The 'whoosh' bottle demonstration

Class practical

A mixture of alcohol and air in a large polycarbonate bottle is ignited. The resulting rapid **combustion** reaction, often accompanied by a dramatic 'whoosh' sound and flames, demonstrates the large amount of **chemical energy** released in the combustion of **alcohols**.

Lesson organisation

This demonstration requires careful preparation, with strict adherence to the conditions required by the risk assessment provided. Schools are advised not to deviate from the details described in this risk assessment. If any variation is necessary, members should contact CLEAPSS [2] for preparing a special risk assessment which is available via their website.

A single demonstration will take 5 – 10 minutes. Repeat demonstrations will require either the drying out of the reaction vessel used for the first demonstration or spare dry reaction vessels.

Apparatus	Chemicals
Eye protection **Reaction vessel, 1 or more (Note 1)** **Rubber stopper or plastic cap (to fit the reaction vessel)** **Beaker (250 cm^3), 1 for each alcohol used** **Wooden splints, as needed (Note 2)** **Meter rule**	*One or more of the following alcohols, 40 cm^3 of each one used:* Methanol [3] (HIGHLY FLAMMABLE, TOXIC) Ethanol [4] (IDA, or Industrial Denatured Alcohol) (HIGHLY FLAMMABLE, HARMFUL) Propan-1-ol [5] (HIGHLY FLAMMABLE, IRRITANT) Propan-2-ol [6] (HIGHLY FLAMMABLE, IRRITANT) **Refer to Health & Safety and Technical notes section below for additional information.**

Health & Safety and Technical notes

Read our standard health & safety guidance [7]

Both demonstrator and class should be wearing eye protection. Select a safe, level place for the demonstration, with at least 2.5 m clearance above the top of the vessel to the ceiling above, and no flammable materials above it. If the laboratory bench does not allow for this, four stable laboratory stools supporting a large wooden tray may give sufficient clearance and stability. Set out the bottles containing the alcohols and the beakers at least 1 m away from the demonstration. No flames within 1 m. Students at least 4 m away.

Methanol [8], $CH_3OH(l)$, (HIGHLY FLAMMABLE, TOXIC) - see CLEAPSS Hazcard.

Ethanol [9] (IDA, Industrial Denatured Alcohol), $CH_3CH_2OH(l)$, (HIGHLY FLAMMABLE, HARMFUL) - see CLEAPSS Hazcard.

Comment [Person A1]: Do NOT flush with oxygen to replenish air and dry vessel
- serious accidents have happened.

Comment [Person A2]: Goggles for demonstrator,
safety spectacles for class + teacher; remember to take about 35,
small size if possible

Comment [Person A3]: As this is being done in an unfamiliar room, need to check that can comply with this before lecture, when setting up demonstration

Comment [Person A4]: Will use only ethanol.
Make sure to replace cap on bottle after pouring sample. Will use only ethanol.
Make sure to replace cap on bottle after pouring sample.

Propan-1-ol [10], $CH_3CH_2CH_2OH(l)$, (HIGHLY FLAMMABLE, IRRITANT) - see CLEAPSS Hazcard.

Propan-2-ol [11], $CH_3CHOHCH_3(l)$, (HIGHLY FLAMMABLE, IRRITANT) - see CLEAPSS Hazcard.

1 The reaction vessel consists of a large polycarbonate bottle, as used in workplace water dispensers. These have a volume of 16 - 20 dm^3. A clean, dry bottle is required for each demonstration. It takes time to clean and dry once it has been used for a demonstration. For this reason, up to 4 bottles may be required. The bottle must be made of polycarbonate (marked PC) and of no other material.

Comment [Person A5]: Must NOT be glass
- serious accidents have happened due to glass breaking.

Comment [Person A6]: Only time to do one demo, so no need to clean & dry four bottles.

If using empty but wet water cooler containers, stand them inverted to allow any remaining water to drain and then leave upright for several days until completely dry.

2 Attach a wooden splint to the end of the meter rule or stick using adhesive tape, angling the splint so that when the meter rule is horizontal, the splint is sloping downwards. Provide a lighter or matches well away from the alcohol bottles.

Procedure

a Pour about 40 cm^3 of the selected alcohol into a beaker and then transfer into the reaction vessel.

b Insert the rubber stopper and roll the reaction vessel on its side for 10 seconds, to and fro, allowing the alcohol to vaporise and the vapour to fill the vessel. Do not warm the alcohol.

c Pour surplus liquid alcohol back into the beaker, draining the vessel as completely as possible, and move the beaker back to the rest of the alcohol stock, away from any risk of catching fire. Surplus liquid left in the vessel may ignite and set fire to the vessel as well.

Comment [Person A7]: Check where beaker can go on arrival in room.

d Stand the reaction vessel securely inside the safety screens and remove the stopper. Light the wooden splint, and apply the lighted end of the splint to the open neck of the vessel. Do not lean over the screens to apply the ignition. It is dangerous to ignite by dropping a lighted match into the vessel when using ethanol or methanol. For both propanols, this method may be used providing the neck of the bottle is above head height

Comment [Person A8]: NB, do NOT lean over or drop match in

e The alcohol vapour should ignite with a loud 'whoosh', with flames shooting out of the top of the vessel.

Teaching notes

This demonstration is the subject of a Supplementary Risk Assessment by CLEAPSS [12], SRA06, which is available on their website. Schools which are unsure of the password should phone CLEAPSS on 01895 251496. Teachers should also, of course, consult their own employer's Risk Assessment.

The experiment demonstrates dramatically just how much chemical energy is released from such a small quantity of fuel.

The flame colour varies with the proportion of carbon in the alcohol molecule. With methanol and ethanol there is a very quick 'whoosh' sound and a blue flame shoots out of the bottle. With propan-1-ol and propan-2-ol, the sound is similar but the reaction is slightly slower, easier to observe, and blue and yellow flames may be observed 'dancing' in the bottle. The presence of water reduces the likelihood of dancing flames.

Health & Safety checked, September 2014

Credits

This Practical Chemistry resource was developed by the Nuffield Foundation and the Royal Society of Chemistry.

Websites

Wikipedia [13] - a wide-ranging and up-to-date review of the production and use of alcohols for vehicle fuels, with links to a variety of related sites.

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Source URL: http://www.rsc.org/learn-chemistry/resource/res00000708/the-whoosh-bottle-demonstration

Links:
[1] http://www.rsc.org/learn-chemistry
[2] http://www.cleapss.org.uk
[3] http://www.rsc.org/learn-chemistry/wiki/Methanol
[4] http://www.rsc.org/learn-chemistry/wiki/Ethanol
[5] http://www.rsc.org/learn-chemistry/wiki/Propan-1-ol
[6] http://www.rsc.org/learn-chemistry/wiki/Propan-2-ol
[7] http://www.rsc.org/learn-chemistry/resource/res00001752/learn-chemistry-health-and-safety-guidance
[8] http://www.rsc.org/learn-chemistry/wiki/Methanol
[9] http://www.rsc.org/learn-chemistry/wiki/Ethanol
[10] http://www.rsc.org/learn-chemistry/wiki/Propan-1-ol
[11] http://www.rsc.org/learn-chemistry/wiki/Propan-2-ol
[12] http://www.cleapss.org.uk
[13] http://en.wikipedia.org/wiki/Alcohol_fuel