Stoichiometry---Determination of Percent by Mass of $NaHCO_3$ in Alka Seltzer Tablets

Introduction

Alka Seltzer is an over-the-counter antacid and pain relief medication that is taken by dissolving it in water before ingesting. Alka Seltzer is an effervescent tablet that contains aspirin (acetylsalicylic acid), citric acid, and sodium bicarbonate ($NaHCO_3$). When the tablet dissolves in water, it produces carbon dioxide gas. The release of carbon dioxide into the atmosphere results in a total weight loss after the reaction.

The balanced chemical equation for the reaction of sodium bicarbonate with an acid is below:

$$NaHCO_3 + CH_3COOH \rightarrow H_2O + CO_2$$

In this lab, we will use acetic acid (vinegar). Your will need to calculate the amount of sodium bicarbonate reacted, and determine the percent by mass of $NaHCO_3$ contained in Alka Seltzer tablets. Additionally, you need to determine the limiting reactant in the reaction of Alka Seltzer tablets and vinegar/water solutions of various ratios.

% by mass of the reacted $NaHCO_3$ in a tablet = (mass of $NaHCO_3$ reacted in a tablet / mass of a tablet) × 100 %

Materials and Equipment

- Alka Seltzer Tablets (Bayer Corporation)
- Vinegar (acetic acid ca. 4.5 %), 150 mL
- 250 mL beaker
- Electronic balance (±0.01g)
- Graduated cylinder (50 mL, 10 mL)

Experimental Procedure

- add 35 mL of water to your beaker
- weigh and record the total weight of the beaker with water in it
- weigh and record the weight of an Alka Seltzer tablet
- drop the tablet into the beaker, carefully swirl the beaker to ensure complete dissolution of the tablet
- weigh and record the weight of the beaker containing water and the dissolved substances when the bubbling ceases
- wash and rinse the beaker with water
- calculate the mass of carbon dioxide generated
- calculate the mass of $NaHCO_3$ reacted
- calculate the percent by mass of the reacted $NaHCO_3$ in the tablet
- repeat the experiments with 5 mL vinegar + 30 mL water, 10 mL vinegar + 25 mL water, 15 mL vinegar + 20 mL water, 20 mL vinegar + 15 mL water, 25 mL vinegar + 10 mL, 30 mL vinegar + 5 mL water, and 35 mL vinegar instead of 35 mL of water
- Plot the calculated % by mass of the reacted $NaHCO_3$ in a tablet versus the volume of vinegar used

Data Table

Experiment No.	Run #1	Run #2	Run #3	Run #4	Run #5	Run #6	Run #7	Run #8
Volume of Vinegar (mL)	0	5	10	15	20	25	30	35
Volume of Water (mL)	35	30	25	20	15	10	5	0
Weight of beaker with liquid (g)	40.92	40.86	40.92	41.06	41.43	41.25	41.28	41.39
Weight of Alka Seltzer tablet (g)	3.20	3.24	3.26	3.26	3.25	3.24	3.20	3.24
Weight of beaker with all substances – **before** reaction (g)	43.44	43.30	43.26	43.33	43.66	43.48	43.47	43.61
Weight of beaker with all substances – **after** reaction	42.76	42.50	42.34	42.34	42.64	42.47	42.46	42.59
Weight loss (mass of CO_2) (g)								
Calculated mass of $NaHCO_3$ reacted (g)								
Calculated % by mass of the reacted $NaHCO_3$ in a tablet								

CALCULATIONS: Show your calculations with units for the first **two trials**

Trial 1

Calculate the mass of CO_2 lost during the reaction. Record your answer in the data table.

Calculate mass of $NaHCO_3$ reacted: This is a stoichiometry calculation beginning with the amount of CO_2 produced and finding the mass of $NaHCO_3$.The balanced chemical equation is found in the introduction. Record your answer in the data table.

Calculate % by mass of reacted $NaHCO_3$ in tablet. Use the equation in the introduction to this lab. Record your answer in the data table.

Trial 2

Calculate the mass of CO_2 lost during the reaction. Record your answer in the data table.

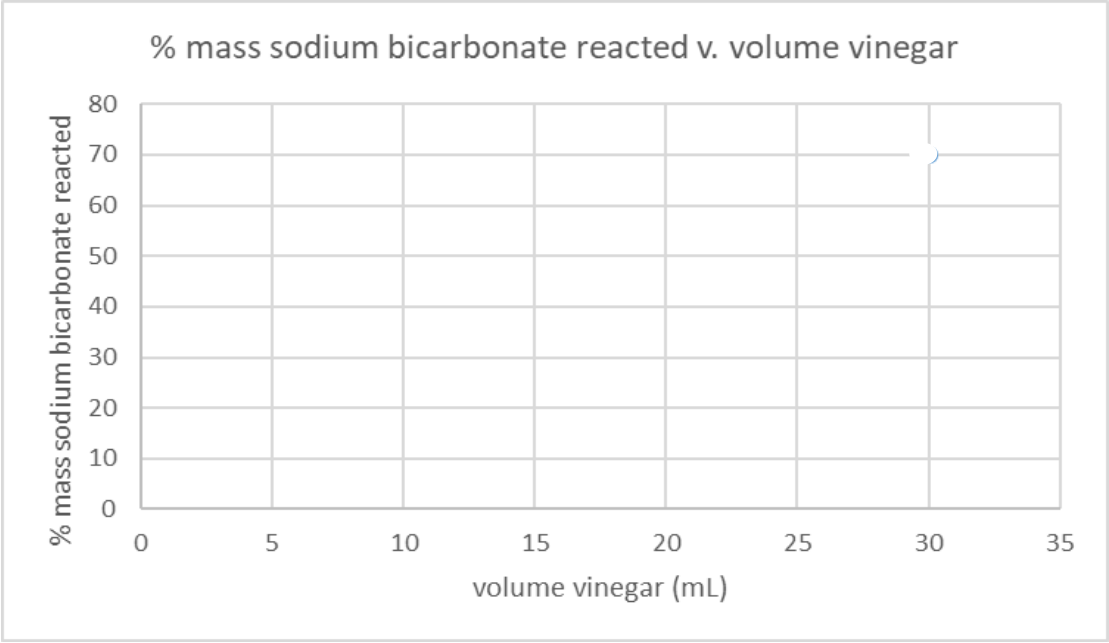
Calculate mass of $NaHCO_3$ reacted: This is a stoichiometry calculation beginning with the amount of CO_2 produced and finding the mass of $NaHCO_3$.The balanced chemical equation is found in the introduction. Record your answer in the data table.

Calculate % by mass of reacted $NaHCO_3$ in tablet. Use the equation in the introduction to this lab. Record your answer in the data table.

Complete your data table. You do not need to show your work for the rest of the trials, but use your work above as a guide.

Analysis:

1. Plot the percent by mass of the reacted $NaHCO_3$ in a tablet versus the volume of vinegar used.



Look carefully at your graph. You should see that initially, the percent mass of sodium bicarbonate reacted steadily increases as the volume of vinegar increases. Then, the percent mass of sodium bicarbonate reacted ***stays about the same*** *as the volume of vinegar increases. What does this mean?*

If the percent mass of sodium bicarbonate reacted is ***increasing*** *that means that there is* ***extra*** *sodium bicarbonate to react. If*

*there is **extra** sodium bicarbonate, that means that the **vinegar is your limiting reactant**. Once the percent sodium bicarbonate reacted levels off and **stays about the same,** that means that no matter how much vinegar you add, there is no more sodium bicarbonate to react so **sodium bicarbonate is your limiting reactant**.*

So, break your graph into two sections:

*a) A section were your data points are going **up** – this is where vinegar (acetic acid) is your limiting reactant*

*b) A section were your data points are in about a **straight** line – this is where sodium bicarbonate is your limiting reactant*

2. According to your graph, what is the limiting reactant when you react an Alka Seltzer tablet with
   a. 5 mL vinegar LR is: _____
   b. 10 mL vinegar LR is: _____
   c. 20 mL vinegar LR is: _____
   d. 30 mL vinegar LR is: _____

3. At what volume of vinegar does the limiting reactant switch? Give a **detailed explanation** of how you know. (Think about were you divided your graph into sections)

4. According to your graph, what is the percent mass of sodium bicarbonate in an Alka Seltzer tablet? (*What is the percent mass of sodium bicarbonate when your graph goes to a straight line?)*

5. An Alka Seltzer tablet actually contains 1.916 g of sodium bicarbonate. If Alka Seltzer tablets average 3.24 g, what is the actual percent mass of sodium bicarbonate in an Alka Seltzer tablet? (Use the equation in the lab intro again)

6. What is the percent error in your experiment?

7. What is one potential source of error in your experiment?