EXPERIMENT NO. 7

Object:-

Find out the ion-exchange capacity of a cation exchanger (Dowex- 50).

Introduction:-

Ion exchange capacity is defined as the number of exchangeable cations or anions per gram of the exchanger when it is placed in an electrolyte solution. It is expressed in milli-equivalent per gram of the exchanger.

Bicarbonates, sulfates, chlorides and nitrates of calcium and magnesium in water create hardness. In general water below 50-ppm hardness is very soft and above 230-250 ppm is said to be hard. Whereas the Carbonates and bicarbonates hardness (carbonate hardness) could be removed by boiling water–(temp hardness) due to sulfates and chlorides (Permanent) need special treatment.

Water can be softened either by

- Removal of Calcium and Magnesium salts Or
- by converting them into corresponding sodium salt.

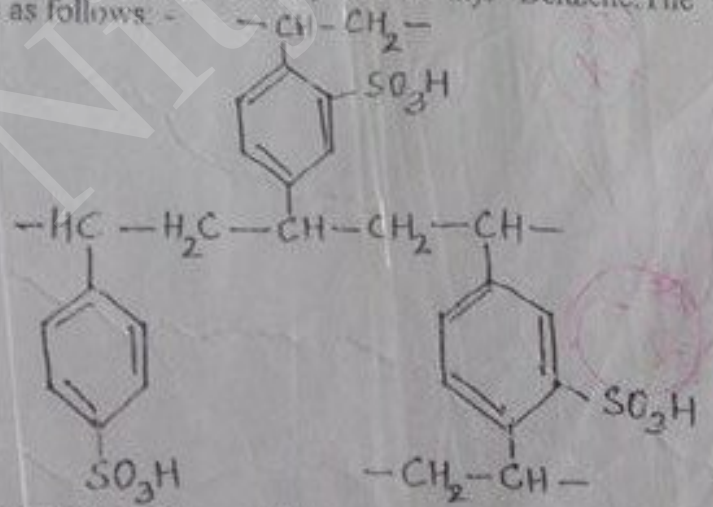
Main water softening processes are:

(a) Lime soda process
(b) Ion Exchanger process
  (i) Zeolite process
  (ii) Ion exchange process

The ion exchangers are of two types.

(a)Cation exchanger - Which can exchange cations present in water. These exchangers are organic molecules manufactured by sulfonation of cross-linked polystyrene. The resins consist of an immovable sulfate group along with equal number of replaceable cations.

Dowex-50 is sulphonated polystyrene divinyl Benzene.The Structure of the compound is as follows: -



(b) Anion exchange resins: - These exchangers can exchanger anion present in water. They are also organic molecules having amine and quaternary ammonium group as part of resins and equivalent amount of anion such as OH- ion (as counter ion)

Requirements:-

- Dowex-50,
- Glass apparatus,
- Standard NaOH solution (0.1N)
- KCl

Procedure:-

1. Put the weighted quantity (1-3 g) of the given ion-exchanger in a glass column having glass wool at the base.
2. The ion-exchanger is converted into H^+ from by passing 100 ml of 0.1 N Nitric acid. (Take out the acid from the bottom drop wise taking around 15 to 20 minutes time)
3. Then the column is washed by 100 ml of distilled water slowly till acid free(confirm with pH paper)
4. The effluent is thrown away.
5. Now pass 100 ml of 0.1 M KCl through the column slowly (20 drops per minutes).
6. The effluent is collected in the beaker / conical flask and it is (25 ml) titrated against standard NaOH (0.1 N) using phenolphthalein as indicator.
7. The volume of NaOH used is to be noted down.

Observations:-

Wt. Of ion exchanger taken = w gram
Volume of 0.1N NaOH used = x ml

Calculation:-

$$X \left(\underset{\text{NaOH)}}{0.1\,N \times X\,ml} = \underset{}{0.1\,N \times X\,ml} = \underset{\text{(of KCl)}}{0.1\,N \times X\,ml} \right)$$

Result:- Ion exchange capacity of given cation exchanger is =

$$\frac{0.1 \times X}{2} \text{ meq / g of } K^+$$

Calculations

$N_1V_1 \equiv N_2V_2$
(Naoh) (working sol^n)

$0.1 \times V_1 = N_2 \times 25$

$N_2 = \frac{0.1 \times V_1}{25} = N$ equivalent

Ion exchange capacity = $\frac{N \times 1000}{\text{cation exchanger}} = \frac{N \times 1000}{2} = x$ meq/g of K$^+$