**Lection 6. Unit pyrometallurgycal processes**

Extractive metallurgy is the process of the extraction of metals from ores, concentrates (enriched ores), scraps, and other sources and their refining to the state of either liquid metal before casting or to solid metals. The extraction and refining operations that are required may be carried out by various metallurgical reaction processes.

In general, metallurgical separation processes involves chemical reactions, and classified as ***pyrometallurgical, hydrometallurgical,*** and ***electrometallurgical***. The processes are also classified as ferrous [dealing with iron and steel] and nonferrous [dealing with all other metals, e.g. base metals (like Cu, Pb, Zn, Ni, ...), light metals (Al, Mg, Ti), precious metals (Au, Ag, Pt, Pd, ...), rare earth (Ce, Nd, Sm, ...), nuclear metals (U, Th, ...), rare metals (Os, Ru, ...) etc].

Pyrometallurgical processes (in Greak, ‘pyr’ means ‘more at fire’) are carried out at high temperatures.

Hydrometallurgy (in Greak, ‘hydor’ means ‘more at water’) is carried out in aqueous media at high or around room temperature. Electrometallurgy employs electrolysis for separation at room temperature as well as at high temperature.

**Pyrometallurgical processes**

Various pyrometallurgical unit processes are:

1. ***roasting,***
2. ***calcination,***
3. ***smelting,***
4. ***converting,***
5. ***refining,***
6. ***distillation etc.***

Each of these processes serves a specific purpose from the point of view of separation. They require specialized reactor depending upon the phases (solid/liquid/gases) involved, mode of contact, temperature, environmental measures etc.

**Calcination and roasting** are used as pre-treatment prior to other pyro- and hydro- metallurgical operations.

***Calcination*** is the thermal treatment of an ore that brings about its decomposition and eliminates the volatile product—usually carbon dioxide or water. The temperature required for calcination can be calculated from the free energy-temperature, relationship for the reaction under considera­tion. For example, the reaction for the decomposition of calcium carbonate in a kiln is

СаСОз (с) = CaO (с) + C02 (g), *∆G0T* (cal) = 42,300 - 37.7 T.

**Smelting** is the most common of pyrometallurgical operations. Reduction smelting is carried out for oxides. During the smelting, metal compound (e.g. oxide of metal) is reduced to metallic form, and the undesirable impurities (gangue) combine with flux to form *slag.*

**A roasting process** is used to extract metals from sulfide ores: in this process the ore is heated in the presence of oxygen and the sulfur is oxidized and driven off as sulfur dioxide. Some metals in this process remain in the sulfide form, while other metals are turned into an oxide form. The desired metal may be in either product.

**VARIOUS ROASTING PROCESSES ARE:**

* **Oxidizing roasting**
* **Volatilizing Roasting**
* **Chloridizing Roasting**
* **Sulphating roasting**
* **Reduction roasting**
* **Blast roasting or sinter roasting.**

**OXIDIZING ROASTING***,* which is the most important roasting process, burns out the sulphur from a sulphide ore and replaces it, in whole or in part, by an oxide. The general reaction is

MS (c) + 3/202 (g) = MO (c) + S02 (g).

For example, in the case of zinc sulphide, the reaction is

ZnS (c) + 3/202 (g) = ZnO (c) + S02 (g).

**VOLATILIZING ROASTING**

*Volatilizing roasting* eliminates volatile oxides such as AS2O3, Sb203, and ZnO from an ore. In volatilizing roasting, the inflow of oxygen should be carefully controlled, as excessive oxidation may lead to the formation of non-volatile higher oxides.

**CHLORIDIZING ROASTING**

***Chloridizing roasting*** is carried out to convert certain metal compounds to chlorides under oxidizing or reducing conditions. Many metals, for example, uranium, beryllium, niobium, zirconium, and titanium, are extracted from their chlorides

Some chloridizing reactions are

2NaCl + MS + 202 = Na2S04 + MCl2

4NaCl + 2MO + S2 + 302 = 2Na2S04 + 2MCl2

**OTHER KINDS OF ROASTING**

Apart from oxidizing roasting, volatilizing roasting, and chloridizing roasting, there are other kinds of roasting processes, some of which are now mentioned. *Sulphating roasting* converts certain sul­phide ores to sulphates, usually prior to leaching. An example of *magnetic roasting* is the controlled reduction of hematite (Fe203) to magnetite (Fe304). *Reduction roasting* is the partial reduction of an oxide ore prior to actual reduction smelting. *Blast roasting* or *sinter roasting* not only modifies the physical condition of an ore (e.g., agglomeration) but also helps in its partial oxidation.

1. Source - ресурс
2. *slag* **– шлак;**
3. impurity – примесь
4. solid – твердый
5. involve – привлекать
6. flux - флюс
7. **Smelting** – выплавка, плавление;
8. Oxidizing roasting – окислительный обжиг;
9. Volatilizing Roasting – возгоночный обжиг;
10. Chloridizing Roasting – хлорирующий обжиг;
11. Sulphating roasting – сульфатизирующий обжиг;
12. Reduction roasting – восстановительный обжиг;
13. Blast roasting – обжиг с дутьем;
14. sinter roasting – агломерирующий обжиг
15. calcinations- кальцинирование, прокаливание