Hard Water and Soap

Tap water in many parts of the country contains minerals that can interfere with the cleaning ability of detergents. That's why water softeners are popular in these locations. Water softeners remove these minerals. In this experiment, you will make "hard" water from distilled water, which contains no minerals, and is therefore "soft." You can then compare the sudsing ability of a detergent in soft and hard water. Hard water in the shower helps you remove soap from your skin but it causes a build up of insoluble calcium or magnesium soap scale on your shower wall that is hard and difficult to remove, thus the term HARD water.

Part A-How Epson Salts (Mg^{2+}) ions Affect the Effectiveness of Soap

Materials : 10 milliliters distilled water , 2g epsom salts (magnesium sulfate), 2 empty and cleaned 5 mL test tubes with stoppers, several drops of liquid dishwasher soap.

Hypothesis: How can you tell if water is soft or hard? How does it affect cleaning?

Procedure:

Pour 5 milliliters (1 cup) of distilled water into each of the empty test tubes.
Add 1g of epsom salts (magnesium sulfate) to *one* of the test tubes.
Stopper or cap and shake the test tube until the epsom salts dissolve.
Add a drop of liquid dish detergent to both test tubes.
Seal the test tubes with their caps or stoppers.
Shake both test tubes.

Part B-The Hardness of Water

Materials: burette and holder on ring stand, 250 mL Erlenmeyer Flask, 25 mL graduated cylinder, 20 mL ammonia-ammonium chloride buffer (mix equal amounts to a pH of about 10), a few drops of eriochrome Black T indicator, 0.01 M EDTA solution, 10 mL distilled water, 10 mL tap water, 10 mL of Hépar water (200-500 mg $CaCl_2$ or $MgCl_2$ per L), 10 mL sea water.

Hypothesis: How hard is the water of various samples?

Procedure:

1. Rinse and fill a clean burette to the zero mark with standard 0.01 M EDTA. Be sure there are no bubbles in the tip of the burette.
2. Using a 10.0 mL pipette with bulb, add 10.0 mL of a water sample (distilled water, tap water, Hepar water, or sea water) to a 250 mL Erlenmeyer Flask along with 20 mL of the ammonia buffer and about 6-8 drops of the eriochrome Black T indicator.
3. Mix by swirling. You will do this procedure for each of the 4 water samples.
4. Place the flask under the burette and carefully turn the stop cock adding the EDTA to the water solution slowly drop by drop until the red color turns blue. As soon as it turns blue shut off the stop cock. Record the mls of EDTA you added. If the solution is already blue, record 0 mls added.
5. Calculate the equivalent milligrams of calcium carbonate ($CaCO_3$) per L in your water samples by multiplying the mls EDTA you titrated from the burette by 50. Levels of about 200-500 mg/L are considered to be fairly hard water.

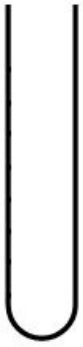
Hard Water and Soap Lab Report

Name: _____ Section: _____

Part A-How Epson Salts (Mg^{2+}) ions Affect the Effectiveness of Soap

Draw what you saw in the two test tubes

Test Tube 1



dishwasher Soap
water Only

Test Tube 2

dishwasher Soap
epson Salts

Part B-The Hardness of Water

Sample	mls EDTA titrated	mg $CaCO_3$/L
Distilled Water	.....	.....
Tap Water	.....	.....
Sea water	.....	.....
Hépar water	.....	.....

How to explain ?

Part A :

A large amount of suds will form in the test tube without epsom salts. Far fewer suds will form in the test tube containing the epsom salts.

The suds formed in this experiment are made of tiny bubbles. The bubbles are formed when air is trapped in a film of liquid. The air is trapped when it is shaken into the water. The film of liquid surrounding each bubble is a mixture of water and detergent. The molecules of detergent form a sort of framework that holds the water molecules in place in the film. If there were no detergent, the bubbles would collapse almost as soon as they are formed. You can see what this would look like by repeating the experiment, but leaving out the detergent.

This experiment will not produce suds if detergent for a dishwashing machine is used. (Try it and see.) No suds are formed because automatic dishwasher detergent is formulated so that it does not form suds. Suds create problems in a dishwasher. They interfere with the movements of the washing arms, and they are difficult to rinse off of the dishes.

The minerals that make water hard usually contain calcium and magnesium. In this experiment, you made water hard by adding epsom salt, which is magnesium sulfate. Calcium and magnesium in water interfere with the cleaning action of soap and detergent.

They do this by combining with soap or detergent and forming a scum that does not dissolve in water. Because they react with soap and detergent, they remove the soap and detergent, thereby reducing the effectiveness of these cleaning agents. This could be overcome by adding more soap or detergent. However, the scum that is formed can adhere to what is being washed, making it appear dingy.

Water can be softened in a number of ways. An automatic water softener connected to water supply pipes removes magnesium and calcium from water and replaces them with sodium. Sodium does not react with soap or detergents. If you don't have an automatic water softener, you can still soften laundry water by adding softeners directly to the wash water. These softeners combine with calcium and magnesium, preventing the minerals from forming a soap scum.

Part B :

A titration is when you add one solution, using a burette, to another solution to measure how much of each solution reacts. Divalent cations like calcium and magnesium ions can be removed or “tied up” using what is called a chelating agent. The chelating agent we will use is EDTA (ethylenediaminetetraacetic acid) that acts like a worm with a head on each end that combines with two calcium or magnesium ions, one at each head. We will add a EDTA solution to a sample of hard water and measure how much is needed to combine with the ions. We will know this when the indicator turns from red to blue. In order for this reaction to work properly we will need to add a buffer to keep the pH or the acid level constant. We will use an ammonia buffer to do this.

Dosage d'une eau dure ETLV	
6 postes : • eau distillée • balance sabot de pesée • 2 tubes à essais sur support avec bouchons • burette graduée 25 mL • pipette jaugée 10,0 mL • propipette • bécher 100 mL • erlenmeyer 100 mL • éprouvette 10 mL	Au bureau : • sulfate de magnésium • chlorure d'ammonium (pH=10) • liquide vaisselle • liquide pour lave-vaisselle • noir ériochrome • solution EDTA 1.10^{-2} $mol.L^{-1}$ • Hépar (1L) • eau de mer (1L)