

Home Assignment-03

Q) A sample of water is found to contain the following dissolving salts in milli gram per litre  
 $Mg(HCO_3)_2 = 73$ ,  $CaCl_2 = 111$ ,  $Ca(HCO_3)_2 = 81$ ,  
 $MgSO_4 = 40$ ,  $NaCl = 10$ , and  $MgCl_2 = 95$ . Calculate temporary and permanent hardness and total hardness.

Ans) Given,  $Mg(HCO_3)_2 = 73$ ,  
 $CaCl_2 = 111$ ,  $Ca(HCO_3)_2 = 81$ ,  $MgSO_4 = 40$ ,  
 $NaCl = 10$ ,  $MgCl_2 = 95$

$$\text{Hardness (mg/L as } CaCO_3) = \frac{\text{Salt concentration (mg/L)} \times \text{Molar mass of } CaCO_3}{\text{Molar mass of salt}}$$

• Temporary hardness (caused by  $Mg(HCO_3)_2$  &  $Ca(HCO_3)_2$ )

•  $Mg(HCO_3)_2 = 73 \text{ mg/L}$

$$\text{Hardness as } CaCO_3 = \frac{73 \times 100}{146} = 50 \text{ mg/L}$$

•  $Ca(HCO_3)_2 = 81 \text{ mg/L}$

$$\text{Hardness of } CaCO_3 = \frac{81 \times 100}{162} = 50 \text{ mg/L}$$

$$\text{Total temporary hardness} = 50 + 50 = 100 \text{ mg/L}$$

• Permanent hardness (caused by  $CaCl_2$ ,  $MgCl_2$  &  $MgSO_4$ ):

•  $CaCl_2 = 111 \text{ mg/L}$

$$\text{Hardness as } CaCO_3 = \frac{111 \times 100}{111} = 100 \text{ mg/L}$$

[cont..]



$$\cdot \text{MgSO}_4 = 40 \text{ mg/L}$$

$$\text{Hardness as CaCO}_3 = \frac{40 \times 100}{120} = 33.33 \text{ mg/L}$$

$$\cdot \text{MgCl}_2 = 95 \text{ mg/L}$$

$$\text{Hardness as CaCO}_3 = \frac{95 \times 100}{95} = 100 \text{ mg/L}$$

$$\text{Total permanent hardness} = 100 + 33.33 + 100 \\ = 233.33 \text{ mg/L}$$

$$\text{Total hardness} = \text{Temporary hardness} + \text{permanent hardness} \\ = 100 + 233.33 \\ = 333.33 \text{ mg/L}$$

2a) write a brief account on

a) Caustic embrittlement b) boiler corrosion.

Ans) a) Caustic embrittlement: It is a type of

corrosion that occurs in boilers due to concentration of caustic (sodium hydroxide) in certain areas, leading to cracks.

Mechanism: High temperatures cause sodium carbonate to decompose into sodium hydroxide, which concentrates in crevices. This creates a highly alkaline environment, leading to embrittlement and cracking of the metal.

(cont.)



b) Boiler Corrosion: Boiler corrosion is the degradation of boiler material due to the reaction with dissolved oxygen, carbon dioxide, and other acidic compounds in water.

Mechanism: Dissolved oxygen reacts with metal, forming iron oxide (rust), while carbon dioxide forms carbonic acid, further accelerating corrosion.

Prevention: Removal of oxygen by deaeration, use of oxygen scavengers like sodium sulfite, and maintaining proper pH levels in boiled water.