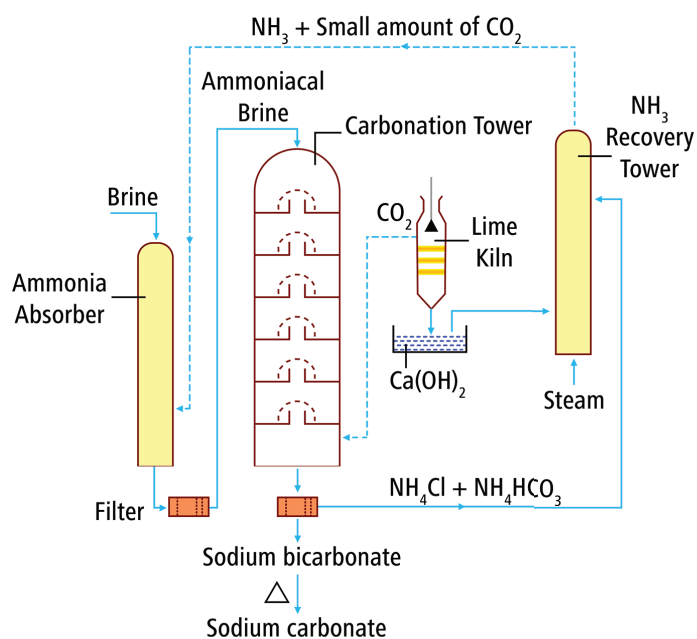


## Analysis of Ammonia in the Preparation of Ammonia-Saturated Brine

Soda ash, otherwise known as sodium carbonate ( $\text{Na}_2\text{CO}_3$ ), is a key chemical in the production of many goods, such as glass, soap, and paper, as well as for treating water and scrubbing sulfur compounds from smokestack emissions. There are two ways to manufacture soda ash: the industrial Solvay process or mining from ores (trona and nahcolite). The Solvay process is most commonly used in Europe, where the mining of ores is not economically feasible.

The major components necessary for the Solvay process besides water are limestone ( $\text{CaCO}_3$ ), brine (saturated  $\text{NaCl}_{(aq)}$ ), ammonia ( $\text{NH}_3$ , 10–35%), and carbon (coke) for the lime kiln (oven). First, ammonia gas is absorbed into concentrated brine solution. Limestone is heated, producing  $\text{CaO}_{(s)}$  (used in a final step) and  $\text{CO}_{2(g)}$  which is mixed with the ammoniated brine in a carbonation tower to form ammonium bicarbonate ( $(\text{NH}_4)\text{HCO}_3$ ). This intermediate can easily degrade on its own, but in the presence of the brine solution it reacts further, forming  $\text{NH}_4\text{Cl}$  and  $\text{NaHCO}_3$ . The sodium bicarbonate is then removed by filtration and heated to produce the final product:  $\text{Na}_2\text{CO}_3$ . The  $\text{CaO}_{(s)}$  (left over from heating the limestone) is mixed with water (slaking) to form  $\text{Ca}(\text{OH})_2$ , which is used to recover  $\text{NH}_3$  by reacting with the ammonium chloride solution. Ammonia is then recycled within the process. Our process analyzers will monitor the amount of ammonia in saturated brine after the absorption tower and help to adjust the concentrations to ensure a good product yield in the carbonation tower. Additionally, an alarm can be sent to a control room if concentrations are out of specification.



*Simplified diagram of the Solvay process used to manufacture sodium carbonate ( $\text{Na}_2\text{CO}_3$ ).*

**Application:** Sample acidified with HCl is accurately titrated with 0.5 mol/L NaOH solution. The indication is performed with a combined pH electrode, and the result is calculated as ammonia.

**Typical Range:** Saturated brine: 55–135 g/L  $\text{NH}_4^+$

**Remarks:** Other applications are available for the soda ash industry such as: alkalinity, carbonate, chloride, calcium oxide, carbon dioxide, and hardness.