



*Hard Water
And
Soft Water*

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- Hard water :
 - has high mineral content (mainly Ca^{2+} and Mg^{2+}) metal cations,
 - and sometimes other dissolved compounds such as bicarbonates and sulfates
- Soft water : mainly content Na^+ ion

Hardness

- Hardness in water is defined as the presence of multivalent cations.
- Hardness also be defined as water that doesn't produce lather (foam) with soap solutions, but produces white precipitate (scum)
- Hardness in water can cause water to form scales and a resistance to soap.

Types of hard water

- Permanent hardness:
 - Hardness (mineral content) that cannot be removed by boiling.
 - It is usually caused by the presence in the water of calcium and magnesium sulfates and/or chlorides which become more soluble as the temperature rises.

Types of Hard Water

- Permanent hardness:
 - Can be removed using a water softener or ion exchange column, where the calcium and magnesium ions are exchanged with the sodium ions in the column.
 - Only contain metal ion

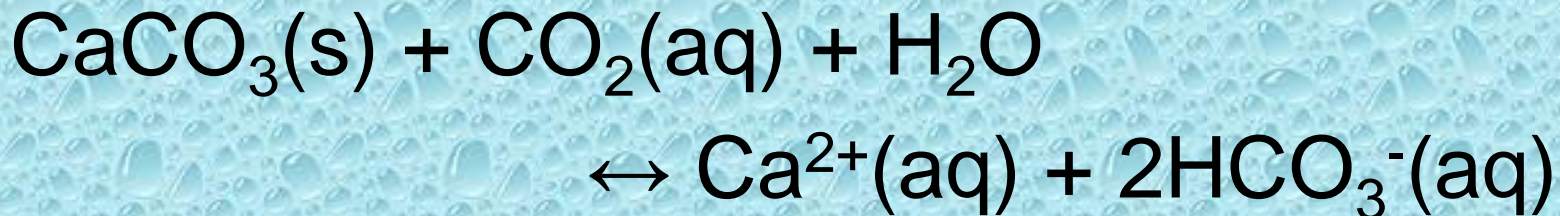
Types of Hard Water

- Temporary hardness:
 - Caused by a combination of calcium ions and bicarbonate ions in the water.
 - Contain metal ion and CO_2

Types of Hard Water

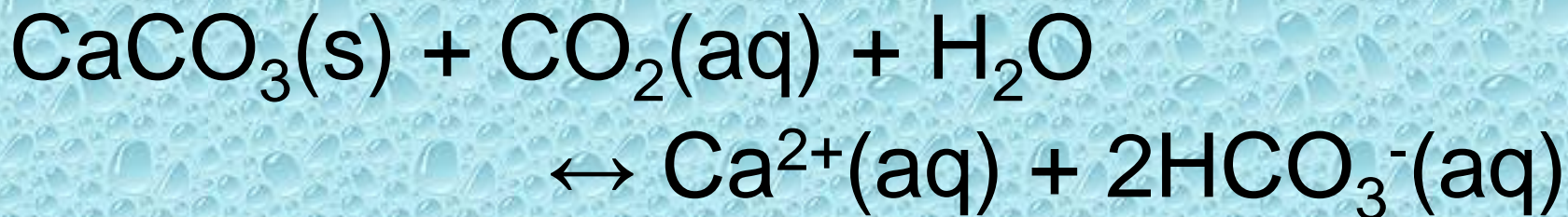
- Temporary hardness:
 - It can be removed by boiling the water or by the addition of lime (calcium hydroxide).
 - Boiling promotes the formation of carbonate from the bicarbonate and precipitates calcium carbonate out of solution, leaving water that is softer upon cooling

Dissolution of CaCO_3



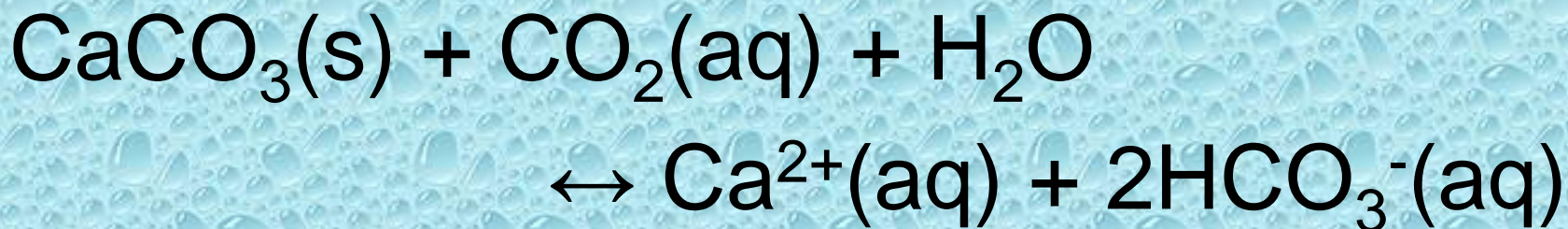
- Upon heating, less CO_2 is able to dissolve into the water.
- Since there is not enough CO_2 around, the reaction cannot proceed from left to right, and therefore the CaCO_3 will not dissolve as rapidly.

Dissolution of CaCO_3



- Instead, the reaction is forced to the left (i.e., products to reactants) to re-establish equilibrium, and solid CaCO_3 is formed.
- Boiling the water will remove hardness as long as the solid CaCO_3 that precipitates out is removed.

Dissolution of CaCO_3

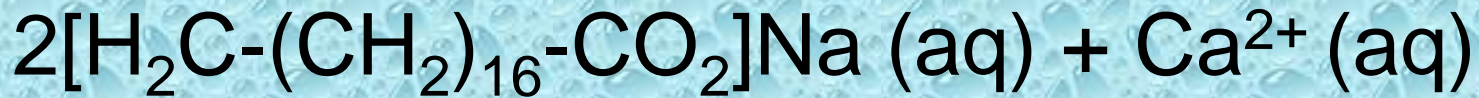


- After cooling, if enough time passes, the water will pick up CO_2 from the air and the reaction will again proceed from left to right, allowing the CaCO_3 to "re-dissolve" into the water.

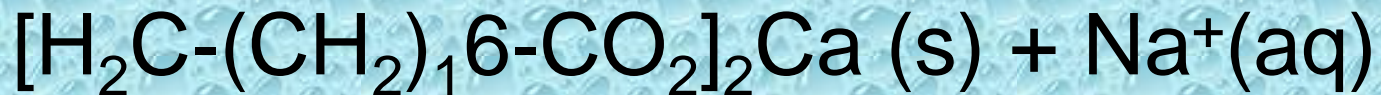
Effect of temporary hardness

- CaCO_3 scaling inside kettle or heater system
- Decrease the effectiveness of soap (K & Na mixture)

Effect of temporary hardness



soap



soap foam



insoluble in water & precipitate
as white precipitation (scum)

Effect of temporary hardness

- Scaling, which is the left-over mineral deposits that are formed after the hard water had evaporated. This is also known as limescale.
- The scale can clog pipes, ruin water heaters, coat the insides of tea and coffee pots, and decrease the life of toilet flushing units

Effect of temporary hardness

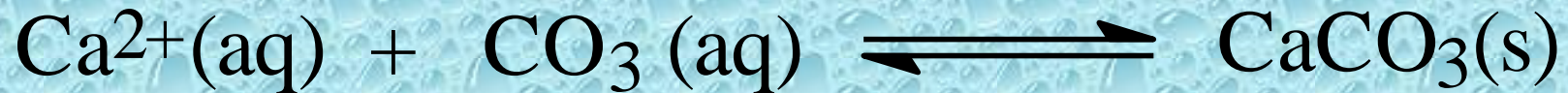


Soften the Water

- It is often desirable to soften hard water, as it does not readily form lather with soap.
- Soap is wasted when trying to form lather, and in the process, scum forms.
- Hard water may be treated to reduce the effects of scaling and to make it more suitable for laundry and bathing.

Soften the Water

1. Lime-soda process : precipitate Ca^{2+}



from hard water



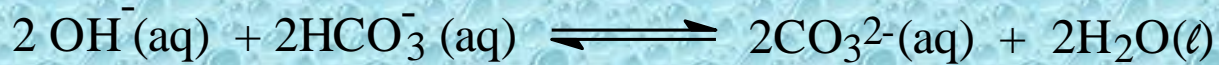
from soda

?





↓
change HCO_3^- (from hard water) to CO_3^{2-}



↓
will precipitate Ca^{2+} (both from CaO and hard water)

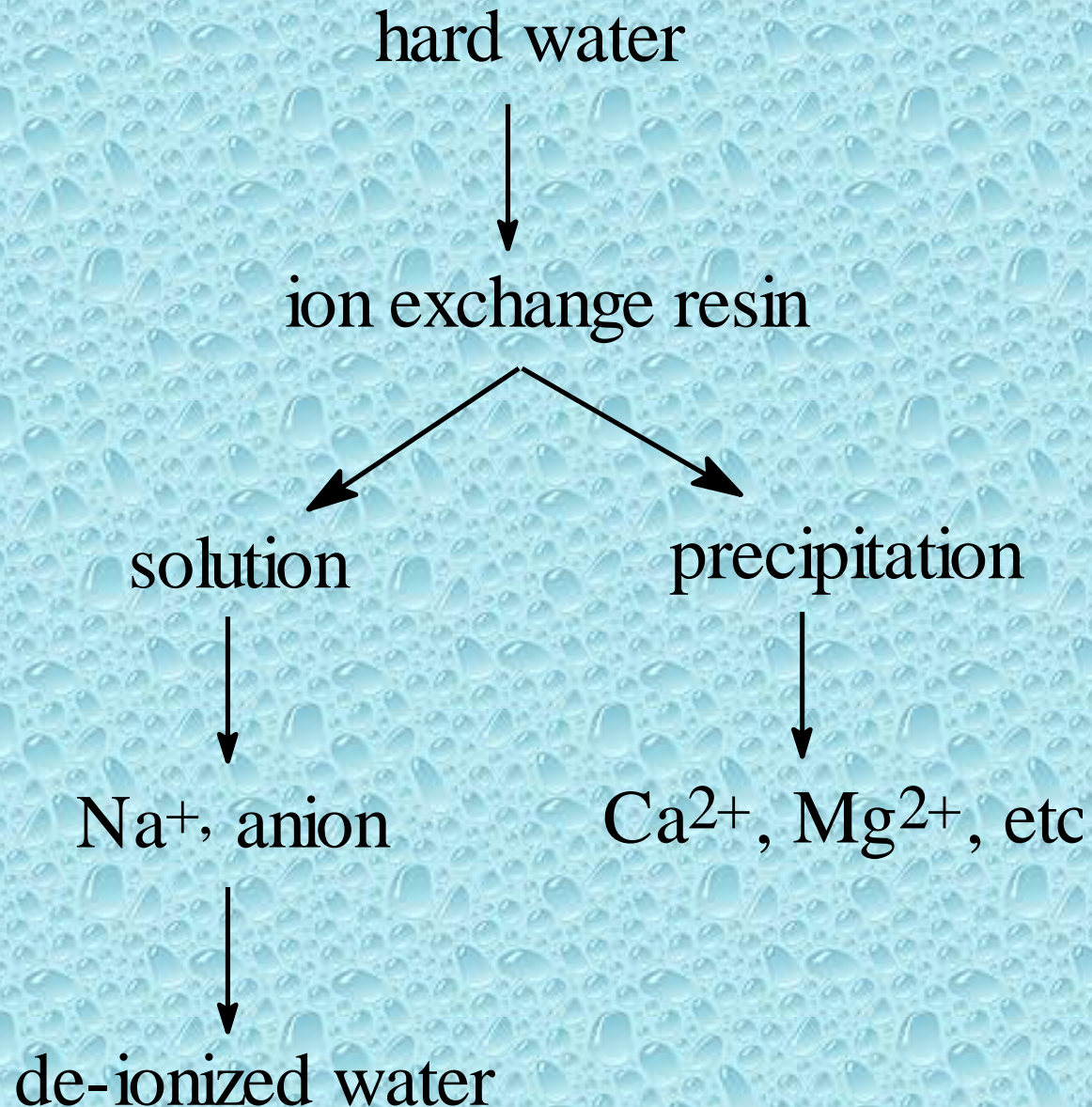
According to the reaction:



↓
must precipitate 2 mol Ca^{2+}
1 mol from CaO
1 mol from hard water

↓
ineffective

2. Ion exchange : complex of sodium salt



- Deionization

- Use resin

- Change cation by hydrogen and anion by hydroxide

- Cation stucked on the resin



Hard water

- Advantages
 - tastes great
 - supplies needed minerals in the diet
 - when rinsing soap - removes all traces of it.

Hard water

- Disadvantages
 - tends to crust up water using/heating devices
 - bad for soap action (less suds, less cleaning power)
 - fades clothes in washers.

Soft water

- Advantages
 - keeps water using/heating appliances clean and deposit free
 - Soap works better (suds up (soap forming) better, gentler washing cycles).

Soft water

- Disadvantages
 - often adds salt to environment
 - can have slimy/soapy feeling even when completely rinsed
 - not as good for you to drink (less minerals).

- Another disadvantages of soft water:
 - Soft water contains more sodium ions than hard water does. Sodium is linked to heart disease.
 - Soft water dissolves metals such as such as cadmium and lead from metal pipes.
 - Lead is poisonous.
 - Cadmium has been linked to hypertension (but it also dissolves copper which your body needs)

Why Is It Harder to Rinse off Soap with Soft Water? (Slippery When Wet)

- Hard water contains calcium and magnesium ions.
- Water softeners remove those ions by exchanging them for sodium or potassium ions.

Why Is It Harder to Rinse off Soap with Soft Water? (Slippery When Wet)

- Two factors contribute to that slippery-when-wet feeling you get after soaping up with soft water.
 - First, soap lathers better in soft water than in hard water, so it's easy to use too much. The more dissolved soap there is, the more water you need to rinse it away.
 - Second, the ions in softened water

Why Is It Harder to Rinse off Soap with Soft Water? (Slippery When Wet)

- Two factors contribute to that slippery-when-wet feeling you get after soaping up with soft water.
 - Second, the ions in softened water lessen its ability to 'stick' to the soap molecules, making it more difficult to rinse the cleanser off your body.