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Balanced Reactions

(Mōre Bang for Your Buck)

Introduction:

Car makers have long known that for better performance, and to reduce wear and tear on engine parts, fuel must be burned with the right "mix" of air. In today's cars a turbocharger in the engine accomplishes this by combining forced air and vaporized gas into a highly flammable mixture. With the right ratio of oxygen, the fuel burns very efficiently. It also burns very cleanly, producing less carbon build-up and other by-products that are harmful to both the engine and the environment.

In this experiment you will determine the right ratio of acetylene, C_2H_2, to air by burning a mixture of the two gases, and observing your results.

Objectives:

1. Use recorded observations to determine the most efficient ratio of acetylene to air in a combustion reaction.
2. Use the balanced formula for the combustion of acetylene to determine the correct ratio of acetylene to oxygen.
3. Determine whether experimental data obtained coincides with expected theoretical data.
4. Generate possible explanations for the appearance of unexpected by-products.

Equipment and materials:

6 medium test tubes
3 beakers (250+400mL)
Calcium carbide
ruler
China marker
matches
distilled water

Safety:

Wear safety goggles at all times.
You are working with a flammable gas.
Don't goof around. Act like a scientist for Pete's sake!

Procedure:

1. Fill the three beakers about one-half full with distilled water.

2. Measure the length of one of your test tubes and record it. Divide that number by 25 and record the length. This represents $\frac{1}{25}$th of the test tube length. How long is $\frac{2}{25}$ths? $\frac{6}{25}$ths? $\frac{12}{25}$ths? With the China marker, mark two of the test tubes $\frac{2}{25}$ths from the bottom of the test tube. Mark two more of the test tubes at $\frac{6}{25}$ths from the bottom , and the remaining two at $\frac{12}{25}$ths.

3. Fill a test tube full of water and cover the mouth with a **small** piece of paper towel. Invert the test tube and place it into the beaker so that the test tube is full of water and no air is trapped near the bottom. A few bubbles will not harm your results. Remove the paper towel with tweezers.

4. Repeat step three so that you have two inverted test tubes in each beaker.

5. Obtain a small piece of calcium carbide from your instructor and drop it into the beaker.

6. Cover the calcium carbide so that the gas evolving is trapped in the test tube. When the gas level is even with the China mark, remove it from the bubbling chip. **(Be ready! This step may go fast!!)**

7. When all the test tubes are filled to the mark, remove them from the beakers, quickly insert a cork in the end and put them in a test tube rack. Don't let your gas escape.

8. Starting with the **fullest** test tubes, ignite the acetylene by holding the tube over a lighted match. Record your observations, and repeat with the other test tubes. Look for smoke, light, sound, and the relative speed of the reaction. Record your observations in Table 1.

Data:

Length of test tube: ____________

divided by 25: ____________

Table 1: Observations

	Smoke	Light	Sound	Rxn Speed
Results from $\frac{12}{25}$ ths test tubes: Length in cm ________.				
Results from $\frac{6}{25}$ ths test tubes: Length in cm ________.				
Results from $\frac{2}{25}$ ths test tubes: Length in cm ________.				

Conclusions:

1. Which volume of acetylene burned most efficiently? What is your evidence?

2. Which reactions gave an additional product? What do you think it was? Why did this product form?

3. When acetylene, C_2H_2, burns completely, it combines with oxygen to form carbon dioxide and water. Write a balanced equation to represent this reaction.

4. From your **balanced** (hint!) equation, determine the best **ratio** of acetylene to **oxygen**.

5. If air is approximately $\frac{1}{5}$th oxygen and $\frac{4}{5}$ths other gases (5 air = 1 O_2), what would be the best ratio of **acetylene** to **air**? (convert the coefficient for $O_2 \rightarrow$ air) **Show Work**

6. Does your experimental data support this theoretical estimate? Explain why or why not? Give examples of observations which support your answer from the data table.

7. The black soot formed in some of the test tubes is carbon. Why do you think it may have formed?

8. If you were to design a "car of the future", what would you do to make it more fuel efficient or better for the environment?