

Q5]

→ Strength of SHW,

Standard Hardwater contains 1.2 g CaCO_3 per 1000 mL

$$= 1200 \text{ mg } \text{CaCO}_3 \text{ per } 1000 \text{ mL}$$

$$1 \text{ mL SHW} = 1.2 \text{ mg } \text{CaCO}_3$$

(i) Standardization of EDTA,

$$38 \text{ mL of EDTA solution} = 100 \text{ mL SHW}$$

$$= (100 \times 1.2) \text{ mg } \text{CaCO}_3 \text{ equivalent}$$

$$1 \text{ mL EDTA} = 120 \times \frac{1}{38} = 3.158 \text{ mg } \text{CaCO}_3 \text{ equivalent}$$

(ii) To calculate total hardness of Water,

$$120 \text{ mL sample water} = 18 \text{ mL EDTA}$$

$$= (18 \times 3.158) \text{ mg } \text{CaCO}_3 \text{ equivalent}$$

$$1000 \text{ mL water} = (18 \times 3.158 \times 1000 / 120)$$

$$= 473.70 \text{ mg } \text{CaCO}_3 \text{ equivalent}$$

$$\text{Total hardness} = 473.70 \text{ ppm}$$

(iii) To calculate permanent hardness of water,

$$150 \text{ mL of boiled \& filtered sample water} = 12 \text{ mL EDTA}$$

$$= (12 \times 3.158) \text{ mg } \text{CaCO}_3 \text{ equivalent}$$

$$1000 \text{ mL boiled water} = (12 \times 3.158 \times 1000 / 150)$$

$$= 252.64 \text{ mg } \text{CaCO}_3 \text{ equivalent}$$

$$\therefore \text{Permanent Hardness} = 252.64 \text{ ppm}$$

(iv) To calculate temporary hardness of water,

$$\begin{aligned} \text{Temp Hardness} &= (\text{Total} - \text{Permanent}) \text{ Hardness} \\ &= 473.70 - 252.64 \end{aligned}$$

$$\text{Temporary Hardness} = 221.06 \text{ ppm.}$$

Q16

$$\text{Ca(HCO}_3)_2 = 24.3 \text{ ppm} = (24.3 \times 100) / 162 = 15 \text{ ppm CaCO}_3$$

$$\text{CaCl}_2 = 55.5 \text{ ppm} = (55.5 \times 100) / 111 = 50 \text{ ppm CaCO}_3$$

$$\text{MgCl}_2 = 38 \text{ ppm} = (38 \times 100) / 95 = 40 \text{ ppm CaCO}_3$$

$$\text{NaCl} = 58 \text{ ppm} = -$$

$$\text{SiO}_2 = 15 \text{ ppm} = -$$

$$\text{FeSO}_4 = 75.9 = \frac{75.9 \times 100}{152} = 49.93 \approx 50 \text{ ppm}$$

$$\text{Lime} = \frac{74}{100} [15 + 50 + 40] \times \frac{3 \times 10^4}{10^6} \times \frac{100}{80}$$

$$\text{Lime} = 2913.75$$

$$\text{Soda} = \frac{106}{100} [50 + 40 + 50] \times \frac{30000}{10^4} \times \frac{100}{80}$$

$$\text{soda} = 5565$$

Q]

Problem-1:

The hardness of 10,000 Lit of hard water was completely removed by passing it through a zeolite softner. The zeolite softner required 5000 Lit of NaCl solution containing 1170 mg/Lit. Determine the hardness of water sample.

$$\rightarrow 5000 \text{ L of NaCl soln} = 5000 \times 1170 \text{ mg/L}$$

$$= 5850000 \text{ mg}$$

$$= 5850000 \times \frac{50}{58.5} \text{ mg CaCO}_3 \text{ eq.}$$

$$= 5000000 \text{ mg}$$

$$\text{Hardness of 10000 L water} = 5000000 \text{ mg}$$

$$\text{Thus hardness for 1L} = \frac{5000000}{10000} = 500 \text{ mg CaCO}_3 \text{ eq.}$$

Hence, Hardness = 500 ppm.

2023

Q]

Calculate Temporary, permanent and total hardness of water sample from the following data: $\text{Mg}(\text{HCO}_3)_2 = 14.6 \text{ mg/L}$, $\text{MgCl}_2 = 9.5 \text{ mg/L}$, $\text{MgSO}_4 = 18 \text{ mg/L}$, $\text{Mg}(\text{NO}_3)_2 = 29.6 \text{ mg/L}$, $\text{Na}_2\text{SO}_4 = 24 \text{ mg/L}$, $\text{CaCO}_3 = 8 \text{ mg/L}$, $\text{MgCO}_3 = 20 \text{ mg/L}$.

→ Ion	Quantity	Conversion factor	CaCO ₃ Eq.	Types of Hardness
$\text{Mg}(\text{HCO}_3)_2$	14.6	$\frac{14.6 \times 100}{146}$	10 ppm	T
MgCl_2	9.5	$\frac{9.5 \times 100}{95}$	10 ppm	P
MgSO_4	18	$\frac{18 \times 100}{120}$	15 ppm	P
$\text{Mg}(\text{NO}_3)_2$	29.6	$\frac{29.6 \times 100}{148}$	20 ppm	P
Na_2SO_4	24	—	—	—

CaCO_3	8	$\frac{8 \times 100}{100}$	8 ppm	T
MgCO_3	20	$\frac{20 \times 100}{84}$	23.8 ppm	T

$$\therefore \text{T.H} = 10 + 8 + 23.8 = 41.8 \text{ ppm}$$

$$\therefore \text{P.H} = 10 + 15 + 20 = 45 \text{ ppm}$$

$$\therefore \text{Total} = \text{T.H} + \text{P.H} = 86.8 \text{ ppm}$$

Q]

Two BOD bottles contained each of 5 ml of sewage sample and water diluted with distilled water to 300 ml. One 100 ml portion of the blank consumed 6.4 ml of 0.05 N thiosulphate in the Winkler's method for the determination of dissolved oxygen while 100 ml of the second bottle incubated at 20 °C for the five days required 1.6 ml of the same thiosulphate solution. Calculate the BOD content of the sample.

$$\rightarrow 6.4 - 1.6 = 4.8 \text{ ml of } 0.05 \text{ N thiosulphate solution.}$$

$$1 \text{ L of } 1 \text{ N Thiosulphate} = 8 \text{ gm of O}$$

$$4.8 \text{ ml of } 0.05 \text{ Thiosulphate} = \frac{8 \times 4.8 \times 0.05}{1000} = 1.92 \times 10^{-3} \text{ g} = 1.92 \text{ mg}$$

$$\therefore 1000 \text{ ml of sewage water sample titrated contains} = 192 \text{ mg/L}$$

$$\text{BOD} = 192 \times \text{Dilution Factor}$$

$$= 192 \times \frac{100}{300} = 64 \text{ ppm}$$

$$\therefore \text{O}_2 \text{ req for } 1000 \text{ ml} = 0.64 \text{ g}$$

$$\text{BOD} = 1285 \text{ mg/L}$$

8]

1.5g of CaCO_3 was dissolved in HCl and the solution made up to 750mL with distilled water. 20 mL of the above solution required 20 of EDTA solution. 50 mL of hard water sample required 25mL of EDTA solution. 50mL of boiled hard water sample required 8mL of EDTA solution. Calculate each type of hardness.

$$1\text{mL S.H.W} = 1\text{mg of CaCO}_3$$

$$20\text{ mL of S.H.W} = 20\text{ mL of EDTA soln}$$

$$1\text{ mL of EDTA} = \frac{20}{20}\text{ mg of CaCO}_3$$

$$50\text{ mL of H.W} = 25\text{ mL of EDTA soln}$$

$$15\text{ mL of EDTA} = 1 \times 15\text{ mg CaCO}_3$$

$$50\text{ mL of H.W} = 15\text{ mg CaCO}_3$$

