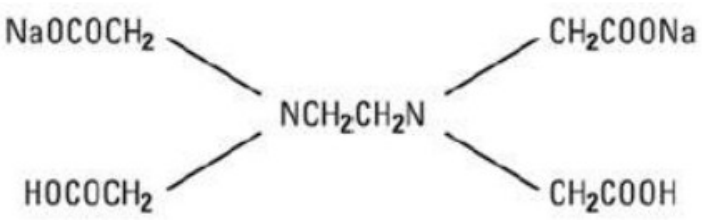
Water Technology

Permanent/Non carbonate Hardness:

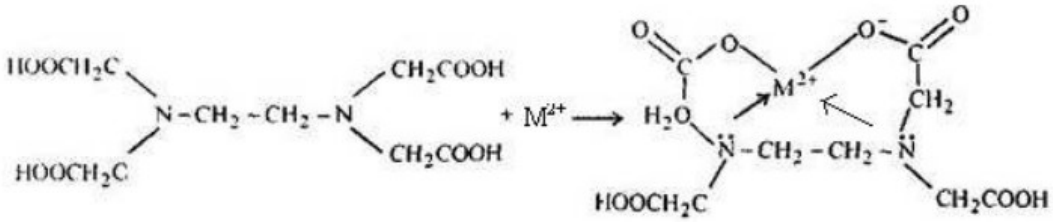
Total hardness= Temporary Hardness +Permanent Hardness

$$\text{mg } CaCO_3 \text{ eq. of any salt} = \frac{\text{Weight of that chemical X 50}}{\text{Equivalent weight of chemical}}$$

Disodium EDTA :



Reaction of Di-Sodium EDTA and metal ion:



Titration of EDTA:

i) M^{++} + EBT ↔ M-EBT + $2H^+$

ii) M^{++} + EDTA → M-EDTA + $2H^+$

iii) M-EBT + EDTA → M-EDTA + EBT

Pink red **colorless** **colourless** **blue**

Total hardness of water sample:

Hardness of water sample = (Y x Z x100 x 1000) / V ppm CaCO3 equivalent

Where, Y=Volume of EDTA

Z=Molarity of EDTA

V=Volume of Water sample

Amount of alkalinities due to OH^-, $CO3^{-2}$, $HCO3^-$

Alkalinity	Quantity of OH^-	Quantity of CO_3^{-2}	Quantity of HCO_3^-
P =0	0	0	M
P =1/2M	0	2P	0
P = M	P	0	0
P < 1/2M	0	2P	M-2P
P > 1/2M	(2P-M)	2(M-P)	0

Where P =Phenolphthalein alkalinity
M= Methyl Orange Alkalinity or Total Alkalinity

Requirements of hardness of water to be used in Boilers:

Types of boilers, Steam pressure	Permitted hardness of feed water
Low pressure: Below 15 Kg/cm^2	25-50 ppm $CaCO^3$ equivalent
Medium pressure: 15-30 Kg/cm^2	10-25 ppm $CaCO^3$ equivalent
High pressure: Greater than 30 Kg/cm^2	0-10 ppm $CaCO^3$ equivalent

Efficiency parameters for Reactions:

$$\textbf{Atom economy} = \frac{\text{Molecular wt of desired product X 100}}{\text{Molecular wt of all products}}$$

Conversion (%)

$$\frac{\text{Amount of reactant taken} - \text{Amount of reactant unconsumed}}{\text{Amount of reactant taken}} \times 100$$

Reaction yield: Yield (%)

$$\text{Yield (\%)} = \frac{\text{Amount of product formed}}{\text{Amount of reactant taken}} \times 100$$

Reaction selectivity:

$$\text{Selectivity (\%)} = \frac{\text{Amount of desired product formed}}{\text{Amount of product expected on the basis of amount of reactant consumed}} \times 100$$

Environmental load factor (E) :

E = Total mass of effluent generated / Mass of desired product

Mass intensity:

Mass intensity (MI) = Mass of reactants used /mass of product desired.

Green Chemistry

Twelve principles of green chemistry:

1. Prevention of waste.
2. High atom economy
3. Less hazardous chemical synthesis.
4. Designing safer chemicals
5. Use of safer solvents & auxiliaries.
6. Design for energy efficiency.
7. Use of renewable feed stock.
8. Reducing derivatives.
9. Catalysis
10. Design for degrading products.
11. New analytical methods.
12. Accident prevention.