California State University of Bakersfield, Department of Chemistry

Isopropyl Alcohol Jet Engine

Standards:

5-PS1-3: Make observations and measurements to identify materials based on their properties.

MS-PS1-2: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

MS-PS1-6: Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

HS-PS1-5: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

Introduction:

Isopropyl alcohol has many different uses in our lives. For example, it serves as a solvent and cleaning fluid for oil basedcompounds, a disinfectant in medicine, and is a way of preserving biological material. However, this experiment focuses on isopropyl alcohol's vaporization properties. The vapor is naturally denser than air and is flammable with a

combustible range between 2% and 12 % in air[1]. By mixing the vapor with the air inside of a 5 gallon water jug, a combustible chamber is produced that can be ignited in a controlled burst. This chemical reaction creates a rocket engine effect, which shoots a flame out of the opening of the container, while continuing to burn up the vapor-air mixture.

Materials:

- 5 gallon water jug
- Isopropyl (rubbing) alcohol, 70% or 91%
- 50 mL graduated cylinder
- BBQ lighter or matches

Procedure:

1. Obtain an empty and dry 5 gallon water jug.
2. Remove the lid of the 5 gallon water jug.
3. Pre-measure and pour 50 mL of isopropyl alcohol into the water jug.
4. Turn the water jug onto its side and slowly turn, coating the inside with the liquid.
5. Once fully coated, cautiously dispose of the excess liquid.
6. Sit the water jug upright in an open area or in a fume hood.
7. Partially insert the flame of the BBQ lighter,or match, into the water jug hole atop.
8. Once ignited, step back and watch.
9. Air out the water jug for repeated use.

Safety:

- Always have an adult with you to help you during your experiment.
- Always wear eye protection and gloves when doing chemistry experiments
- Rubbing alcohol is flammable, so it must be kept away from any open flames or heat.
- Conduct this experiment in a well-ventilated area.

Data and Observations:

What did you see? Anything you were not expecting? Describe it here.

Questions:

1. Explain why is it necessary to coat the inside of the water jug with alcohol prior to combustion?

2. Determine why is it difficult to immediately repeat the experiment inside of the water jug?

References:

1. Sigma-Aldrich. "Isopropanol". [Online early access] Published Online: Jan, 19 2012. http://www.sigmaaldrich.com/MSDS/MSDS/DisplayMSDSPage.do?country=US&language=en&productNumber=W292907&brand=ALDRICH&PageToGoToURL=http%3A%2F%2Fwww.sigmaaldrich.com%2Fcatalog%2Fsearch%3Finterface%3DAll%26term%3Disopropanol%26lang%3Den%26region%3DUS%26focus%3Dproduct%26N%3D0%2B220003048%2B219853269%2B219853286%26mode%3Dmatch%2520partialmax (accessed Jul, 16 2013).

2. Mad Science. Wonder How To. Shoot fire from a water bottle using rubbing alcohol and a match. *Video*. http://mad-science.wonderhowto.com/how-to/shoot-fire-from-water-bottle-using-rubbing-alcohol-and-match-0139210/ (accessed Jul 18, 2013).