

ChE 413: Desalination and Water Treatment

Homework 2: Hardness Removal



1. What are the total and calcium hardness as CaCO_3 of water that contains ions at the concentrations given in the following table?

Ion	Ca^{2+}	Mg^{2+}	Fe^{3+}	Na^+	K^+	CO_2
concentration, mg/L	48	20	0.3	1.2	0.7	2

2. A water has the following partial analysis in mg/l as the ions: (The pH is 6.5.)

Ions	Na^+	Ca^{++}	Mg^{++}	Fe^{+++}	HCO_3^-	SO_4^{--}
mg/l	15	55	20	5	85	35

Calculate the total hardness; carbonate hardness, noncarbonate hardness and total alkalinity all in mg/l as CaCO_3 .

3. Raw water has the following partial analysis as the ions:

Calcium	Total Hardness	Bicarbonate Alka	Total Alkalinity	CO_2
50 mg/l	150 mg/l as CaCO_3	149 mg/l as HCO_3	130 mg/ as CaCO_3	10 mg/l

Calculate the lime and soda dosages needed assuming no excess is used. Also determine these dosages expressed in terms of quick lime (CaO) and soda ash (Na_2CO_3), respectively.

4. A sample of water is found to contain 40.5 mg/l $\text{Ca}(\text{HCO}_3)_2$, 46.5 mg/l $\text{Mg}(\text{HCO}_3)_2$, 27.6 mg/l MgSO_4 , 32.1 mg/l CaSO_4 and 22.45 gm/l CaCl_2 . Calculate the total hardness of this water.
5. A sample of water contains the following salts $\text{Mg}(\text{HCO}_3)_2=73$ mg/l, $\text{CaCl}_2=222$ mg/l, $\text{MgSO}_4=120$ mg/l, $\text{Ca}(\text{NO}_3)_2 =164$ mg/l. Calculate the quantity of lime (74% pure) and soda (90% pure) needed for softening 5,000 L of this water.
6. Calculate the amount of lime and soda required for softening of 15,000 liters of water which analyzed as follows: temporary hardness= 20 ppm, permanent hardness= 15 ppm and permanent magnesium hardness = 10 ppm.

(Atomic Wt: C=12, O=16, Ca=40, H=1, Mg=24, Fe=56, S=32, Na=23, Cl=35.5, K=39.1, N=14)