Alka Seltzer® Poppers

Alka Seltzer is sometimes taken for acid indigestion. This over-the-counter medication is taken differently than most others since it is added to water before ingesting, rather than being “washed down” with the water. Let’s investigate this addition of Alka Seltzer to water.

Materials

- 5 (or more) Alka Seltzer® tablets
- clear container such as a plastic cup or glass
- room-temperature water
- 1 35-mm film canister with lid
- teaspoon measure
- tablespoon measure
- ice-cold water
- very hot tap water
- safety goggles
- (optional) 1/4-cup measure

Safety

Goggles are recommended to protect your eyes from possible flying debris in this activity. Do not use water hot enough to scald.

Exploration

Step 1 Determine and record the active ingredients of Alka Seltzer tablets.

Step 2 Add about 1/4 cup of room-temperature water into a clear container. Add an Alka Seltzer tablet to the water and observe. Keep the solution for use in Step 3. Describe what happens. What role does water play in this system? What is the identity of the most obvious product of this chemical change? Write the chemical equation which describes the reaction that has occurred.

Step 3 Place 1 tablespoon of the solution from Step 2 in the film canister. Add half an Alka Seltzer tablet to the canister and immediately put on the lid. Hold the canister upright and away from your face. What happens? Explain your observations.

Step 4 Design and perform an investigation to determine if the observations in Step 3 are reproducible. What did you do? What did you find out?

Step 5 Repeat Step 3 with room-temperature water which has not had an Alka Seltzer tablet dissolved in it already. How do the results compare with those in Step 3?

Step 6 Rinse out the canister and place 1 teaspoon of room-temperature water in it. Add half an Alka Seltzer tablet to it and immediately put on the lid as before. Compare your observations with those in Step 5 and explain any similarities and differences

Step 7 What do you think would happen if you added 2 tablespoons of water to the canister before adding the Alka Seltzer? Try this variation using the same technique and explain your observations.

Step 8 Design an experiment to determine the impact of changes in the temperature of the water on the system. Do not use water hotter than hot tap water or colder than ice water. Describe what you did and your observations. Explain what you observed.

Step 9 Which trial is the control, the one to which the other trials are compared? Why is the number of variables changed important? What other variables might be studied in this system?

Challenge

What are the effects of changing the volume of water and the temperature of the water used in the investigation?

Alka Seltzer Poppers

Concepts

kinetics, chemical reactions, gases, solubility

Expected Student Responses to Exploration

Step 1 The active ingredients in Alka Seltzer are sodium bicarbonate, citric acid, and aspirin (acetylsalicylic acid).

Step 2 The solution bubbles and the Alka Seltzer tablet disappears. The water dissolves the reactants and facilitates the reaction. The most obvious product is the gas which is carbon dioxide. The reactions are acid-base neutralization reactions between the base, sodium bicarbonate, and each of the two acids. With citric acid the reaction is:

$3\ NaHCO_3\ (aq)\ +\ H_3C_6H_5O_7(aq) \rightarrow 3\ H_2O\ +\ 3\ CO_2(g)\ +\ Na_3C_6H_5O_7(aq)$

With aspirin (acetylsalicylic acid), the reaction is:

$NaHCO_3\ (aq)\ +\ HC_9H_7O_4(aq) \rightarrow H_2O\ +\ CO_2(g)\ +\ NaC_9H_7O_4(aq)$

Step 3 The film canister lid pops off after a few seconds. As the carbon dioxide is produced, pressure builds up inside the canister until it is great enough to force the lid off.

Step 4 Students should repeat the experiment several more times to check for reproducibility. They should measure the time it took for the lid to be forced off for comparison. Or they could do several identical runs simultaneously (team work) to see if the lids pop off at the same time. They should find that the results are reproducible to within a second or two.

Step 5 The top should take a little longer to pop off the film canister. In Step 3, the water was already saturated with carbon dioxide so all the gas produced went toward increasing the pressure within the canister. In Step 5, some of the carbon dioxide gas produced dissolved in the water so it took longer to generate enough gas to cause the top to pop.

Step 6 With one teaspoon of water, it takes longer for the top to pop off the canister. There are several factors to consider. There is less water so the tablet may dissolve less rapidly and less of the carbon dioxide dissolves in the water. There is more air space so it takes longer to produce enough gas to increase the pressure enough to pop the top.

Step 7 Two tablespoons of water nearly fill the canister. There is more water for the tablet and the carbon dioxide to dissolve in. There is very little space for gases so a relatively small amount of gas will get the pressure high enough to force the top off.

Step 8 To investigate the impact of temperature on the system, Step 5 should be repeated with different temperatures of water (e.g., hot tap water and ice cold water) and comparisons made. The reaction rate increases (and gas solubility decreases) with increasing temperature so the top pops the fastest with the hottest water and slowest with the coldest water.

Step 9 The trial in Step 5 functions as the control, the trial against which all the others are compared. One variable was altered in each trial (although this sometimes had several opposing effects). If more than one variable is altered, it is difficult or impossible to determine which variable accounted for observed changes. Another variable which could be tested is the amount of Alka Seltzer tablet used.

Expected Student Answer to Challenge

Water acts as a solvent to dissolve the active ingredients (sodium bicarbonate and the two acids) so that they can react. The rate of the pop is proportional to the temperature of the system and proportional to the volume of the water used.

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