METALLERGY

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PHYSICAL SCIENCE

C K R M C T E

A huge variety of metals are available in the earth's crust. The naturally occurring metallic compounds mixed with sand, soil, and rocks having a definite chemical composition are called minerals.

A metallic compound having a relatively high concentration of metal and can be used to extract particular elements in convenient and economical manner called ore. Metallurgy definition can be given as the branch of chemistry that deals with the extraction of metal in their pure form from their ore.

Metallurgy Process

Metallurgy process involves the refining of metals and the production of alloys of metals. The impurities present in the ore, which has to be separated in order to obtain desired metal from its ore during the process of extraction, are called gangue. A substance added in the furnace to remove the gangue present in the ore is called flux. The key steps involved in the metallurgy of metals are:

Crushing and grinding of the ore concentration of the ore extraction of the crude metal purification of the metal principles of metallurgy. The processes involved in metallurgy are as follows:

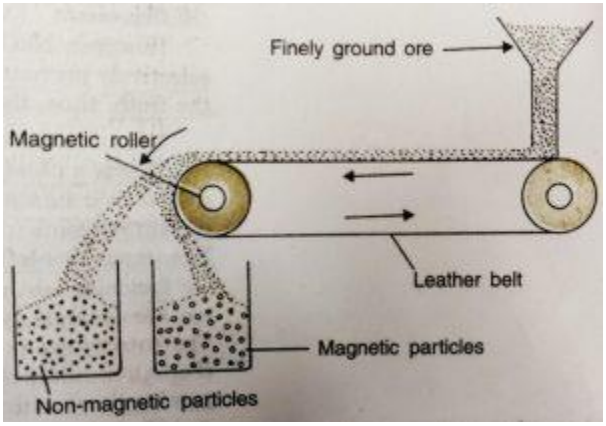
Crushing and Grinding: The primary process involved in the metallurgy of metals is pulverization, which involves the crushing of ores into fine powder in a crusher.

The Concentration of Ores: The ores extracted from the earth's crust contains a large number of unwanted impurities called gangue mixed with them, such as quartz, silicates, sand, feldspar, mica, etc. The removal of these unwanted impurities from the ore is called dressing. The dressing of ore is also called concentration of the ore because it gradually increases the percentage of metal. In metallurgy, the concentration of ore is achieved using the following methods.

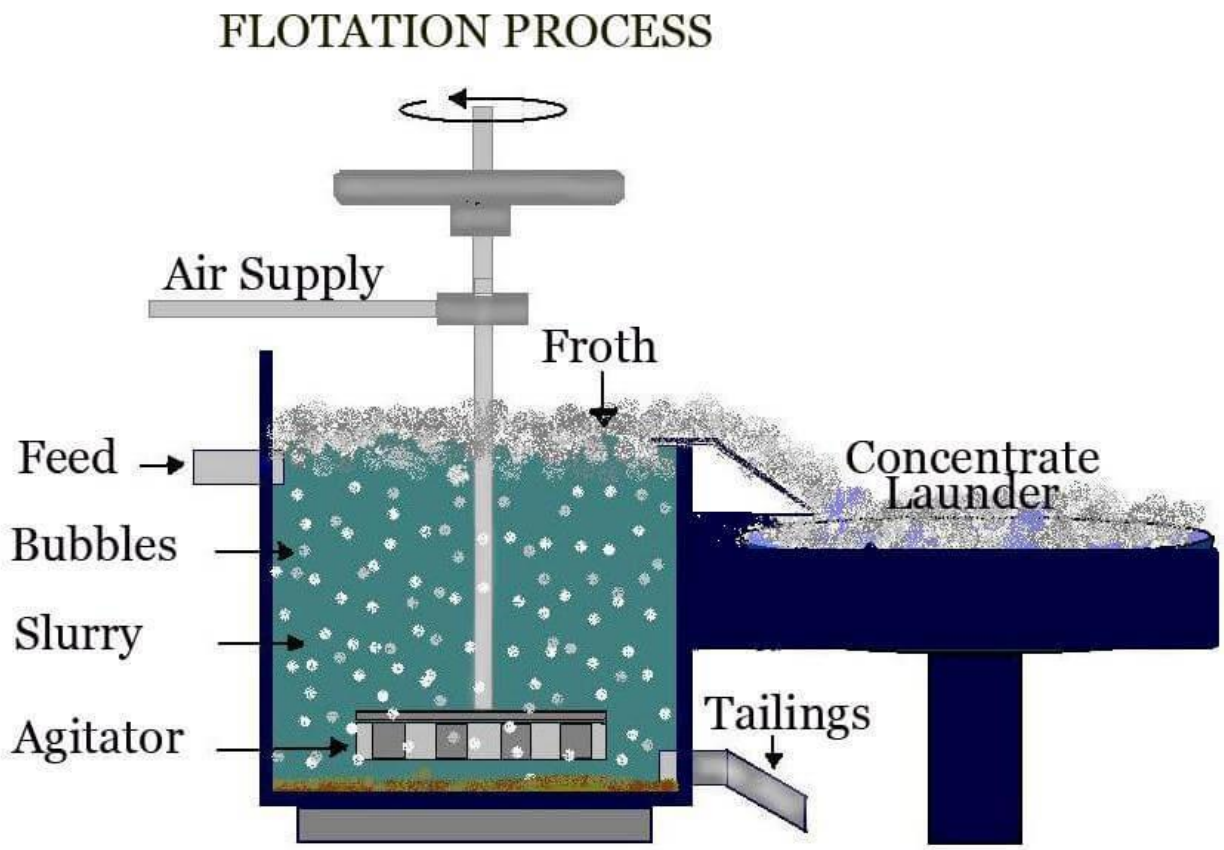
Physical Methods :

Hand-picking is a traditional method of concentrating ore by merely picking it by hand. In this method, the gangue or adhering rocky materials are separated from the ore with the help of a hammer. Hydraulic Method: Hydraulic method or gravity separation or levigation: This method is a gravity separation method of metallurgy, which is based on the differences in the gravity of the ore and gangue particles present in the ore. This method is frequently used when the ore particles are more massive than the rocky gangue particles. It is used to concentrate heavy oxide ores of lead, tin, iron, etc . In this method, the powder ore is agitated with jets of water in 55a hydraulic classifier (or Wilfley table) that makes the more massive ore particle settle down at the bottom and washes away the lighter impurities. The oxides and carbonate ores are concentrated by using this method. This method is also called levigation and is used for gold, chromium, iron, etc.

Magnetic separation: This method of metallurgy is used when either the ore or the impurities are magnetic in nature. For example, magnetic ores like pyrolusite (MnO_2) and chromite ($FeO.Cr_2O_3$) have a difference in the magnetic properties of the ore and gangue particles. In this method, the ground ore is carried on a conveyor belt rotating around two wheels, which passes over a magnetic roller. The magnetic wheel attracts the magnetic particles and separates them from the non-magnetic particles of the mixture.



Froth floatation: The crushed ore is mixed with a mixture of water, pine oil, detergent in a tank to separate sulphide ores. A current of compressed air passes through the pipe of a rotating agitator that produces froth. The presence of differences between the gangue particles and wetting properties of the ore helps to separate them. The pine oil wets and coats the sulphide ore particles which makes them rise up along with the lighter froth. The heavy water wets the gangue particles which sinks to the bottom of the tank. The froth containing the sulphide ore gets transferred to a different container where they are washed and dried.



Chemical Method Leaching: Leaching is a chemical method used for treating ores, which are soluble in a suitable solvent. In leaching, the powdered ore undergoes treatment with specific reagents, which dissolves the ore but not the unwanted impurities. The undissolved impurities are removed by filtration. For example, Bauxite (Al_2O_3) is an ore of aluminum, which contains unwanted

impurities ferric oxide, titanium oxide, and silica. The finely powdered ore of bauxite undergoes treatment with an aqueous solution of sodium hydroxide at about 1500 – 1700C. NaOH dissolves the alumina (Al_2O_3) present in the ore to form soluble meta aluminate, while the other oxides (Fe_2O_3, TiO_2, and SiO_2) remain insoluble and are removed by filtration.

$Al_2O_3.2H_2O$ (s) + 2NaOH(aq) + $3H_2O$ (l) → $2NaAl(OH)_4$(aq)

Sodium aluminate(Hydrated)

$2NaAl(OH)_4$(aq) + CO_2 (g) → $Al_2O_3.xHO$(s) + 2 $NaHCO_3$

The sodium silicate, which remains in the solution, is precipitated out as hydrated alumina and separated by the filtration method. It is then dried by heating to 1470 K, which gives pure alumina.

$Al_2O_3.xH_2O$(s) → Al_2O_3 (s) + xH_2O

This process is called Baeyer’s process.

Roasting: The process of heating a concentrated ore strongly in the presence of excess oxygen at a temperature below the melting point of the metal is called roasting. This process is commonly used for sulphide ores. $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$During Roasting: Sulphides are partially converted to oxides volatile impurities are removed The free elemental forms of sulphur, arsenic, and antimony are removed as SO_2, As_2O_3, and Sb_2O_3, respectively. Calcination: The process of heating a concentrated ore in the absence of air to melt the ores is called calcination. This process is done for carbonate ores

$ZnCO_3 \rightarrow ZnO + CO_2CaCO_3 \rightarrow CaO + CO_2Al_2O_3.2H_2O \rightarrow Al_2O_3 + 2H_2O$

During calcination: Moisture is removed Mass becomes porous volatile impurities are removed carbonate ores decompose to oxides water from hydrated oxide ore is removed Roasting and calcination are carried out in different types of furnaces; the most commonly used is the

reverberatory furnace. In the roasting process, the air holes are always kept open while in the calcination process, the air holes are entirely or partially closed.