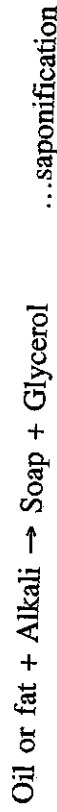


SAPONIFICATION REACTION FOR PREPARATION OF SOAP

Saponification

Alkaline hydrolysis of oils and fats is called *saponification*. This reaction is employed in the preparation of soap by the reaction between a natural oil or fat and an alkali such as sodium hydroxide or potassium hydroxide



Soaps

- Soaps are the sodium or potassium salts of long chain fatty acids.
- Soaps are prepared by saponification (alkaline hydrolysis) of vegetable oil or animal fat
- Soaps can be prepared by cold process and by hot process.
- Soaps are used for cleaning purpose.

EXPERIMENT NO. 2 (a)

Aim. To prepare soap by cold process.

Requirements

Oil or fat, sodium hydroxide, sodium carbonate, sodium chloride, china dish.

Note. Any type of vegetable oil namely cotton seed oil, soyabean oil, palm oil or coconut oil can be used.

Basic Principles Involved

- Soaps are the alkali salts of higher fatty acids.
- Soap is prepared by the action of an alkali (sodium hydroxide or potassium hydroxide) on vegetable oil or animal fat.



- The reaction is called saponification.
- Addition of sodium chloride to the reaction mixture causes the precipitation of soap.
- To make soap hard, some filler namely sodium carbonate or sodium silicate or starch is added to it.

Experimental Procedure

- Take about 15 mL of vegetable oil in a beaker.
- Take about 20 mL of water in a beaker and add 6 grams of sodium hydroxide to it, stir it well with a clean glass rod so that a solution is formed.
- Add the solution of sodium hydroxide to vegetable oil.

- Stir the mixture thoroughly till a thick paste is formed.
- Add small quantity of sodium chloride and sodium carbonate to the paste of soap. Stir it well and transfer it into a soap frame of desired shape.

Precautions

- Sodium hydroxide should be handled with care.
- The mixture of oil and alkali should be stirred thoroughly.
- The soap thus prepared is not pure. Therefore, do not use it to wash your face.

Further activity

Use the soap you have prepared to remove oil or ink spot from a piece of cloth.

EXPERIMENT NO. 2 (b)

Aim. To prepare soap by the process of heating a mixture of oil, ethanol and NaOH solution.

Requirements

Oil, 30% NaOH solution, 95% ethanol, beakers, boiling tube, ice, 100 mL of 20% solution of common salt (in two beakers 50 mL in each), filtration apparatus

Note. (Any type of vegetable oil namely cotton seed oil, soybean oil, palm oil or coconut oil or animal fat can be used).

Basic Principles Involved

- Soaps are the alkali salts of higher fatty acids.
- Soap is prepared by the action of an alkali (sodium hydroxide or potassium hydroxide) on vegetable oil or animal fat. (Oil dissolves easily in alcohol.)
- Oil or fat + Alkali → Soap + Glycerol
- The reaction is called saponification.
- Addition of sodium chloride to the reaction mixture causes the precipitation of soap.

Experimental Procedure

- Take about 150 mL of tap water in a beaker and heat the water on a burner to about 85°C. It will act as thermostat.
- Take about 2 mL of coconut oil in a boiling tube, add 10 mL of ethanol and shake the contents well so that the oil dissolves. [If some oil remains undissolved, shake it again then add 1 or 2 mL of ethanol and stir to dissolve the oil]
- When the oil is completely dissolved in ethanol add 10 mL of 30% NaOH solution. Shake the boiling tube to mix the solutions.
- Place the boiling tube containing the mixture of oil, ethanol and NaOH solution in the water bath (beaker containing hot water).

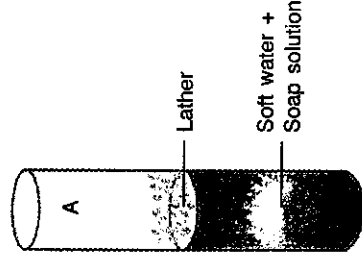
CLEANING CAPACITY OF SOAP IN SOFT AND HARD WATER

Soft and hard water

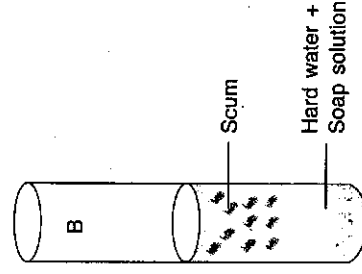
Water along with soap is used for washing purpose. On the basis of effective washing with soap, water has been classified as soft water and hard water.

Soft water

- The sample of water which produces good lather with soap is called **soft water**.
- Washing with soap is easy in **soft water**.



Formation of lather with soap and soft water



Formation of scum with soap and hard water

Hard water

- A sample of water which does not produce good lather with soap is called **hard water**.
- It is hard (difficult) to wash with soap in hard water.
- Soap forms scum in hard water.
- Hard water is not fit for laundry and laboratory.

Types of hard water

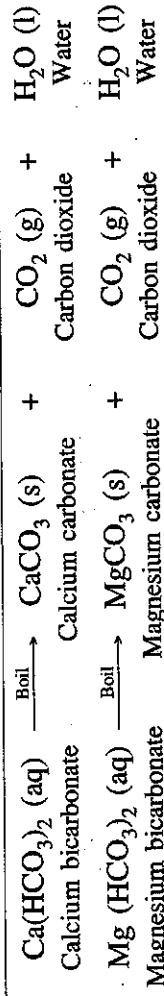
Hard water is classified as temporary hard water and permanent hard water based on the method of effective removal of hardness.

Temporary hard water

When hardness can be removed by boiling, the water sample is said to be temporary hard water. Presence of calcium bicarbonate and magnesium bicarbonate is the main cause of temporary hardness of water.

Removal of temporary hardness of water (Softening of temporary hard water)

Temporary hardness is removed by boiling the sample of water. When a sample of temporary hard water is boiled, the bicarbonates of calcium and magnesium decompose into insoluble carbonates.



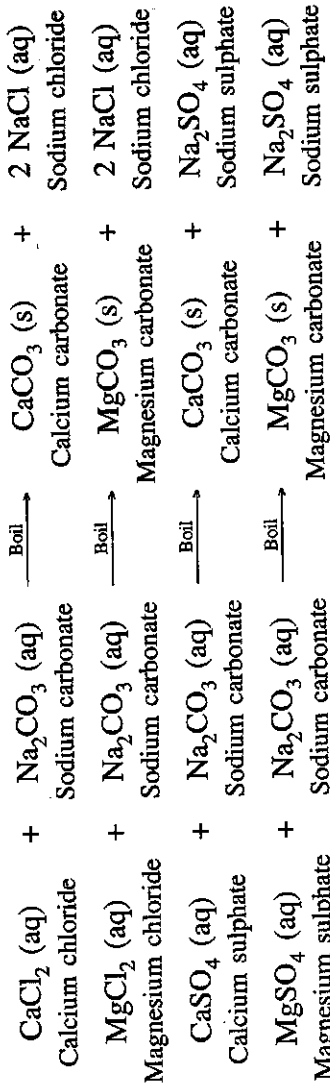
The insoluble carbonates of calcium and magnesium are removed by filtration, or sedimentation followed by decantation. The filtrate free from calcium and magnesium ions is soft water.

Permanent hard water

When hardness cannot be removed by boiling, the water sample is said to be permanent hard water. Presence of chlorides and sulphates of calcium and magnesium are the main cause of permanent hardness of water

Removal of permanent hardness of water (Softening of permanent hard water)

Permanent hardness of water is removed by boiling it with washing soda (sodium carbonate). When the water sample is boiled a double displacement reaction takes place and insoluble carbonates of calcium and magnesium are formed.



The insoluble carbonates of calcium and magnesium are removed by filtration, or sedimentation followed by decantation. The filtrate free from calcium and magnesium ions is soft water.

ACTIVITY

Aim. You are provided with two samples of water marked A and B. Perform the experiments with soap solution and identify the sample of soft water and the sample of hard water.

Requirements

Soap solution, test tubes, droppers, the given samples of water.

Basic Principles Involved

- A sample of soft water gives good lather with soap.
- A sample of hard water does not give good lather with soap.

Steps of experimental procedure

1. Preparation of soap solution

Dissolve small pieces of washing soap (NOT the synthetic detergent) in distilled water. Shake the test tube well to dissolve soap. Separate the clear soap solution in another test tube. Mark it as 'soap solution'

2. Testing the samples of water with the soap solution

S.No.	Experiments	Observations	Inference
1.	2 mL of water sample A in a test tube + 10 drops of soap solution and shake the contents of the test tube ten times.	Good lather is formed	Sample A is soft water
2.	2 mL of water sample B in a test tube + 10 drops of soap solution and shake the contents of the test tube ten times.	No lather is formed	Sample B is hard water

Result

Sample A is soft water and Sample B is hard water

EXPERIMENT NO. 3

Aim. To compare the cleaning capacity of a sample of soap in soft water and in hard water.

Requirements

Sample of soap, distilled water, calcium chloride, ink, dropper, two small pieces (5 cm × 5 cm) of white cloth, two beakers or china dish.

Basic Principles Involved

- Soap gives good lather with soft water but it forms scum and does not give lather with hard water.
- The presence of excess of calcium ions and magnesium ions causes hardness of water.
- It is very hard (difficult) to do washing with hard water.
- Soap gives scum with hard water. Therefore, while washing in hard water, a large portion of soap is wasted.

Experimental Procedure

(A) Putting ink spots on the cloth pieces

- Take two pieces of white cloth of the size of 5 cm × 5 cm each.
- Put a drop of ink in the center of each cloth and allow it to dry.

(B) Preparing soap solution in soft water

- Take about 20 mL of distilled water in a beaker and dissolve about 2 grams of small pieces of soap in it. Mark it *soap solution S* (Soap solution in soft water).

(C) Preparing sample of hard water and then making soap solution in it

- Take about 20 mL of distilled water in a beaker and dissolve about 50 mg of calcium chloride in it to prepare hard water.
- Dissolve about 2 grams of small pieces of soap in hard water prepared as above and mark it *soap solution H*, (soap solution in hard water).

(D) Comparing cleaning capacity of soap in soft water and hard water

- Dip one piece of white cloth with ink spot in *soap solution S* and the other one in *soap solution H*. Turn the pieces of cloths up side down twice.
- Leave the two beakers undisturbed for about ten minutes.
- Remove the pieces of cloths from the beakers. Rub each piece ten times.
- Now record your observations.

Observations

- The ink spot on the cloth dipped in *soap solution S* has almost disappeared.
- There is no change in the colour of the ink spot on the piece of cloth dipped in *soap solution H* rather some scum has deposited on the surface of the cloth piece.

Conclusions

- Soap forms lather in soft water. Therefore, washing is effective in soft water.
- Soap does not form lather in hard water rather it forms scum. Therefore, washing with soap is difficult in hard water.

Precautions

- For the purpose of this experiment only soap should be used and not a synthetic detergent.
- The quantity of ink drop put on each piece of cloth should be equal.
- The ink spot on the cloth must be dry before dipping the cloth in the soap solution.
- Each piece of cloth with ink spot should be rubbed equal number of times after removing from the respective soap solution.

VIVA VOCE

- T. *What do you mean by soft water?*
- S. The sample of water is called soft water with which soap forms good lather.
- T. *What do you mean by hard water?*
- S. A sample of water is called hard water with which soap does not form good lather.
- T. *How does soap work in soft water and in hard water?*
- S. Soap gives good lather in soft water but produces scum in hard water.
- T. *What is meant by lather?*
- S. Foam produced by soap in water is called lather.
- T. *Washing with soap in hard water is difficult. Give reason.*
- S. The organic part of soap ($C_{17}H_{35}COO^-$) combines with the Ca^{2+} ion of hard water and forms insoluble precipitate called scum. Thus, a large portion of soap is wasted in hard water and washing is not effective.
- T. *What is the cause of hardness of water?*
- S. The presence of excess of calcium and magnesium ions in water.