

58 Molybdenum

Molybdenum 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

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 provisional 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

During the field study in 2009-10, GSI continued the work of concept oriented exploration taken up in 2008-09 for molybdenum in Velampatti South Block, Harur-Uttangarai Belt, Dharmapuri district, in Tamil Nadu to test the strike extension, depth persistence

and potentials of the hitherto unexplored footwall shear zone. A total of four boreholes were drilled. Exploration by drilling boreholes at 100 m strike interval was carried out to intersect the shear zone at two levels i.e. 50m and 100m below ground level and ore resource was computed accordingly.

A reconnaissance (G-4) stage investigation for molybdenum was carried out by GSI in Kanavaypudur-Toppur area, Dharmapuri district during the field study 2009-10. A number of prominent NNE-SSW trending sub-parallel shear zones with proto to ultra-mylonite fabric are exposed around Toppur and Kanavaypudur. Within the shear zones quartz veins, quartz-ankerite veins with clusters of limonitised sulphides and occasional specks of molybdenite were recorded. Soil samples have been collected systematically from this area and from Vellakkal-Kilburikkal area.

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 ferro-molybdenum. 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 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.

SUBSTITUTES

There is little substitution for molybdenum in its major application, viz, as an alloying element in steel and cast irons. Because of 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

MOLYBDENUM

Table – 1 : Reserves/Resources of Molybdenum as on 1.4.2010 (P)
(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 MoS ₂	-	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.

MOLYBDENUM

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 2,162 tonnes in 2008-09 to 2,822 tonnes in 2009-10. The reported consumption of ferro-molybdenum in 2009-10 was 1,085 tonnes and 996 tonnes in 2008-09. Alloy steel industry alone accounted for about 67% consumption followed by iron & steel (26%) 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
2005-06 to 2009-10**

(In tonnes)	
Year	Production
2005-06	2827
2006-07	3120
2007-08	2899
2008-09	2162
2009-10	2822

Source: Indian Ferro-Alloys Producers' Association.

**Table – 3 : Reported Consumption of
Ferro-molybdenum, 2007-08 to 2009-10
(By Industries)**

(In tonnes)			
Industry	2007-08	2008-09(R)	2009-10 (p)
All Industries	918	996	1085
Alloy steel	604 (9)	699 (9)	727 (9)
Foundry	87(12)	82(13)	76 (13)
Iron & steel	227 (8)	215 (8)	282 (8)

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 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 over 8.7 million tonnes, located mainly in China (38%), USA (31%), Chile (13%), Canada (5%), besides Armenia, Russia, Peru and Mexico (Table-4).

The world production of molybdenum in terms of metal increased to 2.31 lakh tonnes in 2009 from 2.23 lakh tonnes in the previous year. China, USA and Chile together accounted for about 77% of world production (Table-5).

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

(In '000 tonnes of molybdenum content)	
Country	Reserves
World: Total (rounded)	8700
Armenia	200
Canada	450
Chile	1100
China	3300
Iran	50
Kazakhstan	130
Kyrgyzstan	100
Mexico	135
Mongolia	100
Peru	140
Russia ^(e)	240
USA	2700
Uzbekistan ^(e)	60

Source: Mineral Commodity Summaries, 2010.

MOLYBDENUM

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

(In tonnes of metal content)

Country	2007	2008	2009
World: Total	221000	223000	231000
Armenia	4385	4472	4365
Canada	6819	8229	9210
Chile	44775	33639	34786
China	67700	81000	93500
Mexico	6491	7812	10167
Peru	16787	16721	12295
Russia	4800	4800	4800 ^(e)
USA	57000	55900	50000 ^(e)
Other countries	12243	10427	11877

Source: World Mineral Production, 2005-2009.

In North America, most Canadian Molybdenum reserves are porphyry molybdenum and porphyry copper-molybdenum. The La Caridad was a leading producer.

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

Australia

In December 2008, drilling intersected significant molybdenum-rhenium mineralisation representing a new discovery - now known as the Merlin deposit.

Canada

TCMC was expected to complete expansion of Endako Mine by the end of 2011. The expansion project includes construction of a new mill also and would raise the existing 31,000 tpd ore processing capacity to 55,000 tpd. Annual production was expected to be around 6,800-7,260 tonnes of molybdenum. Taseko Mines Ltd announced expansion and modernisation of its Gibraltar Mine in British Columbia by the last quarter of 2010 to raise the production of molybdenum to 635 tpy from 285 tonnes at present.

Chile

In Chile and the rest of Latin America, molybdenum is produced solely as a by-product of copper mining. Apart from Codelco's (a state owned copper producer) four operating divisions-Norte (Chuquicamata), Salvador, El Teniente and Andina - other Chilean mines, produce significant molybdenum as a by-product. They include Los Pelambres (Antofagasta Plc), and Collahuasi (Xstrata Plc and Anglo American Plc).

China

It is the world's largest producer of molybdenum. Three of the six largest molybdenum mines in the world are located in China. Luanchuan in Henan Province, Daheishan in Jilin Province and Jinduicheng in Shanxi Province. Jinduicheng Molybdenum Group (JDC), China Molybdenum Co., Luoyang Luanchuan Molybdenum Group Co. Ltd and Huludao Lianshan Molybdenum Co. are the major molybdenum enterprises which contribute about two thirds of China's total production and possess more than 30% of world resources.

USA

There were nine producing mines: one primary mine each in Colorado (Henderson), Idaho (Thompson Creek) 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 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 2020.

FOREIGN TRADE

Exports

Exports of molybdenum ores & concentrates declined to 9,056 tonnes in 2009-10 from 29,784 tonnes in the previous year. In 2009-10 exports were mainly to UAE (99%). Exports of molybdenum and scrap decreased to 7 tonnes in 2009-10 from 17 tonnes in 2008-09. Exports were mainly to Poland and UAE (Tables - 6 and 7).

Imports

Imports of molybdenum ores & conc. were 3,751 tonnes in 2009-10 compared to 2,559 tonnes in the previous year. Imports were mainly from Chile (33%), USA (18%), Netherlands (15%) and Canada (8%). Imports of molybdenum and scrap decreased to 297 tonnes in 2009-10 from 420 tonnes in the previous year. China (64%) and Austria were the main suppliers (Tables- 8 and 9).

MOLYBDENUM

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

Country	2008-09		2009-10	
	Qty (t)	Value (Rs. '000)	Qty (t)	Value (Rs. '000)
All Countries	29784	162824	9056	33227
Netherlands	8	1419	23	24139
UAE	54	1327	9000	6961
Bangladesh	–	–	6	1407
Israel	–	–	20	652
Maldives	–	–	1	43
UK	–	–	6	24
China	26133	152159	–	–
Germany	3514	3914	–	–
Vietnam	75	4005	–	–
Other countries	–	–	++	1

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

Country	2008-09		2009-10	
	Qty (t)	Value (Rs. '000)	Qty (t)	Value (Rs. '000)
All Countries	17	56201	7	39440
Poland	4	15353	4	19818
UK	–	–	++	2507
Brazil	++	1575	++	1934
Austria	8	17511	++	1479
Argentina	++	2345	++	1346
Egypt	1	2337	++	1261
Iran	++	949	++	1122
USA	1	1967	++	1120
Singapore	++	2581	++	862
UAE	3	6106	3	625
Other countries	++	5477	++	7366

MOLYBDENUM

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

Country	2008-09		2009-10	
	Qty (t)	Value (Rs. '000)	Qty (t)	Value (Rs. '000)
All Countries	2559	4597646	3751	3336296
Chile	721	1504999	1248	1146953
USA	240	385334	673	654709
Netherlands	300	371758	545	404929
Canada	74	121349	307	257592
Thailand	–	–	130	175318
China	317	699341	121	151937
Belgium	132	120959	155	136321
Germany	55	47633	240	89731
Korea, Rep. of	387	777595	50	54670
Mongolia	129	218192	–	–
Other countries	204	350486	282	264136

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

Country	2008-09		2009-10	
	Qty (t)	Value (Rs. '000)	Qty (t)	Value (Rs. '000)
All Countries	420	1284932	297	664803
China	310	930164	191	366195
Austria	39	81394	49	134707
USA	28	113329	18	48045
Japan	3	14597	13	42924
Germany	15	58566	12	36203
Australia	++	266	1	7049
Canada	2	1750	5	5522
UK	2	12398	1	5062
Netherlands	14	43737	1	1328
Singapore	5	14972	++	560
Other Countries	2	13759	6	17208

FUTURE OUTLOOK

The main end-use of molybdenum is in steel making. The principal use for molybdenum will continue 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, internal demand for molybdenum will continue to be met through imports.