[Zeolite Softner method]

1) A zeolite softener was completely exhausted and was regenerated by passing 100 litres of NaCl solution containing 100 g/litre NaCl. How many litres of water of hardness 500 ppm can be softened by this softener?

$\rightarrow$ Amount of NaCl present in 100 litres of given NaCl Sl^n = 100×100 g/L

$= 10000$ g

Amount of NaCl in terms of $CaCO_3$ equivalent

$$= 10000 \times \frac{100/2}{58.5/1} = 10000 \times \frac{50}{58.5} \text{ g}$$

$$= 8.55 \times 10^6 \text{ mg } CaCO_3 \text{ eq}^{nt}$$

Given water sample has 500 ppm hardness

$\therefore$ 8.55×10^6 mg $CaCO_3$ eq^{nt} hardness present in $= \dfrac{8.55 \times 10^6 \text{ mg}}{500 \text{ mg/litre}}$

$= 1.7 \times 10^4$ litres

($\therefore$ Zeolite softener can soften 1.7×10^4 litres water)

2) The hardness of 100000 litres of water sample was completely removed by passing it through a zeolite softener. The softener required 400 litres of sodium chloride solution containing 100 g/litre of NaCl for regeneration. Calculate the hardness of water sample.

→ Amount of NaCl used = 400 l × 100 g/litre

= 40000 g = 4×10^4 g

= 4×10^7 mg.

Amount of NaCl in terms of $CaCO_3$ equivalent

$$= 4 \times 10^7 \times \frac{50}{58.5} \text{ mg } CaCO_3$$

$$= 3.42 \times 10^7 \text{ mg } CaCO_3 \text{ equivalent.}$$

∴ Hardness of 100 000 litre water :

Total hardness = 3.42×10^7 mg $CaCO_3$ eqvt.

∴ Hardness of 1 litre water

$$= \frac{3.42 \times 10^7 \text{ mg}}{100000 \text{ litre}}$$

Hardness in ppm = 342 mg/litre = 342 ppm

Where, Y is the volume of water sample taken for test. V_1 and V_2 are volume of ferrous ammonium sulphate, in blank and test experiments respectively.

N is the normality of Ferrous Ammonium Sulphate.

1.9.8 : Significance of COD

(M.U. June 2015)

The COD value is not affected by the presence of toxins and other unfavourable conditions for the growth of micro organisms. It measures the effect of pollutants on dissolved oxygen. It is taken as basis for calculation of efficiency of treatment plant. It is important in proposing standards for discharging domestic and industrial effluents in various kinds of water. Due to its rapid determination over BOD, it has become important in the management and design of treatment plants.

1.9.9 : Comparison of BOD and COD

(M.U. Dec. 2012, June 2013)

Table 1.2 below shows comparison of BOD and COD.

BOD	COD
1. It measures the oxygen demand of bio-degradable pollutants only.	1. It measures the oxygen demand for bio-degradable pollutants along with non-biodegradable pollutants.
2. Less stable measurement method as it uses micro-organisms which are susceptible to pH, temperature and other variables in the water.	2. More stable measurement method as it uses potassium dichromate which oxidises regardless of water conditions.
3. Slow process. It takes five days.	3. Fast process. It takes 2-3 hours.
4. BOD values are generally less than COD values.	4. COD values are generally greater than BOD values.

Table 1.33 : Comparison of BOD and COD

1.9.10 : Solved Problems

Problem 1

A 50 ml of sample contains 840 ppm of dissolved oxygen. After 5 days the dissolved oxygen value becomes 230 ppm after the sample has been diluted to 80 ml. Calculate the BOD of the sample.

Solution

$$\begin{aligned} BOD &= (DO_b - DO_i) \times \text{Dilution Factor} \\ &= (DO_b - DO_i) \times \frac{\text{ml. of sample after dilution}}{\text{ml. of sample before dilution}} \\ &= (840 - 230) \times \frac{80}{50} \\ \therefore \quad BOD &= 976 \text{ ppm} \end{aligned}$$

.... Ans.

Problem 2

A 25 ml of a sewage water sample was refluxed with 10 ml of 0.25 N $K_2Cr_2O_7$ solution in presence of dil. H_2SO4, Ag_2SO_4 and $HgSO_4$. The unreacted dichromate required 6.5 ml of 0.1 N ferrous ammonium sulphate. 10 ml. of the same $K_2Cr_2O_7$ solution and 25 ml of distilled water, under the same conditions as the sample, required 27 ml of 0.1 N ferrous ammonium sulphate. Calculate the COD of the sewage water sample.

Solution :

Given : Vb = 27 ml, Vt = 6.5 ml,

N = 0.1 Normal, Ve = 25 ml

$$\therefore \quad COD = \frac{(27 - 6.5 \times 0.1 \times 8)}{25} \times 1000$$

$$\therefore \quad COD = 656 \text{ ppm}$$

.... Ans.

Problem 3

25 ml of sewage water is refluxed with 0.1 N $K_2Cr_2O_7$ solution in presence of H_2SO_4 and Ag_2SO_4. The unreacted dichromate required 5.5 ml of 0.1 N FAS solution. Back titration consumed 15 ml of 0.1 N FAS solution. Calculate COD of the effluent in mg/*l*. *(M.U. Dec. 2014)*

Given : Vb = 15 ml, Vt = 5.5 ml,

N = 0.1 N, Ve = 25 ml

$$\therefore \quad COD = \frac{(15 - 5.5) \times 0.1 \times 8}{25} \times 1000$$

$$\therefore \quad COD = 304 \text{ ppm}$$

.... Ans.