

Metallurgy

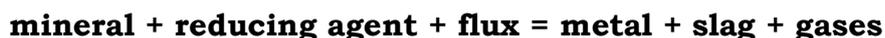
Conversion of metallic oxides to free metal by reduction

The roasted or the calcined ore is then converted to the free metal by reduction. Reduction method depends upon the activity of metal. Metals which are low in the activity series (like Cu, Hg, Au) are obtained by heating their compounds in air: metals which are in the middle of the activity series (like Fe, Zn, Ni, Sn) are obtained by heating their oxides with carbon while metals which are very high in the activity series (e.g., Na, K, Ca, Mg, Al) are obtained by electrolytic reduction method.

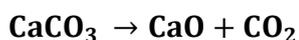
1. Smelting

Smelting is a process in metallurgy to melt the ore to obtain pure metal and discard unwanted material as slag. Metals are found in nature as minerals. Minerals are available in their ores associated with many unwanted gangue mineral particles. Maximum amount of gangue material is rejected by physical and chemical processes before smelting the ore in a furnace. Some amount of gangue usually left with the concentrate. These are to be rejected as slag during smelting operation. Besides that metals which are available as oxides, sulphides, and carbonates are to be smelted to remove the other material to obtain pure metals. Smelting usually carried out in blast furnaces, reverberatory furnaces and electric furnaces. Fluxes like Limestone and Dolomite are also used during smelting process.

The reduction smelting process involves the reduction of oxidic sources of metals with carbon in the presence of a flux. The process can generally be represented as:



During smelting a substance called **flux** is added which removes the non-fusible impurities (**gangue**) as fusible **slag**. This slag is insoluble in the molten metal and is lighter than the molten metal. So, it floats over the molten metal and is skimmed off. For basic impurities, acidic flux is added. e.g.,

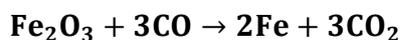
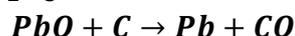
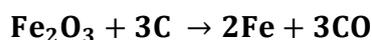


Flux is the material or substance that is added to molten metals to bond with impurities that can be readily removed whereas slag is the waste material which is removed. Fluxes are used during the refining of metals. examples are acid silica, basic lime, rosins etc. The choice of flux depends on the material involved in the given operation

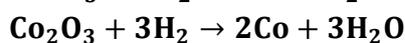
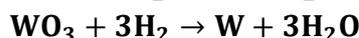
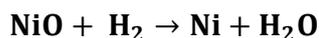
Slag is impure residue that contains large amount of calcium, magnesium silicate, iron, aluminium etc derived during the process of pig iron and steel production and during the smelting of metals such as copper, lead and nickel.

A **gangue** in chemistry can be defined as an unwanted material or impurities in the form of sand, rock or any other material that surrounds the mineral in an ore deposit.

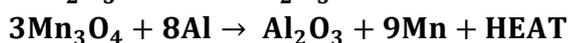
Smelting or Carbon reduction process involves reduction of metal oxides to free metal by coke or carbon monoxide etc.



2. **Reduction by hydrogen:** Metals which are heavier than Magnesium like Ni, Co, W etc are reduced to free metal from corresponding metal oxides. This method is very expensive.



3. **Reduction by aluminium (Aluminothermic process):** Oxides of certain metals like Cr_2O_3 , Mn_3O_4 etc. cannot be reduced by C and Al is used as reducing agent.



This method is highly exothermic. Also known as Goldschmid Aluminothermic process.

Iron oxide Fe_2O_3 and Al powder in 3:1 ratio is called thermite which can be ignited to get the free Iron metal. This method is used in thermite welding.