

Bayer process

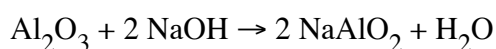
The **Bayer process** is the principal industrial means of refining [bauxite](#) to produce [alumina](#) (aluminium oxide). Bauxite, the most important ore of [aluminium](#), contains only 30–54% [aluminium oxide](#), (alumina), Al_2O_3 , the rest being a mixture of [silica](#), various [iron oxides](#), and [titanium dioxide](#).^[1] The aluminium oxide must be purified before it can be refined to aluminium metal.

Process

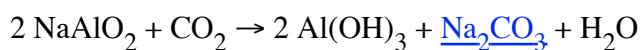
The Bayer process

In the Bayer process, bauxite ore is heated in a pressure vessel along with a [sodium hydroxide](#) solution at a temperature of 150 to 200 °C. At these temperatures, the [aluminium](#) is dissolved as [sodium aluminate](#) in an extraction process. The aluminium compounds in the bauxite may be present as [gibbsite](#)($\text{Al}(\text{OH})_3$), [boehmite](#)(AlOOH) or [diaspore](#)(AlOOH); the different forms of the aluminium component will dictate the extraction conditions. After separation of the residue by filtering, gibbsite ([aluminium hydroxide](#)) is precipitated when the liquid is cooled and then seeded with fine-grained aluminium hydroxide.

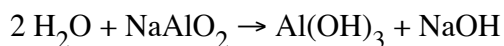
The extraction process converts the aluminium oxide in the ore to soluble [sodium aluminate](#), 2NaAlO_2 , according to the [chemical equation](#):



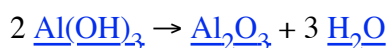
This treatment also dissolves silica, but the other components of bauxite do not dissolve. Sometimes [lime](#) is added at this stage to precipitate the silica as [calcium silicate](#). The solution is clarified by filtering off the solid impurities, commonly with a rotary sand trap and with the aid of a flocculant such as [starch](#), to remove the fine particles. The undissolved waste after the aluminium compounds are extracted, [bauxite tailings](#), contains [iron oxides](#), [silica](#), [calcia](#), [titania](#) and some unreacted [alumina](#). The original process was that the [alkaline](#) solution was cooled and treated by bubbling carbon dioxide through it, a method by which aluminium hydroxide [precipitates](#):



But later, this gave way to seeding the supersaturated solution with high-purity [aluminium hydroxide](#) ($\text{Al}(\text{OH})_3$) crystal, which eliminated the need for cooling the liquid and was more economically feasible:



Some of the aluminium hydroxide produced is used in the manufacture of water treatment chemicals such as [aluminium sulfate](#), PAC (Poly aluminium chloride) or sodium aluminate; a significant amount is also used as a filler in rubber and plastics as a fire retardant. Some 90% of the gibbsite produced is converted into [aluminium oxide](#), Al_2O_3 , by heating in rotary kilns or fluid flash calciners to a temperature in excess of 1000 °C.



The left-over or 'spent' [sodium aluminate](#) solution is then recycled. This, however, allows

[gallium](#) and [vanadium](#) impurities to build up in the liquors, so these can be extracted.

For bauxites having more than 10% silica, the Bayer process becomes uneconomic due to insoluble [sodium aluminium silicate](#) being formed, which reduces yield, and another process must be chosen.

Over 90% of the aluminium oxide produced is used in the [Hall–Héroult process](#) to produce aluminium.