

Experiment - 3

* Experiment on softening of hard water using Lime Soda process.

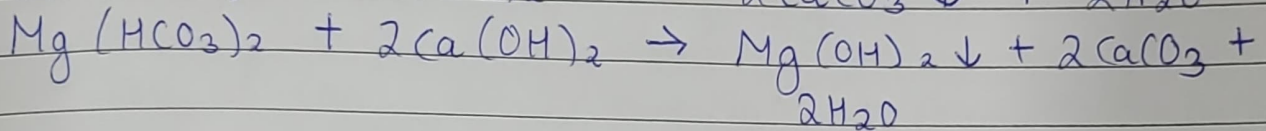
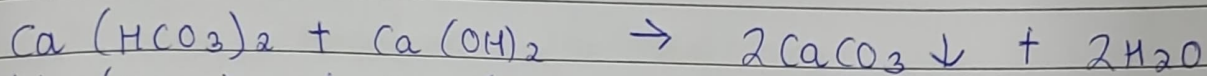
→ Objective :- To estimate amount of lime and soda required to soften the given hard water sample and to check for the removal of hardness in given sample.

→ Principle :- The lime soda process involves the chemical conversion of all the soluble hardness causing salts by addition of soda $[\text{Na}_2\text{CO}_3]$ & lime $[\text{Ca}(\text{OH})_2]$ into insoluble precipitates which can be easily removed by settling & filtration. As lime in the form of lime water is added to hard water, the pH of water sample is raised & equilibrium of carbonate species present in water is shifted. Dissolved CO_2 is changed into HCO_3^- and then CO_3^{2-} . This causes calcium carbonate to precipitate because it exceeds the solubility product. Additionally Magnesium can be precipitated as Magnesium Hydroxide in a double displacement reaction.

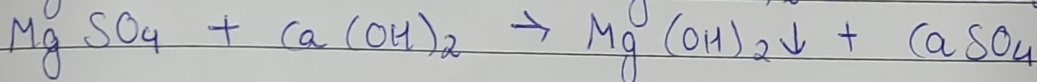
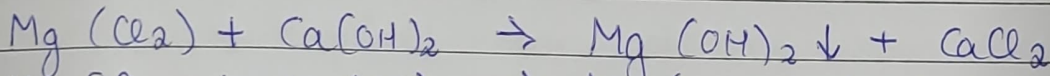
Teacher's Signature _____

In this process both the Calcium as well as Calcium added with lime are precipitated. The chemical reactions involved in lime soda process are:

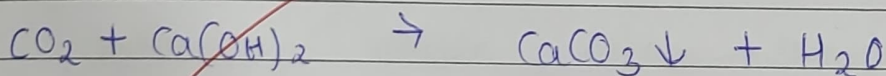
(i) Lime for removal of temporary hardness



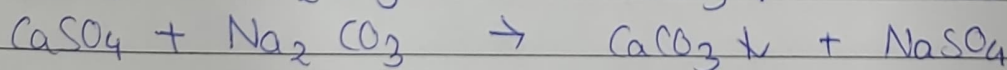
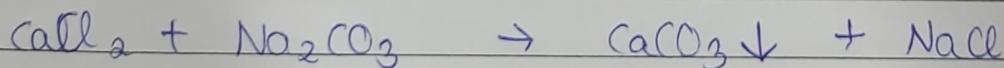
(ii) Lime for removal of permanent Magnesium hardness



(iii) Lime for removal of dissolved CO_2



(iv) Soda for removal of complete Calcium permanent hardness



→ Observations & Calculations

100 parts by mass of CaCO_3 are equivalent to:

- i) 74 part of Ca(OH)_2
 ii) 106 part of Na_2CO_3

→ Lime required for softening

$$= \frac{74}{100} \left[\text{Ca}^{+2} + 2 \times \text{Temp Mg}^{+2} + \text{Perm} (\text{Mg}^{+2} + \text{Fe}^{+2} + \text{Al}^{+3}) + \text{CO}_2 + \text{H}^+ (\text{HCl or H}_2\text{SO}_4) - \text{NaAlO}_2 + \text{HCO}_3^- \right]$$

→ Soda required for softening

$$= \frac{106}{100} \left[\text{Perm.} (\text{Ca}^{+2} + \text{Mg}^{+2} + \text{Fe}^{+2} + \text{Al}^{+3}) + \text{H}^+ - \text{HCO}_3^- \right]$$

→ Hardness of sample before treatment

Sr. No	Vol of H_2O (ml)	Burette Reading		Vol of EDTA consumed (ml)	Avg burette reading (ml)
		Initial	Final		
1	10	30.2	37.1	6.9	
2	10	37.1	43.5	6.4	6.5
3	10	39.8	46	6.2	

Before treatment Hardness = 700 ppm

Teacher's Signature _____

→ Hardness of water after lime soda treatment

Sr. No.	Vol of treated H ₂ O (ml)	Burette Reading		Vol of EDTA consumed (ml)	Avg reading (ml)
		Initial	Final		
1	10	18.3	23.2	4.9	5.2
2	10	23.2	28.3	5.1	
3	10	28.3	34.9	5.6	

After Treatment Hardness

→ Result

- Hardness of water before lime-soda treatment = 700 mg/L
- Hardness of water after lime-soda treatment = 500 mg/L