

Quantitative Determination of Sodium Bicarbonate in Alka Seltzer®

Chen, Y-H, and Yaung, J-F. "Alka Seltzer Fizzing- Determination of Percent by Mass of NaHCO₃ in Alka Seltzer Tablets." J.Chem.Ed. vol 79, no.7, July 2002. p. 848

Introduction:

Alka Seltzer® is an over the counter antacid and pain reliever that is taken after dissolving in water. It and other generic effervescent tablets contain aspirin, citric acid and sodium bicarbonate. As the tablet dissolves in water, an acid base reaction between the citric acid and sodium bicarbonate takes place with the evolution of carbon dioxide gas. The production of the gas produces bubbles into the atmosphere resulting in a loss of mass after the reaction is complete. By determining the loss in mass, one should be able to calculate the amount of sodium bicarbonate reacted and therefore the percent by mass of NaHCO₃ in the tablet. According to the balanced equation, one mole of carbon dioxide gas is produced from one mole of NaHCO₃.

Therefore,

Mass NaHCO₃ reacted = (mass of CO₂ generated/MM of CO₂) × MM of NaHCO₃
and

Percent by mass of NaHCO₃ in a tablet =
(mass of NaHCO₃ in tablet/mass of tablet) × 100%

Materials and Equipment per student or pair of students

8 or more Alka Seltzer® or other available effervescent tablets

vinegar (acetic acid about 4.5%) 150 mL

Clear plastic cups (9 cm depth, about 230 mL) (Do NOT USE Paper cups)

Electronic balance

Graduated cylinder or burettes to accurately dispense the vinegar samples

Procedure:

Measure 35 mL of water into a plastic cup. Record the mass of the cup and the water.

Determine the mass of one tablet and record it.

Carefully place the tablet in the water in the cup.

When the bubbling has ceased, stir the solution to ensure complete reaction.

Reweigh the cup and contents and record the mass.

Repeat the procedure using 30 mL of water and 5 mL of acetic acid in the cup. Dispense the acetic acid accurately using a burette. It is best to run several tests concurrently to allow complete reaction.

The following eight tests should be completed.

Experiment Number	Volume of Acetic Acid, (mL)	Volume of Water, (mL)
1	0	35
2	5	30
3	10	25
4	15	20
5	20	15
6	25	10
7	30	5
8	35	0

Calculations:

- Write the balanced equation for the reaction between the NaHCO_3 and acetic acid.
- Calculate the mass of carbon dioxide gas generated in each of the trials.
- Calculate the mass of NaHCO_3 reacted for each trial.
- Calculate the percent by mass of NaHCO_3 in each of the tablets.
- Calculate the average percent of NaHCO_3 in the tablets.
- Prepare a graph of Percent by Mass of NaHCO_3 in each tablet as a function of the volume of vinegar used.

Questions:

1. This reaction only requires 35 mL of liquid. Why is the reaction run in a large cup?
2. The effervescent tablet contains citric acid which causes it to react in pure water. Why is acetic acid added to the reaction?
3. Why must the mixture be stirred after the reaction is completed?
4. Using the graph determine the limiting reactant. Explain your answer.
5. Does the percent of NaHCO_3 vary in the different tablets?
6. Carbon dioxide dissolves in water and water evaporates into the atmosphere during the experiment. How do these two factors affect the results of your analysis?

Teacher Notes:

1. The quantity of vinegar is not required in the calculation; therefore, the acetic acid content is not crucial. It should remain constant for all trials. Vinegar with a lower concentration of acid will result in a later switch of limiting reactant.
2. To improve the results, it is important to carefully measure the amount of vinegar added. The use of burettes is recommended. Set up several dispensing burettes in the lab. If they are not available, then provide 10 mL graduated cylinders.
3. The spattering of the mixture may cause an extra loss in mass. Therefore the use of tall reaction vessels is encouraged. Also do not use paper cups (such as bathroom cups) as they will absorb water as the reaction is allowed to stand.
4. Swirl or stir the mixture to ensure release of all bubbles.
5. For a 10 minute reaction time, there is a 35-70 mg decrease in mass in the blank (Trial #1) depending on the temperature and humidity in the room. Part of the carbon dioxide may dissolve, up to 46 mg of carbon dioxide may dissolve in 35 mL. While the evaporation of water leads to too large a value of percent mass, the dissolving of carbon dioxide will result in an opposite effect. The combination of the two errors should only give a minimal effect on the shape of the graph and the percent by mass.
6. The reaction mixtures may be diluted with water and poured down the drain.

