

MOLYBDENUM



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MOLYBDENUM

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**GOVERNMENT OF INDIA
MINISTRY OF MINES
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Molybdenum (Mo) is a refractory metal used principally as an alloying agent in steel, cast iron & superalloys to enhance strength and wear and corrosion resistance. It does not occur in nature in free state. Usually, it is found in chemically combined form with other elements. Molybdenite (MoS_2) is the principal ore of molybdenum. About two-thirds of global molybdenum production is as by-product of copper mining and only about one-third is obtained from primary molybdenum mines. In India, by-product concentrates of molybdenum are produced intermittently from uranium ore of Jaduguda mine belonging to Uranium Corporation of India Ltd (UCIL) in Jharkhand. The internal demand for molybdenum and its products is met mostly through imports.

RESOURCES

India continues to lack in several critical minerals and one of them is molybdenum. In India, molybdenum is associated generally with copper, lead and zinc ores. Rakha copper deposit in Jharkhand contains 45 to 48 ppm molybdenum. Malanjkhand copper deposit in Madhya Pradesh contains 0.04% recoverable molybdenum. Dariba-Rajpura lead-zinc deposit in Rajasthan contains molybdenum besides bismuth, arsenic and cadmium. The multimetal deposit at Umpyrtha in Khasi and Jaintia Hills, Meghalaya, reportedly contains molybdenum in association with copper, lead and tungsten. Molybdenum deposit in Karadikuttam in Madurai district, Tamil Nadu, contains 0.02 to 0.14% recoverable molybdenum.

As per the UNFC System, the resources of molybdenum ore in the country as on 1.4.2010 are estimated at about 19.29 million tonnes containing about 12,640 tonnes MoS_2 . The above resources are located in Tamil Nadu (9.97 million tonnes), Madhya Pradesh (8 million tonnes) and Karnataka (1.32 million tonnes) (Table-1).

EXPLORATION & DEVELOPMENT

In Vellampatti area, Dharmapuri district, Tamil Nadu, which was explored by GSI during FS 2009-10, an inferred resource (333) of 2.74 million tonnes of molybdenum ore with an average grade of 0.102% Mo had been estimated.

In Tamil Nadu, GSI had carried out investigation work at prospecting stage (G-3) during FS 2010-12 in Harar-Uttangarai molybdenum belt in Vellakkal Central block of district Dharmapuri. The area falls within Alkaline-Carbonatite Province (ACP). Epidote - hornblende gneiss and quartzo-felspathic gneiss are the major rock types encountered in this area. Molybdenum mineralisation confined to a regional shallow to moderate easterly dipping shear zone trending NNE-SSW, extending from Vellampatti in the South to Nochchipatti in the North in districts Dharmapuri and Krishnagiri. The results of drilling along the shear zone in Vellakkal Central Block, has brought to light the fact that the zones of the quartz veins occur one below the other in a ladder type fashion as sub-horizontal to gentle easterly dipping lensoidal and sigmoidal bodies within the shear zone. The boreholes drilled in the central part of the Vellakkal central block indicated Mo mineralisation ranging from 115-307 ppm. The lead (Pb) values range from 1-2.5%. Exploration has been completed.

USES

Molybdenum is a versatile alloying agent for alloy steel, cast iron, nickel, cobalt and titanium alloys. For desired metallurgical properties, it is used in the form of molybdic oxide or ferromolybdenum. It is used in different proportions for imparting desired properties, such as increased strength, hardness and resistance to corrosion, temperature and chipping. It also finds application in permanent magnet alloys. As a refractory metal, it is used in many electrical and electronic components and as resistance element in electric furnaces and other equipment which are operated

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**Table – 1 : Reserves/Resources of Molybdenum as on 1.4.2010
(By Grades/States)**

Grade/State	Reserves		Remaining resources					Total resources (A+B)
	Total (A)	Pre-feasibility STD221	Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	
All India : Total								
Ore	-	1500000	36000	569304	17013628	167800	19286732	19286732
Contained MoS₂	-	1050	83	287	11169	50	12639	12640
By States								
Karnataka								
Ore	-	-	-	-	1320900	-	1320900	1320900
Contained MoS ₂	-	-	-	-	1719	-	1719	1719
Madhya Pradesh								
Ore	-	-	-	-	8000000	-	8000000	8000000
Contained MoS ₂	-	-	-	-	5020	-	5020	5020
Tamil Nadu								
Ore	-	1500000	36000	569304	7692728	167800	9965832	9965832
Contained MoS ₂	-	1050	83	287	4431	50	5901	5901

Figures rounded off.

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at extremely high temperatures. Its non-metallurgical uses are in lubricants, catalysts, pigments, as an additive in oil and greases, in aerosol sprays, in reducing surface friction and as an antiwear and antifriction agent in plastics. Molybdenum plays a vital role in the energy industry and it may become an increasingly essential factor in green technology.

SUBSTITUTES

There is little substitution for molybdenum in its major application, viz, as an alloying element in steel and cast irons. Owing to the availability and versatility of molybdenum, industry has sought to develop new materials that benefit from the alloying properties of the metal. Potential substitutes for molybdenum include chromium, vanadium, niobium (columbium) and boron in alloy steels; tungsten in tool steels; tungsten and tantalum for refractory materials in high temperature electric furnaces and chrome-orange, cadmium-red and organic-orange pigments for molybdenum orange.

MINING

Molybdenum concentrate is produced intermittently incidental to uranium mining at Jaduguda mine of UCIL.

INDUSTRY AND CONSUMPTION

Usually, molybdenum is used in the form of roasted concentrates, oxide or ferro-molybdenum in the defence industries. HCL has installed a pilot plant for producing molybdenum concentrate from copper ore containing 0.3% Mo at Rakha mine, East Singhbhum district, Jharkhand. However, molybdenum recovery at Rakha is not found economical.

Molybdenum is used chiefly in the form of ferro-molybdenum. The production of ferro-molybdenum increased from 3,090 tonnes in 2010-11 to 4,362 tonnes in 2011-12. The reported consumption of ferro-molybdenum in 2011-12 was 671 tonnes and 929 tonnes in 2010-11. Alloy steel industry alone accounted for about 65% consumption followed by iron & steel (24%) and foundry (7%). The data on production and consumption of ferro-molybdenum are given in Tables - 2 and 3, respectively.

Non-ferrous Technology Development Centre at the Defence Metallurgical Research Laboratory, Hyderabad has a pilot plant for producing molybdenum powder. Institute of Minerals and Materials Technology

(formerly RRL), Bhubaneswar, is carrying out basic research on recovery of molybdenum from spent catalysts.

Table – 2 : Production of Ferro-molybdenum 2007-08 to 2011-12

(In tonnes)

Year	Production
2007-08	2899
2008-09	2112
2009-10	2822
2010-11	3090
2011-12	4362

Source: Indian Ferro-Alloys Producers' Association.

Table – 3 : Reported Consumption of Ferro-molybdenum, 2009-10 to 2011-12 (By Industries)

(In tonnes)

Industry	2009-10	2010-11(R)	2011-12(P)
All Industries	855	929	671
Alloy steel	574(8)	571(8)	435(8)
Electrode	-	25(1)	25(1)
Foundry	57(9)	50(8)	50(8)
Iron & steel	224(9)	283(10)	161(10)

Figures rounded off. Figures in parentheses denote the number of units in organised sector reporting consumption.*

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

TRADE POLICY

As per Foreign Trade Policy, 2009-2014, imports of molybdenum ores & concentrates under heading No. 2613 and molybdenum and articles thereof under heading No. 8102 are allowed freely, except molybdenum waste & scrap (under ITC-HS Code No. 8102 9700) which are restricted.

WORLD REVIEW

The world reserves of molybdenum are 11 million tonnes, located mainly in China (39%), USA (25%), Chile (21%), Peru (4%), besides Russia, Armenia, Canada and Mexico (Table-4).

The world production of molybdenum in terms of metal increased marginally to 2.54 lakh tonnes in 2011 from 2.42 lakh tonnes in the previous year. China, USA and Chile together accounted for about 78% of world production (Table-5).

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**Table – 4 : World Reserves of Molybdenum
(By Principal Countries)**

(In '000 tonnes of molybdenum content)

Country	Reserves
World: Total (rounded)	11000
Armenia	150
Canada	220
Chile	2300
China	4300
Iran	50
Kazakhstan	130
Kyrgyzstan	100
Mexico	130
Mongolia	160
Peru	450
Russia (e)	250
USA	2700
Uzbekistan (e)	60

Source: Mineral Commodity Summaries, 2013.

**Table – 5 : World Mine Production
of Molybdenum
(By Principal Countries)**

(In tonnes of metal content)

Country	2009	2010	2011
World: Total	224000	242000	254000
Armenia	4365	4377	4817
Canada	8721	8648	8326
Chile	34786	37044	40698
China (e)	93500	93600	94000
Iran	3882	3676	3513
Mexico	10167	10849	10787
Peru	12297	16963	19141
Russia (e)	4800	4800	4800
USA	47800	59400	64000
Other countries	3682	2643	3918

Source: World Mineral Production, 2007-2011.

In North America, most Canadian molybdenum reserves are porphyry molybdenum and porphyry copper-molybdenum deposits in British Columbia. The La Caridad deposit in Mexico was a leading producer.

In Chile, the Chuquicamata and El Teniente were among the largest deposits in the world.

Armenia

Zangezur Copper and Molybdenum Combine CJSC was planning to expand its production facility at their Karajan copper-molybdenum mine in Syunik province. In 2011, the annual volume of ore extracted was 16 million tonnes while capacity of the processing facility was approximately 20 Million tonnes per year of ore. In 2010, 8,800 tonnes of Molybdenum was produced.

Australia

Results of pre-feasibility study on Merlin deposit (discovered in 2008) were announced by Ivanhoe Mines Ltd which indicated the project to provide strong, long term cash flows. In the fourth quarter of 2011, the company started a feasibility study, which was expected to be completed by March 2012.

Canada

TCMC announced that its Endako Mine produced 3,160 tonnes of molybdenum in 2011 compared to 3,400 tonnes in 2010. Commissioning of the new Endako mill was completed and commercial production was achieved in February 2012.

Taseko Mines Ltd announced production of 590 tonnes of molybdenum in 2011 compared to 430 tonnes produced in 2010 from its Gibraltar mine.

Chile

Antofagasta plc announced that production from its Los Pelambres mine increased to 9,900 tonnes in 2011 from 8,800 tonnes in 2010. An increase of molybdenum production by 13%. Whereas, production of the Codelco increased to 23,000 tonnes compared to 22,000 tonnes in 2010.

USA

There were ten producing mines: one primary mine each in Colorado (Henderson), Idaho (Thompson Creek), Nevada (Ashdown) and New Mexico (Questa); six by-product producers in Arizona (Sierrita & Bagdad), Utah (Bingham Canyon) and one each in Montana, New Mexico (Chino) and Nevada (Robinson). Exploration at the Bingham Canyon Mine of Rio Tinto identified a new copper-molybdenum-gold porphyry system below the present open pit. The 450-550 million tonnes deposit was of 0.1-0.15% Mo grade compared to 0.045% Mo average grade in the open pit. The new reserves will enable the mining operation to last till 2028.

FOREIGN TRADE

Exports

Exports of molybdenum ores & concentrates increased sharply to 4,477 tonnes in 2011-12 from 939 tonnes in the previous year. In 2011-12, exports were mainly to Canada (43%). Exports of molybdenum and scrap increased to 27 tonnes in 2011-12 from 19 tonnes in 2010-11. Exports were mainly to Italy (Tables - 6 and 7).

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Imports

Imports of molybdenum ores & concentrate were 5,223 tonnes in 2011-12 compared to 4,382 tonnes in the previous year. Imports were mainly from Chile (36%), USA (22%) and Thailand &

Mexico (8% each). Imports of molybdenum and scrap increased sharply to 826 tonnes in 2011-12 from 412 tonnes in the previous year. China (78%) and Austria (9%) were the main suppliers (Tables-8 & 9).

**Table – 6 : Exports of Molybdenum Ore & Conc.
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	939	25412	4477	52488
Canada	–	–	1919	19892
Australia	–	–	54	7638
Kuwait	2	111	4	255
Kenya	–	–	++	16
Mauritius	–	–	++	6
Other countries	937	25301	2500	24681

**Table – 7 : Exports of Molybdenum & Scrap
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	19	61006	27	67508
Poland	3	17690	3	20699
Germany	7	8510	2	7152
Egypt	++	945	++	5814
Italy	++	2929	15	5093
France	++	3254	1	4861
Austria	1	3839	1	4463
USA	1	7213	++	3465
Netherlands	++	97	1	2921
UK	++	698	1	2229
Japan	++	1082	++	2095
Other countries	7	14749	3	8716

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**Table – 8 : Imports of Molybdenum Ore and Conc.
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	4382	6086645	5223	6496596
Chile	928	1254313	1894	2189408
USA	1618	2341606	1129	1413880
Thailand	146	227182	421	630783
Mexico	478	639672	425	498663
China	247	317830	341	451442
Korea, Rep. of	153	170946	157	206076
Canada	388	519776	179	191324
Belgium	82	125993	130	168840
Vietnam	18	28321	94	145288
Germany	38	50057	106	141029
Other countries	286	410949	347	459863

**Table –9 : Imports of Molybdenum & Scrap
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	412	932478	826	1354032
China	259	547882	648	834359
Austria	77	201321	71	209645
Germany	10	36247	25	80172
USA	35	71839	27	79442
Korea Rep. of	++	601	15	29308
Japan	3	13011	5	20884
Australia	++	1849	2	12600
Belgium	-	-	5	10974
France	1	2084	3	10502
Hong Kong	++	1098	3	9936
Other countries	27	56546	22	56210

FUTURE OUTLOOK

The main end-use of molybdenum is as an additive in steel manufacturing, especially in alloys and stainless steel and in chemicals/catalysts. The petroleum refining and automotive catalytic application sectors continue to be strong markets for molybdenum. Strong growth

in superalloys and stainless steel can be expected in the near future.

In India, it is expected that demand for molybdenum will be increasing and this internal demand for molybdenum will continue to be met through imports.