ACID, BASES AND SALTS (MODULE-4/4)

(WRITEUP)

In this module we will be learning about various products derived from NaCl and Water of crystallisation

1. Sodium hydroxide (NaOH), Chlorine Gas and hydrogen gas.
2. Bleaching powder**:**
3. Baking soda (Sodium hydrogen carbonate ($NaHCO_3$)
4. Baking powder
5. Washing soda (**Na_2CO_3 .10H_2O)**

Electrolysis of brine we have done in last module where we have got byproduct as NaOH, chlorine and hydrogen gas.

2. Bleaching powder:
As we have seen that chlorine is produced during the electrolysis of aqueous sodium chloride (brine). This chlorine gas is used for manufacture of bleaching powder.

Bleaching powder is represented as $CaOCl_2$ (calcium chloro hypo chloride), though the actual composition is quite complex.
Bleaching powder is produced by the action of chlorine on dry slaked lime [$Ca(OH)_2$]. It is a dirty white amorphous powder with pungent smell of chlorine gas

$Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$
Raw materials

The manufacture of bleaching powder is carried out in Hasenclever plant as Bachmann's process.

The plant consists of four vertical cylinder of cast iron. Each cylinder is about to 2-3 m long. Each cylinder is provided with a stirrer to ensure the mixing of substances. There is an inlet known as hopper in the upper most cylinders for slaked lime. The bottom cylinder has an inlet for chlorine gas and one outlet for bleaching powder. At the top of the cylinder it has one more outlet for exhaust of waste gases. Each cylinder is connected to the other by means of pipes.

Process: Slaked lime is introduces in the first cylinder with the help of hopper. Chlorine gas is introduced from the lower most cylinders. In this way, these two substances meet, when proper saturation is reached, the product is separated from the last cylinder as bleaching powder. The chlorine used in manufacture of bleaching powder should be dilute and the temperature should be maintained below 40°C

Properties:

- It is a pale yellow powder.
- It has strong smell of chlorine.
- It is soluble in water but a clear solution is never formed due to the presence of impurities.

Uses:

- It is used as an oxidizing and bleaching agent in textile and other industries.
- It is used as a disinfectant and germicide for the purification of drinking water.
- It is also used as an antiseptic.
- It is also used for making wool unshrinkable.

3. Baking soda (Sodium hydrogen carbonate ($NaHCO_3$)

- It is commonly used in kitchen for making crispy food.
- Sometimes it is used to cook food fastly also.
- It is a mild non-corrosive base.
- It is used in cake to make it soft and spongy.
- It is one of the ingredients in antacids because it neutralises excess acid in stomach.
- It is also used in fire extinguishers.
- The chemical name of the compound is sodium hydrogen carbonate
- It is produced using sodium chloride as one of the raw materials.

$$NaCl + H_2O + CO_2 + NH_3 \rightarrow NH_4Cl + NaHCO_3$$

4. It is used for making BAKING POWDER, which is a mixture of baking soda (sodium hydrogen carbonate) and a mild edible acid such as tartaric acid.

- When baking powder is heated or mixed in water, the following reaction takes place
- $NaHCO_3 + \quad H^+ \rightarrow CO_2 + H_2O$ + Sodium Salt of Acid

  (from any Acid)

- Carbon dioxide produced during the reaction causes bread or cake to rise making them soft and spongy.

5. Washing soda ($Na_2CO_3 .10H_2O$):

- Washing soda is sodium carbonate decahydrate.
- Its chemical formula is $Na_2CO_3 .10H_2O$.
- It is a molecule of sodium carbonate (Na_2CO_3) having ten molecules of water

PREPARATION OF WASHING SODA

- Washing soda is manufactured by Solvay process, also called Ammonia- soda process.
- In the first step, sodium carbonate is obtained by heating baking soda.
  $2\ NaHCO_3$ (heat) $\rightarrow Na_2CO_3 + H_2O + CO_2$
- Then washing soda is produced by recrystallisation of sodium carbonate $Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3 .10H_2O$

Are the crystals of salt really dry?

Activity

Aim: To show crystalline salts contain water of crystallization

Materials required: CuSO4.5H2O (Blue vitrol), boiling tube, burner, cork, delivery tube, test tube, clamp, stand.

Procedure:

- Heat a few crystals of copper sulphate in a dry boiling tube fitted in a clamp stand.
- Observe the colour change of copper sulphate after heating.
- Check the presence of water droplets in the boiling tube. Where have these come from?
- Then add 2-3 drops of water to dry copper sulphate.

- Again observe the colour change

Observation: Water vapours get condensed in a test tube and colour of blue crystals changes into white. On adding water to anhydrous copper sulphate it changes into blue again.

Chemical reaction:

On heating $CuSO_4.5H_2O$ (blue vitrol) → $CuSO_4 + 5H_2O$

Conclusion: Crystalline substances seem to appear dry but have water of crystallization which is lost on heating.

WATER OF CRYSTALLISATION is the fixed number of water molecule present in one formula unit of salt

Water of crystallisation (Hydrated salts) gives colour, shape to the crystal salts.

On heating hydrated salts becomes anhydrous (becomes powder, lose colour and shape)

Anhydrous substances are used to test moisture in liquid.

Other examples- $Na_2CO_3.10H_2O$, $CaSO_4.2H_2O$ (Gypsum)

•Plaster of Paris: Obtained from gypsum.

Calcium sulphate hemihydrates ($CaSO_4.\ ½H_2O$) made from Gypsum($CaSO_4.2H_2O$)

$CaSO_4.\ ½\ H_2O$ (POP) prepared by heating Gypsum at 373K or 100°C

$CaSO_4.\ 2H_2O$ (Heat at 373K) → $CaSO_4.\ ½\ H_2O + 1½\ H_2O$

If heated above 100°C, there will be complete loss of water of crystallisation. It will result into anhydrous calcium sulphate also called as dead burnt plaster

Properties of Plaster of Paris:

- It is a white powder having very fine crystals.
- On mixing with water it changes to Gypsum once again giving a hard solid mass by releasing large amount of energy called as heat of hydration.
- On solidification, it slightly expands and hence is excellent for making cast in moulds.

Uses of Plaster of Paris:

- It is used in making toys decorative and cosmetic materials and cast for statue.
- It is the major constituent of surgical bandages that are used for setting fractured bones.
- In laboratory for sealing the air gap in apparatus to make it air tight.
- For making fire-proofing materials
- For making black-board chalk.

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