2.8. ALUMINUM PRODUCTION

Properties and directions of application of aluminum. Raw materials for the production of aluminum. The general scheme of aluminum production. Alumina production. Electrolytic production of aluminum. Cleaning and refining of aluminum. Production of cryolite and coal products

Aluminum is widespread in nature and takes the first place among metals, and is also one of the most popular elements.

The raw materials for the production of aluminum are bauxite: $HAlO_2$ (diasporas); $Al(OH)_3$ (hydroargelite); $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$ (coalinite); α-Al_2O_3 (corundum); nepheline: $(Na, K)_2O \cdot Al_2O_3 \cdot 2SiO_2$ (from fluoroappatite); alunites: $(Na, K)_2SO_4 \cdot Al_2 (SO_4)_3 \cdot 4Al (OH)_3$; kaolins (clays): $Al_2O_3 \cdot SiO_2 \cdot MeO_x \cdot xH_2O$; feldspar (orthoclase): $K_2O\ Al_2O_3 \cdot 6SiO_2$.

The composition of bauxite includes such basic components as: alumina (28-70%); silica (0.5-20%); Fe_2O_3 (2-50%); TiO_2 (0.1%) and other oxides. Alumina consists of hydroxides, corundum and kaolinite.

An important component of aluminum-containing raw materials is the silicon module (Al_2O_3 / SiO_2): bauxite (30-60% Al_2O_3); nepheline concentrate (30% Al_2O_3); alunites (20% Al_2O_3); kaolins (up to 40% Al_2O_3).

Alumina production

There are three methods for producing aluminum oxide from ores:

- acidic;
- electrolytic;
- alkaline.

Technologies for producing alumina from bauxite include alkaline processing and melt electrolysis:

1) Alkaline treatment (Si <5% Bayer method; if > 5% - sintering method)
(3 t of bauxite + 0.25 t (42%) $NaOH$ = 1 t Al_2O_3; E = 300 kWh):

$$HAlO_2 + NaOH \rightarrow NaAlO_2 + H_2O;$$

$$Al(OH)_3 + NaOH \rightarrow NaAlO_2 + H_2O;$$

$$SiO_2 + NaOH \rightarrow Na_2SiO_3 + H_2O;$$

$$2Al(OH)_3 \rightarrow Al_2O_3 + 3H_2O \text{ (1,200 °C, calcination);}$$

2) *Melt electrolysis* (10-13%) of Al_2O_3 in cryolite $3NaF{\cdot}AlF3$ (Na_2AlF_6)
(I = 150 000 A; U_{bath} = 4-5 B; T = 950-960°C; products: Al and O_2)

The device and principle of operation of the electrolysis furnace:

$T_{melting}$ Al_2O_3 = 2,050°C;

$T_{melting}$ cryolite = 1,100°C.

The cell is an iron casing, lined with refractory bricks from the inside; *the bottom* is the cathode (blocks of compressed coal); *top anode* - aluminum frames filled with coal briquettes.

$$Al_2O_3 = Al^3 + AlO_3^{3-}$$