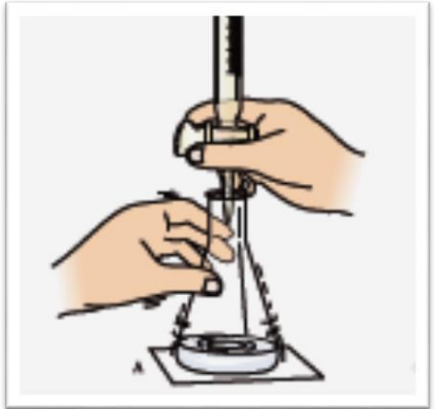
Estimation of hardness of water

➢ **O. Hehner's method:**



❖ ***Temporary Hardness:*** Acid-base titration is performed before and after boiling the hard water

Permanent Hardness: Chloride and sulphates of Ca and Mg are removed as insoluble $CaCO_3$ and $MgCO_3$ by boiling the hard water with excess Na_2CO_3. Acid-base titration is performed before and after removal

$$Ca(HCO_3)_2 \xrightarrow{\text{Boiling}} CaCO_3\downarrow + H_2O + CO_2$$

$$Mg(HCO_3)_2 \xrightarrow{\text{Boiling}} Mg(OH)_2\downarrow + CO_2$$

$$CaCl_2 + Na_2CO_3 \xrightarrow{\text{Boiling}} CaCO_3\downarrow + 2\,NaCl$$

$$MgSO_4 + Na_2CO_3 \xrightarrow{\text{Boiling}} MgCO_3\downarrow + 2\,Na_2SO_4$$

➢ **Soap titration method:**

Hardness is estimated by adding a soap solution of known strength to a sample water solution until a permanent lather is formed after shaking

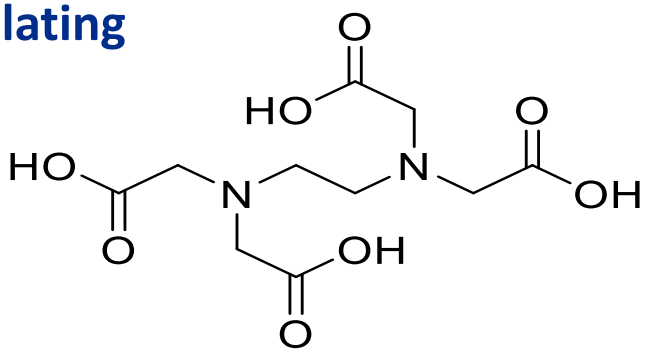
$$2\,C_{17}H_{35}COONa + Ca(HCO_3)_2 \longrightarrow (C_{17}H_{35}COO)_2Ca\downarrow + 2\,NaHCO_3$$

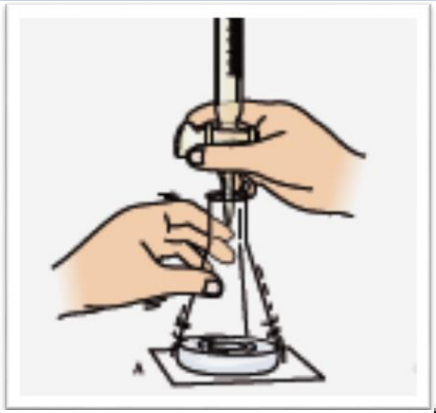
$$2\,C_{17}H_{35}COONa + MgCl_2 \longrightarrow (C_{17}H_{35}COO)_2Mg\downarrow + 2\,NaCl$$

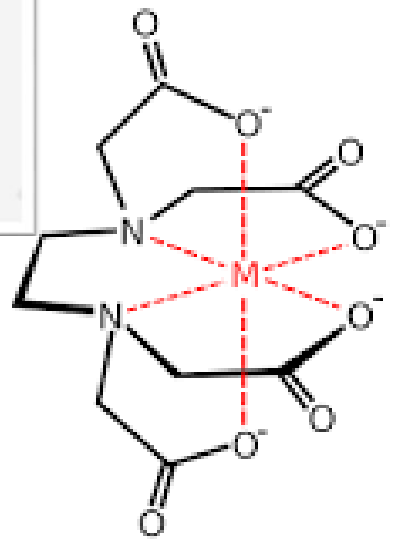
$$2\,C_{17}H_{35}COONa + CaSO_4 \longrightarrow (C_{17}H_{35}COO)_2Ca\downarrow + Na_2SO_4$$

Estimation of hardness of water: EDTA method

- Water hardness can be readily determined by complexo- metric titration with the chelating agent EDTA
- EDTA is *ethylene diamine tetraacetic acid*.
- EDTA solution is colorless

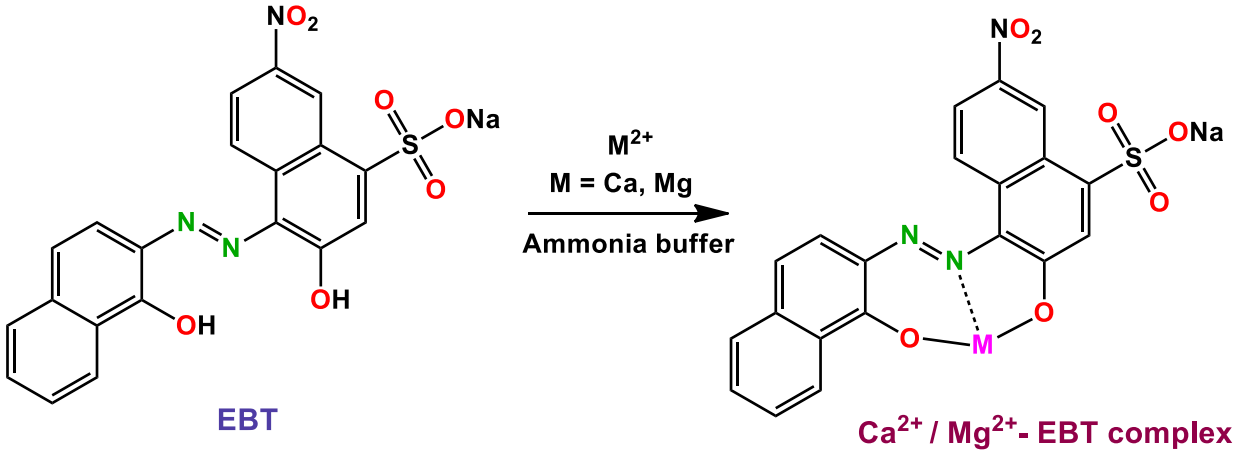






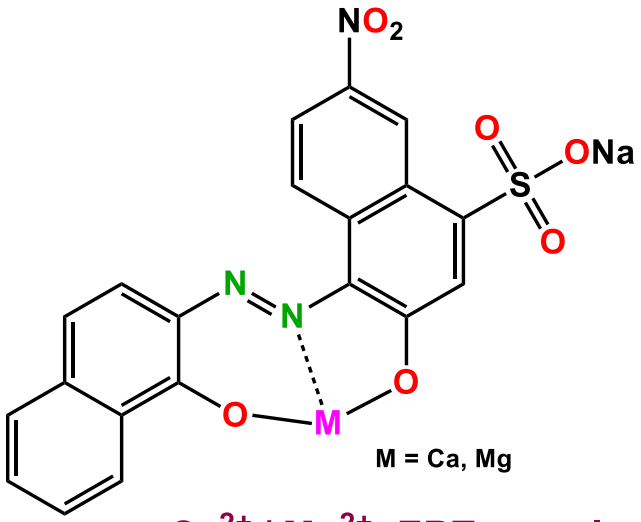
- Corresponding disodium salt is used for the hardness estimation, as this slat forms very strong and stable complex with Ca^{2+} and Mg^{2+}.

- Initially, Ca^{2+} and Mg^{2+} or the are treated with Eriochrome black T (EBT) indicator using ammonia buffer (to maintain pH between 9-10) to get an unstable Ca^{2+}/Mg^{2+} complex which imparts wine-red colour to the solution



EDTA method

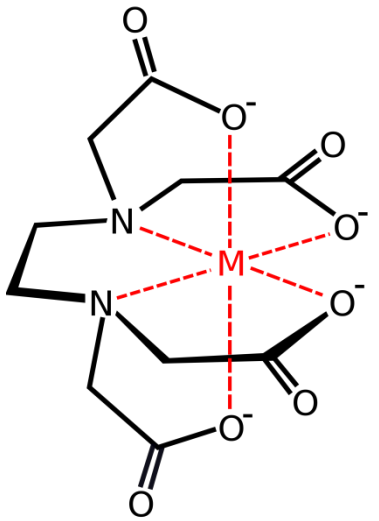
➢ On addition of EDTA, EBT gets replaced by EDTA since EDTA forms a stronger complex with the metal ions



Ca^{2+} / Mg^{2+}- EBT complex

Wine red

EDTA



Ca^{2+}/Mg^{2+} – EDTA complex (colorless)

\+ EBT

Steel blue

❑ Overall process

Ca^{2+} / Mg^{2+} → (EBT (blue); Buffer pH = 9-10) → Ca-EBT / Mg-EBT (Wine red) → (EDTA) → Ca-EDTA / Mg-EDTA (Colorless) + EBT (blue)

EDTA method

- A 100 ml sample of water require 15 ml of 0.02 M EDTA for titration using EBT as indicator. Calculate the total hardness.
- [Ans.: Total=300ppm]
- (Hint:1000 mL 1MEDTA ≡ 1000 mL 1M $CaCO_3$ = 100 g of $CaCO_3$]