

CHAPTER

7



MATERIALS OF COMMON USE

Can we live without common salt ? Common salt (or table salt) is chemically sodium chloride, NaCl. We have seen that it is the product obtained by the neutralisation of HCl with sodium hydroxide NaOH. We use common salt in our food. Can you say some more uses of common salt ?

7.1. Sources of common salt, NaCl

Sodium chloride or common salt, NaCl occurs abundantly in nature as rock salt. Rock salt forms cubic crystals which are colourless when pure, but often have yellow tinge due to the presence of impurities.

Sodium chloride also occurs in solution as brine containing upto about 25% NaCl. Brine also contains chlorides and sulphates of calcium and magnesium. There are brine wells at Ningel, Chandrakhong and Waikhong villages of Thoubal district in Manipur. However, the amount of sodium chloride in these brine solutions is quite low. A small quantity only of *Meitei Thum* is produced now. Sea water also contains about 2.5 % of common salt.

In India, common salt is generally obtained from the sea by evaporation of sea water in open fields or shallow iron pans utilising the heat of sun. Such salts are not of pure quality. Pure sodium chloride is prepared by passing hydrochloric acid gas into a saturated solution of impure salt. The pure salt is precipitated and obtained on filtration. It is then dried. Table salt sold in the market is now iodised to prevent iodine deficiency diseases.

Activity 7.1

- ☞ Take two cups of crushed ice.
- ☞ Insert a thermometer and note the temperature.
- ☞ Mix the ice thoroughly with a $\frac{1}{4}$ cup of common salt.
- ☞ Note the temperature again with the thermometer.
- ☞ What change do you observe ?
- ☞ What can be inferred from the observation ?

Ice and common salt mixture is often used as a freezing mixture and the temperature can even go down upto about -20°C . Why do we use freezing mixture ?

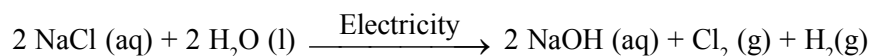
Common salt gives a characteristic flavour to food. It is also used for preserving fish, meat and other foods like pickles etc. Sodium chloride is also used for salting out soap, regenerating water softeners and in the “Salt-glazing” of earthenwares.

7.1.1. Common salt – a raw material for various chemicals

Common salt, a basic component of food for us is also a key raw material for various materials (chemicals) of our use such as sodium hydroxide, sodium carbonate (washing soda), sodium, chlorine, bleaching powder, sodium bicarbonate, sodium sulphate, sodium hypochlorite and sodium chlorate. Let us see how some of these useful materials are obtained from sodium chloride.

Sodium hydroxide, NaOH

On passing electricity through brine (aqueous solution of sodium chloride) in specially designed electrolytic cell, sodium chloride is decomposed to produce sodium hydroxide, hydrogen and chlorine. All these products have industrial applications



Hydrogen gas (H_2) is given off at the cathode and sodium hydroxide (NaOH) is formed around the cathode while chlorine gas (Cl_2) is given off at the anode.

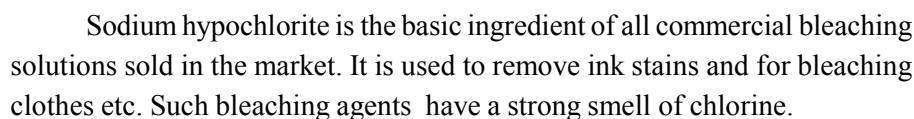
Hydrogen gas so obtained can be used as fuel and for the manufacture of ammonia for further use in the manufacture of fertilisers. Chlorine gas is used for sterilizing water (water treatment), in swimming pools; manufacture of PVC (poly vinylchloride) plastics, pesticides and CFC (Chlorofluoro Carbon). CFC is used in refrigerators. However, its use as refrigerent is not encouraged as it causes depletion of ozone layer.

Can you think of any other use of hydrogen and chlorine ?

Hydrogen and chlorine can be made to combine to form hydrogen chloride (HCl).



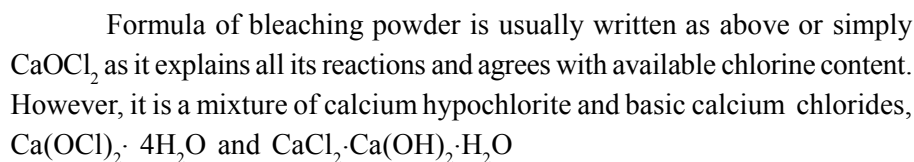
Sodium hydroxide can also combine with chlorine to produce sodium hypochlorite which is a bleaching agent for paper and fabrics.



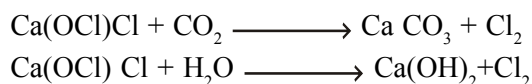
The bleaching action of such a solution is due to the chlorine liberated in solution. Chlorine can also kill germs present in water. These properties are due to the fact that chlorine acts as an oxidising agent.

What is the white powdery substance used to disinfect drains in hospitals ? It is also used to kill germs in drinking water.

The white substance which have a peculiar smell, used as a disinfectant in public places like hospitals, drains, market places etc. is bleaching powder . The chlorine gas produced by the electrolysis of sodium chloride can be used for the manufacture of bleaching powder. Chemically, it is calcium chlorohypochlorite, and is obtained commercially by passing chlorine gas over slaked lime at about 35–45°C.



Carbon dioxide and moisture of the atmosphere decompose bleaching powder liberating chlorine.



Let us answer the following.

1. Why does bleaching powder act as a disinfectant ?
2. Why does bleaching powder act as a bleaching agent ?

Uses: Bleaching powder is used

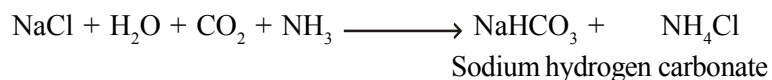
- (i) as a disinfectant,
- (ii) for sterilising water to make water free from disease causing germs and bacteria,
- (iii) for bleaching pulp in paper industry, linen and cotton in textile industry,
- (iv) as an oxidising agent in chemical industries.

Commercial samples of bleaching powder contains 35–37 % available chlorine. Available chlorine is the amount of chlorine set free by the sample of bleaching powder when decomposed. This free chlorine is responsible for the oxidising and bleaching properties of bleaching powder.

7.1.3. Baking Soda (sodium hydrogen carbonate), NaHCO_3

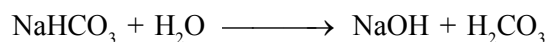
Baking soda is usually kept in all kitchens. It is used in making *Pakor*as and special Manipuri dish *Uti*. Chemically it is sodium hydrogen carbonate NaHCO_3 . It is also known as *Soda bicarb*

When an excess of carbon dioxide is bubbled through a nearly saturated solution of common salt containing ammonia, ammonium hydrogen carbonate is formed. This will react with more of sodium chloride to form sparingly soluble sodium hydrogen carbonate and ammonium chloride.



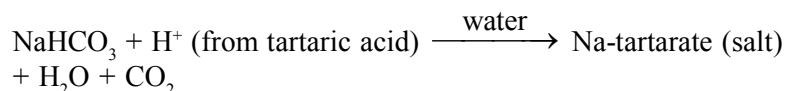
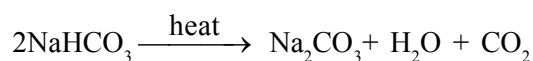
Sodium hydrogen carbonate is separated by filtration. It is then washed with cold water and dried in air.

Sodium hydrogen carbonate is a white solid. It is sparingly soluble in water. The aqueous solution of sodium hydrogen carbonate is slightly hydrolysed and the solution is alkaline in reaction.



Uses

- (i) Sodium hydrogen carbonate is used in medicine to reduce acidity in the stomach.
- (ii) A mixture of NaHCO_3 and mild edible acid like tartaric acid is known as baking powder. When heated or mixed with water the following reaction takes place



Carbon dioxide so produced during the reaction causes bread or cake to swell making them soft and fluffy.

- (iii) sodium hydrogen carbonate is used in soda -acid fire extinguishers.

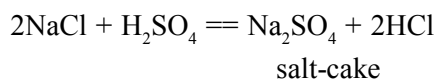
7.1.4. Washing Soda (Sodium carbonate) $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$

Washing soda is another very important chemical obtained from sodium chloride. Sodium carbonate is also found naturally in lakes of Magadi in East Africa, and in lakes of lower Egypt. The Magadi deposits, containing about 200 million tons of native soda, is an important source of soda.

Formerly sodium carbonate was obtained from the ash of plants growing on the sea-shore. This method is no longer used nowadays.

A French chemist Nicholas Leblanc prepared washing soda directly from sodium chloride in the following steps:

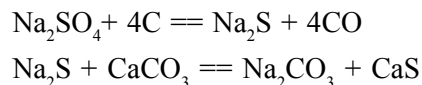
- (i) Sodium chloride is treated with concentrated sulphuric acid to form sodium sulphate which is called **salt-cake**.



The HCl gas liberated is absorbed in water giving commercial hydrochloric acid.

- (ii) The salt-cake is grounded, and mixed with its own weight of limestone and half its weight of coal and strongly heated to $800\text{--}1000^\circ\text{C}$. The salt cake is reduced by coke to sodium sulphide, which then reacts with calcium

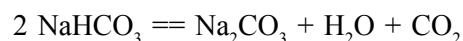
carbonate to form sodium carbonate :



The product called black-ash, contains about 45% sodium carbonate. The Leblanc process is no longer used nowadays but salt-cake is prepared for using in glass industry.

The ammonia soda or Solvay Process

Sodium carbonate is prepared by this process. In the section 7.1.3, you have seen that NaHCO_3 is prepared from brine solution by bubbling CO_2 into it after being saturated with ammonia (NH_3). From the solution sparingly soluble NaHCO_3 is separated by filtration and dried. NaHCO_3 is then calcined (heated at high temperature) to produce Na_2CO_3 :



Carbon dioxide so liberated is used for further reaction with brine.

Washing soda has the formula $\text{Na}_2\text{CO}_3 \cdot 10 \text{H}_2\text{O}$. It is prepared by crystallising the solution below 32°C . It is commercially known as **washing soda**.

Anhydrous Na_2CO_3 is called soda ash and it is an amorphous powder. It absorbs moisture from air, forming sodium carbonate monohydrate, $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$ which is known as **crystal carbonate**.

Uses of washing soda

- (i) Sodium carbonate is used as cleansing agent for domestic purposes and that is why it is called washing soda.
- (ii) It is used in the manufacture of glass, soap, paper and borax.
- (iii) It is used for making hard water soft.

You have seen amorphous sodium carbonate and crystalline sodium carbonate. Why is Na_2CO_3 amorphous while $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$ and $\text{Na}_2\text{CO}_3 \cdot 10 \text{H}_2\text{O}$ are crystalline ?

Let us find out the reason.

7.1.5. Water of Crystallisation

Na_2CO_3 is an amorphous white solid while $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$ and $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ are crystalline solids. It is evident that H_2O molecules play an important role in the crystal structures of solids. Let us see this fact.

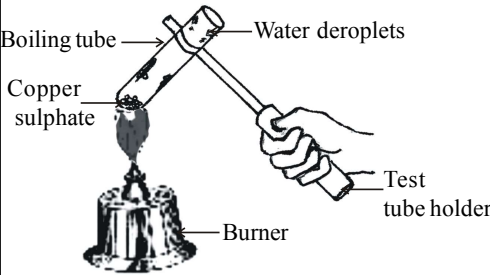


Fig. 7.1. To show that water of crystallisation can be lost on heating.

Activity 7.2

- ☞ Take a dry boiling tube and place in it some crystals of copper sulphate.
- ☞ Heat the copper sulphate crystals in the tube over a spirit lamp.
- ☞ What is the colour of copper sulphate now ?
- ☞ What do you observe near the mouth of the boiling tube ?
(Droplets of water are collected near the mouth of the tube)

☞ Can you explain the collection of water drops?

☞ Cool the tube, then add 1–2 drops of water. What happened to the colour of the crystal?

Blue colour is restored again.

Crystalline copper sulphate is blue and is called blue vitriol. It has the formula $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$. These five molecules of water present in copper sulphate is called its **water of crystallisation**. When the blue crystals are heated, these water molecules are lost and the blue colour becomes colourless. When it is treated with water the lost water of crystallisation is regained and it is again blue in colour. Many a crystal contain water of crystallisation.

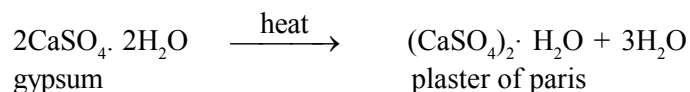
Examples are : Green vitriol $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$, (Ferrous sulphate), Zinc sulphate $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ (white vitriol), Gypsum $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.

All crystals need not have water of crystallisation. For example NaCl , NH_4Cl , KCl , KI , sugar etc.

Gypsum is naturally occurring calcium sulphate, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$. Do you know the white powder used for making casts and used in surgical bandages?

7.1.6. Plaster of Paris, $2\text{CaSO}_4 \cdot \text{H}_2\text{O}$.

When gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) is heated to about $120^\circ\text{--}130^\circ\text{C}$ it loses water molecule to form calcium sulphate hemihydrate $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$. It can also be written as $(\text{CaSO}_4)_2 \cdot \text{H}_2\text{O}$ i.e. two calcium sulphate molecules share one water molecule. This substance is called Plaster of Paris.



Uses : Plaster of paris is a white powder. It can be converted back to gypsum when treated with water. The newly formed product, on rehydration, sets into a hard solid. Plaster of paris is, therefore, used for making casts in moulds, and as a plaster for supporting fractured bones in the right position. It is also used for wall plaster.

7.2. Soaps and Detergents

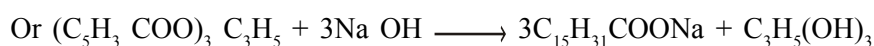
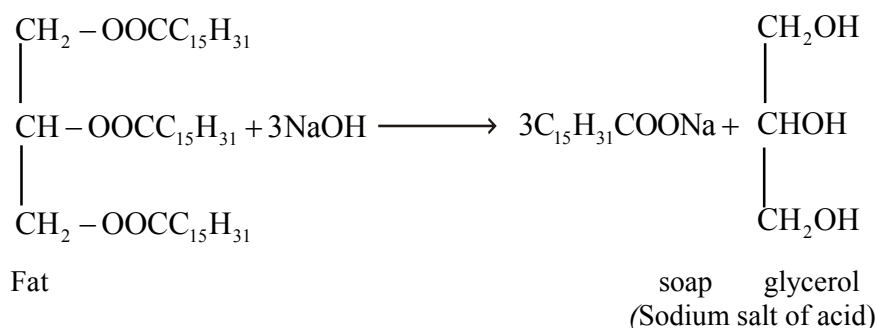
Soap has been used as a cleansing agent for more than two thousand years. It is used for washing clothes. We use toilet soaps in the form of solid cakes or in the solution form. Can you think of any other material which can be used for washing clothes ?

Activity 7.3

- ☞ Collect some ash obtained by burning straw or dried plantain leaves or dried stems of pea, cowpea etc, in a beaker.
- ☞ Add sufficient water to leach it and stir. Allow it to settle for some time.
- ☞ Filter the mixture.
- ☞ Soak your dirty handkerchief in the filtrate for some time and wash it.
- ☞ Does the hadkerchief become clean ?

The ash is rich in carbonates of potassium and sodium. The solution is actually alkaline and therefore, it can remove oil and grease from dirty clothes and linens.

Soap is made from oil or fat which are esters of higher fatty acids and glycerol. When fats and oils are heated with a solution of sodium hydroxide, they are decomposed (hydrolysed) to form sodium salt of the fatty acid and glycerol. An example is given below:



The soap is precipitated by the addition of common salt. It is called salting out of soap. The soap is separated from the mixture by filtration and the filtrate is used for the recovery of glycerol. The soap is then mixed with colours, perfumes etc. and cast into various shapes for use.

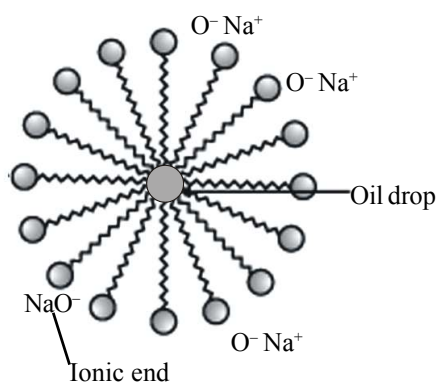


Fig. 7.2. Formation of Micelles

Activity 7.4.

- ☞ Take two test tubes and label them A and B.
- ☞ In each of them, put 10mL of water and two drops of cooking oil
- ☞ To the tube A add a few drops of soap or detergent solution.
- ☞ Shake both the test tubes vigorously by closing the mouth of the tube with your thumb. After some time leave the tubes undisturbed.
- ☞ In which test tube the oil layer appears again? Why?

This activity demonstrates the cleansing action of soap or detergent. Dirt is oily in nature and oil is not soluble in water. The molecules of soap, which are sodium salt of long chain fatty acid, have two ends. One end, which is water soluble, is ionic and the other end is non-ionic hydrocarbon part which is fat or oil soluble. The soap molecules, thus, form structures called micelles (Fig. 7.2) where the hydrocarbon end lies inside the oil drop and the ionic-end

lies in the aqueous region. When the dirty cloth is soaked in soap solution and then beaten, the oily drop is converted into innumerable pieces on being pulled out by the soap molecules. Thus the dirt (oil) is passed into water and the cloth is washed clean.

Now a days detergents have replaced soap for washing cloths. Detergents are of many types. They are generally ammonium or sodium sulphonate salts of long chain hydrocarbons which are generally obtained from petroleum. A typical example is $C_{17}H_{35}-OSO_3Na$. The cleansing action of detergents is similar to that of soaps. One advantage of detergent is that it can form copious lather even with hard water and therefore, washes clothes more effectively. Soap forms insoluble scum with hard water which contains calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions. This is due to the formation of calcium and magnesium salts of fatty acids. However, one disadvantage of synthetic detergents is that, they are not biodegradable. Therefore, they may pollute soily river, lake and other water bodies. Soaps are biodegradable.

Let us answer these

1. Why are beating, scrubbing or agitation required while washing clothes ?
2. Devise a simple method for detection of hard or soft water.
3. Can detergent be used to detect hard water ?

SUMMARY

- We use common salt for the preparation of food daily.
- Rock salt is natural common salt.
- Brine wells are available in Manipur.
- A mixture of crushed ice and common salt is called freezing mixture.
- NaCl is a starting material for the manufacture of NaOH, Na_2CO_3 , $NaHCO_3$, and Na_2SO_4 .
- Cl_2 , H_2 and NaOH are the products obtained from the electrolysis of NaCl.
- Bleaching powder is prepared by passing chlorine over slaked lime.
- Bleaching powder is a strong antiseptic and bleaching agent.
- The bleaching and antiseptic properties of bleaching powder are due to Cl_2 liberated on hydrolysis

- ✱ Baking powder is NaHCO_3 mixed with some edible organic acid.
- ✱ Washing soda is prepared from NaCl solution.
- ✱ Washing powder contains 10 molecules of water of crystallisation.
- ✱ Water of crystallisation may be removed by heat
- ✱ Anhydrous salts may regain colour by absorbing water.
- ✱ Plaster of Paris is prepared from gypsum.
- ✱ Soaps and detergents are used for cleansing.
- ✱ Soap is sodium or potassium salt of long chain fatty acids.
- ✱ Detergents are ammonium or sodium sulphonates of long chain hydrocarbons.

EXERCISES

1. How is pure sodium chloride obtained from the impure salt ?
2. What is the product obtained by reacting NaOH with HCl ?
3. How is freezing mixture made ?
4. Give important uses of sodium chloride.
5. Name the products obtained when aqueous sodium chloride is electrolysed.
6. What are the main uses of chlorine ?
7. What is the use of sodium hypochlorite ?
8. How is bleaching powder prepared ?
9. How does bleaching powder decompose in moist air ?
10. Give the important use of bleaching powder
11. Give a method for obtaining sodium hydrogen carbonate.
12. What happens when NaHCO_3 reacts with dil HCl ?
13. What is salt cake ?
14. Describe Solvay process.
15. What is the colour of anhydrous copper sulphate ?
16. What are green vitriol and blue vitriol ?
17. How is plaster of Paris made ?
18. What is the difference between soap and detergents ?

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