

TUNGSTEN



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(Part- II :Metals and Alloys)

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**TUNGSTEN**

**(ADVANCE RELEASE)**

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

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**T**ungsten, 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,  $\text{CaWO}_4$ ) and Wolframite [mixture of ferrous tungstate and manganous tungstate,  $(\text{Fe,Mn})\text{WO}_4$ ] 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 coefficient 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 alloys product including waste & scrap. Old scrap consists of tungsten-bearing products, such as, cemented carbide parts that are used in metal cutting tools & metal forming tools.

## 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  $\text{WO}_3$  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  $\text{WO}_3$  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  $\text{WO}_3$  noticed were 0.09% and 1.62%, respectively. At Balda of Sirohi district, Rajasthan, the average  $\text{WO}_3$  content ranges from 0.24 to 0.48 per cent. In Dewa-Ka-Bera of Sirohi district, the average  $\text{WO}_3$  is 0.03% and in Udwaya of Sirohi, it is 0.27%. In West Bengal, Bankura deposit contains an average of 0.1%  $\text{WO}_3$ . 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%  $\text{WO}_3$  in Kuhl block, 0.13 to 0.38%  $\text{WO}_3$  in Khobana block and 0.48%  $\text{WO}_3$  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%  $\text{WO}_3$ .

## EXPLORATION & DEVELOPMENT

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

## PRODUCTION & PRICES

There was no reported production of tungsten ore/concentrate during 2018-19. 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.

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

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

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.

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.

NMDC Ltd & Mishra Dhatu Nigam (MIDHANI) have already signed a Memorandum of Understanding (MoU) to develop tungsten mines and processing technology for the metal.

As per Annual Report of NMDC for 2018-19, 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 entered into MoUs with both MIDHANI and DMRL to explore tungsten investment opportunities in India and abroad. NMDC is presently conducting detailed due diligence of a shortlisted tungsten asset for acquisition of minor stake, for defence requirement, subject to committed off-take from Defence Sector companies.

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

## USES

Tungsten is mainly used in the form of ferro-tungsten in making of special and alloy steels and military applications. Ferro-tungsten 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, super alloys 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. Use of tungsten scrap could be increased. 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 % scrap, including 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 ferro-tungsten for production of alloy steel. However, the current information regarding consumption of ferro-tungsten by these Companies is 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 3.2 million tonnes, distributed broadly amongst China (59%), Russia (7%), Vietnam (3%) & Spain (2%) (Table-2).

The world mine production of tungsten in terms of metal content in 2018 decreased by 13% to 77,300 tonnes from 88,600 tonnes in 2017. China was the leading producer (78%) followed by Vietnam (7%), Russia (3%) and Korea Dem. P. R. of, UK & Rwanda (2% each) (Table-3).

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

(In '000 metric tonnes of Tungsten content)

Country	Reserves
<b>World: Total (rounded)</b>	<b>3200</b>
Austria	10
Bolivia	NA
China	1900
Korea, Dem P. R. of	29
Mangolia	NA
Portugal	3
Russia	240
Rwanda	NA
Spain	54
UK	44
USA	NA
Vietnam	95
Other countries	820

*Source: USGS, Mineral Commodity Summaries, 2020*

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

(In tonnes of metal content)

Country	2016	2017	2018
<b>World: Total (rounded)</b>	<b>81000</b>	<b>88600</b>	<b>77300</b>
Austria	950	950 <sup>e</sup>	1000 <sup>e</sup>
Bolivia	848	776	1043
China	63956	71737	59932
Korea, Dem. P. R. of	50 <sup>e</sup>	300 <sup>e</sup>	1370 <sup>e</sup>
Portugal <sup>a</sup>	549	669	715
Russia	3067	2174	2661
Rwanda <sup>b</sup>	1040	923	1178
Spain	699	711	1079
U K	923	1370	1240 <sup>e</sup>
Vietnam	6357	6483	5486
Other countries	2594	2542	1624

*Source: BGS, World Mineral Production, 2014-2018.*

*a: Wolframite and scheelite*

*b: Exports*

## FOREIGN TRADE

### Exports

Exports of tungsten and alloys including scrap decreased by 21% to 467 tonnes in 2018-19 from 593 tonnes in the previous year. Exports were mainly to Germany (19%), Vietnam Soc Rep (17%), USA (15%), Thailand (11%), Japan (7%) & Finland (6%). In year 2018-19, exports of tungsten ore & concentrates increased by 13% to 34 tonnes as against 30 tonnes in the preceding year. The exports were entirely to Vietnam Soc Rep (Tables-4 & 5).

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**Imports**

Imports of tungsten and alloys including scrap decreased by 14% to 399 tonnes in 2018-19 from 465 tonnes in the previous year. Imports were mainly from China P Rep (43%), Korea, Rep. of (15%), USA (14%),

Austria (12%), Singapore (5%) and Germany & Belgium (4% each). Imports of tungsten ores and concentrate increased by 32% to 461 tonnes in 2018-19 from 350 tonnes in the previous year. Imports were mainly from Netherlands (69%) followed by Kuwait (24%) & Brazil (5%) (Tables-6 & 7).

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

Country	2017-18 (R)		2018-19 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
<b>All Countries</b>	<b>592940</b>	<b>1471426</b>	<b>466667</b>	<b>1254346</b>
Germany	132143	331309	90121	258021
USA	93679	197722	70702	140666
Poland	8337	124880	10123	125443
Thailand	39256	69560	49239	101330
Japan	50263	108189	34332	81274
Vietnam Soc Rep	++	3	77077	80364
Italy	5919	83583	4962	72694
Finland	116634	172938	29178	52703
Sweden	10433	26102	16064	52214
Bangladesh Pr	2783	34166	12360	41635
Other countries	133493	322974	72509	248002

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

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>30</b>	<b>29880</b>	<b>34</b>	<b>43180</b>
Vietnam Soc Rep	30	29880	34	43180

**Table -6: Imports of Tungsten & Alloys Incl. Scrap  
(By Countries)**

Country	2017-18 (P)		2018-19 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
<b>All Countries</b>	<b>465223</b>	<b>1718857</b>	<b>399205</b>	<b>1726273</b>
China P Rep	221616	717695	170818	685822
Austria	88917	406414	48960	389314
Korea, Rep. of	63162	199913	61084	233588
USA	21399	60787	55265	132044
Germany	23034	124397	17202	108327
Singapore	18876	58181	18011	73778
Belgium	79	194	16855	25908
Switzerland	2914	15553	2807	20325
Japan	2309	16614	1259	15156
Taiwan	1509	14203	373	10641
Other countries	21408	104906	6571	31370

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**Table - 7: Imports of Tungsten Ores & Conc.  
(By Countries)**

Country	2017-18 (P)		2018-19 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>350</b>	<b>23609</b>	<b>461</b>	<b>64520</b>
Netherlands	276	22029	320	40839
Kuwait	-	-	111	15171
Thailand	-	-	5	5667
Brazil	-	-	25	2843
Taiwan	73	1195	-	-
Uzbekistan	1	385	-	-

## 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 concentrates. Besides, high content of WO<sub>3</sub> in the tailing dumps of Kolar can be worked on priority basis to meet the demand.

World tungsten supply was dominated by production and exports from China. China's Government regulated its Tungsten Industry by

limiting the number of mining and export licenses, imposing quotas on concentrate production and placing constraints on mining & processing. Production of tungsten concentrate outside China in 2018 was expected to be less than that of 2017, owing to lower ore grades being mined in Vietnam and the closure of the sole tungsten mine in the United Kingdom after the owner entered voluntary administration in Oct, 2018. Near-term new concentrate production was anticipated in the Republic of Korea and Spain. Scrap continued to be an important source of raw material for the Tungsten Industry worldwide. China was the world's leading tungsten consumer.

As per Tungsten - Outlook to 2029, 14<sup>th</sup> Edition by Roskill, the tungsten market faces several headwinds, including a potential sustained downturn in car production, which ultimately consumes about a third of all tungsten units. In addition, market sentiment remains subdued by the ongoing trade dispute between the USA and China, affecting a host of chemical, metal and finished products, including ferro-tungsten and tungsten-containing tools. A resolution to trade discussions would be a major boost for tungsten markets. There remain bright spots for the Industry, however, with aerospace and electronics markets (users of tungsten alloys and mill products, respectively) set to continue growing strongly. 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.