AMMONIA SOLVAY'S PROCESS

INTRODUCTION:

The method commonly used for the preparation of sodium bicarbonate and sodium carbonate was designed by a Belgian engineer Solvay and is called Solvay's process.

RAW MATERIALS:

i. Saturated solution of NaCl (Brine)
ii. Ammonia (NH_3)
iii. Lime Stone
iv. Water.

STEPS OF MANUFACTURING

a. Ammoniation Of Brine:

Ammonia gas containing a little CO_2 is passed through brine to saturate it.

$$2NH_3 + CO_2 + H_2O \longrightarrow (NH_4)_2CO_3$$

Salts of magnesium and calcium are precipitated as carbonates, if present as impurities:

$$Ca^{+2} + (NH_4)_2CO_3 \longrightarrow CaCO_3 + 2NH_4^+$$

$$Mg^{+2} + (NH_4)_2CO_3 \longrightarrow MgCO_3 + 2NH_4^+$$

b. Carbonation:

The ammonia brine is passed to carbonating tower (Solvay tower) where CO_2 is pumped in at the bottom of the tower following reactions take place.

$$(NH_4)_2CO_3 + CO_2 + H_2O \longrightarrow 2NH_4HCO_3$$

$$2NH_4HCO_3 + NaCl \longrightarrow NH_4Cl + NaHCO_3$$

*CO_2 required in this step is obtained by heating calcium carbonate in a special kiln called lime kiln.

$$CaCO_3 \longrightarrow CaO + CO_2$$

c. Filteration:

The solid sodium bicarbonate is filtered off, washed with a l;ittle water and dried, where as filtrate is sent to ammonia recovery tower.

d. Calcinations:

Sodium bicarbonate obtained in the above step is heated to get anhydrous sodium carbonate i.e. Soda ash.

$$2NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2$$

Carbon dioxide obtained here is recycled for carbonation. If washing soda i.e.$Na_2CO_3.10H_2O$ is required then dissolved soda ash in hot water and crystallized by cooling as $Na_2CO_3.10H_2O$.

$$Na_2CO_3 + 10H_2O \longrightarrow Na_2CO_3.10H_2O$$

e. Recovery Of Ammonia:

As ammonia is much more costly than sodium carbonate or sodium bicarbonate therefore it is recovered in ammonia recovery tower by the following processes.

$$Ca(OH)_2 + 2NH_4Cl \longrightarrow CaCl_2 + 2NH_3 + 2H_2O$$

$$Ca(OH)_2 + (NH_4)_2CO_3 \longrightarrow CaCO_3 + 2NH_3 + 2H_2O$$

ADVANTAGES OF SOLVAY'S PROCESS

i. It employs cheap materials.
ii. The consumption of fuel is much less, since there is no solution to evaporate.
iii. No harmful by products are produced.
iv. A pure product is obtained.
v. Raw materials NH_3 and CO_2 are recovered and recycled.

CHEMICAL REACTION OF SODIUM CARBONATE

a. Hydrolysis:

Hydrolysis of sodium carbonate produces strong alkali. That is why aqueous solution of sodium carbonate is alkaline in nature.

$$Na_2CO_3 + 2H_2O \longrightarrow \underset{\text{Weak acid}}{H_2CO_3} + \underset{\text{Strong alkal}}{NaOH}$$

b. Reaction With CO_2:

When CO_2 is passed through a cold solution of sodium carbonate, sodium bicarbonate is formed.

$$Na_2CO_3 + H_2O + CO_2 \longrightarrow 2NaHCO_3$$

c. Action Of Dilute Acids:

On treating with dilute acid it produces carbon dioxide.

$$Na_2CO_3 + HCl \longrightarrow NaCl + H_2O + CO_2$$

$$Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + CO_2$$

d. Precipitation Of Insoluble Metallic Carbonates:

Precipitation of metallic carbonates are occurs when aqueous solution of sodium carbonate is mixed with the solution containing metallic cat ion.

$$Ba(NO_3)_2 + Na_2CO_3 \longrightarrow 2NaNO_3 + BaCO_3\downarrow$$

$$CaCl_2 + Na_2CO_3 \longrightarrow 2NaCl + CaCO_3\downarrow$$

USES:

1. Soda ash is used in the manufacture of glass enamels, soaps and paper.
2. It is used for water softening.
3. Sodium carbonate $Na_2CO_3.10H_2O$ is marketed as washing soda.
4. It is used as a common laboratory reagent.
5. It is used in the smelting of iron ores of high sulphur content.

SODIUM HYDROGEN CARBONATE

Properties of Sodium Hydrogen Carbonate

a. PHYSICAL PROPERTIES:

i. It is white non crystalline compound.
ii. Its taste is bitter, although commonly known as meetha soda.
iii. It is soluble in water, but its solubility is less than that of sodium carbonate.
iv. It is weakly alkaline and its solution changes red litmus to blue.

b. CHEMICAL PROPERTIES:

i. When heated, it loses carbon dioxide and changes to sodium carbonate.

$$2NaHCO_3 \xrightarrow{heat} Na_2CO_3 + H_2O + CO_2$$

ii. With acids it forms salt and water, carbon dioxide is also given out.

$$2NaHCO_3 + HCl \longrightarrow NaCl + H_2O + CO_2$$

USES:

i. It is as baking powder (mixture of $NaHCO_3$ + Citric acid)
ii. Used in fire extinguishers to get CO_2 gas for extinguishing fire.
iii. Used as an anti acid (medicine) to cure acidity (hyper acidity).
iv. Used in preparation of effervescent drinks and fruit salts.
v. Used in the textile, tanning, paper, ceramics industries.

SODIUM HYDROXIDE

Properties Of Sodium Hydroxide

a. PHYSICAL PROPERTIES:

i. It is white crystalline solid.
ii. It melts at 318°C to a clear liquid, and at 322°C, it decomposes.
iii. Its density is 2.13 g/cm^3.
iv. It is highly soluble in water and liberate large amount of heat.

b. CHEMICAL PROPERTIES:

The chemical reactions of NaOH are following.

i. Reaction With Acids:

It reacts with acids to form salt and water.

For Example:

1. $NaOH + HCl \longrightarrow NaCl + H_2O$
2. $2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O$
3. $NaOH + HNO_3 \longrightarrow NaNO_3 + H_2O$

ii. Reaction With Ammonium Salts:

When NaOH reacts with ammonium salt it liberates ammonia gas on warming.

1. $NaOH + NH_4Cl \xrightarrow{\Delta} NaCl + NH_3 + H_2O$
2. $2NaOH + NH_4NO_3 \xrightarrow{\Delta} Na_2SO_4 + NH_3 + H_2O$

iii. Reaction With Carbon Dioxide:

It absorbs carbon dioxide to produce sodium carbonate and water.

$$2NaOH + CO_2 \longrightarrow Na_2CO_3 + H_2O$$

iv. Reaction With Chlorine Gas:

The reaction of sodium hydroxide with chlorine gas results in the formation of sodium salt of oxy acids such as,

$$2NaOH + Cl_2 \longrightarrow NaOCl + NaCl + H_2O$$
$$6NaOH + 3Cl_2 \longrightarrow NaClO_3 + NaCl + H_2O$$

v. Reaction With Metals:

Sodium hydroxide dissolves certain metals like zinc, tin, aluminum etc to liberate H_2 gas.

$$2\,NaOH + Zn \longrightarrow \underset{\text{Sodium Zincate}}{Na_2ZnO_2} + H_2$$

$$2\,NaOH + Sn \longrightarrow \underset{\text{Sodium Stannite}}{Na_2SnO_2} + H_2$$

$$2\,NaOH + Al + 2H_2O \longrightarrow \underset{\text{Sodium Aluminate}}{Na_2AlO_2} + 3H_2$$

USES OF SODIUM HYDROXIDE:

1. It is used in the manufacture of soap and petroleum industry.
2. It is used in textile and paper industries.
3. It is used in bleaching and dying process as well as for mercerizing the cotton cloths.
4. It is used in purification of bauxite.
5. It is used in manufacture of artificial silk.

FOOD PRESERVATION

INTRODUCTION:

Food whether grown on trees e.g. fruits, in the ground as plants e.g. vegetables, cereals etc. or as animals e.g. mutton, beef etc, above the ground do not last forever. Fruits, vegetables and cereals grains begin to deteriorate once they are harvested. Similarly meat begins to deteriorate in quality soon after slaughter of the animal.

In this modern world, the food needs to be stored or supplied to distant areas, it is therefore necessary to prevent the food from being destroyed or spoiled.

CAUSES OF FOOD SPOILAGE:

The food may subject to several decay mechanisms.

For example:

- Moisture
- Biological attack by pests
- Disease or decay micro organisms
- Chemical reaction
- Physical changes

The producer and processor therefore want to prevent or minimize chances of spoilage of the foods.

i. Moisture:

The agriculture products of low moisture contents such as corn and soya bean when exposed to higher humidity take up enough moisture contents to permit the growth of moulds and bacteria.

ii. Microbial Activities:

There are several kinds of food which tend to spoil by microbial attack. Fish, poultry and dairy products are specifically spoiled by microbial growths.

iii. Chemical Changes:

The chemical changes brought by enzymes are responsible for food spoilage. These enzymes may have their origin in the food material or may be produced by yeast, moulds and bacteria which contaminate the product. The chemical and biochemical changes renders the fats and oil rancid and are also responsible for browning of fruits and vegetables.

FOOD PRESERVATION METHODS:

There are numerous methods of preservation of foods. Some of the most widely used ones are described here.

i. Removal Of Moisture:

This method of preservation of food relates with removal of water or drying process. The products that need to be dried are the various pastes, milk, coffee and tea, some vegetables, fruits, meat and eggs.

ii. Addition Of Salt And Sugar:

As a means of chemical preservation, sugar and salt are added to many sausages to increase their shelf life. The sugar and salt bind the water, which helps the microorganisms to grow. The inhibition in growth of microbes by this way retards the process of food spoilage. The water binding agents are known as humectants.

iii. Temperature Control:

One of the controlling factors for preservation of food is temperature. Environmental conditions related to temperature though not destroy organisms however it prevents their growth. Refrigeration and freezing of foods in this respect lowers the environmental temperature to levels which do not allow the growth of many destructive organisms.

iv. Preservation By Storage:

Many types of fresh foods such as fruits, vegetables, meats, fish etc. when required to be stored for long term are preserved by heat treatment employing various methods. Among these methods canning and irradiation are noteworthy.

a. Canning:

The preservation of food by sealing into air tight containers is called canning. The method is widely used for food preservation. The containers may be metal which is often plastic lined aluminum or special strength glass. The raw food is packed into the container sealed and then whole package is then treated with heat in a steam pressure used to cook the food and sterilized both the container and the contents.

b. Irradiation:

The process of passing radiation through any substance is called irradiation. The radiation is comprised of alpha (α), beta (β) and gamma (γ) rays.

Radiation can be used to preserve food such as meat, potatoes and onions etc. without causing undesirable protein denaturation or appreciably altering the taste. The process leaves no residual radioactivity in the food. There is a little loss of vitamins in all foods by the recommended doses then that seen with canning, freezing or drying.

v. Preservation By Chemical Addition:

Certain chemical substances are added in small proportions to preserve food. In this regard commonly used food additions are salts of calcium, magnesium, potassium and sodium.

a. The use of sodium sulphide and potassium meta - bi - sulphite is to prevent the growth of micro organisms.

b. Sodium dihydrogen phosphate is incorporated to improve the texture and magnesium hydroxide reduces the acidity in foods.

c. Addition of common salt preserves meat and fish items.

d. Propanoic acid, benzoic acid and their salts prevents the bread and cheese from moulds and yeasts.

e. Dry fruits, jam and jellies are preserved by addition of sulphur dioxide or salts of sulphurous acid.

SOAPS

DEFINITION:

The sodium and potassium salts of fatty acids for cleaning purpose are called soaps.

Example:

1. Potassium Palmitate ($C_{15}H_{31}COOK$)
2. Sodium Stearate ($C_{17}H_{35}COONa$)
3. Sodium Palmitate ($C_{15}H_{31}COONa$)
4. Potassium Oleate ($C_{17}H_{33}COOK$)

RAW MATERIALS:

i. Tallow:

It is the main fatty materials used in soap making vegetable oil like linseed oil or palm oil and animal fat can also be used in place of tallow.

ii. Caustic Soda or Caustic Potash:

NaOH KOH

MANUFACTURE OF SOAP: (SAPONIFICATION)

Large units known as kettles are used for preparation of soap nowadays. Animal fat or vegetable oil is placed in large tank and alkali (NaOH/ KOH) is added.

The mixture is mixed with steam and boiled during reaction using a steam coil. The chemical process for the preparation of soap is called saponification. The reaction is represented by the following equation.

SEPARATION OF GLYCERIN (SALTING OUT):

Salt is added to the soap and glycerin mixture. Salt solution with glycerin settles down as it is heavier than soap. This process is called salting out.

The salt water glycerin solution is drained from the tank and glycerin as a byproduct is separated.

TYPES OF SOAP:

i. **Laundry Soap:**

Soap precipitated is mixed with resin, some more caustic soda solution is added and mixture is boiled.

To increase its weight sodium silicate is added which also makes it less soluble. Washing soda and sodium phosphate are called to improve washing quality. It is now molded into soap, cake or blocks.

ii. **Toilet Soap:**

Good quality fat and edible oils used for toilet soap. Soap is passed through hot heavy rollers to remove the moisture color and perfumes are added to it and casted into soap cakes.

iii. **Kitchen Soap:**

The soaps containing finely divided sand, washing soda are called kitchen soaps. It is used in kitchen for washing utensils.

iv. **Shaving Cream:**

Good quality animal fat or edible oil is saponified using caustic potash (KOH). Some extra amount of steric acid is added to prevent it from quick drying.

PLASTICS

DEFINITION:

Plastics are high molecular compounds formed as a result of polymerization or poly condensation of simple molecules.

CLASSIFICATION:

Plastics are divided into two basic types,

1. Thermoplastics
2. Thermosetting plastics

◆ **Thermoplastic:**

On heating these plastics become soft. On cooling they regain their rigidity, they can be heated and cooled repeatedly without any change in composition such plastics are easily molded into shapes.

Example:

Cellulose nitrate, cellulose acetate and vinyl polymers are examples of this class.

◆ **Thermosetting Plastics:**

Thermosetting plastics become soft on heating on further heating, they become permanently hard. They can cot be softened again. They are practically insoluble in all organic solvents and water.

Example:

Bakelite, epoxy resins (araldite and adhesives)

SOME COMMON PLASTICS & THEIR USES:

a. Polythene (Poly Ethylene):

It is the polymer of ethene.

$$n(CH_2 = CH_2) \xrightarrow[0.01\% \text{ oxygen}]{100atm \; ; \; 200°C} (—CH_2—CH_2—)n$$

Polythene

It is most commonly used in the preparation of polythene bags and plastic bottles.

b. Poly Vinyl Chloride:

It is the polymer of vinyl chloride.

c. Bakelite:

It is the polymer of phenol and form aldehyde.

It is used to manufacture components of electric board sheets, camera, radio, telephone etc.