

Determining the Mass Percent of Sodium Bicarbonate in an Alka-Seltzer Tablet

Background:

The extent of a chemical reaction is determined by the amount of reacting materials, or reactants, present in the reacting system. Reagents are generally not mixed in exact amounts needed for the reaction to take place, there is usually one of the reacting materials added in excess, called the excess reactant. The reagent that is completely used is called the limiting reactant. Once the limiting reactant is used up, the reaction will stop, thus the amount of product formed is determined by the limiting reactant.

In this lab you will be using Alka-Seltzer tablets to investigate limiting reactants. An Alka-Seltzer tablet contains sodium bicarbonate (NaHCO_3), aspirin, and citric acid. Once the tablet is dissolved in water, sodium bicarbonate reacts with aspirin and citric acid producing carbon dioxide gas.

However, some sodium bicarbonate is left unreacted. This excess NaHCO_3 is available to neutralize stomach acids responsible for indigestion, sour stomach, and/or heartburn. In the laboratory, vinegar (acetic acid, $\text{HC}_2\text{H}_3\text{O}_2$) can be used in place of stomach acid to react with the remaining sodium bicarbonate:



In this experiment, Alka-Seltzer tablets will be added to 8 solutions with increasing amounts of vinegar. The amount of carbon dioxide produced by the reaction will be determined by massing the reaction components (beaker, solution, and tablet) before and after the production of CO_2 gas. Stoichiometric calculations will then be performed to determine the mass of NaHCO_3 reacted in each trial and to identify the limiting reactant.

Safety:

Safety goggles must be worn at all times. Waste can be discarded down the sink. Wash your hands thoroughly upon completion of the lab.

Materials:

- 8 Alka-Seltzer tablets
- Acetic acid (vinegar)
- Two 250 mL beakers
- 10 mL graduated cylinder
- 50 mL graduated cylinder
- Glass stirring rod

Procedure:

1. Measure 35 mL of distilled water into a 250 mL beaker. Weigh the beaker and water and record the mass.
2. Weigh and record the mass of an Alka-Seltzer tablet.
3. Place the Alka-Seltzer tablet into the water in the 250 mL beaker.
4. When bubbling has ceased, stir the solution to ensure complete dissolution of the tablet and to remove any visible bubbles of carbon dioxide. Gently tap the stirring rod against the inside of the beaker to remove any drops of liquid before weighing the beaker and its contents.
5. Weigh the beaker and its contents. Record the mass.
6. Dispose of the solution in the beaker down the sink. Wash the beaker with tap water then rinse it with distilled water.
7. Repeat the experiment using 5 mL of acetic acid (vinegar) and 30 mL of water in the 250 mL beaker.

NOTE: once the reaction has started, you may use a second 250 mL beaker to run the next trial in the experiment. You can continue to alternate beakers, running the additional experiments in simultaneous, but staggered trials. Be sure to keep track of the mass of each beaker used, as the exact mass of each beaker is different.

- Repeat the experiment using 10 mL of acetic acid (vinegar) and 25 mL of water in the 250 mL beaker. Continue to repeat the experiment 5 more times increasing the volume of the acetic acid by 5 mL and decreasing the volume of water by 5 mL for each new trial as indicated in Table 1.

Data:

Table 1

Trial #	Volume of Acetic Acid (mL)	Volume of Water (mL)	Mass of Beaker and Acetic Acid/Water	Mass of Alka-Seltzer Tablet	Total Mass of Beaker and Contents After Reaction
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:

- For each trial, calculate the total mass of the beaker with acetic acid/water and tablet before the reaction occurred. Show all work for each trial.

2. For each trial, determine the mass of CO_2 lost from each beaker due to gas production. Show all work for each trial.

3. Using stoichiometry, determine the mass of NaHCO_3 that reacted in each trial. Show all work.

- For each trial, determine the mass percent of NaHCO_3 that reacted in each Alka-Seltzer tablet.

Analysis:

- What is the minimum volume of vinegar required to react with all of the NaHCO_3 present in an Alka-Seltzer tablet? Explain your reasoning.
- The theoretical mass percent of sodium bicarbonate in an Alka-Seltzer tablet is 59.1%. Calculate the experimental error. (keep in mind that not all trials resulted in the complete consumption of sodium bicarbonate)