

TUNGSTEN



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(Part- II :Metals and Alloys)

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TUNGSTEN

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

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18 Tungsten

Tungsten, also known as 'wolfram' is a very dense lustrous greyish white to steel-grey metal. It is inherently brittle therefore making it that much more difficult to work with. Tungsten is a metal of strategic importance and is essential for the industrial development of the country. Tungsten does not occur naturally as free metal. The major sources of tungsten are minerals scheelite (Calcium tungstate, CaWO_4) and Wolframite [mixture of ferrous tungstate and manganous tungstate, $(\text{Fe},\text{Mn})\text{WO}_4$] which are predominantly hydrothermal in origin. Tungsten has a melting point of $3,422^\circ\text{C}$, the highest of all metals and is resistant to all acids at ordinary temperatures. It has good corrosion resistance, good thermal & electrical conductivity and low co-efficient of expansion. It is elastic, ductile and has high tensile strength and can be drawn into very thin wires. Tungsten is considered the most important metal for thermo-emission applications not only because of its high electron emissivity but also because of its high thermal and chemical stability. As tungsten has extremely high melting point and is ductile, it is widely used in filaments of light bulbs and vacuum tubes, and for heating elements in electrical furnaces.

When exposed to air, a protective oxide is formed on the surface of the metal, but tungsten can be oxidised more fully at high temperature. When alloyed in small quantities with steel, tungsten greatly increases the hardness of steel.

The domestic requirements of tungsten and its products are met mainly through imports. A significant amount of tungsten is recovered through recycling of tungsten and its alloys including waste & scrap.

RESERVES/RESOURCES

The total resources of tungsten ore in the country, as per NMI data, as on 1.04.2015 based on UNFC system, has been estimated at 87.39 million tonnes with WO_3 content of 1,42,094 tonnes. All these resources are placed under 'Remaining Resources' category.

Resources of tungsten-bearing minerals are mainly distributed in Karnataka (42%), Rajasthan (27%), Andhra Pradesh (17%) and Maharashtra (9%). The remaining 5% resources are in Haryana, Tamil Nadu, Uttarakhand and West Bengal (Table- 1).

Incidences of WO_3 in tungsten ore have been reported from different areas of the country. At Degana, Rajasthan, in a total of 7 blocks, the minimum and maximum values of WO_3 noticed were 0.09% and 1.62%, respectively. At Balda of Sirohi district, Rajasthan, the average WO_3 content was found to range from 0.24 to 0.48 per cent. In Dewa-Ka-Bera of Sirohi district, the average WO_3 is 0.03% and in Udwarya of Sirohi, it is 0.27%. In West Bengal, Bankura deposit contains an average of 0.1% WO_3 . In Kuhl-Khobana-Agargaon belt of Maharashtra, GSI has estimated resources in Sakoli basin in the district of Bhandara and Nagpur. The analysis showed 0.01 to 0.19% WO_3 in Kuhl block, 0.13 to 0.38% WO_3 in Khobana block and 0.48% WO_3 in Pardi-Dahegaon-Pipalgaon block. Gold ore at Mysore mine of BGML in Karnataka has been reckoned as a potential source of scheelite. The tailing dumps at Kolar Gold Fields (as per NMI database) contain about 0.01 to 0.05% WO_3 .

EXPLORATION & DEVELOPMENT

The details on exploration and development, if any, are covered in the Review on Exploration & Development under "General Reviews".

PRODUCTION & PRICES

There was no reported production of tungsten ore/concentrate during 2019-20. In the past, production of tungsten was reported from Degana in Rajasthan and Chendapathar in West Bengal. The domestic prices of tungsten ore and concentrate are furnished in the General Review on 'Prices'.

MINING & PROCESSING

Deposits of wolframite that were established at Degana in Rajasthan and at Chendapathar in West Bengal are found associated with quartz veins, with width that varied from a few centimetres to three metres or sometimes even more. In Degana, it is also associated with gravel beds overlain by 2.5 m thick sand.

Gravel mining was carried out in the past in selected areas where wolframite was found to be concentrated. The overburden sand was at first loosened and loaded manually and transported by tractor unit to dump sites. The payable gravel was then worked.

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

(In tonnes)

Grade/State	Reserve Total (A)	Remaining Resources						Total Resources (A+B)	
		Feasibility STD211	Pre-feasibility STD222	Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334		
All India : Total									
Ore	-	2230000	173063	19611152	23435954	25356049	16581246	87387464	87387464
Contained WO₃	-	3568	450	9914	20180.92	103415.15	4566.28	142094.35	142094.35
By States									
Andhra Pradesh									
Ore	-	-	-	3640000	4700800	5952500	509000	14802300	14802300
Contained WO ₃	-	-	-	5096	6574.64	8273.65	318.28	20262.57	20262.57
Haryana									
Ore	-	2230000	-	-	-	-	-	2230000	2230000
Contained WO ₃	-	3568	-	-	-	-	-	3568	3568
Karnataka									
Ore	-	-	-	15361152	11805499	172921	9338246	36677818	36677818
Contained WO ₃	-	-	-	2915	1775	142	1403	6235	6235
Maharashtra									
Ore	-	-	-	610000	5637250	1830000	-	8077250	8077250
Contained WO ₃	-	-	-	1903	10304	3828	-	16035	16035
Rajasthan									
Ore	-	-	-	-	963666	17000628	5964000	23928294	23928294
Contained WO ₃	-	-	-	-	1421.44	90171.5	2115	93707.94	93707.94
Tamil Nadu									
Ore	-	-	-	-	-	-	250000	250000	250000
Contained WO ₃	-	-	-	-	-	-	50	50	50
Uttarakhand									
Ore	-	-	-	-	138000	-	520000	658000	658000
Contained WO ₃	-	-	-	-	25	-	680	705	705
West Bengal									
Ore	-	-	173063	-	190739	400000	-	763802	763802
Contained WO ₃	-	-	450	-	80.84	1000	-	1530.84	1530.84

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In case of vein deposits, the orebody was cut with chisel and hammer at convenient places to form undercuts. At Degana, tungsten orebody occurs as vein, stockwork and alluvial deposits.

Inclined veins were developed by putting adits in the stockwork.

Degana in Rajasthan and Chendapathar in West Bengal were the only mines of tungsten in India that had produced meagre quantities of concentrate. These mines, owing to economic non-viability, had to be closed down.

As per Annual Report of MIDHANI for 2018-19, the Company is exploring to setup a facility to produce 500 TPA tungsten powder.

As per Annual Report of NMDC for 2019-20, the Company has submitted a proposal for reservation of Khobna Tungsten Block, Nagpur District, Maharashtra under Section 17(A) (2A) of MM (D&R) Amendment Act, 2015, for tungsten prospecting and exploitation. The matter is being pursued with Govt. of Maharashtra. NMDC has a majority stake of 92.32% in Legacy Iron Ore Limited, an ASX listed entity based in Perth, Australia which has iron ore (magnetite), gold, nickel, base metal and tungsten interests (total 21 tenements) in Western Australia.

USES

Tungsten is mainly used in the form of ferro-tungsten in making of special and alloy steels and military applications. Ferrotungsten typically contains between 25% and 75% tungsten. The other principal use of tungsten is in the manufacture of tungsten carbide, one of the hardest synthetic materials used in various industries like construction, metalworking, mining and oil drilling. It is used widely in the manufacture of cutting tools & devices and in wear-resistant materials, particularly those that need to be operated at high temperatures. In making this, cobalt or nickel metal powder is used as a binder to hold together the tungsten carbide grains.

Tungsten compounds are used in dyes and pigments; manufacture of paints & printing ink; and also in Ceramic Industry for producing yellow tint. Other alloys bearing tungsten have wide range of applications, i.e., ornaments, heat sinks, radiation shielding, weights & counter-weights, superalloys for turbine parts, tool steels wear-resistant alloy parts & coatings, etc.

Tungsten alloys and tungsten composites are used as a substitute for lead in bullet and shot. Tungsten is used as filament in incandescent light bulbs and cathodes for electronic tubes, cell phones, television set, HID lamps and other electrical consumer products. The metal is used in superalloys with copper or silver and in Chemical Industry. Tungsten carbide is often used in armor-piercing ammunition.

SUBSTITUTES

Tungsten remains essentially unsubstitutable in its use for production of filaments, electrodes and contacts in lamp & lighting applications. However, an electrodeless, non-tungsten lamp is available as alternative for commercial and industrial uses. Titanium, tantalum and niobium carbides can be used in certain wear-resistant applications. Molybdenum tool steels and tungsten tool steels are interchangeable. In some cutting tool applications, bulk ceramic is an alternative. In some applications, substitution would most often result in increased cost or reduction in product performance.

TECHNICAL POSSIBILITIES

Further development of new metal shaping methods, i.e., laser is becoming a viable proposition. Development of new cutting tool materials coating on cemented carbide parts, that increase their useful life could reduce the usage of tungsten. There is increase in the use of tungsten scrap. The recycling of tungsten-bearing scrap and the recovery of tungsten from scrap materials are well-established practices for a number of reasons. The value of tungsten and other metals present in the scrap, such as, cobalt, columbium, copper, nickel, rhenium, silver, titanium and tantalum, is worthy enough reason to recycle them from scrap. Recycling of tungsten in high speed steel is high and a typical melt contains about 60-70% of the metal scrap, including from that of internally generated scrap. On the other hand, recycling in such applications as lamp filaments, welding electrodes and chemicals uses is also considered viable. Recycling is more environment-friendly and more practicable in economic terms than disposing as waste. Scrap recycling is an important factor in the world's tungsten supply.

POLICY

As per the Foreign Trade Policy, 2015-20, the imports and exports of tungsten ores and concentrates (HS Code 26110000) are allowed free.

CONSUMPTION

The entire domestic requirement of tungsten ore/concentrates is met by imports. Sandvik Asia Pvt. Ltd, Pune, Maharashtra; Widia (India) Ltd, Bengaluru, Karnataka; Rapicut Carbides Ltd, Ankleshwar, Gujarat; Mishra Dhatu Nigam Ltd, Hyderabad, Andhra Pradesh; and Sunflag Iron & Steel Co. Ltd, Bhandara, Maharashtra were the important consumers of ferrotungsten for production of alloy steel. However, the current information regarding consumption of ferrotungsten by these companies are not available. Mining Machinery Industry is the main consumer of the imported ore/concentrates.

WORLD REVIEW

World tungsten resources are geographically widespread. China ranks first in the world in terms of tungsten resources and reserves and has some of the largest deposits. The world reserves of tungsten in terms of metal content are about 3.4 million tonnes, distributed broadly amongst China (56%), Russia (12%), Vietnam (3%) and Spain (2%) (Table-2).

**Table - 2: World Reserves of Tungsten
(By Principal Countries)**

(In '000 tonnes of Tungsten content)

Country	Reserves
World: Total (rounded)	3400
Austria	10
Bolivia	NA
China	1900
Korea, Dem P. R. of	29
Mangolia	4.3
Portugal	3.1
Russia	400
Rwanda	NA
Spain	54
USA	NA
Vietnam	95
Other countries	880

Source: USGS, Mineral Commodity Summaries, 2021

The world mine production of tungsten in terms of metal content in 2019 increased considerably by 12% to 91,500 tonnes from 81,700 tonnes in 2018. China was the leading producer (82%) followed by Vietnam (5%), Russia (3%) and Austria, Bolivia, Congo, Dem. P. R. of Korea, Rwanda & Spain (1% each) (Table-3).

**Table – 3 : World Mine Production of Tungsten
(By Principal Countries)**

Country	(In tonnes of metal content)		
	2017	2018	2019
World: Total (rounded)	83700	81700	91500
Austria	975	936	892
Bolivia	776	1043	1074
China	67472	64938	75452
Congo, Dem. R.	150	230	887
Korea, Dem. P. R. of	300 ^e	1370 ^e	1130 ^e
Russia	2174	2661	2825
Rwanda ^a	929	1039	1303
Spain	711	1079	760
Vietnam	5178	4350	4816
Other countries	5055	4082	2404

Source: BGS, World Mineral Production, 2015-2019.

a: Includes exports and year ended 30 June of that stated

FOREIGN TRADE

Exports

Exports of tungsten and alloys including scrap decreased drastically by 33% to 313 tonnes in 2019-20 from 467 tonnes in the previous year. Exports were mainly to Vietnam (12%), Mexico (11%), Germany (10%), USA (9%), Sweden (7%) and Bangladesh Pr & Italy (2% each). In the year 2019-20, exports of tungsten ore & concentrates were reported as Nil as against 34 tonnes in the preceding year (Tables-4 to 6).

Imports

Imports of tungsten and alloys including scrap decreased slightly by 3% to 386 tonnes in 2019-20 from 399 tonnes in the previous year. Imports were mainly from China (47%), Republic of Korea (16%), Austria & USA (10% each) and Germany, Singapore & UK (3% each). Imports of tungsten ores and concentrate also decreased by 3% to 447 tonnes in 2019-20 from 461 tonnes in the previous year. Imports were mainly from Netherlands (85%) followed by Japan (8%) and Sweden (7%) (Tables-7 to 9).

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**Table-4: Exports of Tungsten and Alloys Incl. Scrap
(By Countries)**

Country	2018-19 (R)		2019-20 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	466667	1254346	313499	870319
Germany	90121	258021	31494	116923
USA	70702	140666	29359	70194
Japan	34332	81274	3935	65340
Sweden	16064	52214	20914	54808
Mexico	4822	29663	35300	45582
Poland	10123	125443	2626	45081
Vietnam	77077	80364	37330	44150
Italy	4962	72694	4824	42640
Oman	105	51	590	41679
Bangladesh	12360	41635	6055	40321
Other countries	145999	372322	141072	303601

Figures rounded off

**Table -5 : Exports of Tungsten Ores & Conc.
(By Countries)**

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	34	43180	-	-
Vietnam	34	43180	-	-

Figures rounded off

**Table-6: Exports of Tungsten
(By Items)**

Country	2018-19 (R)		2019-20 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Items	466667	1254346	313499	870319
Tungsten & alloys, unwrought	101097	221764	159316	311953
Tungsten & alloys, worked NES	82085	196811	142506	278483
Tungsten powder	19012	24953	16810	33470
Tungsten filament	22515	119720	7226	70313
Tungsten, unwrought	48620	76367	1871	1645
Tungsten waste & scrap	256465	376672	121385	138380
Tungsten wire	37970	459824	23701	348028

Figures rounded off

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**Table -7: Imports of Tungsten & Alloys Incl. Scrap
(By Countries)**

Country	2018-19 (R)		2019-20 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	399205	1726276	385732	1467498
China	170818	685822	181121	580761
Austria	48960	389314	40160	307041
Korea, Rep. of	61084	233588	61272	182132
USA	55265	132044	37805	81917
Singapore	18011	73778	11304	63900
Germany	17202	108327	11445	40113
UAE	70	444	3339	39058
France	421	2544	3197	35914
UK	2888	10474	9998	27928
Switzerland	2807	20325	3761	24015
Other countries	21679	69615	22330	84719

Figures rounded off

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

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	461	64520	447	69235
Netherlands	320	40839	380	51267
Japan	-	-	35	13753
Sweden	-	-	30	2473
Singapore	-	-	2	1741
Kuwait	111	15171	-	-
Thailand	5	5667	-	-
Brazil	25	2843	-	-

Figures rounded off

**Table-9: Imports of Tungsten
(By Items)**

	2018-19 (R)		2019-20 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Items	399205	1726276	385732	1467498
Tungsten & alloys, unwrought	188556	752737	173266	682569
Tungsten & alloys, worked NES	71882	420715	63401	387413
Tungsten powder	116674	332022	109865	295157
Tungsten filament	3176	57427	2105	35721
Tungsten, unwrought	48193	159468	89051	206482
Tungsten waste & scrap	16841	25728	19118	28993
Tungsten wire	142439	730916	102192	513733

Figures rounded off

FUTURE OUTLOOK

Strong growth in tungsten market is driven by the surging demand for downstream tungsten products in varied end-user sectors including automotive, industrial engineering, energy and aviation. Apart from that, the uncovering of a wide-range of applications in allied industries like medical, defense and electric & electronic, has had an impelling effect on growth of the tungsten market.

Based on application, global tungsten market has been segmented into tungsten carbide, metal alloys, mill products and other applications, such as, salts, tungstates, sulfides, oxides, etc. Carbide is the largest application segment and usage of these products as drilling, boring and cutting tools in various industries will drive its market. Mill products of tungsten and their applications are another important segment. Mill products are pure tungsten metal products, such as, electrodes, lighting filaments, electrical & electronic contacts, sheets, wires, rods, etc. Developments in the Electronics Industry will be the major factor driving the mill tungsten market growth.

In India, the entire demand of tungsten can only be met by imports and recycling, as there is no indigenous production of tungsten ore & concentrates. High content of WO_3 in the tailing dumps of Kolar can be worked on priority basis to meet the demand.

World tungsten supply was dominated by production in China and exports from China. China's Government regulated its Tungsten Industry by limiting the number of mining and export licences, imposing quotas on concentrate production, and placing constraints on mining and processing. Scrap continued to be an important source of raw material for the Tungsten Industry worldwide. China was the world's leading tungsten consumer. It was forecasted that global tungsten consumption in 2020 will be less than that in 2019 as a result of the impacts of the global COVID-19 pandemic on the global economy and industrial production, particularly tungsten consuming end-use sectors. The decrease in tungsten consumption in 2020 is expected to result in a market surplus.

As per Tungsten - Outlook to 2030, 15th Edition by Roskill, China has for several decades been the world's largest mine and refined producer of tungsten, accounting for just over 80% of mine output in 2020. It is similarly dominant in the production of the tungsten intermediates ammonium paratungstate and tungsten oxide, and of tungsten metal powder and tungsten carbide. A large proportion of this output feeds the country's substantial Cemented Carbide Tool Sector, but there is also sizeable export of tungsten refined and finished products to the rest of the world – making Chinese mine and refined production of tungsten integral to conditions in the global market. Tungsten's performance across 2020 was largely impacted by the ongoing COVID-19 pandemic. As lockdown restrictions were imposed on large parts of the world, several key end-use demand sectors have suffered from the impacts of the pandemic, with the automotive and aerospace sectors bearing the brunt of this. Looking ahead, the tungsten market still faces several headwinds. Global vehicle production remains below pre-pandemic levels and far below 2017's peak production levels. With the threat of greater uptake of electric vehicles over internal combustion engines, tungsten consumption in the automotive sector may never recover to 2017 levels. In addition, market sentiment remains subdued by the ongoing trade dispute between the USA and China. Early indications suggest that the Biden Administration is unlikely to end US/China trade tensions, however, it looks likely that the new Administration will take a lighter, less tariff-heavy, approach. There remain bright spots for the industry, with long-term growth set for most first-use sectors. Strong growth in superalloys and other alloys is set to drive steel and alloys demand, whilst in the Chemicals Sector, the use of semiconductors and demand for consumer electronics is expected to enter another period of promising demand. In the Cemented Carbides Sector, strong growth in most demand segments will offset lacklustre performance in automotive tooling. In addition, there are opportunities further up the supply chain for new mine projects to come online. Several large mines in China and Russia are reaching their end of life and will need to be replaced for the market to remain adequately supplied.