

MOLYBDENUM



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MOLYBDENUM

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

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11 Molybdenum

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 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.

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	
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

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 increased from 428 tonnes in 2020-21 to 435 tonnes in 2021-22 (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
2017-18 to 2021-22**

(In tonnes)

Year	Production
2017-18	1205
2018-19	1003
2019-20	527
2020-21(P)	428
2021-22(P)	435

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 Union Territory 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 12 million tonnes, located mainly in China (31%), USA (22%), Peru (20%), Canada (11%) 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)	12000
China	3700
USA	2700
Peru	2400
Canada	1400
Russia	430
Turkey	360
Armenia	150
Mexico	130
Argentina	100
Chile	72
Iran	43
Korea.Rp.of	8
Mongolia	NA

Source: USGS, Mineral Commodity Summaries, 2023.

The world mine production of molybdenum in terms of metal content decreased marginally by 5% to 2.98 lakh tonnes in 2021 from 3.12 lakh tonnes in 2020. China with 44% production was the main producer of molybdenum in the world followed by Chile (17%), USA (14%), Peru (11%) and Mexico (5%) (Table-4).

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

(In tonnes of metal content)

Country	2019	2020	2021
World: Total (rounded off)	281000	312000	298000
China	104435	120000	130000
Chile	53541	59319	49403
USA	43600	51100	41100
Peru	30441	32185	34148
Mexico	21694	20577	16319
Armenia	7360	12691	11310
Iran ^(a)	8711	6762	*6800
Mongolia	2492	2889	2973
Canada	3955	2671	2023
Other countries	3702	4246	3843

Source: BGS World Mineral Production, 2017-21, (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.

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. Corporación 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 Sonora, 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 was negligible in 2021-22 from 45 tonnes in 2020-21. Exports were mainly to Mexico & South Africa. Exports of molybdenum and scrap also increased sharply 106 % to 365 tonnes in 2021-22 from 119 tonnes in 2020-21. Exports were mainly to Netherlands (83%), and Germany (14%) (Tables-5 to 8).

Imports

Imports of molybdenum ores & concentrates decreased by 1% to 9,114 tonnes in 2021-22 from 9117 tonnes in 2020-21. Imports were mainly from Chile (48%), Thailand (14%), UAE (12%), and Netherlands (8%). Imports of molybdenum and scrap increased to 554 tonnes in 2021-22 from 430 tonnes in 2020-21. Imports were mainly from China (58%), Austria (10%) and USA (10%) (Tables-9 to 13).

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

Country	2020-21(R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	45	43181	++	120
Mexico	-	-	++	90
South Africa	-	-	++	21
Austria	-	-	++	9
Korea,Rep of	40	41622	-	-
Kenya	5	1559	-	-

Figures rounded off.

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	119	182537	365	342257
Netherlands	23	4400	303	106840
Germany	63	31197	51	76887
Austria	6	72646	6	67219
China P RP	1	20820	1	30848
USA	2	11987	++	17583
Belgium	++	4347	1	9730
Brazil	++	1545	++	6379
Poland	1	5219	1	5718
Bangladesh Pr	1	2799	1	2799
Japan	++	2582	++	2249
Other countries	22	24995	1	16005

Figures rounded off.

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	3	8907	++	261
France	++	31	++	188
Egypt	++	9	++	69
Canada	-	-	++	4
Thailand	-	-	++	++
Malaysia	3	8698	-	-
UAE	++	169	-	-
Kazakhstan	++	++	-	-

Figures rounded off.

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	18	152861	14	208691
Austria	6	72646	6	67219
Germany	2	17909	3	50422
China P RP	1	20820	1	30848
USA	2	11987	++	17583
Belgium	++	4347	1	9730
Brazil	++	1545	++	6379
Poland	1	5219	1	5718
Bangladesh	1	2799	1	2799
Japan	++	2582	++	2249
Italy	++	150	++	2073
Other countries	5	12857	1	13671

Figures rounded off

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	9177	8848441	9114	15470962
Chile	3567	3190606	4376	6700724
Thailand	1977	2082011	1330	2677220
UAE	756	748294	1114	1999829
Netherlands	622	597959	734	1370753
USA	1300	1302431	877	1327059
China	150	146839	210	430143
Korea Rep.of	274	317728	172	415532
Luxembourg	-	-	138	259116
Switzerland	95	137817	53	138738
Germany	43	28603	72	45419
Other countries	393	296153	38	66429

Figures rounded off

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹000)	Qty (t)	Value (₹000)
All Countries	430	1540722	554	2453374
China	323	964917	324	1242523
Austria	45	293841	53	475271
USA	20	81188	59	312761
UAE	1	1793	30	111426
Singapore	4	38224	18	110780
Germany	19	56291	9	46360
Hong Kong	2	10747	11	45057
Korea Rp	++	472	35	34202
Italy	1	1076	5	26676
Malaysia	-	-	5	11849
Other countries	15	92173	5	36469

Figures rounded off

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	12	62407	12	62407
USA	8	32025	8	32025
Singapore	2	17840	2	17840
Japan	++	5539	++	8180
Germany	++	241	3	5695
Hong Kong	++	2344	1	5043
Korea	-	-	23	4283
China	1	1889	1	2960
Italy	1	947	3	2559
Belgium	++	1538	++	1437
Canada	++	44	++	517
Other Countries	-	-	++	396

Figures rounded off

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	231	1047016	315	1696847
China	140	540752	193	800322
Austria	45	293841	53	475271
USA	12	49146	46	251208
Singapore	2	20384	6	61733
Germany	19	56050	6	40665
Italy	++	19	2	24078
Malaysia	-	-	5	11849
Australia	-	-	1	10712
Hong Kong	++	4522	1	9654
Russia	++	31267	2	5037
Other countries	13	51035	++	6318

Figures rounded off

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	187	431299	193	639861
China	182	422276	130	439241
UAE	1	454	30	111426
Hong Kong	2	3881	9	30360
Korea Rep of	-	-	12	28857
Singapore	-	-	10	24997
Netherlands	2	4130	2	4934
Italy	++	110	++	39
USA	++	17	++	7
Belgium	++	420	-	-
UK	++	11	-	-
Other countries	-	-	-	-

Figures rounded off

FUTURE OUTLOOK

The principal uses for molybdenum are expected to continue to be as catalysts 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 lower 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) containing 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.