Salahaddin University -Hawler
College of Education
Department of Chemistry

Determination of total cations in tap water

Assist. Lec. Hawraz Sami

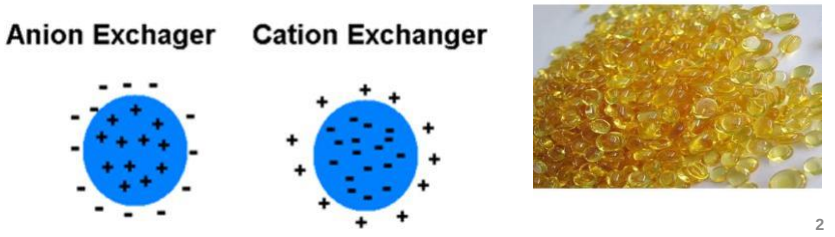
2nd Course , Separation Method, ((Exp. 7))
5/5/2020

Ion Exchange Theory

Ion Exchange Process in which ions of one substance are replaced by similarly charged ions of another substance. Ion exchange is an adsorption phenomenon.

Ion exchange is a physical separation process in which the ions exchanged are not chemically altered.

There is two types of ion exchanger resin



2

Types of Ion Exchanger Resin

There is two types of ion exchanger resin

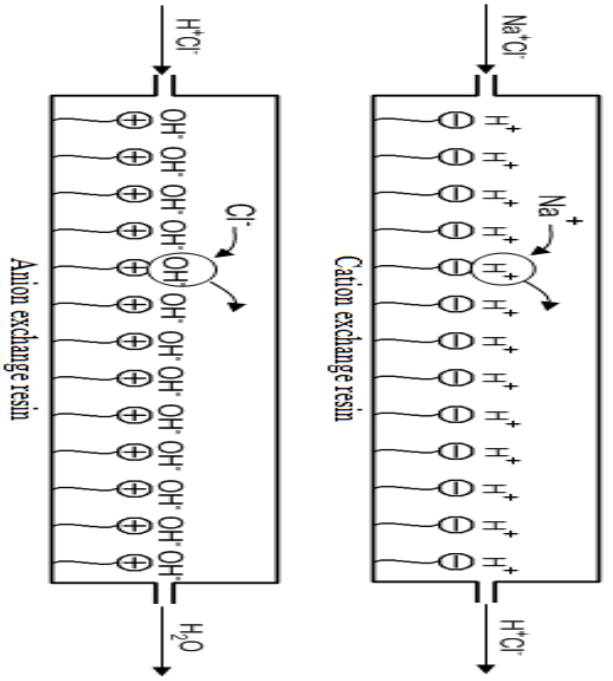
1) Cation-exchanger resin

$$Res.SO_3^-H^+ + Na^+Cl^- \leftrightarrow Res.SO_3^-Na^+ + HCl$$

2) Anion-exchanger resin

$$Res.NMe_3^+OH^- + H^+Cl^- \leftrightarrow Res.NMe_3^+Cl^- + H_2O$$

3



Previous Experiment

Calculation of Ion–Exchange Capacity

The total ion exchange capacity is commonly expressed in milli-equivalents of ionic species per gram of dry weight of ion exchange particles (meq/g)·

$$\textbf{Capacity (TIEC)} = \frac{\textit{Milliequivallents of titrant}}{\text{Weight of dry resin}} = \frac{(N * V)_{\text{titrant}}}{\text{Weight of dry resin}}$$

Note:

Unit of TIEC: milli-equ./g $_{\text{(resin)}}$

The capacity of most ion exchange resin is in the range 2 - 10 m.eq./g.

5

Exp. 7: Determination of total cations in tap water

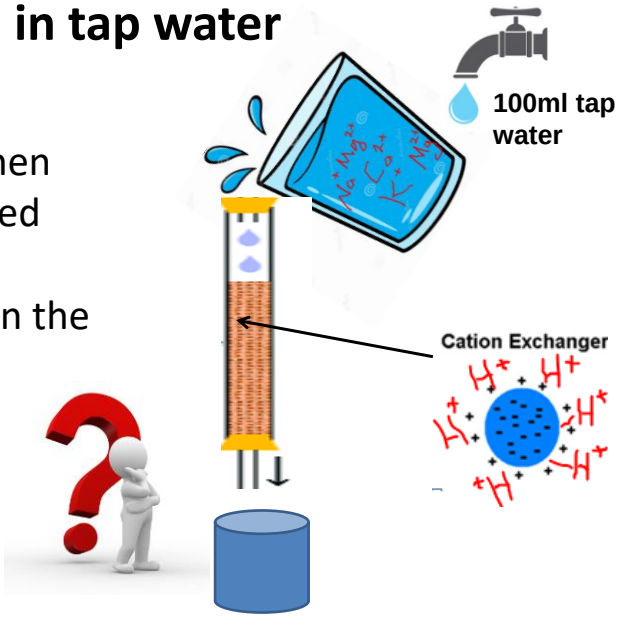
6

Exp. 7: Determination of total cations in tap water

- ***Theory***

What happen when tap water is passed through a cation exchanger resin in the hydrogen form

(Res.$SO_3^-H^+$) ?



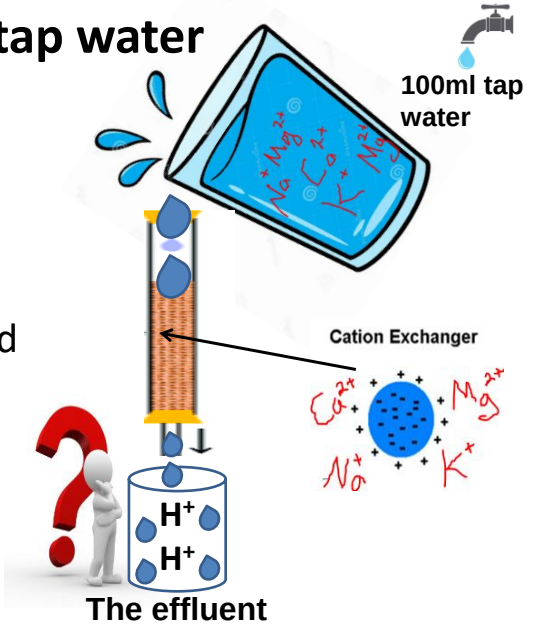
7

Exp. 7: Determination of total cations in tap water

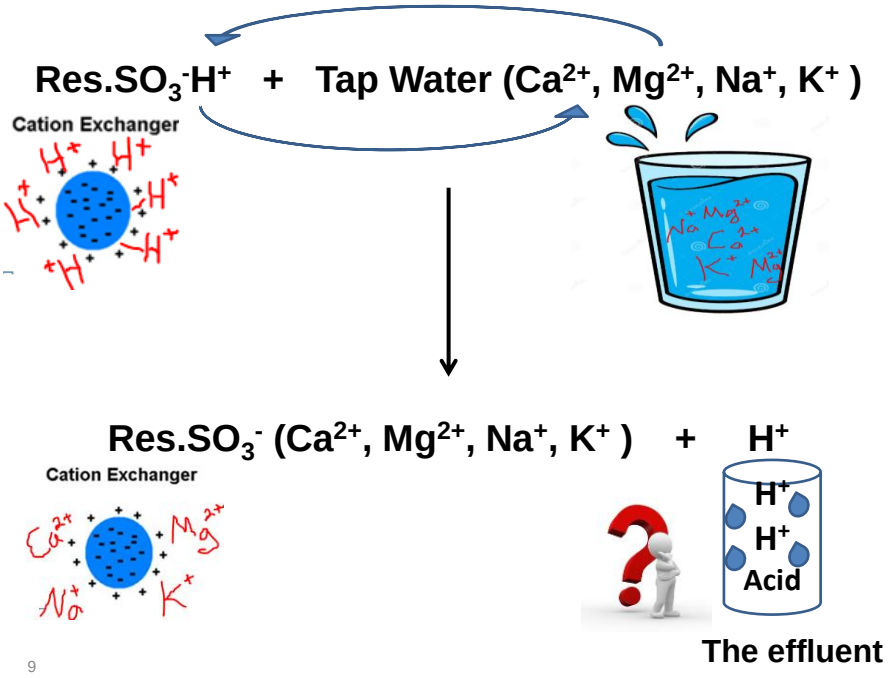
- ***Theory***

Answer:

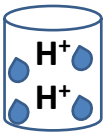
All cations including **(Ca^{2+}, Mg^{2+}, Na^+, K^+ & etc..)** are removed and replaced by hydrogen (H^+) ions in the resin.



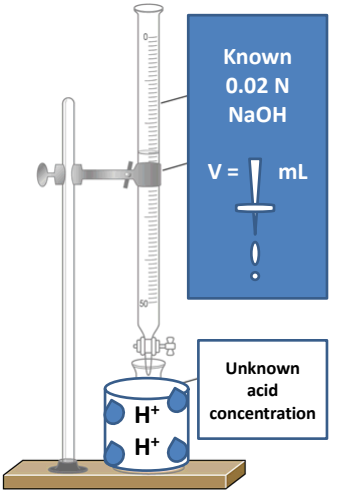
8



Exp. 7: Determination of total cations in tap water

The effluent 

is titrated with standard sodium hydroxide (NaOH). The results expressed as the **E**quivalent **M**ineral **A**cidity (**E.M.A**) in terms of mg $CaCO_3$ /L of water. (ppm of $CaCO_3$).



Detailed procedure

1- Prepare 25-30cm column containing (10 -15 g) strongly acidic cation exchanger (Res.$SO_3^-H^+$).

2- Rinse the column with D.W., the level of the water should never be below the upper surface of the resin in the column.

3- Pass **100ml** of sample of **TAP WATER** through the column at a rate of 3-4ml/min., then, collect the effluents in a conical flask.

4- Wash the column with D.W. and pass 50 ml of D.W. through the column, add to first eluent.

5- Titrate the effluents with standard 0.02N NaOH using methyl orange (or bromo cresol green) as indicator.

6- Calculate total cations as mg/L (ppm)? $ppm_{CaCO_3} = \frac{(N.V)_{NaOH} \times (Eq.wt_{CaCO_3}) \times 1000}{V_{sample\ or\ tap\ water}}$

11

Calculation

Find total cations (TC) in tap water as a mg/L (ppm) ???

$(N \times V)_{CaCO_3\ \text{tap water}} = (N \times V)_{NaOH}$

$\left(\frac{ppm}{Eq.wt. \times 1000} \times V\right)_{CaCO_3} = (N \times V)_{NaOH}$

E.M.A = TC = $ppm_{CaCO_3} = \frac{(N.V)_{NaOH} \times (Eq.wt_{CaCO_3}) \times 1000}{V_{sample\ or\ tap\ water}}$

Eq. wt = $\frac{M.Wt.}{n}$, n = 2 for $CaCO_3$

12

More Applications

Commercial samples of water are frequently alkaline due to the presence of bicarbonates, carbonates or hydroxides. That means these ions equivalence some effluent H+ when the sample passed through the column and lead to low results of total cations. The alkalinity is determined by titrating a 100ml sample with standard HCl using methyl orange as indicator. To obtain the total cation content in terms of $CaCO_3$, the total methyl orange alkalinity is added to the equivalent mineral acidity.

13

This Experiments Calculation

100 mL of tap water were passed through 15 g of cation exchanger resin (R^--H^+) in a suitable column. Next, the eluent was titrated with 0.02 N of NaOH standard solution. **Calculate total cations (TC) in the sample** when required volume of standard solution (NaOH) is equal to 7 mL?

At.wt. Ca=40, C=12, O=16

$$ppm_{CaCO_3} = \frac{(N.V)_{NaOH} \times (Eq.wt_{CaCO_3}) \times 1000}{V_{sample\ or\ tap\ water}}$$

14

Home works

Q1 0.10 L of well water was passed through 10 g of cation exchanger resin (R^-—H^+) in a suitable column. Then, the eluent was titrated with 0.03 N of NaOH standard solution. Calculate total cations in the sample if the required amount of standard solution is equal to 0.4 milliequivalents?

Q2 0.25 L of tap water was passed through 15 g of cation exchanger resin (R^-—H^+) in a suitable column. Then, the eluent was titrated with standard solutions (0.02 N of NaOH). Calculate the required volume of the standard solution (V= ?? NaOH) to get end point when the total cation concentration is equal to 300 mg/L?

15

Home works

Q3 80 mL sample solution of tap water was passed through 8.0 g of cation exchanger resin (Res^--H^+). Then, the eluent was titrated with 80×10^{-3} N of standard NaOH solution. Calculate total cations level in the sample if 8.0 mL of the standard solution needed at end point?

Q4 80 mL of river water passed through 8.00 g of Res--H+ resin. Then, the eluent solution was titrated with standard NaOH solution. Find the required milli-equivalents of the standard to get end point when total cations level equal to 180 ppm?

16

Home works

Q5 50 mL tap water was passed through 15.00 g of strong cation exchanger resin (Res^{-}-H^{+}). Then, the eluent solution was titrated with 0.01 N standard NaOH solution. Calculate total cations level in the sample when 8.0 mL of the standard required at end point?

Q6 50 mL of tap water passed through 10 g of cation exchanger resin. Then, eluate solution was titrated with standard NaOH solution in order to calculate total cations (TC) in the tap water. Find required milli-equivalents of NaOH at end point when TC is 110ppm? **At.wt: Ca= 40 , C=12 , O =16**

17

OTHER HOME WORK

1) Complete the following equation reaction:

$Res.SO_3^{-}H^{+} + NaCl \rightarrow \qquad +$

$Res.NMe_3^{+}OH^{-} + NaCl \rightarrow \qquad +$

2) Prove that the unit of TC is equal to mg/L ?

18