

58 Molybdenum

Molybdenum is a refractory metal used principally as an alloying agent in steel, cast iron and 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. Malanjhand 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 total resources of molybdenum ore in the country as on 1.4.2005 are estimated at about 19.29 million tonnes containing about 12,640 tonnes MoS_2 . Of these, 1.5 million tonnes are in reserves category and 17.79 million tonnes in resources category. Molybdenum resources are mainly located in Tamil Nadu (9.97 million tonnes), Madhya Pradesh (8 million tonnes) and Karnataka (1.32 million tonnes) (Table-1).

EXPLORATION & DEVELOPMENT

During 2006-07 and 2007-08, GSI undertook the investigation for molybdenum and associated rare earth elements and recorded sporadic mineralisation of molybdenum along a North-South trending shear zone in Kanigiri granite near Devangnar, Prakasam district, Andhra Pradesh. Out of 25 samples, three samples have indicated 45.49, 47.05 and 105.40 ppm molybdenum.

MINING

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

INDUSTRY AND CONSUMPTION

Molybdenum is a versatile alloying agent for alloy steel, cast iron, nickel, cobalt and titanium alloys. It is used in different proportions for imparting desired properties, such as increased strength, hardness, 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 resistant 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. Potential substitutes for molybdenum include chromium, vanadium, columbium and boron in alloy steels and tungsten in tool steels.

Usually, molybdenum is used in the form of roasted concentrates, oxide or ferromolybdenum in the defence industries. HCL has installed a pilot plant for producing molybdenum concentrates from copper ore containing 0.3% Mo

MOLYBDENUM

**Table - 1 : Reserve/Resources of Molybdenum as on 1.4.2005
(By Grades/States)**

(In tonnes)

Grade/State	Reserves		Remaining resources					Total resources (A+B)
	Probable STD121	Total (A)	Pre-feasibility STD222	Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	
All India : Total								
Ore	1500000	1500000	425180	36000	569304	15266248	1490000	17786732
Contained MoS ₂	1050	1050	128	83	287	10049	1043	11590
By States								
Karnataka								
Ore	-	-	-	-	-	1320900	-	1320900
Contained MoS ₂	-	-	-	-	-	1719	-	1719
Madhya Pradesh								
Ore	-	-	-	-	-	8000000	-	8000000
Contained MoS ₂	-	-	-	-	-	5020	-	5020
Tamil Nadu								
Ore	1500000	1500000	425180	36000	569304	5945348	1490000	8465832
Contained MoS ₂	1050	1050	128	83	287	3310	1043	4851

Figures rounded off.

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 decreased slightly from 3,120 tonnes in 2006-07 to 2,899 tonnes in 2007-2008. The consumption of ferro-molybdenum in 2007-08 increased slightly to 940 tonnes from 907 tonnes in 2006-07. Alloy steel industry alone accounted for about 67% consumption followed by iron & steel (24%) and foundry (9%). 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 2003-04 to 2007-08

(In tonnes)	
Year	Production
2003-04	2949
2004-05	2864
2005-06	2827
2006-07	3120
2007-08	2899

Source : Indian Ferro Alloys Producers' Association.

Table - 3 : Reported Consumption of Ferro-molybdenum, 2005-06 to 2007-08 (By Industries)

(In tonnes)			
Industry	2005-06(R)	2006-07	2007-08(p)
All Industries	888	907	940
Alloy steel	626 (10)	626 (10)	626 (10)
Foundry	69 (11)	82 (12)	87 (12)
Iron & steel	193 (8)	199 (9)	227 (9)

Figures rounded off

Data collected on non-statutory basis.

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

WORLD REVIEW

The world reserve base of molybdenum was over 19 million tonnes, located mainly in China (39%), USA (31%), Chile (13%), Canada (5%), besides Armenia, Russia, Peru and Mexico (Table-4).

The world production of molybdenum metal increased to 1.93 lakh tonnes in 2007 from 1.89 lakh tonnes in previous year. China, USA and Chile together accounted for about 76% of world production (Table-5).

In 2006, world demand for molybdenum grew by about 5% to about 196,000 tonnes. The USA, Japan, Germany and China are the largest markets, accounting for about 50% of world demand.

Australia

Thor Mining Plc completed feasibility study for its 100% owned molyhill Molybdenum-tungsten project in Australia's Northern Territory. This project is based on open pit operation and 400,000 tpy processing plant. Moly Mines Ltd of Australia's Spinifex Ridge molybdenum-copper project was to start plant operations in July 2009. The project has 20 million tpy open pit mine and concentrator, capable of about 11,000 tpy molybdenum in concentrate and 12,250 tpy copper in concentrate in the initial decade of production.

Table - 4 : World Resources of Molybdenum (By Principal Countries)

(In '000 tonnes)	
Country	Reserve base
World : Total (rounded)	19000
Armenia	400
Canada	910
Chile	2500
China	8300
Iran	140
Kazakhstan	200
Kyrgyzstan	180
Mexico	230
Mongolia	50
Peru	230
Russia ^(e)	360
USA	5400
Uzbekistan ^(e)	150

Source: Mineral Commodity Summaries, 2008.

MOLYBDENUM

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

(In tonnes of metal content)

Country	2005	2006	2007
World : Total	188000	189000	193000
Armenia	3030	4090	4295
Canada	7935	7723	6841
Chile	47885	43158	41528
China ^(e)	40000	43900	46000
Mexico	4245	2519	6491
Peru	17325	17209	16781
Russia	4800	4800	4800 ^(e)
USA	58000	59800	59400 ^(e)
Other countries	4780	5801	6864

Source: World Mineral Production, 2003-2007.

Canada

Thompson Creek Metals Co. Inc (TMC) has plans to develop the Davidson deposits in British Columbia as an underground mine, and expects to produce around 2,000 tpy from 2009. Adanac Molybdenum Corp has announced Ruby Creek low grade molybdenum project in Atlin, British Columbia, with an annual processing of 7.6 million tonnes. The plant will mill about 157 million tonnes averaging 0.058% Mo.

Chile

In Chile and the rest of Latin America, molybdenum is produced solely as a by-product of copper mining. Almost all Chile's production of molybdenum is exported. 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). They produced about 9,800 tonnes and 3,400 tonnes of molybdenum in concentrate, respectively, in 2006. A new molybdenum plant

at Collahuasi will be capable of producing 12,000 tpy of molybdenum in concentrate.

China

It is the world's third 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.

China's largest producer JDC produces about 1,200 tpy of molybdenum.

Peru

In Peru, output of molybdenum at Phelps Dodge's Cerro Verde mine was expected to reach 3,650 tpy by 2007.

USA

There were nine producing mines: one primary mine each in Colorado (Henderson), Idaho (Thompson Creek) and New Mexico (Questa) and six by-product producers in Arizona (Sierrita & Bagdad), Utah (Bingham Canyon) and one each in Montana, New Mexico, (Chino) and Nevada (Robinson). There are plans to reopen the Climax mine in Colorado at the end of 2009 through its Phelps Dodge Mining Corporation's (PDMC) subsidiary, Quadra Mining Ltd. The company which also acquired Robinson copper mine in Nevada in 2004, produced 109 tonnes molybdenum in 2006 for the first time.

Molycorp operates the Questa underground mine in New Mexico using block caving techniques. There are sufficient resources to last at least another 50 years.

MOLYBDENUM

FOREIGN TRADE

Exports

Exports of molybdenum ores & conc. decreased sharply to 33 tonnes in 2007-08 from 4,712 tonnes in the previous year. Exports were to Vietnam in 2007-08. Exports of molybdenum and scrap decreased marginally to 11 tonnes in 2007-08 from 13 tonnes in 2006-07. Exports were mainly to Poland, Iran and Ukraine (Tables - 6 and 7).

Imports

Imports of molybdenum ores and conc. decreased to 2,783 tonnes in 2007-08 from 3,968 tonnes in the previous year. Imports were mainly from China (30%), Chile (28%), USA (10%) and Rep. of Korea and Netherlands (9% each). Imports of molybdenum and scrap increased slightly to 385 tonnes in 2007-08 from 221 tonnes in the previous year. China, USA and Austria were the main suppliers (Tables - 8 and 9).

Table - 6 : Exports of Molybdenum Ores & Conc. (By Countries)

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	4712	53529	33	3048
Vietnam	110	3520	33	3048
China	4600	49910	-	-
Malaysia	2	99	-	-

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

Country	2006-07		2007-08	
	Qty. (t)	Value (Rs. '000)	Qty. (t)	Value (Rs. '000)
All Countries	13	55920	11	38578
Poland	2	5584	3	6753
Iran	2	7894	2	5775
Ukraine	1	5796	2	4371
Egypt	1	2863	1	3104
Argentina	1	5113	1	2956
UAE	1	3167	1	2922
Singapore	++	488	1	2105
USA	1	7039	++	1784
Japan	++	935	++	1766
France	1	2136	++	748
Other countries	3	14905	++	6294

Table - 8 : Imports of Molybdenum Ores & Conc. (By Countries)

Country	2006-07		2007-08	
	Qty. (t)	Value (Rs. '000)	Qty. (t)	Value (Rs. '000)
All Countries	3968	7825021	2783	6340190
China	1358	2834424	840	1827376
Chile	516	970486	771	1769281
Netherlands	525	1028994	234	613174
USA	868	1774565	277	603916
Korea, Rep. of	278	490904	240	587681
Belgium	152	240438	60	143376
Iran	1	4824	53	135171
Mongolia	16	17848	63	129268
Mexico	57	125367	35	83143
Canada	71	129994	27	50394
Other countries	126	207177	183	397410

MOLYBDENUM

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

Country	2006-07		2007-08	
	Qty. (t)	Value (Rs. '000)	Qty. (t)	Value (Rs. '000)
All Countries	221	752997	385	1211521
Austria	34	123500	22	95857
Belgium	1	1801	10	28386
China	130	415210	299	885125
Germany	12	44235	11	53541
Hong Kong	1	4625	++	493
Hungary	++	2528	++	2556
Japan	2	9539	4	16992
Netherlands	3	10432	7	18597
UK	2	11114	2	7509
USA	34	123138	28	94249
Other countries	2	6875	2	8216

FUTURE OUTLOOK

There are abundant resources and adequate production capabilities in China, Chile, USA and other countries. Therefore, the future requirement for molybdenum can be readily met by world producers. The main end-use of molybdenum is in steel making. The iron and steel industry accounts for about 75% molybdenum consumption in the world of which 30-35% is in stainless steel sector, 15% in alloy steel, 10% in tool & high-speed steel, 9% in high-strength low-alloy steel and rest in carbon 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. Recovery of molybdenum from spent catalysts is increasing world over due to environmental legislation that prevents disposal of such catalysts. The supply of molybdenum is increasingly in form of recovered 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.