378	8378	8378	8378	8157	8157	8157	8157
21.12.10	Scotiabank, Patricia Mohr	9921	9921	9921	9921	9370	9370	9370	9370	-	-	-	-	-	-	-	-
01.01.11	Deutsche Bank Daniel Brebner	9500	10000	10500	11000	12000	13000	11000	10000	10000	10000	10000	10000	8000	8000	8000	8000
31.01.11	Sucden Financial	8500	8500	8500	8500	-	-	-	-	-	-	-	-	-	-	-	-

**3 M rather than cash prices. Source: Metal Bulletin ,London-28 February,2011*

Annexure: 6-I

Compounded Annual Growth Rate of Different Copper Consuming Equipments and Machines.

Sl. No.	Name of Production	Average Growth %
1.	Refrigeration and Air Conditioning Plants	17.44
2.	Refrigerator (Domestic)	17.36
3.	Electric Generators	20.77
4.	Electric Motors	11.51
5.	Electric fans	11.47
6.	Power and distribution Transformers	7.65
7.	Power capacitors	9.28
8.	ACSR/AA conductors	12.78
9.	Winding Wires	8.70
10.	Telecommunication Cables	(-)16.89
11.	Switch Gears	4.05
12.	HT Insulators	9.11
13.	Insulated Cables	83.65
14.	Electric Motors(Phase one)	1.95
15.	Motor Starter & Conductors	20.63
16.	Window type Air Conditioners	29.11
17.	Washing/Laundry Machines	13.45
18.	Dumper	2.83
19.	Wheel mounted dump loaders	5.20
20.	Commercial vehicles	7.28
21.	Jeep type vehicles	7.54
22.	Passenger Cars	10.22
23.	Auto Rickshaws	6.58
24.	Scooters & Mopeds	5.33
25.	Motor Cycles	5.89

Source : Department of Industrial Policy and Promotion, Ministry of Commerce & Industry.

Cu