

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 vital metal 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 it 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. 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 1.4.2010 has been estimated at 87.4 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).

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 . Scheelite ore at Mysore mine of BGML in Karnataka has been reckoned as a potential source of gold. The tailing dumps at Kolar Gold Fields contain about 0.035 to 0.18% WO_3 .

EXPLORATION & DEVELOPMENT

GSI, in Maharashtra, reconnaissance stage investigation (G-4) was carried out in and around Inzewara, Bhandara district to identify target zones of tungsten and associated mineralisation. The work carried out includes 200 Sq km aerial reconnaissance, 100 Sq km large-scale mapping (LSM) on 1:12,500 scale, 100 soil sampling on 50 m x 200 m grid, pitting & trenching of 102 cu m and collection of 51 Business Requirement Specification (BRS). Tungsten mineralisation is confined mainly to the quartz veins and the tourmaline greisens within the mica schist. In Salheti area one grab sample of quartz vein boulders containing scheelite recorded 0.62% of WO_3 . BRS samples of 5 quartz-tourmaline veins and greisens from SW of Inzewara gave values ranging from 70 -175 ppm. Pitting and trenching in Salheti area established 10 m strike length of scheelite-bearing quartz vein having a thickness of 0.5 m. 16 pit samples from the Salheti area show W values ranging from 200 ppm to 0.15% and three pit samples recorded Au values of 148 ppb, 164 ppb and 208 ppb respectively. Out of 19 soil samples from Salheti only one soil sample has given Au value of 547 ppb. The SEM-EDX studies of both the quartz vein and the quartz-chlorite schist of Salheti area confirmed the presence of scheelite. A single platinum grain and REEs like xenotime and monazite were also noticed in the quartz-chlorite schist near to the scheelite-bearing quartz vein. Gold grain of 2 urn size was observed in SEM studies from smoky quartz vein located west of village Chandrapur.

PRODUCTION & PRICES

There was no production of tungsten ore /concentrate during 2013-14. 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 1.4.2010
(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	-	2230000	173063	19611152	23435954	25356049	16581246	87387464	87387464
Ore	-	3568	450	9914	20180.92	103415.15	4566.28	142094.35	142094.35
Contained WO ₃	-	-	-	-	-	-	-	-	-
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	-	-	-	190739	400000	-	-	763802	763802
Contained WO ₃	-	-	-	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, Rajasthan, 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 ore body was cut with chisel and hammer at convenient places, to form undercuts. At Degana, Rajasthan, 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 operative 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 wires form the filament in incandescent light bulbs and cathodes for electronic tubes. The metal is used in superalloys with copper or silver and in Chemical Industry. It is also used in armour plate and armour-piercing ordinance. 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.

SUBSTITUTES

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. 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. 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. Tungsten compounds could be used in light-sensitive applications.

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, Ankaleshwar, 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. Annual consumption of tungsten ore /concentrate during the year 2013-14 is estimated at 493 tonnes. Mining Machinery is the main industry which consumed almost (98%) 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%), Australia (5%), and USA (4%) (Table -2).

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

(In '000 tonnes of Tungsten content)

Country	Reserves
World: Total (rounded)	3300
Australia	160
Austria	10
Bolivia	53
Canada	290
China	1900
Portugal	4
Russia	250
Vietnam	87
USA	140
Other countries	853

Source: Mineral Commodity Summaries, 2015.

The world mine production of tungsten in terms of metal content in 2013 decreased drastically to 77200 tonnes from 80300 tonnes in 2012. China was the leading producer (78%), followed by Russia (9%) Canada (4%) and Rwanda (2%) (Table-3).

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

(In tonnes of metal content)

Country	2011	2012	2013
World: Total	77800	80300	77200
Austria	861	706	850
Bolivia	1418	1573	1580
Burundi	164	165 ^e	165 ^e
Canada	2368	2505	2762
China	61802	64000	60000 ^e
Korea, Dem. Peoples Rep. of ^e	200	200	100
Peru ^e	546	365	35
Portugal*	818	763	692
Russia	7103	7252	7300 ^e
Rwanda	950	1105	1800 ^e
Spain	425	496	702
Thailand	229	107	203
Uzbekistan ^(e)	300	300	300
Other countries	616	763	711

Source: World Mineral Production, 2009-2013.

*: Wolframite & Scheelite.

Canada

North American Tungsten Corp. Ltd (NATC) (Vancouver) produced slightly less tungsten in scheelite concentrates from its Cantung operation in the Northwest Territories than in 2012, in part because of lower ore grades. The company began a project to increase Cantung's mill through put by as much as 20% and to increase metallurgical recovery from the gravity and flotation circuits.

China

In 2013, China's production of concentrates increased to 68,000 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.

Rep. of Korea

Woulfe Mining Corp.(Vancouver) worked with IMC International Metalworking Companies B.V. (Gouda, Netherlands) to finalise agreements for IMC to help finance the reopening of the Sandong tungsten-molybdenum mine southeast of Seoul in Gangwon Province.

Russia

In December 2012, the Government of Russia imposed a 10% export duty on tungsten concentrates in response to high levels of exports, which hampered military programmes and national stockpiling. In 2013, five companies mined tungsten and produced concentrates.

UK

Wolf Minerals Ltd was studying the feasibility of redeveloping the Hemerdon tungsten-tin-mine near Plymouth. The open pit mine and beneficiation plant are expected to produce approximately 2,700 tonnes per year of tungsten from wolframite concentrates and 450 tonnes per year of tin from concentrates for a minimum of 10 years.

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FOREIGN TRADE

Exports

Exports of tungsten alloys and scrap increased drastically to 745 tonnes in 2013-14 from 409 tonnes in the previous year. Exports were mainly to Germany (42%), USA (27%), Israel (7%), UK (6 %) and Japan & Sweden (3% each). In 2013-14 exports of tungsten ores & concentrates increased considerably to 323 tonnes as against 93 tonnes in the preceding year. Export were mainly to Vietnam (88%). (Tables- 4 and 5).

Imports

Imports of tungsten ores and concentrates drastically decreased to 17 tonnes in 2013-14 from 107 tonnes in the previous year. Imports are mainly from Singapore, USA & UK. Imports of tungsten and alloys including scrap increased to 530 tonnes in 2013-14 from 436 tonnes in the previous year. Imports were mainly from China (41%), USA (15%), Israel (13%) and Korea Rep. of (11%) (Tables- 6 to 8).

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

Country	2012-13		2013-14	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	408664	1951349	745397	2265367
Germany	100523	504413	313775	779298
USA	140991	351347	203572	478577
Poland	10597	181912	8784	157326
Japan	937	39710	25547	115576
Israel	14947	22812	52535	102202
Italy	13869	37707	20783	90231
Sweden	39290	100418	22070	81609
UK	33326	262410	48326	80138
France	4537	58381	4740	67921
Brazil	3106	46907	2648	44320
Other countries	46541	345332	42617	268169

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

Country	2012-13		2013-14	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	93	9198	323	64205
Vietnam	73	4131	260	46949
UK	4	4110	13	13980
Italy	16	956	50	3276
Other countries	++	1	-	-

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

Country	2012-13		2013-14	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	107	28762	17	28235
USA	16	10536	5	25136
Singapore	2	1455	7	2029
UK	39	13987	5	1069
Other countries	50	2784	++	1

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

Country	2012-13		2013-14	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Countries	436356	1608465	530126	2150364
China	214148	722405	216288	795522
USA	77953	361997	79520	369290
Israel	-	-	70112	280492
Korea, Rep. of	52596	189139	57170	241260
Germany	36898	157425	24758	134628
Austria	10476	44430	15230	123657
Vietnam	1000	2614	23750	71619
Japan	7207	30568	8197	39040
UK	1356	5768	17491	34354
Singapore	16727	37358	7919	21564
Other countries	17995	56761	9691	38938

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

Item	2012-13		2013-14	
	Qty (kg)	Value (₹'000)	Qty (kg)	Value (₹'000)
All Items	634336	2191215	826598	3209348
Tungsten & alloys, unwrought	197980	582750	296490	1058984
Tungsten & alloys, worked NES	94604	255088	60321	243804
Tungsten powder	103376	327662	236169	815180
Tungsten filament	19962	86790	13171	98030
Tungsten, unwrought	20427	76514	19193	84689
Tungsten waste & scrap	3480	5123	15793	22812
Tungsten wire	194507	857288	185461	885849

FUTURE OUTLOOK

World tungsten supply will continue to be dominated by China's production and exports. The Chinese Ministry of Land and Resources maintained the total tungsten production quota for 2014 at 89,000 tonnes (65% WO₃) equal to that of 2012 and 2013 and extended the

ban on issuing new mining licenses to June, 2015. In the next few years, tungsten concentrates production from outside China is expected to increase.

In India, the entire demand can only be met by imports, as there is no indigenous production of tungsten concentrates.

