EXPERIMENT - 5

OBJECT: To determine temporary and permanent hardness of given water sample by titrating it against standard solution of M/100 Ethylene Diamine Tetracetic Acid (EDTA) using Eriochrome black-T (Metallochromic) as an internal indicator.

REQUIREMENTS:

APPARATUS: Burette, pipette, conical flask, beaker, dropper and funnel.

CHEMICALS: Standard solution of M/100 EDTA, hard water sample, boiled water sample, buffer solution ($NH_4Cl + NH_4OH$)

INDICATOR: Eriochrome black –T (EBT)

PRINCIPLE:

- Soap consuming capacity of water is known as its hardness.
- It is due to the presence of bicarbonate, sulphates and chlorides of calcium and Magnesium salts.
- It is determined by complexometric titration.
- EDTA is used as a complexing reagent.
- The calcium and magnesium ions present in water are titrated with EDTA using EBT as internal indicator.
- The indicator Eriochrome Black – T (EBT) which is blue colour organic dye forms an unstable complex with calcium and magnesium ion in hard water at pH 10. The complex formed is wine red in colour.

$$Ca^{+2}/Mg^{+2} + EBT \rightarrow [(Ca^{+2}/Mg^{+2} - - - - - EBT)]\ \text{complex}$$

Wine Red colour

- As the solution is titrated against EDTA, the free calcium and magnesium ion in water forms stable metal ion EDTA complex.
- Once the EDTA replaces calcium and magnesium ions from the unstable indicator complex to form stable complex with the result the indicator is set free. Since the indicator is blue in colour at pH 10, the end point is appearance of blue colour.

$$[(Ca^{+2}/Mg^{+2} - - - - EBT)]\ \text{complex} + EDTA \rightarrow [(Ca^{+2}/Mg^{+2} - - - EDTA)] + EBT$$

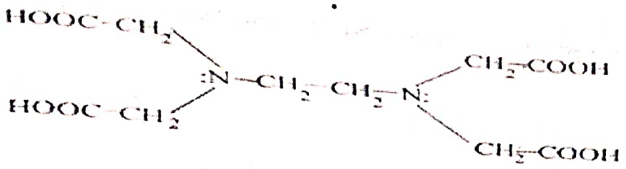
Blue colour

- Thus, the amount of EDTA used corresponds to the hardness of water.
- The temporary hardness can be removed by boiling and after removal of precipitate the permanent hardness in filtrate is determined by titrating with EDTA.
- Temporary hardness can be removed by boiling and is calculated by subtracting permanent hardness from total hardness.
- Hardness in water is generally expressed in terms of calcium carbonate equivalent because it is the most insoluble salt and its molecular weight is 100, which make the calculation easy.

PROCEDURE:

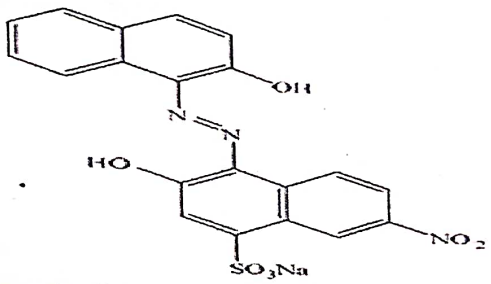
Rinse the glassware with distilled water. Fill the burette with standard solution of M/100 EDTA solution. Pipette out 10 ml of hard water sample in a conical flask and 2 ml of buffer solution ($NH_4Cl + NH_4OH$), then add two drops of EBT indicator to it. The solution turns to wine red colour. Titrate this wine red colour solution with M/100 EDTA till the solution becomes blue in colour. This is the end point of titration. Repeat the process till two concordant readings are obtained. Repeat the above process with boiled water.

Structure of EDTA:



Structure of EDTA

Structure of EBT:



Sod-[(1- hydroxyl 2- naphthyl azo) 6- nitro 2- naphthol 4- sulphonate]

OBSERVATIONS

FOR HARD WATER SAMPLE (TOTAL HARDNESS)

S. No.	Volume of hard water taken in conical flask	BURETTE READING (ml)			Volume of M/100 EDTA solution used (ml)
		Initial	Final	Final –Initial	
1. 2. 3.	10 ml 10 ml 10 ml				X ml

FOR BOILED WATER SAMPLE (PERMANENT HARDNESS)

S. No.	Volume of Boiled water taken in conical flask	BURETTE READING (ml)			Volume of M/100 EDTA solution used (ml)
		Initial	Final	Final –Initial	
1. 2. 3.	10 ml 10 ml 10 ml				Y ml

CALCULATIONS:

FOR TOTAL HARDNESS

10 ml of hard water consume = X ml of EDTA
1 ml of hard water consume = X/10 ml of EDTA
1000ml of hard water consume =(X /10) x 1000 ppm = - - - - - - - ppm

FOR PERMANENT HARDNESS

10 ml of boiled water consume = Y ml of EDTA
1 ml of boiled water consume = Y/10 ml of EDTA
1000ml of hard water consume =(Y/10) x 1000 ppm = - - - - - - - ppm

FOR TEMPORARY HARDNESS = Total hardness – Permanent hardness

RESULT:

The given water sample contains following type of hardness:
Total Hardness:
Permanent Hardness:
Temporary Hardness:

PRECAUTIONS:

1. Do the titrations drop wise.
2. Never forget to add basic buffer solution.