

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 is a hard steel-grey shiny metal that is often brittle and hard to work and is of strategic importance. The chief sources of tungsten are minerals scheelite (CaWO_4) and wolframite $[(\text{Fe},\text{Mn})\text{WO}_4]$ which are predominantly hydrothermal in origin. Tungsten has a melting point of 3422°C , the highest of all metals and is resistant to all acids at ordinary temperatures. It is elastic, ductile and has high tensile strength and can be drawn into very thin wires. Thus, tungsten is 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. The domestic requirements of tungsten and its products are met mainly through imports. A significant amount of tungsten is recovered through recycling of tungsten scrap products.

RESOURCES

The total resources of tungsten ore in the country, as per UNFC system, as on 1.4.2013 has been estimated at 87.4 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

GSI

In Assam, a G-4 stage investigation was taken up in 2014-15 for search of W, Sn & REE in Chakrashila, Nadangiri and Bhumeswar area in Bongaigaon, Dhubri and Kokrajhar districts. The rocks at places are intruded by basic intrusive of doleritic composition. The PCS and BRS samples collected from the lepidolite bearing pegmatite has been analysed by XRF and show a higher value of 15337 ppm of Rb and 943 ppm of Y (Yttrium). ICPMS study of these samples show a high value of 287 ppm of Tantalum and 338 ppm of tin. A G-4 stage investigation was taken up for search of W, Sn & REE in Satali, Surya pahar, Pancharatna, Bamundanga, Nalanga and Pandaba in the Goalpara district, Assam. Analytical results of the samples so far received are not encouraging.

A G-4 stage investigation was taken up for tungsten and associated mineralisation in Lawari-Amboli area, Chandrapur District, Maharashtra

TUNGSTEN

**Table -1 : Reserves/Resources of Tungsten as on 1.4.2013
(By Grades/Stages)**

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	19611152	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

TUNGSTEN

with an objective to identify the zones of tungsten and associated mineralisation in Lawari-Amboli area. Scheelite is observed (under UV lamp) in quartz tourmaline vein studied SW of Amboli village. The tungsten mineralisation is confined mainly in quartz-tourmaline veins and greisen zones. The exposed rock shows smoky quartz and peacock colour staining indicating copper and possible gold mineralisation. In the Lawari reserve forest, bed rock samples of quartz tourmaline vein, analysed W values of 301 ppm and Pb values of 0.34%. The highest W value so far recorded is 530 ppm from bed rock sample of quartz vein near Amboli village. Bed rock samples of the study area give the W value of 532 to 50 ppm. Pitting and trenching samples of quartz tourmaline vein of the Amboli village give the maximum W value of 284 ppm and sulphide mineralisation is also observed in PT samples. Scheelite was noticed only in the samples of Lawari reserve forest. Bed rock sample of pegmatite vein from Chichola village gives the W value of 151 ppm. Similarly, 80 ppb gold values is also reported from BRS and PT samples of quartz tourmaline vein.

PRODUCTION & PRICES

There was no production of tungsten ore/concentrate during 2014-15. 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'.

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. Here 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.

USES

Tungsten is mainly used in the form of ferro-tungsten in making of special and alloy steels. 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. 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. 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, wear-resistant parts & coatings

etc. 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. It is also used in armour plate and armour-piercing ordnance.

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 could reduce the usage of tungsten. Use of tungsten scrap could be increased. 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 environmentally 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, 2009-14, the imports and exports of tungsten ores and concentrates can be made freely.

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 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. Mining Machinery is the main Industry which consumed almost 98% of the imported ore/ concentrates.

WORLD REVIEW

The world reserves of tungsten in terms of metal content are about 3.3 million tonnes, distributed broadly amongst China (58%), Canada (9%), Russia (8%), Vietnam (3%) and UK (2%) (Table -2).

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

(In '000 tonnes of Tungsten content)

Country	Reserves
World: Total (rounded)	3300
Austria	10
Canada	290
China	1900
Portugal	4
Russia	250
Spain	32
UK	51
Vietnam	100
USA	NA
Other countries	670

Source: Mineral Commodity Summaries, 2016.

TUNGSTEN

The world mine production of tungsten in terms of metal content in 2014 increased to 85,292 tonnes from 80,990 tonnes in 2013. China was the leading producer (80%), followed by Russia (7%), Canada (3%) and Rwanda (2%) (Table-3).

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

(In tonnes of metal content)

Country	2012	2013	2014
World: Total	78223	80990	85292
Austria	706	851	862
Bolivia	1573	1580	1578
Brazil#	381	494	500 ^e
Burundi	190	50	50 ^e
Canada	2505	2762	2689
China	62009	64895	68000 ^e
Korea, Dem. P. R. of ^e	100	60	70
Kyrgyzstan	100	100	100
Myanmar	130	140	140
Peru	365	35	77
Portugal*	763	692	671
Russia	7252	6266	6300 ^e
Rwanda	1105	1800 ^e	1700 ^e
Spain	496	614	1036
Thailand*	107	203	139
Uzbekistan ^(e)	300	300	300
Vietnam	0	0	1000 ^e
Other countries	141	148	80

Source: World Mineral Production, 2010-2014.

* Wolframite & Scheelite.

Canada

North American Tungsten Corp. Ltd (NATC) (Vancouver) produced 10% more tungsten in 2014 from scheelite concentrates from its Cantung operation in the Northwest Territories in comparison to 2013. The Project, in east-central New Brunswick, comprised an open pit mine, a beneficiation plant to produce tungsten and molybdenum concentrates, and an onsite processing plant to convert the scheelite concentrate to ammonium paratungstate (APT).

China

In 2014, China's production of concentrates increased to 71,000 tonnes of contained tungsten. Despite its position as the world's leading miner of tungsten, China has imported significant quantities of tungsten concentrate in recent years. China's Government maintained a programme to conserve its tungsten resources to ensure that its tungsten supply would meet anticipated demand.

Korea, Rep. of

Woulfe Mining Corp.(Vancouver) updated the feasibility study on restarting production from the underground Sangdong tungsten-molybdenum mine southeast of Seoul in Gangwon Province. The project have a mine life of 12 years and would use mineral flotation to produce 3,000 to 3,700 tonnes of tungsten from scheelite concentrate.

Russia

In 2014, five companies mined tungsten and produced concentrates. In addition, Wolfram Company (Moscow) produced concentrates from tailings generated during earlier mining.

TUNGSTEN

United Kingdom

Wolf Minerals Ltd (Subiacco) began construction of its Hemerdon tungsten and tin project in Devon, northeast of Plymouth. The open pit mine and beneficiation plant are expected to produce approximately 2,740 tonnes of tungsten per year from wolframite concentrates and 460 tonnes of tin per year from concentrates for a minimum of 9 years. By year end, construction was 67% complete and more than 1,00,000 tonnes of ore had been stockpiled at the mine.

FOREIGN TRADE

Ammonium paratungstate (APT)[(NH₄)₁₀H₂W₁₂O₄₂] is the main intermediate and also the main tungsten raw material traded in the market.

Exports

Exports of tungsten alloys and scrap decreased drastically to 475 tonnes in 2014-15 from 745 tonnes in the previous year. Exports were mainly to Germany (45%), USA (36%), Sweden (6%), Italy and Poland (2% each). In 2014-15, exports of tungsten ores & concentrates decreased considerably to 175 tonnes as against 323 tonnes in the preceding year. Exports were mainly to Vietnam (82%). (Tables- 4 and 5).

Imports

Imports of tungsten ores and concentrates increased to 191 tonnes in 2014-15 from 17 tonnes in the previous year. Imports are mainly from Uganda, Rwanda, USA & France. Imports of tungsten and alloys including scrap decreased to 438 tonnes in 2014-15 from 530 tonnes in the previous year. Imports were mainly from China (52%), USA (11%), Korea, Rep. of (10%), Austria (9%) and Germany (6%). (Tables- 6 to 8)

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

Country	2013-14		2014-15(P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	745397	2265367	475385	1574148
Germany	313775	779298	214877	476775
USA	203572	478577	170179	411991
Poland	8784	157326	7988	126974
Japan	25547	115576	3265	82363
Sweden	22070	81609	27126	79684
Italy	20783	90231	8752	77955
France	4740	67921	4075	58185
Iran	2820	27305	3804	37926
Bangladesh	1561	30916	4685	37280
China	1735	31182	2446	25996
Other countries	140010	405426	28188	159019

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

Country	2013-14		2014-15(P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	323	64205	175	29666
Vietnam	260	46949	143	27383
Italy	50	3276	32	2283
Other countries	13	13980	++	++

Table – 6 : Imports of Tungsten Ores & Conc. (By Countries)

Country	2013-14		2014-15(P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	17	28235	191	61582
Uganda	-	-	35	36904
Rwanda	-	-	10	10008
USA	5	25136	2	9145
France	-	-	144	5198
Germany	-	-	++	326
Other countries	12	3099	++	1

TUNGSTEN

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

Country	2013-14		2014-15(P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	530108	2150364	438233	1868711
China	216288	795522	229012	874043
Austria	15230	123657	39526	349710
Korea, Rep. of	57170	241260	42541	191181
USA	79520	369290	47840	163240
Germany	24758	134628	25854	124106
Singapore	7919	21564	20422	54242
Japan	8179	39040	10162	42548
UK	17491	34354	11948	19806
Italy	323	1550	3591	16822
Vietnam	23750	71619	3250	9861
Other countries	79480	317880	4087	23152

**Table – 8 : Imports of Tungsten
(By Items)**

Item	2013-14		2014-15(P)	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Items	530108	2150364	438233	1868711
Tungsten & alloys, unwrought	296490	1058984	213527	727169
Tungsten & alloys, worked NES	60321	243804	68459	306468
Tungsten powder	236169	815180	145068	420701
Tungsten filament	13171	98030	17977	128294
Tungsten, unwrought	19193	84689	28800	119949
Tungsten waste & scrap	15793	22812	11011	14887
Tungsten wire	185461	885849	166918	878412

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 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.