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TUNGSTEN

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GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

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18 Tungsten

Tungsten is a hard steel-grey shiny metal that is often brittle and hard to work and is of strategic importance. The chief sources of tungsten are minerals scheelite ($CaWO_4$) and wolframite [$(Fe,Mn)WO_4$] which are predominantly hydrothermal in origin. Tungsten has a melting point of 3,422 ^{o}C, the highest of all metals and is resistant to all acids at ordinary temperatures. It is elastic,ductile and has high tensile strength and can be drawn into very thin wires. Thus, tungsten is the most important metal for thermo-emission applications not only because of its high electron emissivity but also because of its high thermal and chemical stability. The domestic requirements of tungsten and its products are met mainly through imports.

When exposed to air, a protective oxide is formed on the surface of the metal, but tungsten can be oxidised more fully at high temperature. When alloyed in small quantities with steel, tungsten greatly increases the hardness of steel.

A significant amount of tungsten is recovered through recycling of tungsten scrap products. Old scrap consists of tungsten-bearing products, such as, cemented carbide parts that are used in metal cutting tools & metal forming tools. As tungsten has extremely high melting point and is ductile (can be readily drawn into wires), it is widely used in filaments of light bulbs and vacuum tubes, and for heating elements in electrical furnaces.

RESERVES/RESOURCES

The total reserves/resources of tungsten ore in the country, as per NMI data, as on 1.04.2015 based on UNFC system, has been estimated at 87.39 million tonnes with WO_3 content of 1,42,094 tonnes. All these resources are placed under 'Remaining Resources' category.

Resources of tungsten-bearing minerals are mainly distributed in Karnataka (42%), Rajasthan (27%), Andhra Pradesh (17%) and Maharashtra (9%). The remaining 5% resources are in Haryana, Tamil Nadu,Uttarakhand and West Bengal (Table- 1).

At Degana, Rajasthan, out of 7 blocks, the minimum and maximum values of WO_3 were noticed, 0.09% & 1.62% respectively. At Balda of Sirohi district, Rajasthan, the average WO_3 content ranges from 0.24 to 0.48 per cent. In Dewa-Ka-Bera of Sirohi district the average WO_3 is 0.03% and in Udwarya of Sirohi it is 0.27%. In West Bengal, Bankura deposit contains on an average of 0.1% WO_3. In Kuhi-Khobana-Agargaon belt of Maharashtra, GSI has estimated resources in Sakoli basin in Bhandara and Nagpur district, Maharashtra. The analysis showed 0.01 to 0.19% WO_3 in Kuhi block, 0.13 to 0.38% WO_3 in Khobana block and 0.48% WO_3 in Pardi-Dahegaon-Pipalgaon block. Gold ore at Mysore mine of BGML in Karnataka has been reckoned as a potential source of scheelite. The tailing dumps at Kolar Gold Fields (as per NMI database) contain about 0.01 to 0.05% WO_3.

EXPLORATION & DEVELOPMENT

The Exploration and development details, if any, are given in the Review on Exploration & Development in "General Reviews".

PRODUCTION & PRICES

There was no production of tungsten ore/concentrate during 2017-18. The past production of tungsten was reported from Degana, Rajasthan and Chendapathar, West Bengal. The domestic prices of tungsten ore and concentrate are furnished in the General Review on 'Prices'.

Table –1 : Reserves/Resources of Tungsten as on 1.4.2015
(By Grades/States)

(In tonnes)

Grade/State	Reserve Total (A)	Remaining Resources							Total Resources (A+B)
		Feasibility STD211	Pre-feasibility STD222	Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	
All India : Total									
Ore	**-**	**2230000**	**173063**	**19611152**	**23435954**	**25356049**	**16581246**	**87387464**	**87387464**
Contained WO_3	**-**	**3568**	**450**	**9914**	**20180.92**	**103415.15**	**4566.28**	**142094.35**	**142094.35**
By States									
Andhra Pradesh									
Ore	-	-	-	3640000	4700800	5952500	509000	14802300	14802300
Contained WO_3	-	-	-	5096	6574.64	8273.65	318.28	20262.57	20262.57
Haryana									
Ore	-	2230000	-	-	-	-	-	2230000	2230000
Contained WO_3	-	3568	-	-	-	-	-	3568	3568
Karnataka									
Ore	-	-	-	15361152	11805499	172921	9338246	36677818	36677818
Contained WO_3	-	-	-	2915	1775	142	1403	6235	6235
Maharashtra									
Ore	-	-	-	610000	5637250	1830000	-	8077250	8077250
Contained WO_3	-	-	-	1903	10304	3828	-	16035	16035
Rajasthan									
Ore	-	-	-	-	963666	17000628	5964000	23928294	23928294
Contained WO_3	-		-	-	1421.44	90171.5	2115	93707.94	93707.94
Tamil Nadu									
Ore	-	-	-	-	-	-	250000	250000	250000
Contained WO_3	-	-	-	-	-	-	50	50	50
Uttarakhand									
Ore	-	-	-	-	138000	-	520000	658000	658000
Contained WO_3	-	-	-	-	25	-	680	705	705
West Bengal									
Ore	-	-	173063	-	190739	400000	-	763802	763802
Contained WO_3	-	-	450	-	80.84	1000	-	1530.84	1530.84

MINING & PROCESSING

Deposits of wolframite that were established at Degana in Rajasthan and at Chendapathar in West Bengal are found associated with quartz veins, with width that varied from a few centimetres to three metres or sometimes even more. In Degana, it is also associated with gravel beds overlain by 2.5 m thick sand.

Gravel mining was carried out in the past in selected areas where wolframite was found to be concentrated. The overburden sand was at first loosened and loaded manually and transported by tractor unit to dump sites. The payable gravel was then worked.

In case of vein deposits, the orebody was cut with chisel and hammer at convenient places to form undercuts. At Degana, tungsten orebody occurs as vein, stockwork and alluvial deposits.

Inclined veins were developed by putting adits in the stockwork.

Degana in Rajasthan and Chendapathar in West Bengal were the only mines of tungsten in India that produced meagre quantities of concentrate. These mines, owing to economic non-viability, had to be closed down. As per the press release by NMDC dated 24th October 2016, NMDC Ltd & Mishra Dhatu Nigam (MIDHANI) have signed a Memorandum of Understanding (MoU) to develop tungsten mines and processing technology for the metal. Presently NMDC is scouting for acquisition of tungsten assets in India and abroad as per requirement of Defence & Aerospace sectors.

USES

Tungsten is mainly used in the form of ferro-tungsten in making of special and alloy steels and military applications. Ferro-tungsten typically contains between 25% and 75% tungsten. The other principal use of tungsten is in the manufacture of tungsten carbide, one of the hardest synthetic materials used in various industries like construction, metalworking, mining and oil drilling. It is used widely in the manufacture of cutting tools & devices and in wear-resistant materials, particularly those that need to be operated at high temperatures. In making this, cobalt or nickel metal powder is used as a binder to hold together the tungsten carbide grain. Tungsten compounds are used in dyes and pigments; manufacture of paints & printing ink; and also in Ceramic Industry for producing yellow tint. Other alloys bearing tungsten have wide range of applications, i.e., ornaments, heat sinks, radiation shielding, weights & counter-weights, super alloys for turbine parts, tool steels wear-resistant alloy parts & coatings, etc. Tungsten alloys and tungsten composites are used as a substitute for lead in bullet and shot. Tungsten is used as filament in incandescent light bulbs and cathodes for electronic tubes, cell phones, television set, HID lamps and other electrical consumer products. The metal is used in superalloys with copper or silver and in Chemical Industry. Tungsten carbide is often used in armor-piercing ammunition.

SUBSTITUTES

Tungsten remains essentially unsubstitutable in its use for production of filaments, electrodes and contacts in lamp & lighting applications. However, an electrodeless, non-tungsten lamp is available as alternative for commercial and industrial uses. Titanium, tantalum and niobium carbides can be used in certain wear-resistant applications. Molybdenum tool steels and tungsten tool steels are interchangeable. In some cutting tool applications, bulk ceramic is an alternative. In some applications, substitution would most often result in increased cost or reduction in product performance.

TECHNICAL POSSIBILITIES

Further development of new metal shaping methods, i.e., laser is becoming a viable proposition. Development of new cutting tool materials coating on cemented carbide parts, that increase their useful life could reduce the usage of tungsten. Use of tungsten scrap could be increased. The recycling of tungsten-bearing scrap and the recovery of tungsten from scrap materials are well-established practices for a number of reasons. The value of tungsten and other metals present in the scrap, such as, cobalt, columbium, copper, nickel, rhenium, silver, titanium and tantalum, is worthy enough reason to recycle them from scrap. Recycling of tungsten in high speed steel is high and a typical melt contains about 60-70 % scrap, including internally generated scrap. On the other hand, recycling in such applications as lamp filaments, welding electrodes and chemicals uses is also considered viable. Recycling is more environment-friendly and more practicable in economic terms than disposing as waste. Scrap recycling is an important factor in the world's tungsten supply.

POLICY

As per the Foreign Trade Policy, 2015-20, the imports and exports of tungsten ores and concentrates (HS Code 26000000) are allowed free.

CONSUMPTION

The entire domestic requirement of tungsten ore/ concentrates is met by imports. Sandvik Asia Pvt. Ltd, Pune, Maharashtra;Widia (India) Ltd, Bengaluru, Karnataka; Rapicut Carbides Ltd, Ankleshwar, Gujarat; Mishra Dhatu Nigam Ltd, Hyderabad, Andhra Pradesh; and Sunflag Iron & Steel Co. Ltd, Bhandara, Maharashtra were the important consumers of ferro-tungsten for production of alloy steel. Mining Machinery Industry is the main consumer of the imported ore/concentrates.

WORLD REVIEW

The world reserves of tungsten in terms of metal content are about 3.3 million tonnes, distributed broadly amongst China (58%), Russia (7%), Vietnam (3%), Spain (2%) (Table-2).

The world mine production of tungsten in terms of metal content in 2017 increased slightly to 82,500 tonnes from 81,100 tonnes in 2016. China was the leading producer (79%), followed by Vietnam (8%), Russia (3%) and Austria, Bolvia, UK, Rwanda, (1% each) (Table-3).

Table - 2: World Reserves of Tungsten (By Principal Countries)

(In '000 tonnes of Tungsten content)

Country	Reserves
World Total (rounded)	**3300**
Austria	10
Bolivia	NA
China	1900
Portugal	3
Russia	240
Rwanda	NA
Spain	54
UK	43
Vietnam	95
USA	NA
Other countries	1000

***Source** : Mineral Commodity Summaries, 2019*

Table – 3 : World Mine Production of Tungsten (By Principal Countries)

(In tonnes of metal Content)

Country	2015	2016	2017
World:Total	**82800**	**81100**	**82500**
Austria	870	950	950[e]
Bolivia	1116	848	1400[e]
Brazil[c]	452	400e	400[e]
Burundi	78	131	150[e]
Canada	2114	-	-
China	66545	63956	65000[e]
Congo, Dem. Rep.	65	93	153
Korea, Dem. P. R. of[e]	70	50	300
Kyrgyzstan[e]	100	100	100
Peru	139	-	-
Russia	2608	3048	2072
Rowanda[b]	1081	1040	923
UK	195	923	1370
Uzbekistan[e]	300	300	300
Vietnam	5123	6357	6483
Zimbabwe[e]	200	1200	1000
Other countries	91	134	-

***Source:** World Mineral Production, 2013-2017.*

b*: Exports*

c*: Mainly scheelite.*

FOREIGN TRADE

Exports

Exports of tungsten and alloys including scrap increased to 593 tonnes in 2017-18 from 373 tonnes in the previous year. Exports were mainly to Germany (22%), Finland (20%), USA (16%), Japan (8%), Thailand (7%). In 2017-18, exports of tungsten ore & concentrates increased to 30 tonnes as against 8 tonnes in the preceding year. The exports were almost entirely to Vietnam (Tables-4 & 5).

Imports

Imports of tungsten and alloys including scrap increased to 465 tonnes in 2017-18 from 401 tonnes in the previous year. Imports were mainly from China (48%), Austria (19%), Korea, Rep. of (14%) and Germany & USA (5% each). Imports of tungsten ores and concentrate also increased to 350 tonnes in 2017-18 from 283 tonnes in the previous year. Imports were mainly from Netherlands (79%) followed by Chinese Taipei/Taiwan (21%) (Tables-6 & 7).

Table-4: Exports of Tungsten and Alloys Incl. Scrap (By Countries)

Country	2016-17		2017-18	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**372621**	**1198574**	**592946**	**1471428**
Germany	64318	311211	132143	331309
USA	64234	144206	93679	197722
Finland	15935	27279	116634	172938
Poland	7922	129174	8337	124880
Japan	10474	75101	50263	108190
Italy	4409	79820	5919	83582
Thailand	23333	41125	39256	69560
France	3353	44001	3923	50224
Austria	15319	37017	6431	36141
Korea, Rep. of	2241	28321	2695	34211
Other countries	161083	281319	133666	262671

Table –5 : Exports of Tungsten Ores & Conc. (By Countries)

Country	2016-17		2017-18	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**8**	**6064**	**30**	**29880**
Vietnam	-	-	30	29880
Rwanda	7	6014	-	-
Germany	1	50	-	-

Table –6: Imports of Tungsten & Alloys Incl. Scrap (By Countries)

Country	2016-17		2017-18	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	**400849**	**1558902**	**465226**	**1718862**
China	214893	677684	221616	717696
Austria	45614	330963	88917	406414
Korea, Rep. of	38531	153879	63162	199913
Germany	26152	140776	23034	124397
USA	8043	44225	21399	60787
Singapore	14174	52271	18876	58181
UAE	-	-	2944	40102
Vietnam	39600	79824	10678	20962
Japan	3238	20684	2309	16615
Switzerland	1591	12523	2914	15553
Other countries	9013	46073	9377	58242

Table 7: Imports of Tungsten Ores & Conc.
(By Countries)

Country	2016-17		2017-18	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**283**	**29630**	**350**	**23609**
Netherlands	171	13668	276	22029
Chinese Taipei/Taiwan	-	-	73	1195
Uzbekistan	-	-	1	385
Australia	23	7435	-	-
Germany	3	2769	-	-
Singapore	63	5271	-	-
Slovenia	23	487	-	-

FUTURE OUTLOOK

World tungsten supply will continue to be dominated by China's production and exports. As per Global Tungsten Market Trends, statistics and forecast 2015-20, Europe is an important market for tungsten demand. The demand for tungsten for industrial applications is expected to witness strong growth, particularly in Asia Pacific and Latin America regions. In the next few years, tungsten concentrates production from outside China is expected to increase. Some of the increase is expected to come from improved production from existing mines and some is expected to come from the ramp up of production at recently started mines and tailings operations. The consumption of tungsten in cemented carbides, which is the leading end-use sector is expected to rise in the near future.

In India, the entire demand can only be met by imports and recycling, as there is no indigenous production of tungsten concentrates. High content of WO_3 in the tailing dumps of Kolar can be worked on priority basis to meet the demand.