Required Training

UC Lab Safety Fundamentals

Required PPE

Flame-resistant lab coat, safety glasses/goggles, nitrile gloves

Performers Required: 1

Equipment

Chemicals

1 L Erlenmeyer flask with solid rubber stopper

Boric acid (B(OH)$_3$)

40-60mm Ceramic Buchner funnel with rubber stopper

Methanol (CH$_3$OH)

Watch glass (slightly larger than Buchner funnel)

Sulfuric acid (H$_2$SO$_4$), 18 M

Hotplate with clamp for flask

BBQ-style butane lighter (≥ 6” long)

Procedure:

1. Add 2-3 mL of H$_2$SO$_4$ to 150 mL of CH$_3$OH in the 1-L Erlenmeyer flask.
2. Add 30 g of B(OH)$_3$ to the mixture and stir until all solids have dissolved.
3. Add the boiling chips to the flask and secure it in the clamp on the hotplate. Place the ceramic Buchner funnel (with tight-fitting rubber stopper) in the neck of the flask and heat the mixture to a vigorous boil. This may take 5-10 minutes, and should be started slightly before the demo is to be performed.
4. Ignite the vapor in the Buchner funnel with the lighter. If the vapor does not ignite, increase the heat from the hotplate. Ensure the mixture is boiling rapidly enough to maintain a flame, which will be the same diameter as the Buchner funnel and up to 12” in height. Do not heat the flask so rapidly that it boils over.
5. When finished turn off the hot plate. To extinguish the flame either place a watch glass on top of the Buchner funnel or simply wait until the mixture has cooled sufficiently, as the flame will diminish and then self-extinguish as the boiling subsides.

Clean-up: The flask should remain clamped to the hotplate to minimize the chance of spilling methanol around any ignition sources. Once everything has cooled to room temperature, the mixture should be saved for future use by
replacing the Buchner funnel with a solid rubber stopper.

**Hazards:** Sulfuric acid is strongly oxidizing and corrosive, and will cause immediate chemical burns on contact. Methanol is toxic and highly flammable. Keep all solutions away from ignition sources until the demo is performed.

**Principle:** $\text{B(OH)}_3$ will react with $\text{CH}_3\text{OH}$ in the presence of a dehydrating agent ($\text{H}_2\text{SO}_4$) to form trimethyl borate ($\text{B(OCH}_3)_3$) and $\text{H}_2\text{O}$. This borate ester is volatile (b.p. = 68 °C) and burns with the green flame characteristic of all boron compounds. The color is due to broadband emissions in the green region of the spectrum from various molecular species as they relax from excited electronic states back to their ground states.

**Notes:** A freshly-prepared solution may be added to the flask whenever the volume of the solution becomes too low to perform the demonstration (<50 mL). Do not heat the flask with an open flame, as this may cause the mixture to bump and boil out of the flask, creating a fast-spreading methanol fire.