

TUNGSTEN



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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, in its raw form, is a hard steel-grey metal that is often brittle and hard to work. If made very pure, tungsten retains its hardness and become malleable enough. Tungsten objects are also commonly formed by sintering. Tungsten is found in the minerals wolframite (iron - manganese tungstate, $\text{FeWO}_4/\text{MnWO}_4$), scheelite (calcium tungstate, CaWO_4) ferberite and huebnerite.

Of all metals in pure form, tungsten is one of heaviest metals and has the highest melting point of any element except carbon (3422°C , 6192°F), lowest vapor pressure (at temperatures above 1650°C , 3000°F) very high thermal creep resistance and the highest tensile strength. It is extremely resistant to corrosion and can be attacked only slightly by most mineral acids. 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.

A significant amount of tungsten is recovered through recycling of tungsten scrap products. Old scrap consists of tungsten bearing products such as cemented carbide parts include metal cutting tools & metal forming tools. As tungsten has extremely high melting point and is ductile (can be readily drawn into wires), it is widely used in filaments of light bulbs and vacuum tubes, and for heating elements in electrical furnaces.

RESERVES/RESOURCES

The total reserves/resources of tungsten ore in the country, as per NMI data, based on UNFC system, as on 1.04.2015 have been estimated at 87.39 million tonnes with WO_3 content of 142,094 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).

At Degana, Rajasthan, WO_3 value in vein deposits varies from 0.25 to 0.54% while in gravel deposit, it is on an average of 0.04%. In Sirohi deposit, Rajasthan, WO_3 content ranges from 0.02 to 2.2%. In West Bengal, Bankura deposit contains an average of 0.1% WO_3 . In Kuhi-Khobana-Agargaon belt, GSI has identified seven mineralised zones in Sakoli basin in Bhandara and Nagpur districts, Maharashtra. The analysis showed 0.01 to 0.19% WO_3 in Kuhi block, 0.13 to 0.38% WO_3 in Khobana block and 0.48% WO_3 in Pardi-Dahegaon-Pipalgaon block. The deposit contains an average of 0.17% WO_3 . 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 contain about 0.035 to 0.18% WO_3 .

EXPLORATION & DEVELOPMENT

The Exploration and development details are given in the review on EXPLORATION & DEVELOPMENT in "GENERAL REVIEWS".

PRODUCTION & PRICES

There was no production of tungsten ore/concentrate during 2016-17. The past production of tungsten was reported from Degana, Rajasthan and Chendapathar, West Bengal. The domestic prices of tungsten ore and concentrate are furnished in the General Review on 'Prices'.

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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)	
All India : Total									
Ore	-	2230000	173063	1961152	23435954	25356049	16581246	87387464	87387464
Contained WO ₃	-	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

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.

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 produced meagre quantities of concentrate. These mines, owing to economic non-viability, had to be closed down. As per the press release by NMDC dated 24th October 2016, NMDC Ltd. & Mishra Dhatu Nigam (MIDHANI) have signed a Memorandum of Understanding (MoU) to develop tungsten mines and processing technology for the metal.

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 grain. 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

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tantalum, provides economic reasons to recycle. 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 done. Recycling is more environment friendly and usually more economic than waste disposal. Tungsten compounds could be used in light-sensitive applications. 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 26000000) 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, and Rapticut 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. Mining Machinery Industry is the main consumer of the imported ore/ concentrates.

WORLD REVIEW

The world reserves of tungsten in terms of metal content are about 3.2 million tonnes, distributed broadly amongst China (56%), Russia (5%), Vietnam (3%), Mongolia and Spain (2% each) (Table-2).

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

(In '000 tonnes of Tungsten content)	
Country	Reserves
World Total (rounded)	3200
Austria	10
Bolivia	NA
China	1800
Mongolia	63
Portugal	3
Russia	160
Rawanda	NA
Spain	54
UK	43
Vietnam	95
USA	NA
Other countries	950

Source : Mineral Commodity Summaries, 2018

The world mine production of tungsten in terms of metal content in 2015 increased slightly to 80,866 tonnes from 80,849 tonnes in 2014. China was the leading producer (80%), followed by Vietnam (6%), Russia & Canada (3% each) and Bolivia & Rwanda (1% each) (Table-3).

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

(In tonnes of metal content)			
Country	2013	2014	2015
World: Total	76404	80849	80866
Austria	851	830	870
Bolivia	957	956	1116
Brazil [#]	494	510	500 ^e
Canada	2762	2689	2114
China	64895	65369	65000 ^e
Korea, Dem. P. R. of ^e	60	70	70
Kyrgyzstan ^e	100	100	100
Myanmar ^e	140	140	90
Peru	35	77	139
Portugal*	692	671	474
Russia	2982	2659	2700 ^e
Rwanda	1344	1313	1081
Spain	487	822	835
Thailand*	161	110	39
Uzbekistan ^(e)	300	300	300
UK	0	0	195
Vietnam	0	4134	5123
Other countries	144	99	120

Source: World Mineral Production, 2011-2015.

* Wolframite & scheelite.

Mainly scheelite

FOREIGN TRADE

Ammonium paratungstate (APT) $(\text{NH}_4)_{10}\text{H}_2\text{W}_{12}\text{O}_{42} \cdot 4\text{H}_2\text{O}$ is the main intermediate and also the main tungsten raw material traded in the market.

Exports

In 2016-17, exports of tungsten ores & concentrate were about 7 tonnes. Exports were solely to Rawanda (Table- 4). Exports of tungsten and alloys including scrap decreased drastically to 314 tonnes in 2015-16 from 475 tonnes in the previous year. Exports were mainly to Germany (25%), USA (20%), Sweden (10%), UK and Austria (8% each). In 2015-16, exports of tungsten ore & concentrates decreased drastically to only 1 tonne as against 175 tonnes in the preceding year. Exports were solely to Nepal (100%) (Tables-5 & 6).

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Imports

In 2016-17, imports of tungsten ores & concentrates were about 283 tonnes. Imports were mainly from Netherlands (60%), Singapore (16%), Australia and Slovenia (8% each) (Table-7). Imports of tungsten ores and concentrates also decreased drastically to 78 tonnes in 2015-16 from 191 tonnes in the previous year. Imports were mainly from Singapore (67%), Rwanda (19%) & Uganda (12%). Imports of tungsten and alloys including scrap decreased to 385 tonnes in 2015-16 from 438 tonnes in the previous year. Imports were mainly from China (58%), Korea, Rep. of (11%), Austria (10%), Germany (8%) and Singapore (4%) (Tables- 8 & 9).

Table-4: Exports of Tungsten Ores & Conc. (By Countries)

Country	2016-17 (P)	
	Qty (t)	Value (₹'000)
All Countries	7	6064
Germany	++	50
Rawanda	7	6014

Table-5: Exports of Tungsten and Alloys Incl. Scrap (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	475385	1574148	313688	1196642
Germany	214877	476776	78260	309856
USA	170179	411991	63552	162883
Poland	7988	126974	8124	127765
Sweden	27126	79684	32191	78134
Italy	8752	77955	4963	71964
Japan	3265	82362	2428	69875
France	4075	58185	3585	47158
UK	849	7319	24069	40762
Austria	11477	23672	25110	38930
Bangladesh	4685	37280	3270	37779
Other countries	22112	191950	68136	211536

Table -6 : Exports of Tungsten Ores & Conc. (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	175	29666	1	391
Nepal	-	-	1	390
Vietnam	143	27383	-	-
Italy	32	2283	-	-
UK	-	-	++	1

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

Country	2016-17	
	Qty (t)	Value (₹'000)
All Countries	283	29631
Australia	23	7435
Germany	3	2769
Netherlands	171	13669
Singapore	63	5271
Slovenia	23	487

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

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	191	61582	78	34081
Rwanda	10	10008	15	13200
USA	2	9146	2	10128
Uganda	35	36904	9	8996
Singapore	-	-	52	1566
Germany	++	326	++	191
France	144	5198	-	-
Other countries	-	-	-	-

Table -9: Imports of Tungsten & Alloys Incl. Scrap (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	437833	1868711	384803	1591491
China	229012	874042	224700	790689
Austria	39526	349710	36925	266864
Germany	25854	124107	29340	171139
Korea, Rep. of	42141	191181	42368	156025
Singapore	20422	54243	14197	49891
USA	47840	163241	10797	47726
Japan	10162	42548	10073	35080
Italy	3591	16822	6644	23296
UK	11948	19805	3074	12877
Switzerland	2024	5783	2183	12192
Other countries	5313	27229	4502	25712

FUTURE OUTLOOK

World tungsten supply will continue to be dominated by China's production and exports. As per Global Tungsten Market Trends, statistics and forecast 2015-20, Europe is an important market for tungsten demand. The demand for tungsten for industrial applications is expected to witness strong growth, particularly in Asia Pacific and Latin America regions. In the next few years, tungsten concentrates production from outside China is expected to increase. Some of the increase is expected to come from improved

production from existing mines and some is expected to come from the ramp up of production at recently started mines and tailings operations. The consumption of tungsten in cemented carbides, which is the leading end-use sector is expected to rise in the near future.

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