

### 13. SECONDARY AND MICRONUTRIENT FERTILIZERS-Manufacturing of Zinc sulphate and Ferrous sulphate

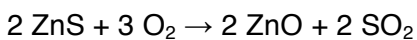
#### Zinc

Zinc is the fourth most common metal in use, trailing only iron, aluminium, and copper with an annual production of about 12 million tonnes.[14] The world's largest zinc producer is [Nyrstar](#), a merger of the Australian [OZ Minerals](#) and the Belgian [Umicore](#). [74] About 70% of the world's zinc originates from mining, while the remaining 30% comes from recycling secondary zinc. [] Commercially pure zinc is known as Special High Grade, often abbreviated *SHG*, and is 99.995% pure.

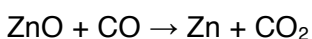
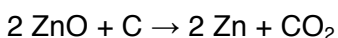
Worldwide, 95% of the zinc is mined from [sulfidic](#) ore deposits, in which sphalerite ZnS is nearly always mixed with the sulfides of copper, lead and iron. [77] There are zinc mines throughout the world, with the main mining areas being China, Australia and Peru. China produced 29% of the global zinc output in 2010.

Zinc metal is produced using [extractive metallurgy](#). [78] After grinding the ore, [froth flotation](#), which selectively separates minerals from [gangue](#) by taking advantage of differences in their [hydrophobicity](#), is used to get an ore concentrate. [78] A final concentration of zinc of about 50% is reached by this process with the remainder of the concentrate being sulfur (32%), iron (13%), and SiO<sub>2</sub> (5%). [78]

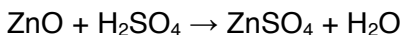
[Roasting](#) converts the zinc sulfide concentrate produced during processing to zinc oxide: [77]



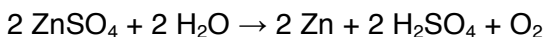
The sulfur dioxide is used for the production of sulfuric acid, which is necessary for the leaching process. If deposits of zinc carbonate, zinc silicate or zinc spinel, like the [Skorpion Deposit](#) in Namibia are used for zinc production the roasting can be omitted. For further processing two basic methods are used: [pyrometallurgy](#) or [electrowinning](#). Pyrometallurgy processing reduces zinc oxide with [carbon](#) or [carbon monoxide](#) at 950 °C (1,740 °F) into the metal, which is distilled as zinc vapor. [80] The zinc vapor is collected in a condenser. [77] The below set of equations demonstrate this process



Electrowinning processing leaches zinc from the ore concentrate by [sulfuric acid](#)



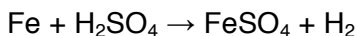
After this step [electrolysis](#) is used to produce zinc metal.[77]



The sulfuric acid regenerated is recycled to the leaching step.

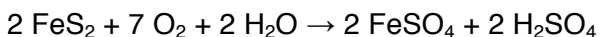
### **Ferrous Sulfate**

In the finishing of [steel](#) prior to plating or coating, the steel sheet or rod is passed through [pickling baths](#) of sulfuric acid. This treatment produces large quantities of iron(II) sulfate as a by-product.[2]



Another source of large amounts results from the production of [titanium dioxide](#) from [ilmenite](#) via the sulfate process.

Ferrous sulfate is also prepared commercially by oxidation of pyrite:



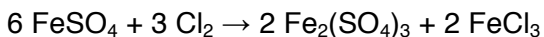
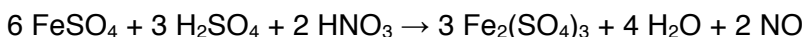
[\[edit\]](#)

### **Reactions**

On heating, iron(II) sulfate first loses its [water of crystallization](#) and the original green crystals are converted into a dirty-yellow anhydrous solid. When further heated, the anhydrous material releases [sulfur dioxide](#) and white fumes of [sulfur trioxide](#), leaving a reddish-brown iron(III) oxide. Decomposition of iron(II) sulfate begins at about 480 °C.



Like all iron(II) salts, iron(II) sulfate is a reducing agent. For example, it reduces nitric acid to nitrogen oxide and chlorine to chloride:



Ferrous sulfate outside [titanium dioxide](#) factory in Kaanaa, [Pori](#).

Upon exposure to air, it oxidizes to form a corrosive brown-yellow coating of basic ferric sulfate, which is an adduct of [ferric oxide](#) and [ferric sulfate](#):

