

Chemistry 51
Experiment 8a
Quantitative Analysis of Water

INTRODUCTION

Physical changes involve "actions" which do not change the composition of the compound. The individual atoms are not rearranged in a different order after an "action" takes place. Some physical properties include boiling point, melting point, density, hardness, and color. For example, when ice (H_2O) melts, it becomes liquid water (H_2O). If that water is boiled it becomes a vapor or gas (H_2O). The chemical composition has not changed. Physical changes alter the state of matter (gas, liquid or solid). Chemical changes involve "actions" which change the composition of the compound. If the compound was initially water, H_2O , then after an "action", it changed to H_2 and O_2 gases then a chemical change has happened. The atoms of the compound have been rearranged. Chemical properties involve two basic methods, analysis and synthesis. Analysis is the breakdown of a material for the purpose of uncovering what compounds or elements make up that material and synthesis is the construction of materials from smaller or different starting materials.

In this experiment you will analyze different types of water via a physical change. You will physically change liquid water to gaseous water (by boiling) so that only the less volatile solid residue is left. The percent of solid residue in tap water, distilled water, and seawater will be calculated and compared to government standards. The maximum contaminant level for total dissolved solids is 1000 ppm (mg/L). When the amount of substance is calculated the procedure is referred to as quantitative analysis. We will only be analyzing for total amount of materials (contaminant) in water.

In contrast, when analyzing water qualitatively, the experimenter identifies the substances that are present in the residue, possibly to detect certain toxic chemicals. One toxic component of drinking water is lead (Pb). Lead is classified as a B2 carcinogen, it is known to have cancer-causing properties in animals but there is insufficient data on its effect on humans. A major source of lead in drinking water is the lead plumbing materials and fixtures. One of the problems with lead (Pb^{2+}) depends on its suspected ability to replace calcium

(Ca²⁺) in bones and tissue. For more information about the drinking water in your area contact the water department in your local city government.

PROCEDURE

- i. Set up your Bunsen burner and ring stand. Attach a wire gauze about 2 inches above the top of the burner. Check if your Bunsen burner is working properly. If you have never used one before, inform the instructor.
- ii. Clean and dry two 150 ml beakers. Identify each beaker using a pencil on the white area on the beaker. Do not touch the beakers with your bare fingers after cleaning, you want to avoid putting the oils from your hand onto the beaker
- iii. Put 2 to 3 clean boiling chips into each of the clean beakers then weigh them, remember not to touch it with your hands. Use the mitts provided or a paper towel as a protective glove. Weigh the beaker to the nearest thousandths.
- iv. Fill a graduated cylinder with 75.0 mL of water (one beaker contains the tap water while the other beaker is for the DI water). The graduated cylinder is read by aligning your eyes with the bottom of the meniscus, again if you have not used a graduated cylinder before see your instructor. Pour the water into the 150-mL beaker then re-weigh the beaker. If you can not use the digital (analytical) balance for this measurement use the triple beam balance. Calculate the weight of the water by using the following equation (wt is short for weight). Do this for both types of water.

$$(\text{wt. of water \& beaker \& stones}) - (\text{wt. of empty beaker \& stones}) = \text{wt. of water}$$

- v. Place the beaker filled with water on the wire gauze and gently boil the water away. If the rate of boiling becomes too vigorous then control the boiling by moving the burner away from the beaker. When the amount of water left is about 15 mL, it may be necessary to cover the beaker with a watch glass to avoid splattering. If you do this, the watch glass will have to be rinsed so use your best judgment.
- vi. When all of the water has been boiled away, rinse the splattered watch glass with a small amount of DI water and evaporate that water away by gently waving the burner under the beaker. Make sure that all of the liquid has been evaporated but remember not to look directly down into the beaker while it is being heated. Record the color of the residue.
- vii. Carefully cool the beaker on the wire gauze. Weigh the beaker and record your measurement, remember not to touch the beaker with your hands.
- viii. Next you will repeat this experiment with seawater supplied by your instructor. This water has been pre-filtered and heated to eliminate organic residue. Weigh a 250-mL beaker + boiling chips, taking all of the precautions as before. Add 100 to 125 mL of seawater then re-weigh. Boil the water as before but be aware that seawater should contain much more solid residue than either drinking or DI. As the water level goes down there is a greater risk of salt splattering. If you notice splattering, place an oversize watch glass over the mouth of the beaker as it is boiling. Once on, do not handle the watch glass with your hands since it will be extremely hot! Remember to rinse the watch glass with DI water once all of the water has boiled away. Place the moist seawater residue in the oven for 20-30 minutes to dry completely without splattering. Weigh the cooled beaker containing the seawater residue.

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CALCULATIONS

a. Calculate the percent, %, of total solids in your sample, it takes two steps.

i. $\text{wt. of total solids} = (\text{wt. of beaker/chips with dry solids}) - (\text{wt. of beaker empty/chips})$

ii. $X \% \text{ of total solids in sample} = \left[\frac{\text{wt. of total solids}}{\text{wt. of water sample}} \right] * 100\%$

b. Calculate the amount of total solids in parts per million (ppm or mg/L)

i. $X \text{ ppm of total dissolved solids} = \left[\frac{\text{wt. of total solids}}{\text{wt. of water sample}} \right] * 10^6 \text{ ppm}$

REPORT SHEET: ANALYSIS OF WATER

TYPE OF WATER	Wt of beaker + chips	Wt of beaker, chips, & water	Wt of water	Wt of beaker, chips & dry solids	Wt of dried solids (residue)	% of total solids in water	Total dissolved solids in ppm
Drinking							
Deionized							
Salt Lake							
Seawater							

SHOW SAMPLE CALCULATIONS:

QUESTIONS

1. Is evaporation a physical or chemical change? _____
2. How does the drinking water ppm value obtained from the experiment compare to the maximum contaminant level of 1000 ppm set by the federal government? What is the percent error?
3. How do the experimental values for tap water compare to that obtained for DI water? Explain the differences.
4. In the future, which type of water should be used when performing chemistry experiments? Explain your reasoning.
5. Why do you think dissolved substances are permitted in drinking water (*i.e.* why is drinking water not "pure")?
6. Seawater is, on average, 3.3 to 3.7% salt. The amount of salt varies from place to place. If all of the salt in the ocean were dried, it would form a mass of solid salt the size of Africa. How does your experimental value compare to the average value of 3.5%? How would you explain the discrepancies, if any?