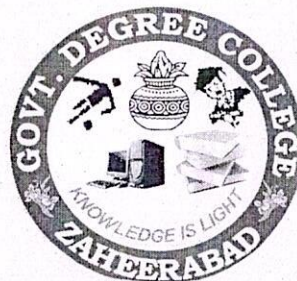


Govt. Degree College Zaheerabad



Student Study Project

Topic: Water Softening

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JIGNASA

A PROJECT WORK

ON

WATER SOFTENING

DEPARTMENT OF CHEMISTRY

GOVERNMENT DEGREE COLLEGE

ZAHEERABAD

OSMANIA UNIVERSITY

TELANGANA STATE

Submitted by

B.Sc (M.P.C & B.Z.C) T/M

2017-2018

CERTIFICATE

This is to certify that Abhilash, Ramesh, Prabhavathi, G. Laxmi, Krishnavani students of Chemistry, Govt. Degree College Zaheerabad, has completed the project on the topic of "Water Softening" under the supervision and guidance of Sri.Ch. Bhagavan Reddy, Lecturer in Chemistry, Govt. Degree College Zaheerabad.

To best of my Knowledge the report is original and has not been copied or submitted anywhere else. It is an independent work done by him.

GUIDE

(Ch. Bhagavan Reddy)



PRINCIPAL

DR.K.SRINIVASA RAJU

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WATER SOFTENING

- removal of hardness

» Hardness is?...

primarily Ca, Mg, plus Fe, Mn, St, Al

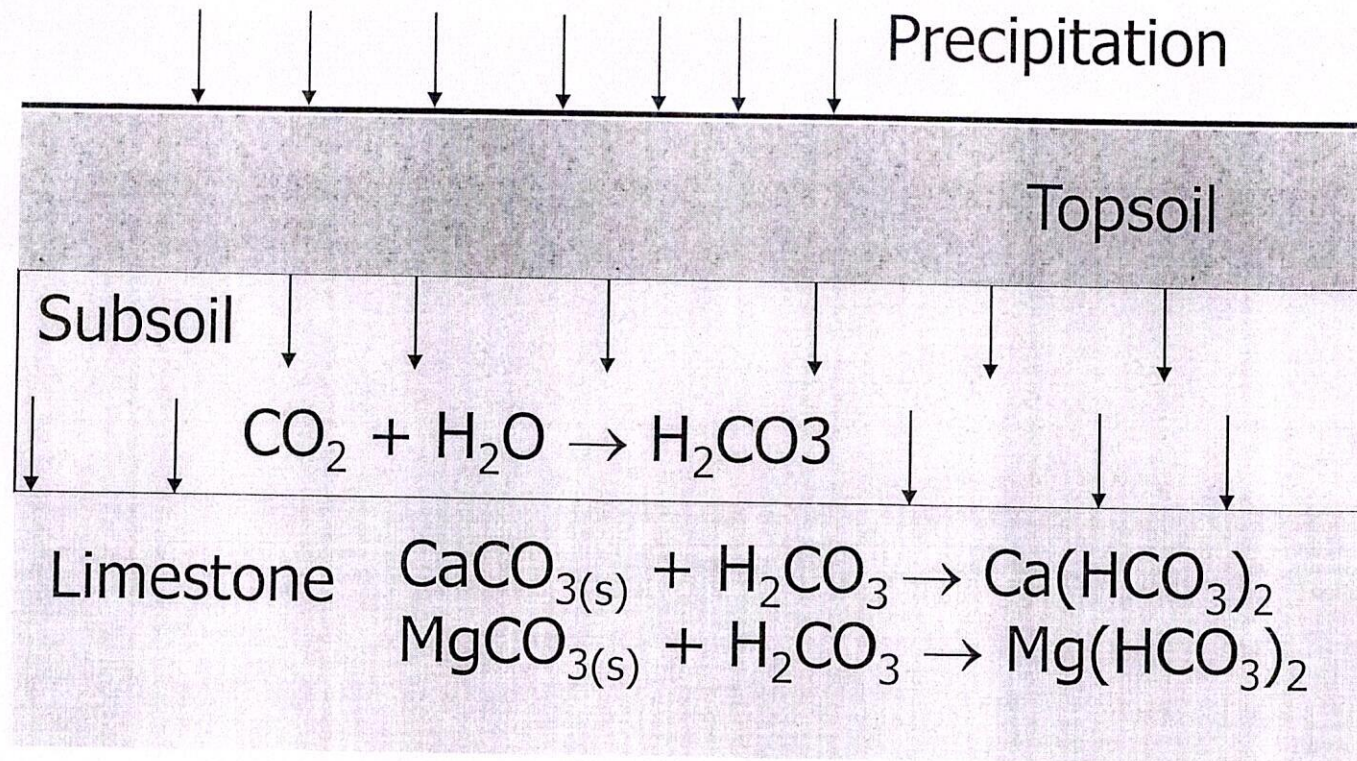
- How is Softening done?...

Precipitation of Ca and Mg, or
Ion exchange of Ca / Mg with ion such as Na

Why bother?

- Hardness in 300-500 mg/l as CaCO_3 range considered excessive
 - high soap consumption
 - scaling in heating vessels and pipes
- Even > 150 mg/l may result in consumer objection
- 60-120 mg/l as CaCO_3 is considered a moderate amount

Formation of Hardness



Hardness

- Carbonate Hardness
 - » Often called "temporary hardness" because heating the water will remove it. When the water is heated, the insoluble carbonates will precipitate and tend to form bottom deposits in water heaters.
 - » Ca^{2+} , Mg^{2+} associated with HCO_3^- , CO_3^{2-}
 - » $\text{CH} = \text{TH}$ or Total alkalinity, whichever is less

Hardness

- Non-Carbonate Hardness
 - » Called permanent hardness because it is not removed when the water is heated. It is much more expensive to remove non-carbonate hardness than carbonate hardness.
 - » Ca^{2+} , Mg^{2+} associated with other ions, Cl^- , NO_3^- , SO_4^{2-}
 - » $\text{NCH} = \text{TH} - \text{CH}$
 - » If Alkalinity \geq Total hardness, then $\text{NCH} = 0$

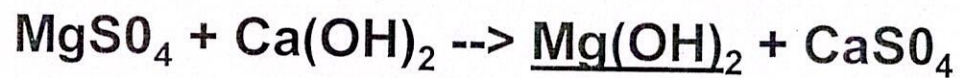
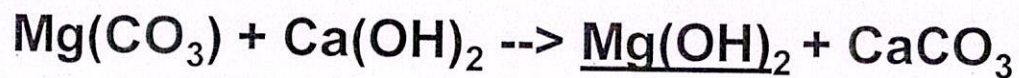
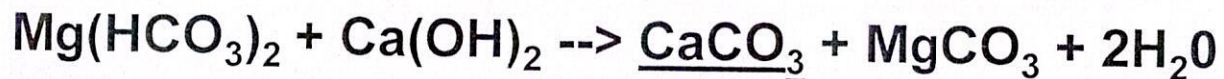
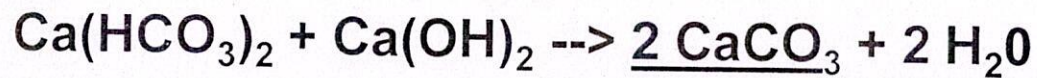
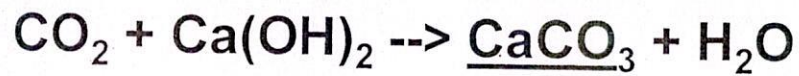
Hardness Units

- milligrams per liter (mg/L) as calcium carbonate (most common)
- parts per million (ppm) as calcium carbonate
- grains per gallon of hardness (to convert from grains per gallon to mg/L, multiply by 17.1)
- equivalents/liter (eq/L)

LIME - SODA ASH SOFTENING

- Addition of lime, Ca(OH)_2 , & soda ash, Na_2CO_3 causes precipitation of Ca, Mg
- Lime often added as CaO , quick lime
 - » $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2$
- Three basic processes
 - » *Excess lime treatment*
 - » *Selective calcium removal*
 - » *Split treatment*

Stoichiometry



Solubilities

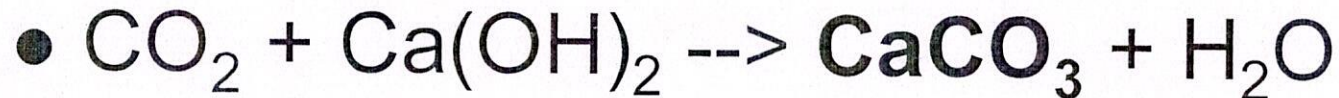
- Ca(OH)_2 is very soluble, **Mg(OH)_2** is not
- MgCO_3 is very soluble, **CaCO_3** is not
 - » CaCO_3 and Mg(OH)_2 are relatively insoluble
 - ✓ CaCO_3 : ~ 30 mg/l as CaCO_3
 - 0.6 meq/l
 - ✓ Mg(OH)_2 : ~ 10 mg/l as CaCO_3
 - 0.2 meq/l
 - MW is ?... 58 mg/mmol
 - EW is?... 29 mg/meq
 - mg/l is ?... 5.8 mg/l as Mg(OH)_2

Removal by precipitation

- Is complete removal possible?...

No, lime-soda ash softening cannot remove all hardness

What about CO₂?



CO₂ must be considered because it consumes lime

Effectiveness

- 80-100 mg/l as CaCO_3 is usually considered acceptable result of lime-soda ash softening,
 - » as long as Mg is < 40 mg/l as CaCO_3
 - ✓ any more causes scaling in heating vessels

Stoichiometry Table

- meq of lime and soda ash to remove a meq of X initially present

X	Lime	Soda Ash
CO ₂	1	0
Ca(HCO ₃) ₂	1	0
Mg(HCO ₃) ₂	2	0
MgCO ₃	1	0
MgSO ₄	1	1
CaSO ₄	0	1