

ChE 308

Lecture 4

Chlor-Alkali Industries: Caustic soda, Chlorine, Soda Ash(cont'd)

Sodium Carbonate Production

SOLVAY TECHNIQUE

- The Overall reaction:



Besides Soda the Solvay Technique also causes CaCl_2 as a by-product.

- General bases of the production process:

For the manufacture of 1 ton of Soda Ash by means of SOLVAY TECHNIQUE 1.5 ton salt, approximately 80 m³ water, 1.2 ton limestone and 0.1-0.5 ton coke are required.

Sodium Carbonate Production cont'd

SOLVAY TECHNIQUE cont'd

The total process can be divided into the following reaction steps:

1. Brine Cleaning
2. Manufacture of the product
3. Lime Milk preparation
4. NH_3 recovery

Sodium Carbonate Production cont'd

1. Brine Cleaning

- Precipitation of Magnesium Hydroxide and Calcium Carbonate by the addition of lime milk and soda solution into the brine:



2. Manufacture of the product

- Precipitation of the relatively heavy-soluble bicarbonate (NaHCO_3) by the addition of carbonic acid into a salt solution saturated with ammonia:



- Thermo decomposition of the bicarbonate:



Sodium Carbonate Production cont'd

3. Lime Milk preparation

- Manufacture of caustic lime:

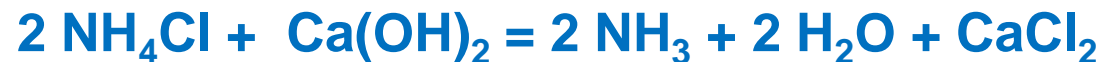


- Manufacture of lime milk:



4. NH₃ recovery

- Recovery of the ammonia by distillation of ammonium chloride containing mother liquor with lime milk:



- The calcinations also lead to the following parallel reactions, which generate ammonia as well as sodium chloride:

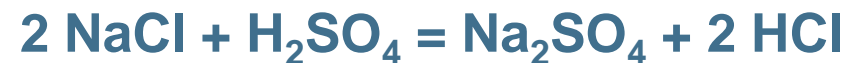


In this side reaction, soda is polluted with sodium chloride

Sodium Carbonate Production cont'd

LeBlanc Process

- The LeBlanc process was a batch process in which sodium chloride was subjected to a series of treatments, eventually producing sodium carbonate.
- In the first step, the sodium chloride was heated with sulfuric acid to produce **sodium sulfate (salt cake)** and **hydrochloric acid gas** according to the chemical reaction:



- LeBlanc's contribution was the second step, in which the salt cake was mixed with **crushed limestone (calcium carbonate)** and coal and fired.
- In the ensuing chemical reaction, the coal (carbon) was oxidized to **carbon dioxide**, reducing the **sulfate** to **sulfide** and leaving behind a solid mixture of sodium carbonate and calcium sulfide (black ash).



Sodium Carbonate Production cont'd

LeBlanc Process cont'd

- Because sodium carbonate is soluble in water, but neither calcium carbonate nor calcium sulfide is, the soda ash was then separated from the black ash by washing it with water.
- The wash water was then evaporated to yield solid sodium carbonate. This extraction process was termed lixiviation.

Sodium Carbonate Production cont'd

Uses of sodium carbonate include:

- manufacture of soap, glass, ceramics, paper, sodium hydroxide and sodium hydrogen carbonate (carb. soda)
- petroleum refining
- water softener
- cleaner and degreaser in washing compounds
- removing sulfur dioxide from waste gases in power stations.