

TUNGSTEN AND COSTS

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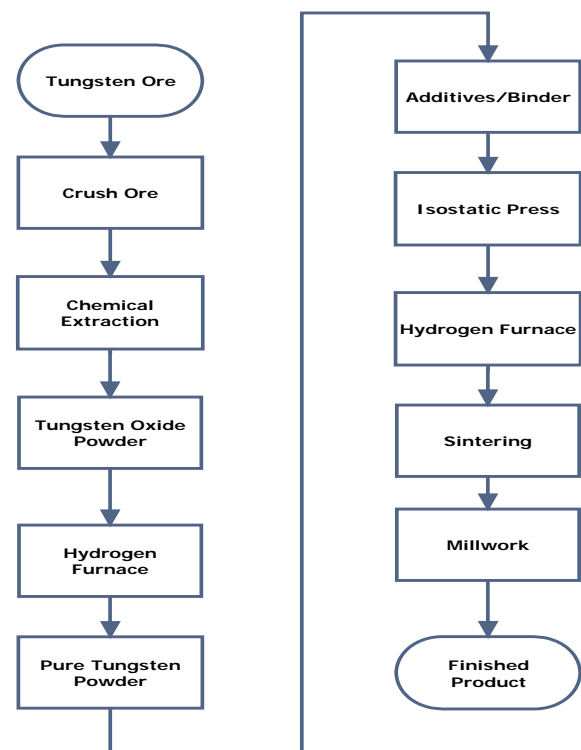
We regularly receive requests for more information about tungsten mining, refining, and pricing. Often the people making these requests are considering using tungsten in some way and would like to know more about this rather unusual material.

Tungsten does not occur naturally in its pure metallic state, but is always found as an ore such as wolframite or scheelite. Tungsten ore is not currently mined in the United States due to financial and environmental considerations although the U. S. has substantial deposits. Other countries with significant tungsten resources include Russia, Bolivia, Canada, and China. Currently, most tungsten used in the U.S. is of Chinese origin. Recycled tungsten is of considerable importance as well. Because no tungsten is being currently mined in the U. S. and because it is vital to our national defense, tungsten is considered a strategic material and is stockpiled by the government.

Tungsten is not refined by smelting or in a manner similar to many other metals due to the fact that it has the highest melting point of any metal. Tungsten is, therefore, extracted chemically from the crushed ore in a series of chemical reactions, titrations, washings, and filterings. It is common that a partially refined chemical such as ammonium paratungstate (APT) will be sold and shipped for further processing, rather than shipment of raw ore itself. The company which purchases the APT will then continue the process of chemical refining. The end result of the refining process is high purity tungsten powder. Two parameters, particle size and particle size distribution are controlled to create powder which is suitable for the company's purpose. Tungsten is sometimes used in powder form, but very often it must be consolidated into a solid form.

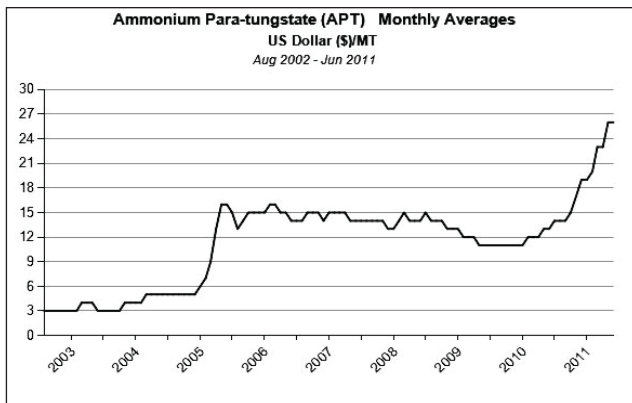
To consolidate tungsten powder it may be blended with a binder and very small amounts of other materials that will provide desired properties to the finished product. The most common method of consolidation is sintering. Tungsten powder is pressed into cakes or fragile bars which are heated in a furnace until the particles adhere to one another. The bar is then placed in a sintering bottle for further heating. Electric current is run through the bars until they become extremely hot, and the individual tungsten grains merge together and form a solid part. During this process the bar shrinks and becomes more dense.

The bar is not yet fully dense and lacks other desirable properties such as ductility and high tensile strength that will be gained as the material is drawn or rolled into final form. The exact process that the tungsten undergoes at this point depends greatly on the final form



and use, but usually involves drawing through dies, or rolling through a mill, with annealing at various points. During the process the tungsten is further compacted, becoming more dense, and the crystal structure of the tungsten is manipulated in order to improve physical properties.

Tungsten alloys are made in a similar fashion, but are blended with up to ten percent of a combination of nickel and iron or copper. These metals serve as the binder to hold the tungsten particles in place after sintering. The alloys do not require millwork to enhance properties in the same way that pure tungsten does, but may be worked anyway to achieve desired shape. These heavy metal alloys are quite useful for many purposes and are machined much more easily than pure tungsten.



So what does tungsten cost? There is no one answer as there are many variables that can contribute to the final price of any given tungsten product. However, we can discuss some of the variables that affect the pricing of tungsten. First, there are market considerations. What is the going rate for tungsten ore, tungsten powder, or APT? The London Metals Bulletin can provide these prices on a timely basis. For many years, China had kept market prices low in order to capture market share, but a number of factors including China's rising internal need for tungsten have caused the price to rise substantially beginning in 2004. The standard pricing unit for tungsten trading is the mtu or metric ton unit. Second, we must consider the

form of the tungsten. Tungsten chemicals, tungsten powder, tungsten plate, tungsten wire, and tungsten rod would each have a different price per kilo cost. This is a function of the raw material cost and of the amount of work involved in producing the finished product. A broad range of prices for finished tungsten products would be from \$25 to \$2500 per kilo, with the majority of products in the \$100 to \$350 per kilo range.

What is the future of tungsten pricing? As this TIPs goes to press (mid 2011), tungsten pricing is on the rise. The increase has been quite dramatic, but has stabilized somewhat very recently. What we are seeing now appears to be the new normal. The weak dollar, increased environmental concerns, and China's reduction of export quotas appear to mean that higher pricing is here to stay. Pricing is expected to continue to rise long term, but at a slower rate than before. Higher prices have raised the interest in tungsten mining around the globe, and this may keep prices in check somewhat moving forward.

Midwest Tungsten Service manufactures a wide variety of products from pure tungsten and the heavy metal tungsten alloys. We also purchase used tungsten for recycling. Please feel free to contact us with any inquires which you might have or with any questions regarding tungsten materials.

Useful tungsten links on the internet:

www.tungsten.com

<http://minerals.er.usgs.gov/minerals/pubs/commodity/tungsten/>

<http://www.webelements.com/webelements/elements/text/W/key.html>

<http://www.itia.org.uk/>

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