Alternative Transportation and Technology

Measuring the Effects of Fuel Emissions on the pH of Rainwater

DRAFT

Title:
How does Fuel Emissions Affect the pH of Rainwater?
Adapted from Science and Sustainability SEPUP 2000

Objective:

Students will produce scientific data that supports the claim that the combustion of fossil fuels, compared to the combustion of ethanol, produces air pollution that significantly changes the pH of rainwater, creating acid rain. When we burn fuel, different chemicals are released into our atmosphere in the form of gases and solids. We often refer to the solids as particulate matter. Examples of gases that are released are carbon dioxide, sulfur oxides, and nitrogen oxides. The latter 2 gases can have a particularly negative effect on the pH of water. In the atmosphere, these two gases can react with water and produce an acid. This acid falls as "acid rain". Acid rain negatively impacts lakes, rivers, and streams. It can corrode metals and materials made of limestone (statues and buildings), and it can also have negative effects on vegetation (agriculturally important crops and timber).

Standards:

Chemistry Content Standards 9-12
Acids and Bases 5d
Students know how to use the pH scale to characterize acid and base solutions.
Investigation and Experimentation k
Recognize the cumulative nature of scientific evidence.

Materials:

Glass burner containing ethanol
Glass burner containing kerosene
(2) 4" x 6" piece of aluminum foil
Dropper bottle of universal indicator
Dropper bottle of 0.05 M NaOH
Wash bottle
(3) 250 mL plastic bottle w/ lid
(4) 30 mL graduated cups
pH color chart

Big Questions?

Which fuel, ethanol or kerosene, produces the most environmentally-friendly emissions?

Procedure:

1. Obtain an ethanol and a kerosene burner. Light their wicks and observe both flames. Describe the similarities and differences you observe between each of the flames. Record your results in an organized data table.
2. Hold one of your pieces of aluminum foil about 6 cm above the ethanol flame for approximately 15 seconds. Hold a second piece of aluminum foil over the kerosene flame for the same amount of time. Extinguish both flames using their caps.
3. Compare the changes that occurred on each of the pieces of aluminum foil. Record your results in your organized table.
4. In each of your (4) 30 mL graduated cups, place 10 mL of tap water. Add 4 drops of universal indicator to each cup and swirl to mix.
5. Record the color of the universal indicator solution in each of the graduated cups. Record their colors in an organized data table. Using a pH color chart determine the pH of each of the solutions. Record your results.
6. Open one 250 mL plastic bottle. Pour the contents of one of your 30 mL graduated cups into this bottle. Cap the bottle. Shake the bottle vigorously 30 times in order to adequately mix the solution with the gases present in the bottle. Pour the universal indicator solution back into the 30 mL graduated cup from which it came. Record the color of the universal indicator solution in the cup. Again, use a pH color chart to determine the pH of the solution in the cup. Record the pH.
7. Re-light the ethanol burner. Open another one of your 250 mL plastic bottles. Invert the bottle and place the mouth of the bottle over the lit wick of the burner and let it rest on the metal casing. When the flame has been extinguished, keeping the bottle inverted, quickly raise the bottle off the burner and screw on the cap.
8. Again, as quickly as possible, uncap the bottle, pour the contents of one 30 mL graduated cup into this bottle and recap. Shake vigorously 30 times. Pour the universal indicator solution back into the 30 mL graduated cup from which it came. Observe the color of the universal indicator solution in the cup. Record its color in your data table. Using a pH color chart, determine the pH of the solution. Record your results in the data table.
9. Repeat steps 7 and 8 with the kerosene burner.
10. Compare the colors between each cup and to the 30 mL graduated cup containing the 10 mL of water and 4 drops of universal indicator.
11. Determine the pH changes that occurred in each one of the 250 mL plastic bottles. Record your findings in the data table.
12. To each of the graduated cups, add 0.05 M NaOH one drop at a time and then swirl. Keep track of the number of drops needed to bring the solution back to its original color of universal indicator.
13. When done, rinse out each of the 30 mL graduated cups and 250 mL plastic bottles with distilled water several times. Throw away your aluminum foil pieces.

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Analysis/Conclusions:

1. Which one of the fuels was a cleaner burning fuel? Use data collected during the experiment to justify your answer.
2. Which of the fuel emissions has the greater acidifying effect on the pH of “rain”water? Explain using data from your experiment.
3. Which fuel do you consider to be a more environmentally-friendly fuel? Justify your answer.