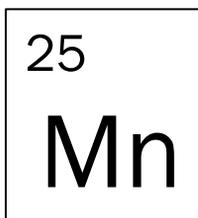


## About Manganese

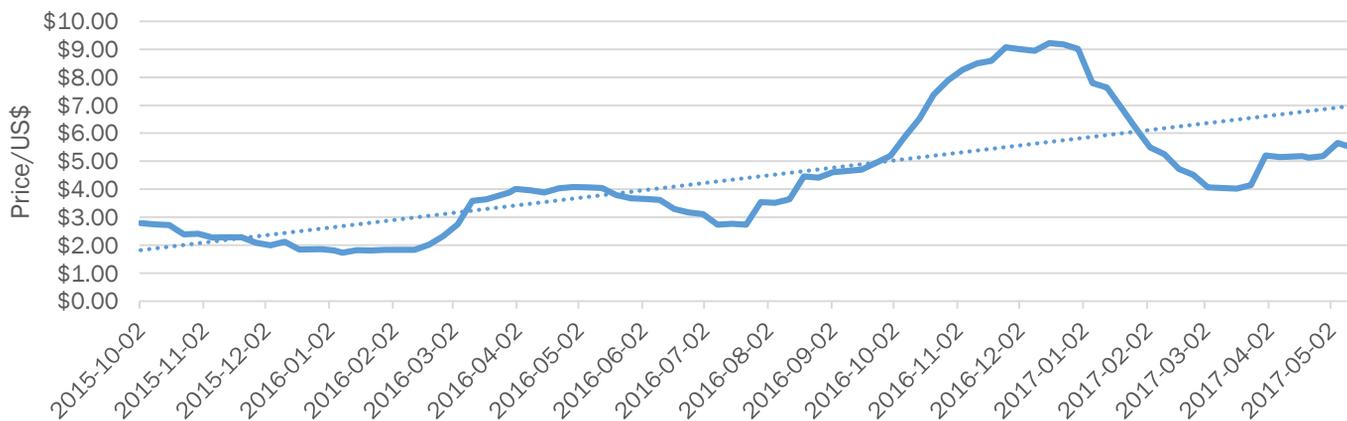
Manganese is element number 25 on the periodic table. Its symbol is Mn. Manganese is widely used in steel production and is a required trace element for living organisms and is often used in both animal feeds and fertilizers.



Manganese was first used during the Stone Age as a pigment (e.g. in cave paintings). From about 1500 BC it was used in the production of glass and increasingly used in chemical processes. In the early 19<sup>th</sup> century it was recognized that iron alloyed with manganese was harder but not more brittle than its unalloyed counterparts. Today most of the world's manganese production is used in the production of high-strength steel. The U.S. Geological Survey has recognized manganese as a "critical mineral".

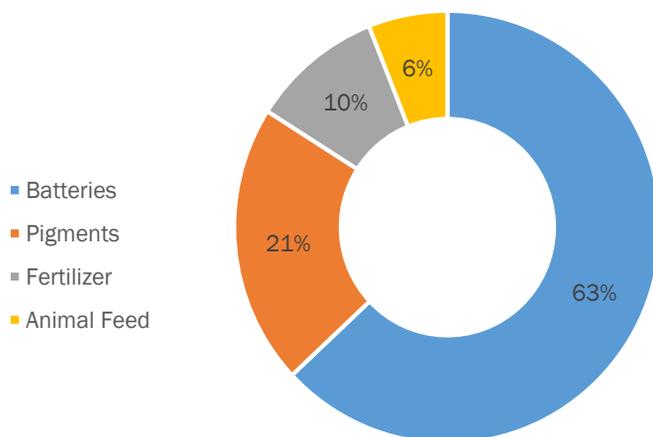
With the invention of batteries in the middle of the 19<sup>th</sup> century, demand for manganese dioxide increased. In the 20<sup>th</sup> century, it became widely used in the production of standard and alkaline batteries. Today manganese is a key ingredient in the production of next-generation lithiated manganese dioxide (LMD) batteries, which can offer greater output and improved thermal stability over other Li-ion batteries. LMD batteries are already being used in certain electric vehicles and may have applications in extended energy storage.

## Weekly Price for 44% Mn CIF Tianjin



Source: Metal Bulletin

## Specialty Applications for High-Grade Manganese ~1.2 million tpa



Source: Roskill, Global Energy Industry Analytics

**50 million tonnes of Mn consumed globally each year**

**90%+ of Mn is used in making alloy steel**

**Applications in next-generation battery and storage technology**

## Manganese Pricing

Manganese is priced in the context of the market. The largest producers set a weekly spot price that other groups use as a benchmark for their negotiations. The price for manganese in recent months has trended higher as certain producers shuttered production in the face of greater supply in 2016.

## Mining Manganese

The most common manganese ore is pyrolusite (manganese dioxide) although it occurs in other forms, often in close proximity to iron ores. Manganese is typically mined using surface mining methods including strip and open-pit mining (predominant in Africa).

Once recovered, high purity manganese can often be beneficiated through simple crushing and jigging. Ferromanganese and pure manganese are often produced using heating and solvent extraction / electrowinning methods, respectively.



## Manganese Production Market Dynamics

Key manganese-producing countries have historically included Australia, Brazil, China, Gabon and South Africa. Approximately three quarters of the world's supply of manganese comes from Africa, with Gabon in particular producing very high grades. Brazil is also among the highest grade producers in the world. Although China's manganese reserves are lower grade, the country's steel industry has relied on significant domestic production for the manufacture of high strength steel.

High grades of manganese are important because they facilitate blending with lower grades but also support lower energy costs in the production of steel. Producers of batteries, fertilizers and animal feeds also prize high grade manganese.

## Manganese Resources

International Manganese Institute - <http://www.manganese.org/>

## Top Producing Countries by Grade (2013)

