

16/03/2021

Engineering ChemistryTutorial 2 - Water.

- 1) What is the total hardness of water sample which has following impurities in mg/l.

$\text{Ca}(\text{HCO}_3)_2 = 162$ ,  $\text{CaCl}_2 = 22.2$ ,  $\text{MgCl}_2 = 95$ ,  $\text{NaCl} = 20$

→ Conversion into  $\text{CaCO}_3$  equivalent:

Constituents	Quantities in PPM	Multiplication factor	$\text{CaCO}_3$ equivalent
$\text{Ca}(\text{HCO}_3)_2$	162	$\frac{100}{162}$	100
$\text{CaCl}_2$	22.2	$\frac{100}{111}$	20
$\text{MgCl}_2$	95	$\frac{100}{95}$	100
$\text{NaCl}$	20	-	-

$$\therefore \text{Temporary hardness} = \text{Hardness due to } \text{Ca}(\text{HCO}_3)_2 \\ = 100 \text{ ppm}$$

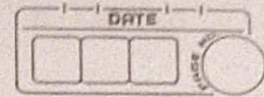
$$\text{Permanent hardness} = \text{Hardness due to } [\text{MgCl}_2 + \text{CaCl}_2] \\ = 100 + 20 \\ = 120 \text{ ppm}$$

$$\therefore \text{Total Hardness} = \text{Temporary Hardness} + \text{Permanent Hardness} \\ = 100 + 120 = 220 \text{ ppm}$$

$\therefore$  Total Hardness is 220 ppm.

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2) Calculate all types of hardness of water sample containing.

$\text{Ca}(\text{HCO}_3)_2 = 81 \text{ ppm}$ ,  $\text{MgSO}_4 = 60 \text{ ppm}$ ,  $\text{MgCO}_3 = 42 \text{ ppm}$ ,  $\text{Ca}(\text{NO}_3)_2 = 82 \text{ ppm}$

Constituents	Quantity in ppm	Multiplication factor	$\text{CaCO}_3$ equivalent
$\text{Ca}(\text{HCO}_3)_2$	81	$\frac{100}{162}$	50
$\text{MgSO}_4$	60	$\frac{100}{120}$	50
$\text{MgCO}_3$	42	$\frac{100}{84}$	50
$\text{Ca}(\text{NO}_3)_2$	82	$\frac{100}{164}$	50

$$\therefore \text{Temporary Hardness} = \text{Hardness due to } [\text{MgCO}_3 + \text{Ca}(\text{HCO}_3)_2] \\ = 50 + 50 = 100 \text{ ppm}$$

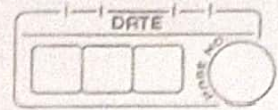
$$\text{Permanent Hardness} = \text{Hardness due to } [\text{MgSO}_4 + \text{Ca}(\text{NO}_3)_2] \\ = 50 + 50 = 100 \text{ ppm}$$

$$\text{Total Hardness} = \text{Temporary Hardness} + \text{Permanent Hardness} \\ = 100 + 100 = 200 \text{ ppm}$$

Thus,

Temporary Hardness = 100 ppm, Permanent Hardness = 100 ppm,  
Total Hardness = 200 ppm.





3) After treating  $10^5$  liters of water by ion exchanger, the cationic resin required 400 liter of 0.2 N HCl and anionic resin required 300 liter of 0.2 N NaOH solutions. Find the hardness of the above sample of water.

**Ans** In an ion-exchanger all hardness causing cations are removed by cation exchanger. Hence the amount of acid used for regeneration of cation refers to hardness.

$$\begin{aligned}
 \therefore \text{Hardness in } 10^5 \text{ litres of water} &= 400 \text{ liter of } 0.2 \text{ N HCl} \\
 &= 400 \text{ liter of } 0.2 \text{ N CaCO}_3 \text{ eq.} \\
 &= 400 \times 0.2 \text{ liter of } 1 \text{ N CaCO}_3 \text{ eq.} \\
 &= 80 \text{ liter of } 1 \text{ N CaCO}_3 \text{ eq.} \\
 &= 80 \times 50 \text{ g of CaCO}_3 \text{ eq.} \\
 &= 4000 \text{ g of CaCO}_3 \text{ eq.}
 \end{aligned}$$

$$\begin{aligned}
 \therefore \text{Hardness in } 1 \text{ L of water} &= \frac{4000}{10^5} \text{ g of CaCO}_3 \text{ eq.} \\
 &= 0.04 \text{ g of CaCO}_3 \text{ eq.} \\
 &= 40 \text{ mg of CaCO}_3 \text{ eq.}
 \end{aligned}$$

$\therefore$  Hardness of water sample is 40 mg/L