

MOLYBDENUM



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60th Edition

MOLYBDENUM

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**GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU 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 resistivity to wear & corrosion. 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.

RESERVES/RESOURCES

India though is endowed with rich mineral wealth, there are several critical minerals that it lacks 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. Malanjkhanda 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 as on 1.4.2020, based on UNFC System, the resources of molybdenum ore in the country have been estimated at 27.20 million tonnes containing about 16,891 tonnes MoS_2 . The above resources of ore are located in Tamil Nadu (17.88 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 covered in the Review on "Exploration & Development" under "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 molybdenic 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.

SUBSTITUTES

There is hardly any substitution for molybdenum in its major application, viz, as an alloying element in steel and cast irons. Owing to the non-availability of molybdenum, there was an apparent need to develop new materials that could be a suitable substitute vis-a-vis 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.

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Table – 1 : Reserves/Resources of Molybdenum as on 1.4.2020 (P)
(By Grades/States)

(In tonnes)

Grades/States	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	2382000	3269204	19884394	167800	27203398	27203398
Contained MoS₂	-	1050	1599.54	1733.29	12457.39	50.34	16890.56	16890.56
By States								
Karnataka								
Ore	-	-	-	-	1320900	-	1320900	1320900
Contained MoS ₂	-	-	-	-	1718.7	-	1718.7	1718.7
Madhya Pradesh								
Ore	-	-	-	-	8000000	-	8000000	8000000
Contained MoS ₂	-	-	-	-	5020	-	5020	5020
Tamil Nadu								
Ore	-	1500000	2382000	3269204	10563494	167800	17882498	17882498
Contained MoS ₂	-	1050	1599.54	1733.29	5718.69	50.34	10151.86	10151.86

Figures rounded off

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INDUSTRY AND CONSUMPTION

Usually, molybdenum is used in the form of roasted concentrates, oxide or ferro-molybdenum in the Defence industries. The production of ferro-molybdenum decreased from 527 tonnes in 2019-20 to 428 tonnes in 2020-21 (Table-2).

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, has been undertaking basic research on recovery of molybdenum from spent catalysts.

**Table – 2 : Production of Ferromolybdenum
2016-17 to 2020-21**

(In tonnes)	
Year	Production
2016-17	1603
2017-18	1205
2018-19	1003
2019-20(R)	527
2020-21(P)	428

Source: Monthly Statistics of Mineral Production, March, 2021, IBM

Moly Metal LLP, a leading manufacturer of Molybdenum alloys ferromolybdenum (FeMo) and molybdenum disulphide (MoS₂), commenced production in 2007 at a new manufacturing plant in the U.T. of Daman. RUBAMIN, a Gujarat-based Company, reportedly has a capacity of 1,500 tonnes per annum sodium molybdate and 800 tonnes per annum ammonium molybdate both of which are derivatives of molybdenum.

TRADE POLICY

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

WORLD REVIEW

The world reserves of molybdenum are at 18 million tonnes, located mainly in China (52%), USA (17%), Peru (14%), Chile (9%) and Russia (3%) (Table-3).

**Table– 3 : World Reserves of Molybdenum
(By Principal Countries)**

(In '000 tonnes of molybdenum content)

Country	Reserves
World: Total (rounded off)	16000
Argentina ^(e)	100
Armenia ^(e)	150
Canada	96
Chile	1400
China ^(e)	8300
Iran ^(e)	43
Mexico	130
Mongolia	NA
Peru	2300
Russia ^(e)	430
Turkey ^(e)	360
USA	2700
Uzbekistan ^(e)	60

Source: USGS, Mineral Commodity Summaries, 2022.

The world mine production of molybdenum in terms of metal content increased marginally by 4% to 2.97 lakh tonnes in 2020 from 2.85 lakh tonnes in 2019. China with 35% production was the main producer of molybdenum in the world followed by Chile (20%), USA (17%), Peru (11%) and Mexico (6%) (Table-4).

**Table-4: World Mine Production of Molybdenum
(By Principal Countries)**

(In tonnes of metal content)

Country	2018	2019	2020
World: Total (rounded off)	289000	285000	297000
China	113308	104435	105000
Chile	60248	53541	59319
USA	41400	48000	51100
Peru	28034	30441	32185
Mexico	20265	21694	18562
Iran ^(a)	7662	8711 ^(e)	8700
Armenia	5666	7360	12691
Canada	5036	3955	2671
Mongolia	2579	2492	2889
Other countries	5227	4345	4244

Source: BGS World Mineral Production, 2016-20, (a) years ended 20th March following that stated.

To give a generalised view of the development in various countries, the countrywise description sourced from available publication, i.e., Minerals Yearbook of USGS, 2018 is furnished below.

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Canada

Teck Resources Ltd announced that its Highland Valley Mine in south-central British Columbia produced 3,900 tonnes of molybdenum in concentrate in 2018, about 7% decrease from the 4,200 tonnes produced in 2017. The Company attributed the decrease to lower ore grades.

At its Gibraltar Mine in south-central British Columbia, Taseko Mines Ltd produced 1,070 tonnes of molybdenum, about 11% decrease from the record 1,200 tonnes of molybdenum in concentrate produced in 2017.

Chile

Amerigo Resources Ltd (Canada) reported that it produced 860 tonnes of molybdenum in 2018, compared with 730 tonnes of molybdenum in 2017 at its Minera Valle Central processing facility in central Chile. Amerigo forecast production of 1,100 tonnes of molybdenum in 2019.

Antofagasta plc (United Kingdom) announced that by-product molybdenum production at its 60% owned Los Pelambres Mine was 13,300 tonnes in 2018 a 27% increase compared with 10,500 tonnes produced in 2017. Antofagasta also announced that its new molybdenum plant at the 70% owned Centinela Mine produced 300 tonnes of molybdenum in concentrate in 2018. The Centinela molybdenum plant started production in the third quarter of 2018 and had a capacity to produce an average of 2,400 tonnes per year of molybdenum in concentrate. The Centinela Mine is 1,350 kilometers north of Santiago in the Antofagasta Region. The company expected Centinela to produce approximately 2,000 tonnes of molybdenum in concentrate 2019. Corporacion Nacional del Cobre de Chile (CODELCO), the state-controlled copper and molybdenum producer, announced that it produced 24,000 tonnes of molybdenum in 2018 compared with 28,700 tonnes in 2017. The Sierra Gorda Mine produced 6,900 tonnes of molybdenum in concentrate in 2018, a decrease from 2017 molybdenum production. The company attributed the decrease to lower grade ore.

Mexico

Southern Copper Corp. (a subsidiary of Grupo Mexico S.A.B. de C.V.) reported that it produced 21,990 tonnes of molybdenum in concentrate in 2018,

a 3% increase from 21,330 tonnes in 2017, owing mainly to higher production at the Buenavista Mine. The Buenavista Mine produced 8,400 tonnes of molybdenum in concentrate in 2018 as compared with 3,460 tonnes in 2017. Southern Copper reported that its La Caridad Mine, in northeastern Sonoro, produced 9,800 tonnes of molybdenum in concentrate in 2018, compared with 9,900 tonnes in 2017. The molybdenum recovery plant had a capacity to process 2,000 tonnes per day of copper-molybdenum concentrates.

Peru

Teck announced that it produced 4,600 tonnes of molybdenum in concentrate in 2018 at its Antamina copper-zinc mine in Peru, 17% more than that in 2017. Copper, molybdenum and zinc production at Antamina can vary significantly from year to year owing to the geology of the deposit and proportion of copper to copper-zinc ore processed. The Cerro Verde Mine is an open pit copper and molybdenum mining complex with the production in 2018 was approximately 12,700 tonnes of molybdenum in concentrate as compared with 12,200 tonnes in 2017. Southern Copper produced 3,100 tonnes of molybdenum in concentrate at its Cujajone operation in 2018 as compared with 3,700 tonnes in 2017. Production at the Cujajone operation began in 2016.

China

China's molybdenum production took place predominantly in Hebei, Henan, and Shaanxi Provinces and the Nei Mongol Autonomous Region. China had a large number of small-scale mining operations that were susceptible to changes in prices and also were able to quickly increase or decrease production during price fluctuations. Environmental inspections at molybdenum mines and processing facilities continued in 2018 and disrupted production at a variety of molybdenum producers. Jiangxi Copper Co. Ltd, produced 7,500 tonnes of molybdenum concentrate in 2018, a 3% increase from 2017.

Jinduicheng Molybdenum Co.Ltd. announced that it was expected to produce 48,000 tonnes of 45% grade molybdenum concentrate in 2019 as compared with 47,500 tonnes in 2018. China announced that it was expected to impose a 5% tariff on imports of

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both roasted and unroasted molybdenum concentrates, effective September 24,2018.

Armenia

The Zangezur Copper-Molybdenum Combine continued to produce molybdenum at its Kajaran Mine. According to Cronimet Mining AG, the Kajaran Mine is the leading copper and molybdenum mine in Armenia. Zangezur's company shareholders are Cronimet Mining (60%), Pure Iron Plant OJSC (15%), Armenian Molybdenum Production Ltd (12.5%), and Zangezur Mining Ltd (12.5%).

FOREIGN TRADE

Exports

Exports of molybdenum ores & concentrates increased drastically to 45 tonnes in 2020-21 from 3 tonnes in 2019-20. Exports were solely to Korea, Rep of (89%) & Kenya (11%). Exports of molybdenum and scrap also increased sharply 45 % to 119 tonnes in 2020-21 from 82 tonnes in 2019-20. Exports were mainly to Germany (53%), Netherlands (19%), and Philippines (12%) (Tables-5 to 8).

Imports

Like exports, imports of molybdenum ores & concentrates increased by 16% to 9,177 tonnes in 2020-21 from 7,901 tonnes in 2019-20. Imports were mainly from Chile (39%), Thailand (22%), USA (14%) UAE (8%), Netherlands (7%). Imports of molybdenum and scrap decreased to 430 tonnes in 2020-21 from 429 tonnes in the 2019-20. Imports were mainly from China (75%), Austria (10%) and USA (5%) (Tables-9 to 13).

Table – 5 : Exports of Molybdenum Ores & Conc. (By Countries)

Country	2019-20(R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	3	3023	45	43181
Korea,Rep of	-	-	40	41622
Kenya	-	-	5	1559
UAE	3	3023	-	-

Figures rounded off.

Table – 6 : Exports of Molybdenum & Scrap (By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	82	122342	119	182537
Austria	3	40669	6	72646
Germany	10	11088	63	31197
China	1	12744	1	20820
USA	++	7658	2	11987
Malaysia	++	20	3	8698
Poland	1	4721	1	5219
Netherlands	60	14723	23	4400
Belgium	++	7067	++	4347
Egypt	++	1682	1	3978
Philippines	-	-	14	3081
Other countries	7	21970	5	16164

Figures rounded off.

Table – 7 : Exports of Molybdenum Powders. (By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	++	399	3	8907
Malaysia	++	20	3	8698
UAE	-	-	++	169
France	-	-	++	31
Egypt	-	-	++	9
Kazakhstan	++	++	++	++
UK	++	355	-	-
USA	++	24	-	-

Figures rounded off.

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**Table-8: Exports of Molybdenum: Worked
(By Countries)**

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	21	105744	18	152861
Austria	3	40669	6	72646
China	1	12744	1	20820
Germany	10	11088	2	17909
USA	++	7634	2	11987
Poland	1	4721	1	5219
Belgium	++	7067	++	4347
Egypt	++	1682	1	3969
Bangladesh	3	2840	1	2799
Japan	++	2265	++	2582
France	++	912	++	2065
Other countries	3	14122	4	8518

Figures rounded off

**Table-9: Imports of Molybdenum Ores and Conc.
(By Countries)**

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	7901	9809780	9177	8848441
Chile	3328	3793869	3567	3190606
Thailand	2302	3230436	1977	2082011
USA	288	279469	1300	1302431
UAE	502	604464	756	748294
Netherlands	200	308666	622	597959
Korea	188	153457	274	317728
China	215	235472	150	146839
Switzerland	137	227884	95	137817
Belgium	104	110323	234	104372
Turkey	376	619472	62	85472
Other countries	261	246268	140	134912

Figures rounded off

**Table-10: Imports of Molybdenum & Scrap
(By Countries)**

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	429	1545908	430	1540722
China	340	1021928	323	964917
Austria	49	293674	45	293841
USA	19	123114	20	81188
Germany	9	36913	19	56291
Singapore	3	23532	4	38224
UK	7	20741	11	33882
Russia	++	1442	++	31267
France	++	6335	++	11125
Hong Kong	1	5486	2	10747
Japan	++	6495	++	6617
Other countries	1	6248	6	12623

Figures rounded off

**Table-11: Imports of Molybdenum Powders
(By Countries)**

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	15	79969	12	62407
USA	11	44841	8	32025
Singapore	3	22772	2	17840
Japan	++	5222	++	5539
Hong Kong	++	2364	++	2344
China	1	3062	1	1889
Belgium	++	1302	++	1538
Italy	-	-	1	947
Germany	++	41	++	241
Canada	-	-	++	44
UK	++	365	-	-

Figures rounded off

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**Table –12: Imports of Molybdenum :Worked
(By Countries)**

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	284	1109940	231	1047016
China	218	716313	140	540752
Austria	42	248529	45	293841
Germany	9	36484	19	56050
USA	8	78270	12	49146
UK	5	13793	11	33871
Russia	++	1442	++	31267
Singapore	++	760	2	20384
France	++	6335	++	11125
Hong Kong	1	2419	++	4522
Canada	++	2353	2	2950
Other countries	1	3242	++	3108

Figures rounded off

**Table –13: Imports of Molybdenum & Scrap
(By Countries)**

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	130	355999	187	431299
China	121	302553	182	422276
Netherlands	-	-	2	4130
Hong Kong	++	703	2	3881
UAE	-	-	1	454
Belgium	-	-	++	420
Italy	-	-	++	110
USA	++	3	++	17
UK	2	6583	++	11
Austria	7	45145	-	-
Japan	++	624	-	-
Other countries	++	388	-	-

Figures rounded off

FUTURE OUTLOOK

The principal uses for molybdenum are expected to continue to be as catalysts and in chemicals and as an additive in steel manufacturing, most importantly alloy and stainless steel. Molybdenum plays a vital role in the Energy Industry, and it may become an increasingly important factor in environmental 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 the Petroleum and Plastics industries. A major use is in the hydrodesulfurisation of petroleum, petrochemicals, and coal-derived liquids. Catalysts are estimated to account for more than 70% of chemical uses of molybdenum. Molybdenum not only allows for economical fuel refining, it also contributes to a safer environment through lowers sulphur emissions. Analysts expect global demand for molybdenum-based catalysts to continue its increasing trend as there are no practical alternatives to molybdenum in many of the catalytic applications. The need for companies to reduce carbon dioxide emissions from coal-fired power stations will

require plants to run at higher temperatures, resulting in greater demand for higher grade molybdenum-bearing steels. Increase in molybdenum use is expected to continue in stainless steels and full alloy steels mainly in the consumer product and transportation industries.

According to the International Molybdenum Association 2021/2022, SMR predicts that over the next 10 years the chemical processing industry and the oil and gas industry will be significant growth areas for molybdenum demand. Transport vehicle production with stainless steel bipolar plates (BPP) Containig 2% moly is forecasted to be the main technology in the future for hydrogen fuel cells. While these will be used in electric vehicles and buses, the main demand is expected to be in the truck sector,

There are many exciting opportunities on the horizon which are likely to lead to an increase in demand for molybdenum, for example, molybdenum alloying is particularly valuable to special steels used in wind power generation. Due to the growth of the sector and the increasing size and power output of wind turbines, such special steels are reaching high tonnages. The potential molybdenum use, based on likely wind power capacity scenarios, is estimated to amount to 300,000 metric tonnes by 2050.