

73 Sulphur and Pyrites

In India, there are no mineable elemental sulphur reserves. Pyrites was used as a substitute for sulphur in the manufacture of sulphuric acid by M/s Pyrites Phosphates and Chemicals Ltd (PPCL). There was no production of pyrites since 2003.

The domestic production of elemental sulphur is limited to by-product recoveries from petroleum refineries and fuel oil used as feedstock for manufacturing fertilizer. In addition, during the production of non-ferrous metals from sulphide ores, sulphur is recovered in the form of by-product sulphuric acid. HZL (Vedanta) and HCL together produced about 981,585 tonnes and 1,045,521 tonnes by-product sulphuric acid from indigenous lead-zinc and copper ores in 2008-09 and 2009-10, respectively, equivalent to about 255,000 tonnes and 272,000 tonnes of contained sulphur. In addition, about 2.03 million tonnes and 2.13 million tonnes sulphuric acid equivalent to 528,000 tonnes and 554,000 tonnes of sulphur was indigenously produced from imported copper and zinc concentrates as by-product by Sterlite Industries, Binani Zinc Ltd and Hindalco during 2008-09 and 2009-10, respectively. The total production of sulphuric acid from

sulphide ores was thus about 3.00 million tonnes and 3.18 million tonnes, respectively, equivalent to about 784,000 tonnes and 826,000 tonnes of sulphur during 2008-09 and 2009-10, respectively.

Sulphur consumption in the manufacture of sulphuric acid has been reported by some of the chemical and fertilizer industries. Travancore Titanium Products Ltd produced 64,053 tonnes of sulphuric acid in 2009-10.

The sulphuric acid is further used for manufacturing phosphoric acid and single superphosphate (SSP) from rock phosphate which is imported from Jordan, Morocco, Egypt, Israel, Togo, etc.

RESOURCES

Resources of sulphur (native) were estimated in the inferred (STD333) category. The resources are located in Jammu & Kashmir and are placed at 0.21 million tonnes as on 1.4.2010 as per UNFC System.

Total resources of pyrites in the country as per UNFC system as on 1.4.2010 are placed at 1,674 million tonnes. There are no reserves and all resources are

**Table – 1 : Reserves/Resources as on 1-4-2010 (P) : Pyrites
(By Grades and States)**

(In '000 tonnes)

Grade/State	Reserves Total (A)	Feasibility STD211 STD222	Remaining resources				Total (B)	Total (A+B)
			Pre- feasibility	Measured STD331	Indicated STD332	Inferred STD333		
All India : Total	–	27129	32597	9590	77729	1527356	1674401	1674401
By Grades								
Soil Reclamation	–	–	3000	–	–	3024	6024	6024
Beneficiable	–	27129	29597	–	–	4902	61628	61628
Low	–	–	–	9590	26310	1519430	1555330	1555330
Unclassified	–	–	–	–	51419	–	51419	51419
By States								
Andhra Pradesh	–	–	–	–	–	880	880	880
Bihar	–	13462	9680	–	51419	1500000	1574561	1574561
Himachal Pradesh	–	–	–	–	–	2560	2560	2560
Karnataka	–	–	–	–	–	3000	3000	3000
Rajasthan	–	13667	22917	9590	26310	18392	90876	90876
Tamil Nadu	–	–	–	–	–	24	24	24
West Bengal	–	–	–	–	–	2500	2500	2500

Figures rounded off.

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grouped under 'remaining resources' category. Of these, about 27 million tonnes are under feasibility (STD211) category. Out of the total resources, beneficiable grade resources are 62 million tonnes, low grade 1,555 million tonnes and soil reclamation grade resources are about 6 million tonnes. Balance of about 51 million tonnes resources fall under unclassified/not known grades. Major resources are located in Bihar and Rajasthan (Table - 1).

PRODUCTION & STOCKS

Sulphur

The production of sulphur recovered as by-product from fertilizer plants and oil refineries was at 263 thousand tonnes in 2009-10 as against 270 thousand tonnes in the preceding year.

Two fertilizer plants and seven oil refineries, all in the public sector, reported production of sulphur during the year. Of the total quantity produced in 2009-10, Indian Oil Corp. Ltd contributed about 82.75% of the total production during the year under review. Haryana accounted for 55.6%, Tamil Nadu 15.7%, Uttar Pradesh 13.7%, West Bengal 5.9%, Gujarat 4.6% and the remaining 4.5% was contributed by Bihar, Punjab and Assam (Tables - 2 to 4).

Table - 2 : Principal Producers of By-product Sulphur, 2009-10

Name & address of producer	Location of plant/refinery	
	State	District
Indian Oil Corporation Ltd, (Refineries Division), Scope Complex, Core-II, 7, Institutional Area, Lodhi Road, New Delhi -110 003.	Assam	Guwahati
	Bihar	Begusarai
	Gujarat	Vadodara
	Haryana	Panipat
	Uttar Pradesh	Mathura
Chennai Petroleum Corp. Ltd, 536, Anna Salai, Teynampet, Chennai - 600 018.	West Bengal	Midnapur
	Tamil Nadu	Chennai
National Fertilizers Ltd, Scope Complex, Core-III, 7, Institutional Area, Lodhi Road, New Delhi -110 003.	Haryana Punjab	Panipat Ropar

In addition, oil refineries pertaining to M/s Hindustan Petroleum Corporation Ltd. and M/s Bharat Petroleum Corporation Ltd have reported production of 28,000 and 65,000 tonnes of by-product sulphur, respectively, in 2009-10.

Table – 3 : Production of By-product Sulphur 2007-08 to 2009-10 (By States)

(In tonnes)			
State	2007-08	2008-09	2009-10 (P)
India	227311	269572	263124
Assam	224	566	665
Bihar	8150	10186	8681
Gujarat	13608	13293	12045
Haryana	108064	130155	146278
Punjab	3456	3894	2468
Tamil Nadu	44932	48453	41346
Uttar Pradesh	31673	42915	36130
West Bengal	17204	20110	15511

Table – 4 : Production of By-product Sulphur 2008-09 and 2009-10 (By Sectors/States/Districts)

State/District	(In tonnes)			
	2008-09		2009-10 (P)	
	No. of units	Quantity	No. of units	Quantity
India/Public sector	9	269572	9	263124
Assam/Guwahati	1	566	1	665
Bihar/Begusarai	1	10186	1	8681
Gujarat/Vadodara	1	13293	1	12045
Haryana/Panipat	2	130155	2	146278
Punjab/Ropar	1	3894	1	2468
Tamil Nadu/Chennai	1	48453	1	41346
Uttar Pradesh/Mathura	1	42915	1	36130
West Bengal/Midnapur	1	20110	1	15511

Pyrites

Pyrites Phosphates and Chemicals Ltd (PPCL) had two pyrites production units located at Amjhore (Bihar) and Saladipura (Rajasthan) besides phosphorite division in Dehradun. The Government approved closure and hiving off of these two units in July 2002 and Amjhore unit in June 2003. Hence, there was no production of pyrites since 2003.

APPLICATIONS & USES

One of the direct uses of sulphur is in vulcanisation of rubber. Sulphur is a component of gunpowder. It reacts directly with methane to give carbon disulphide, which is used to manufacture cellophane and rayon.

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Elemental sulphur is mainly used as a precursor to other chemicals. Most of the sulphur is converted to sulphuric acid (H_2SO_4), which is of prime importance to the world economy. The production and consumption of sulphuric acid is an indicator of a nation's industrial development. The principal use of the sulphuric acid is in the manufacture of phosphatic fertilizer.

Other applications of sulphuric acid include oil refining, wastewater processing and mineral extraction. Sulphur compounds are also used in detergents, fungicides, dyestuffs and agrichemicals. In silver based photography, sodium and ammonium thiosulphate are used as "fixing agents". Sulfites, derived from burning sulphur, are used to bleach paper. They are also used as preservatives in dried fruit and processed fruit products.

Sulphur is used as a light-generating medium in the rare lighting fixtures known as "sulphur lamps". The sulphur lamp is a highly efficient full-spectrum electrodeless lighting system whose light is generated by sulphur plasma that has been excited by microwave radiation.

CONSUMPTION

The total reported consumption of elemental sulphur in 2009-10 was about 1.65 million tonnes. The main consumer of sulphur was fertilizer industry which accounted for about 74%. Chemical industry, the next important consuming industry, accounted for about 16% consumption for manufacturing carbon disulphide & dye-stuffs. Other industries like explosives, iron & steel, paint, paper, pesticides, pharmaceuticals and sugar consumed about 10% (Table - 5).

TRADE POLICY

Imports of sulphur of all kinds other than colloidal sulphur, precipitated sulphur and sublimed (flowers) sulphur under heading No. 2503 are allowed freely under the Foreign Trade Policy, 2009-14. Similarly, the imports of unroasted pyrites under heading No. 2502 are allowed freely.

Table – 5 : Reported Consumption of Sulphur 2007-08 to 2009-10 (By Industries)

(In tonnes)			
Industry	2007-08	2008-09(R)	2009-10(P)
All Industries	1757700	1672700	1650100
Alloy steel	3600(4)	3600(4)	3600(4)
Chemical	272100(34)	263800(34)	267000(34)
Explosive	1200(2)	1200(2)	1200(2)
Fertilizer	1271200(37)	1248200(37)	1217900(37)
Iron & steel**	33400(3)	30600(3)	29500(3)
Paint	2200(2)	2200(2)	2200(2)
Paper	3900(7)	3900(8)	3900(8)
Pesticide	25800(6)	21800(6)	24400(6)
Pharmaceutical	4100(4)	4100(5)	4100(5)
Sugar (e)	139300(e)	92000(e)	95000(e)
Others (Abrasive, asbestos products, dry cells battery, electrical, glass & rubber)	900(18)	1300(20)	1300(20)

Figures rounded off. Data collected on non-statutory basis. Figures in parentheses denote the number of units in organised sector reporting consumption.*

*(*Includes actual reported consumption and/or estimates made wherever required).*

*** The consumption relates to manufacturing sulphuric acid in the steel plants.*

(e) estimate based on sugar production.

WORLD REVIEW

Reserves of sulphur in crude oil, natural gas and sulphide ores are large. Because most sulphur production is a result of the processing of fossil fuels, supplies should be adequate for the foreseeable future. Because petroleum and sulphide ores can be processed long distances from where they are produced, sulphur production may not be in the country for which the reserves were attributed. For instance, sulphur reserves from Saudi Arabia may be recovered at oil refineries in the United States.

In 2009, the world production of sulphur was estimated at 66.40 million tonnes and that of pyrites at 5.3 million tonnes. USA (15%), Canada and China (11% each), Russia (9%), Japan and Saudi Arabia (5% each) were the major producers of sulphur. China (93%) and Finland (3%) were the major producers of pyrites (Table - 6).

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**Table – 6 : World Production of Sulphur & Pyrites
(By Principal Countries)**

(In '000 tonnes of sulphur content)			
Country	2007	2008	2009
World: Total (Sulphur)	65400	66700	66400
(Pyrites)	6700	6600	5300
Abu Dhabi (Sulphur)	2183	1900	1760
Australia (Sulphur)	926	986	986
Canada (Sulphur)	8789	8155	7467
China (Sulphur)	5685	6805	7543
(Pyrites)	6082	6022	4946
Chile (Sulphur)	1533	1541	1601
Finland (Pyrites)	194	226	154
(Sulphur)	451 ^e	448	401
Iran (Sulphur)	1456	1629	1699
Germany (Sulphur)	1686	1617	1624
Japan (Sulphur)	3714	3831	3538
Kazakhstan (Sulphur)	1896 ^e	2124	2740
Korea Rep. (Sulphur)	1582 ^e	1650 ^e	1559 ^e
Mexico (Sulphur)	1583	1477	1524
Poland (Sulphur)	1349 ^e	1282	642
Russia (Sulphur)	7162	7265	6217
(Pyrites)	210	161	71
Saudi Arabia (Sulphur)	3100	3100	3124
South Africa (Sulphur)	571	510	520 ^e
Turkey (Pyrites)	61	79	79
USA	9097	9443	9810 ^e
Zimbabwe (Pyrites)	20	30	–
Other countries(Sulphur)	13563	13923	14541
(Pyrites)	133	82	50

Source: World Mineral Production, 2005-2009.

The global sulphur industry remained divided into two sectors - discretionary and non-discretionary. In the discretionary sector, the mining of sulphur or pyrites is the sole objective. In the non-discretionary sector, sulphur or sulphuric acid is recovered as involuntary by-product; the quantity of output is subject to demand for the primary product and environmental regulations. Elemental sulphur is obtained from ores by conventional mining or by the Frasch method of mining sulphur (mined sulphur) or as a by-product of sour natural gas processing, sour crude refining, tar sand processing and stack gas clean-up (recovered sulphur). Recovered sulphur production accounted for over 98% world elemental sulphur production.

In Frasch method, three concentric pipes are used. The outermost pipe contains superheated water, which melts the sulphur, and the innermost pipe is filled with hot compressed air, which serves to create foam and pressure. The resulting sulphur foam is then expelled through the middle pipe. The

Frasch process produces sulphur with 99.5% purity content, and it needs no further purification. Frasch sulphur production on a commercial scale was operated in USA, Poland and Iraq.

Canada

Canada was the leading sulphur and sulphuric acid producer and exporter. About two third of Canadian sulphur is recovered as natural gas and oil sands operations in Alberta, with some recovered from gas in British Columbia and oil refineries in other parts of the country. Sulphur recovery from natural gas has declined for several years, but increased sulphur production from oil sands offset that, and this trend was expected to continue.

China

Though the importance of pyrites to the world sulphur supply has significantly decreased, China was the world's leading producer of pyrites producing about 93% of world pyrite production. The country was also the leading sulphur importer.

Kazakhstan

Kazakhstan's Tengiz Chevroil's sulphur stockpiles reached more than 9 million tonnes in 2008. The company produced about 1.6 million metric tonnes per year but exported only about 1 million tonnes, requiring the rest to be stockpiled. The company was developing plans for indoor storage of their sulphur stocks that were expected to continue to expand along with oil production at this and other operations. The industry insiders forecasted that sulphur production in Kazakhstan could reach 5 million tonnes by 2020.

FOREIGN TRADE

Exports

Exports of sulphur (excluding sublimed, precipitated and colloidal) decreased substantially to 124,884 tonnes in 2009-10 from 171,160 tonnes in the previous year. Exports were mainly to China (92%), Brazil (4%) and Bangladesh (2%).

Exports of sulphur (sublimed, precipitated and colloidal) increased to 5,608 tonnes in 2009-10 from 5,068 tonnes in the previous year. Sulphur (sublimed) alone accounted for more than 98.2%. The precipitated and colloidal sulphur together shared 1.8% exports in 2009-10. Exports were mainly to Germany, Turkey, Czech. Rep., South Africa, Portugal, Spain, Rep. of Korea, etc. (Tables - 7 to 11).

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Imports

Imports of sulphur (excluding sublimed, precipitated and colloidal) increased to 15.34 lakh tonnes in 2009-10 from 12.86 lakh tonnes in the previous year. Imports were mainly from Saudi Arabia (32%), UAE (19%), Kuwait (12%), Iran (11%), Qatar (10%), Bahrain (6%) and Japan (5%).

Imports of sulphur (sublimed, precipitated and colloidal) increased sharply to 2,369 tonnes in 2009-10 from 1,202 tonnes in the previous year. Out of the total imports, 1,529 tonnes was precipitated sulphur, 823 tonnes sublimed sulphur and 17 tonnes colloidal sulphur (Tables - 12 to 16).

Table – 7 : Exports of Sulphur (Excl. Sublimed, Precipitated & Colloidal) : Total (By Countries)

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	171160	3971228	124884	504615
Bangladesh	3197	38293	2355	29551
Brazil	–	–	5000	48380
China	38000	746173	114490	309651
Chinese Taipei/ Taiwan	3215	74941	7	398
Israel	35200	1092714	–	–
Jordan	29035	990314	33	507
Korea, Rep. of	30059	52266	–	–
Mozambique	27400	847344	1	31
Myanmar	948	37325	–	–
Nepal	681	5162	1590	77025
Other countries	3425	86696	1408	39072

Table – 8 : Exports of Sulphur (Sublimed, Precipitated & Colloidal) : Total (By Countries)

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	5068	420343	5608	492006
Germany	628	60799	966	90747
Czech Rep.	–	–	660	64141
Turkey	664	64298	673	62573
South Africa	540	56434	437	41316
Portugal	84	7663	444	40478
Spain	365	38207	402	39162
Korea, Rep. of	530	51852	390	33122
Iran	270	28416	355	32787
Indonesia	311	28771	376	30713
UK	136	13118	180	15661
Other countries	1540	70785	725	41306

Table – 9 : Exports of Sulphur (Colloidal) (By Countries)

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	53	990	35	806
Sri Lanka	2	376	2	391
Nepal	50	560	32	284
Mozambique	–	–	1	94
Oman	–	–	++	32
Congo, People's Rep. of	1	54	++	3
Indonesia	–	–	++	2

Table - 10 : Exports of Sulphur (Precipitated) (By Countries)

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	118	1513	67	965
Sri Lanka	44	538	45	618
Kenya	45	598	22	347
Nepal	28	233	–	–
Saudi Arabia	1	103	–	–
Malaysia	++	24	–	–
Ethiopia	++	11	–	–
Ghana	++	5	–	–
Other countries	++	1	–	–

Table – 11 : Exports of Sulphur (Sublimed) (By Countries)

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	4897	417840	5506	490235
Germany	628	60799	966	90747
Czech Rep	–	–	660	64141
Turkey	664	64298	673	62573
South Africa	540	56434	437	41316
Portugal	84	7663	444	40478
Spain	365	38207	402	39162
Korea, Rep. of	530	51852	390	33122
Iran	270	28416	355	32787
Indonesia	311	28771	376	30711
UK	136	13118	180	15661
Other countries	1369	68282	623	39537

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**Table – 12 : Imports of Sulphur
(Excl. Sublimed, Precipitated & Colloidal) : Total
(By Countries)**

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	1286429	29944603	1533628	6810816
Saudi Arabia	285122	6413338	493391	2024956
UAE	354378	7682359	293602	1271499
Kuwait	153047	4896241	190206	893297
Iran	172430	3449769	169300	869867
Qatar	47695	1734214	148123	670483
Bahrain	71782	1413617	97757	362172
Japan	59961	1347061	74665	327390
Syria	11303	300806	14466	164929
Chinese Taipei/ Taiwan	16519	593112	–	–
Iraq	27190	835895	–	–
Other countries	87002	1278191	52118	226223

**Table – 13 : Imports of Sulphur
(Sublimed, Precipitated & Colloidal) : Total
(By Countries)**

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	1202	114502	2369	221905
Malaysia	1063	102403	1276	134135
Germany	10	1149	227	38484
France	35	1613	561	27421
China	42	3128	168	10848
Japan	15	2278	37	4743
USA	34	3674	57	3622
UK	1	104	19	1866
Korea, Rep. of	++	13	23	699
Belgium	–	–	1	73
Unspecified	2	139	–	–
Other countries	++	1	++	14

**Table – 14 : Imports of Sulphur (Colloidal)
(By Countries)**

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	7	971	17	386
Germany	7	971	–	–
Korea, Rep. of	–	–	17	386

**Table – 15 : Imports of Sulphur (Precipitated)
(By Countries)**

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	777	76999	1529	130614
Malaysia	658	67062	912	97716
France	35	1613	540	26040
Germany	2	111	21	2185
China	42	3128	29	1880
USA	33	3579	23	1536
Japan	5	1367	3	1183
Belgium	–	–	1	73
Unspecified	2	139	–	–
Other countries	–	–	++	1

**Table – 16 : Imports of Sulphur (Sublimed)
(By Countries)**

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	418	36532	823	90905
Malaysia	405	35341	364	36419
Germany	1	67	206	36299
China	–	–	139	8968
Japan	10	911	34	3560
USA	1	95	34	2086
UK	1	104	19	1866
France	–	–	21	1381
Korea, Rep. of	++	13	6	313
Slovak Rep.	–	–	++	12
Other countries	++	1	++	1

FUTURE OUTLOOK

In 2009 and 2010, world production of sulphur was expected to nearly satisfy demand, but severe sulphur surpluses were expected beginning in 2011 due to increased production from oil sands in Canada, natural gas in Middle East, expanded oil and gas operations in Kazakhstan, and heavy oil processors in Venezuela.

World consumption of natural gas is expected to maintain strong growth, and sulphur recovery from that sector is likely to increase. Future gas production, however, is likely to come from deeper, hotter and more sour deposits that would result in even more excess sulphur production and surpluses, unless more efforts are made to develop new large scale uses of sulphur.