

MOLYBDENUM



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**MOLYBDENUM**

(FINAL RELEASE)

**GOVERNMENT OF INDIA  
MINISTRY OF MINES  
INDIAN BUREAU OF MINES**

Indira Bhavan, Civil Lines,  
NAGPUR – 440 001

PHONE/FAX NO. (0712) 2565471  
PBX : (0712) 2562649, 2560544, 2560648  
E-MAIL : [cme@ibm.gov.in](mailto:cme@ibm.gov.in)  
Website: [www.ibm.gov.in](http://www.ibm.gov.in)

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# 11 Molybdenum

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**M**olybdenum (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 ( $\text{MoS}_2$ ) 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.

## RESERVES/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. 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 NMI database, based on UNFC System, the resources of molybdenum ore in the country as on 1.4.2015 have been estimated at 19.37 million tonnes containing about 12,668 tonnes  $\text{MoS}_2$ . The above resources of ore are located in Tamil Nadu (10 million tonnes), Madhya Pradesh (8 million tonnes) and Karnataka (1.32 million tonnes) (Table-1).

## EXPLORATION & DEVELOPMENT

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

## 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. Molybdenum plays a vital role in the energy industry and it may become an increasingly essential factor in green technology.

## MINING

Molybdenum concentrate is produced intermittently from uranium ore at Jaduguda mine of UCIL.

## 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; graphite, tungsten and tantalum for refractory materials in high temperature electric furnaces and chrome-orange, cadmium-red and organic-orange pigments for molybdenum orange.

MOLYBDENUM

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

(In tonnes)

Grade/State	Reserves		Remaining Resources					Total Resources (A+B)
	Total (A)		Pre-feasibility STD221	Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	
<b>All India : Total</b>								
Ore	-	1500000	36000	17098594	167800	19371698	19371698	19371698
Contained MoS <sub>2</sub>	-	1050	83	11198.03	50.34	12668.37	12668.37	12668.37
<b>By States</b>								
<b>Karnataka</b>								
Ore	-	-	-	1320900	-	1320900	1320900	1320900
Contained MoS <sub>2</sub>	-	-	-	1718.7	-	1718.7	1718.7	1718.7
<b>Madhya Pradesh</b>								
Ore	-	-	-	8000000	-	8000000	8000000	8000000
Contained MoS <sub>2</sub>	-	-	-	5020	-	5020	5020	5020
<b>Tamil Nadu</b>								
Ore	-	1500000	36000	7777694	167800	10050798	10050798	10050798
Contained MoS <sub>2</sub>	-	1050	83	4459.33	50.34	5929.67	5929.67	5929.67

Figures rounded off.

## 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 mine is not found economical.

Molybdenum is used chiefly in the form of ferro-molybdenum. The production of ferro-molybdenum increased from 1,459 tonnes in 2015-16 to 1,603 tonnes in 2016-17 (Table-2).

Consumption of ferro-molybdenum for the years 2013-14 to 2015-16 (by industries) is given in Table-3. Alloy steel industry alone accounted for about 66% consumption followed by iron & steel (29%) and foundry (4%).

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 2012-13 to 2016-17**

(In tonnes)

Year	Production
2012-13	1076
2013-14	1231
2014-15	1295
2015-16	1459
2016-17 (P)	1603

*Source: Monthly Statistics of Mineral Production, March 2017, IBM.*

## TRADE POLICY

As per Foreign Trade Policy, 2015-2020, imports of molybdenum ores & concentrates under Exim code 2613 and molybdenum & articles thereof under Exim code 8102 are allowed free, except molybdenum waste & scrap (under ITC-HS Code No. 8102 9700) which are restricted.

**Table – 3 : Consumption\* of Ferro-molybdenum, 2013-14 to 2015-16 (By Industries)**

(In tonnes)

Industry	2013-14	2014-15	2015-16 (P)
<b>All Industries</b>	<b>672</b>	<b>708</b>	<b>1449</b>
Alloy steel	435	472	950
Electrode	20	17	17
Foundry	57	59	59
Iron & steel	160	160	423

(\* Includes actual reported consumption and/or estimates made wherever required and due to paucity of data, coverage may not be completed).

## WORLD REVIEW

The world reserves of molybdenum are 17 million tonnes, located mainly in China (49%), USA (16%), Peru (13%), Chile (11%) and Russia (6%) (Table-4).

The world mine production of molybdenum in terms of metal content decreased to 2.76 lakh tonnes in 2016 from 2.88 lakh tonnes in 2015. China with 47% production was the main producer of molybdenum in the world followed by Chile (20%), USA (11%), Peru (9%) and Mexico (4%) in 2016 (Table-5).

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

(In '000 tonnes of molybdenum content)

Country	Reserves
<b>World: Total (rounded)</b>	<b>17000</b>
Armenia	150
Argentina	100
Canada	150
Chile	1800
China <sup>(e)</sup>	8300
Iran	43
Mexico	130
Mongolia	160
Peru	2200
Russia <sup>(e)</sup>	1000
Turkey	100
USA	2700
Uzbekistan <sup>(e)</sup>	60

*Source: Mineral Commodity Summaries, 2018.*

MOLYBDENUM

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

Country	(In tonnes of metal content)		
	2014	2015	2016
<b>World: Total (rounded)</b>	<b>303000</b>	<b>288000</b>	<b>276000</b>
Armenia	6022	5324	5438
Canada	8681	1983	2764
Chile	48898	52398	55834
China	128538	135000	129150
Iran	4000	6705	6500 <sup>e</sup>
Mexico	14370	11327	11896
Peru	17000	20153	25757
Russia	3114	3254	3300 <sup>e</sup>
USA	68200	47400	31600 <sup>e</sup>
Other countries	4108	4491	3591

Source: World Mineral Production, 2012-16.

### Canada

At its Gibraltar Mine in south-central British Columbia, Taseko Mines Ltd produced 437 tonnes of molybdenum in 2015, a 59% decrease from the 1,057 tonnes of molybdenum produced in 2014. Molybdenum production decreased because the company idled its molybdenum circuit at the end of July. There was no molybdenum production in the fourth quarter of 2015.

### Chile

Antofagasta plc (London, United Kingdom) announced that in 2015, by-product molybdenum production at its Los Pelambres Mine was 10,100 tonnes, a 28% increase compared with 7,900 tonnes of molybdenum produced in 2014. Antofagasta anticipated 2016 molybdenum production to be approximately 8,000 to 9,000 tonnes. Antofagasta also announced that it was constructing a new molybdenum plant at Centinela. The feasibility study was ongoing in 2015 and the project was delayed to preserve cash in 2016. The new plant was expected to produce approximately 2,400 tonnes per year of molybdenum concentrate and was expected to be completed in 2017.

CODELCO, the state-controlled copper and molybdenum producer, announced that it produced 27,700 tonnes of molybdenum in 2015 compared with 30,600 tonnes in 2014. CODELCO

attributed the 10% decrease in molybdenum production to lower output from the Chuquicamata Division. The Chuquicamata open pit mine produced 12,640 tonnes of molybdenum in 2015, a 14% decrease compared with the 14,620 tonnes of molybdenum produced in 2014.

CODELCO, through its subsidiary MOLYB Ltd, continued building its molybdenum concentrate treatment plant, located in Mejillones, Antofagasta Region. The plant was scheduled to begin operations in the second half of 2016 and was expected to produce 16,500 tonnes per year of molybdenum trioxide and 30,000 tonnes per year of sulphuric acid. It was also expected to produce rhenium as a by-product.

The Sierra Gorda project, in the Antofagasta Region in northern Chile, was a joint venture among KGHM International Ltd, Sumitomo Metal Mining Co., Ltd, and Sumitomo Corp. under the company Sierra Gorda SCM. The Sierra Gorda Mine produced 7,000 tonnes of molybdenum concentrate in 2015. The company expected to complete a ramp up phase in 2016 and was expected to produce between 18,100 and 22,600 tonnes per year of molybdenum concentrate.

### China

Liaoning Hongda Molybdenum Industry Co. Ltd suspended all molybdenum production in 2015. Inner

Mongolia Zhongxi Mining Co. Ltd announced a 2,000 tonnes decrease in production of molybdenum concentrate during the first 3 quarters of 2015. This was offset by Yichun Luming molybdenum mine increasing its production by 12,000 tonnes. Jinduicheng Molybdenum Co. Ltd (JDC) and China Molybdenum Co., Ltd both announced that their 2015 molybdenum production levels remained unchanged from 2014 levels. JDC operated the Jinduicheng open pit molybdenum mine, two concentrators, one smelter, and two processing plants in Jinduicheng, Hua County, in northwest Shaanxi Province.

## Mexico

Southern Copper Corp. reported that its La Caridad Mine, in northeastern Sonora, produced 10,040 tonnes of molybdenum concentrate in 2015 compared with 10,800 tonnes of molybdenum concentrate in 2014. Southern Copper also announced that the new coppermolybdenum concentrator at its Buenavista Mine was expected to reach full capacity in the second quarter of 2016. The concentrator has a production capacity of 188,000 tonnes per year of copper and 2,600 tonnes per year of molybdenum concentrate. The Buenavista Mine is located 40 kilometers (km) south of the Arizona U.S.- Mexican border.

## Peru

The Cerro Verde Mine of FCX is an open pit copper and molybdenum mining complex, 16 km southwest of Arequipa. The Cerro Verde expansion project commenced operations in September 2015. The project expanded the concentrator facilities to a capacity of approximately 6,800 tonnes per year of molybdenum concentrate. Production in 2015 was approximately 3,200 tonnes of molybdenum concentrate compared with 5,000 tonnes in 2014.

Southern Copper's Toquepala Mine, located in southern Peru, 870 km from Lima, produced 7,923 tonnes of molybdenum concentrate in 2015 compared with 7,000 tonnes of molybdenum concentrate in 2014. Southern Copper announced that the construction permit for the Toquepala expansion project was approved in April. The Toquepala expansion project was expected to increase annual molybdenum production by 3,100 tonnes in 2018. Southern Copper's Cuajone Mine in southern Peru produced 4,440 tonnes of molybdenum concentrate in 2015 compared with 4,000 tonnes of molybdenum concentrate in 2014.

## FOREIGN TRADE

### Exports

Exports of molybdenum ores & concentrates decreased to 22 tonnes in 2016-17 from 45 tonnes in 2015-16. Exports were solely to Oman. Exports of molybdenum and scrap remained static to 12 tonnes in 2016-17 & 2015-16 and the export was mainly to Iran (25%) (Tables-6 & 7).

### Imports

Imports of molybdenum ores & concentrates decreased slightly to 7,139 tonnes in 2016-17 from 7,511 tonnes in 2015-16. Imports were mainly from Chile (32%), Thailand (22%), Mexico (13%) and USA (8%). Imports of molybdenum and scrap increased marginally to 398 tonnes in 2016-17 from 351 tonnes in the 2015-16. Imports were mainly from China (74%), Austria (11%), USA (7%) and Korea, Rep. of (5%) (Tables- 8 & 9).

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

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value ('000)	Qty (t)	Value ('000)
<b>All Countries</b>	<b>45</b>	<b>2199</b>	<b>22</b>	<b>1005</b>
Oman	45	2198	22	1004
UK	++	1	++	1

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

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value ('000)	Qty (t)	Value ('000)
<b>All Countries</b>	<b>12</b>	<b>152053</b>	<b>12</b>	<b>143814</b>
Germany	1	33078	1	32032
Japan	1	18230	1	26325
USA	2	18975	1	11165
Italy	1	17491	++	10524
Austria	1	15739	1	9165
Singapore	++	12853	++	9076
Iran	++	853	3	7670
Poland	1	7668	1	7179
Belgium	1	6681	1	6666
Philippines	-	-	++	3777
Other countries	4	20485	3	20235

## MOLYBDENUM

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

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
<b>All Countries</b>	<b>7511</b>	<b>4903721</b>	<b>7139</b>	<b>5442499</b>
Chile	3682	2145557	2274	1748715
Thailand	1399	1149674	1541	1323969
Mexico	821	491385	910	605988
USA	575	415476	578	399108
Netherlands	345	220820	421	375147
Korea, Rep. of	227	180572	513	345157
Iran	25	17516	254	252403
Belgium	163	117530	245	190455
China	74	57663	90	76895
Vietnam	40	19952	94	47753
Other countries	160	87576	219	76909

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

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
<b>All Countries</b>	<b>351</b>	<b>1148230</b>	<b>398</b>	<b>1104069</b>
China	254	721187	294	724047
Austria	50	252263	44	208529
USA	30	109368	26	95963
Germany	6	24163	3	17350
Korea, Rep. of	++	121	21	14932
Hong Kong	1	7753	3	12763
Singapore	++	707	2	11176
UK	6	12676	3	6864
France	1	3095	1	4727
Hungary	++	5304	++	2019
Other countries	3	11593	1	5699

## **FUTURE OUTLOOK**

The principal uses of molybdenum in chemical applications and as catalyst and as an additive in steel manufacturing, most importantly alloy and stainless steel, are expected to continue. Molybdenum plays a vital role in the energy industry and it may become increasingly important factor in environment protection technology, where it is used in high strength steels for automobiles to reduce weight and improve fuel economy and safety. Molybdenum-based catalysts have a number of

important applications in Petroleum and Plastic Industries.

A major use is in the hydrodesulfurization of petroleum, petrochemicals and coal-derived liquids. Production of ultra-low-sulfur diesel fuels is expected to more than double the amount of molybdenum used in oil refineries. Molybdenum not only allows for economical fuel refining, it also contributes to a safer environment through lower sulfur emissions. Analysts expect global demand for catalysts to continue to increase as there are no practical alternatives to molybdenum in many of its catalytic applications.