Lime-Soda Softening

Lime-Soda Softening is a very old system to reduce Hardness & Alkalinity and the same is very effective even today esp. for effluent Treatment. The unit operations are generally used where hardness levels are high. For comparatively Lower hardness, Ion exchange resin-based Softeners can be used.

In Lime-Soda Treatment hydrated Lime ($Ca(OH)_2$) and Soda Ash (Na_2CO_3) are used to precipitate the dissolved salts of Ca^{+2} & Mg^{+2} as $CaCO_3$ and $Mg(OH)_2$.

Lime Reacts with Temporary Hardness, Acids, Carbon Dioxide but it can't remove Calcium permanent hardness for which Soda Ash is required. For Magnesium Permanent hardness removal, Lime & Soda both are required.

There are two types of Lime-Soda Processes

a. Cold Lime-Soda - Reaction Takes place at ambient Temperature.
b. Hot Lime-Soda - reaction takes place at higher Temperature nearly @ boiling Point of water. It is more effective as compared to Cold Lime-Soda Process.

Temporary Hardness Removal - Can be Removed using Lime

- Calcium Temporary hardness /Calcium Alkalinity - One Equivalent Lime required
- Magnesium Temporary hardness /Calcium Alkalinity - Two Equivalent Lime required

Permanent Hardness Removal -

- Calcium Noncarbonate Hardness - One Equivalent Soda required
- Magnesium Noncarbonate hardness - One Equivalent Lime + One Equivalent Soda required

Required Lime quantity depends on the Alkalinity in the water. The Hydroxyl group of Lime reacts with Alkalinity of Calcium, Magnesium & Other cations first & then with Mineral acidity linked with Magnesium.

Reactions in Lime-Soda Process

Lime Reactions									
1.	CO_2	+	$Ca(OH)_2$	→	$CaCO_3\downarrow$	+	H_2O		
2.	$Ca(HCO_3)_2$	+	$Ca(OH)_2$	→	$2CaCO_3\downarrow$	+	$2H_2O$		
3.	$Mg(HCO_3)_2$	+	$Ca(OH)_2$	→	$2CaCO_3\downarrow$	+	$MgCO_3$	+	$2H_2O$
	$MgCO_3$	+	$Ca(OH)_2$	→	$Mg(OH)_2\downarrow$	+	$CaCO_3\downarrow$		
4.	$NaHCO_3$	+	$Ca(OH)_2$	→	$CaCO_3\downarrow$	+	$NaOH$	+	$2H_2O$
5.	$KHCO_3$	+	$Ca(OH)_2$	→	$CaCO_3\downarrow$	+	KOH	+	$2H_2O$

Lime-Soda Reactions												
Calcium Salts												
6.	$CaSO_4$	+	Na_2CO_3			→	$CaCO_3$ ↓	+	Na_2SO_4			
7.	$CaCl_2$	+	Na_2CO_3			→	$CaCO_3$ ↓	+	2NaCl			
8.	$Ca(NO3)_2$	+	Na_2CO_3			→	$CaCO_3$ ↓	+	$2NaNO_3$			
9.	CaF_2	+	Na_2CO_3			→	$CaCO_3$ ↓	+	2NaF			
Magnesium Salts												
10.	$MgSO_4$	+	Na_2CO_3	+	Ca $(OH)_2$	→	$CaCO_3$ ↓	+	Mg $(OH)_2$↓	+	Na_2SO_4	
11.	$MgCl_2$	+	Na_2CO_3	+	Ca $(OH)_2$	→	$CaCO_3$ ↓	+	Mg $(OH)_2$↓	+	2NaCl	
12.	Mg $(NO3)_2$	+	Na_2CO_3	+	Ca $(OH)_2$	→	$CaCO_3$ ↓	+	Mg $(OH)_2$↓	+	$2NaNO_3$	
13.	MgF_2	+	Na_2CO_3	+	Ca $(OH)_2$	→	$CaCO_3$ ↓	+	Mg $(OH)_2$↓	+	2NaF	
Other than above, there are other Heavy metals, which precipitates at higher pH, The reactions are one the same line as Mg.												

Silica Removal Using Dolomite

Silica removal is possible using Lime when Magnesium is already available in water and the same will be precipitated as Magnesium Hydroxide ($Mg(OH)_2$). Silica is removed by adsorption on Magnesium Hydroxide. If the water/effluent doesn't have required magnesium concertation, then additional aid, i.e. Dolomite ($CaMg(CO_3)_2$) is dosed in water/effluent. This will ensure desired concertation of Magnesium and thus the silica removal.

Silica removal is lesser when Water / effluent TDS is on higher side.

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