The Non-Burning Towel

Hazards

Isopropanol is very flammable. Be sure your hands are washed of any spilled isopropanol prior to lighting!

Chemicals and Solutions

- Isopropanol
- Water

Materials

- 100 mL graduated cylinder
- Large glass sheet for covering a crystallizing dish
- Tongs
- Bunsen burner and matches
- Two cloth towels (you can cut up an old lab coat)
- Three large crystallizing dishes

Procedure

1. Into one crystallizing dish place a mixture of 50 mL isopropanol and 50 mL water.
2. Immerse a towel into the mixture and thoroughly wet the towel.
3. Squeeze out the excess liquid.
4. Dry off your hands and light the bunsen burner.
5. Holding the damp towel with tongs, bring the towel close to the flame. A flame will surround the towel without burning it.
6. As the flame subsides, snuff it out with a quick jerk.
7. Repeat the experiment on a second towel but instead of using a mixture of water and alcohol, immerse the cloth in straight isopropanol. This time the cloth will catch fire. (If you cannot snuff out the flame with a quick jerk place the burning cloth into a third dry dish and cover it with a glass sheet.)

Discussion

The combustion reaction is:

\[ 2C_3H_7OH + 9O_2 \rightarrow 6CO_2 + 8H_2O \]

The heat of reaction for this equation is -1987kJ/mole. Most of this energy is lost to the surrounding air. The remaining energy can cause the combustion of the towel. The function of the water is to absorb some of the energy of the combustion reaction. The energy is used to heat the water to its boiling point and to vaporize it. The energy diverted by the water is sufficient to keep the towel from burning.
As an example, the energy available from the combustion of 50g of isopropanol is 1659kJ. Heating 50 g of water from 20°C to 100°C requires 17kJ, and vaporizing the water requires 113kJ, making a total of 130kJ absorbed by these processes. Clearly then, most of the heat produced by the combustion of the alcohol is lost to the surrounding air but the energy required by the water processes are significant enough to keep the towel from burning.