

The Bayer process

Use the attached map of the aluminium-plant to fill in the four steps of the process. Wherever possible, add reaction equations and indicate if the Steps involve a chemical reaction or a physical process.

The Bayer process involves four steps: digestion, clarification, precipitation, and calcination. In the first step, bauxite is ground, mixed with a solution of caustic soda (sodium hydroxide) and pumped into large pressure tanks called digesters, where the ore is dissolved under steam heat and pressure. The sodium hydroxide reacts with the hydrated aluminium oxide ($\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$ or $\text{Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$) of bauxite to form a saturated solution of sodium aluminate ($\text{Na}[\text{Al}(\text{OH})_4]$); insoluble impurities, called red mud because of their iron oxide content, settle to the bottom. During clarification, the mixture is passed through a series of pressure-reducing tanks (called blow-off tanks) and filter presses. Filters catch the red mud, which, except at plants where lower grade ores are refined, is discarded. A resultant green liquor passes through filters into cooling towers (heat exchangers) and then into tall, silo-like precipitators. Sizable amounts of hydrated alumina ($\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$) crystals are added to the solution in the precipitators as "seeding" to hasten crystal separation. The seed crystals attract other crystals and form groups physically heavy enough to settle out of solution. This precipitate of aluminium hydrate ($\text{Al}(\text{OH})_3$) crystals is filtered out, washed to remove impurities, and heated in long, rotary kilns at temperatures in excess of 1800°F (980°C). Free water and water that is chemically combined or fluidized-bed calciners with the aluminium hydrate are driven off, leaving commercially pure alumina – or aluminium oxide – (Al_2O_3) a superdry, fine white powder similar to sugar in appearance and consistency. It is still half aluminium and half oxygen by weight, bonded so firmly that neither chemicals nor heat alone can separate them.

(from: Encyclopedia Britannica)

to discard - to throw away

filter press – Filterpresse

impurity - Verunreinigung

lower grade - less rich in aluminium oxide

plant - here: factory

resultant (adj) – to be the result of something

rotary kiln – Drehrohrföfen

saturated – gesättigt

seeding - hier: Impfkristalle

sizable amounts of sth. - quite a lot of sth.