The methane rocket

Description

A strong plastic bottle is filled with a 2 : 1 ratio of oxygen to methane and the mixture ignited with the bottle standing on a suitable 'launch pad'. The mixture ignites with a loud bang and the bottle flies several metres.

This experiment takes around ten minutes.

Apparatus and chemicals

- Eye protection
- Ear protection
- A carbonated soft drink bottle of between 300 cm^3 and 500 cm^3 capacity.
- A rubber bung to fit the bottle.
- A large trough or washing up bowl.
- Measuring cylinder, 500 cm^3.
- Rubber tubing to fit the gas tap
- Access to an oxygen cylinder or other source of oxygen. Canisters of oxygen can be bought on the internet.

Procedure

HEALTH & SAFETY: Both demonstrator and audience should wear eye protection.

The demonstrator should wear ear protectors and the audience should be advised to cover their ears.

Do not use a larger bottle than specified and use each bottle for one demonstration only.

Your employer's risk assessment should be consulted before carrying out this activity.

This activity is covered by model (general) risk assessments widely adopted for use in UK schools such as those provided by CLEAPSS®, SSERC and ASE. Bear in mind, however, that these may need some modification to suit local conditions.

Before the demonstration

a Select a suitable place to fire the bottle. If launched approximately horizontally it may well fly the whole length of a typical laboratory so make sure that there are no obstacles (such as reagent bottles) that it might hit – a corridor might be a better choice than a laboratory.
b Also prepare a launch pad. For instance, open a fairly heavy paperback book in the middle and place it, covers down, on a table. The bottle can be placed in the V formed between the left hand and right hand pages and this can be pointed in a suitable direction to aim the rocket when it is ignited.

The demonstration

c Fill a plastic carbonated drinks bottle of between 300 cm^3 and 500 cm^3 capacity with water and pour the water into a measuring cylinder to determine its total volume.
d Pour one-third of the bottle's volume of water back into the bottle and mark the level with a waterproof pen. It is important that a carbonated drink bottle is used; bottles used to contain still drinks may not be strong enough. Each bottle should be used for one demonstration only as it may be weakened by the explosion.

e Next completely fill the bottle and invert it in a trough or washing-up bowl of water.
f Place the end of a rubber tube connected to the gas tap under the neck of the bottle. and fill the bottle to the marked level with methane (natural gas) from the gas tap. Remember to turn the tap on for a few seconds to allow air in the tube to be displaced before starting to fill the bottle. Now fill the rest of the bottle with oxygen from the chosen source, again remembering to displace air in the delivery tube for a few seconds before starting to fill. The bottle now contains a 2 : 1 mixture of oxygen and methane by volume. This is the stoichiometric mixture.
g Stopper the bottle with a rubber bung and place the bottle on the launch pad. Check the aiming of the rocket and ensure than none of the audience is near the flight path.
h Wear eye and ear protection and advise the audience to cover their ears. Remove the bung and ignite the gas mixture by applying a lighted splint to the neck of the bottle. The rocket will take off with a loud bang and fly for several metres.

If a second flight is to be done, use a new bottle.

Teaching notes

After firing, the rocket can be recovered and shown to the audience to point out that it is covered on the inside by condensation – droplets of water formed in the reaction.

Theory

The reaction is

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$ $\Delta H = -890$ kJ mol^{-1}

The gases react in a 2 : 1 ratio and the reaction is strongly exothermic.

Note that there are three moles of gas on both sides of the equation so all the force that propels the rocket comes from the expansion of the gases as they are heated by the energy given out by the reaction, rather than by the production of extra molecules of gas.

Please note: You can get students to balance the equation and try to work out for themselves what the ratio should be, then fill the bottle and launch. The best bang will be from a stoichiometric mix.

References

This experiment has been reproduced from the RSC video material for teachers of chemistry
http://www.rsc.org/education/teachers/learnnet/videoclips.htm

Useful resources

A similar experiment, the hydrogen rocket, is described in T. Lister, *Classic Chemistry Demonstrations*, London: Royal Society of Chemistry, 1995. This describes ignition using an electric spark, a method which could be adapted for this experiment.

To view a video clip of this experiment visit

http://www.rsc.org/learn-chemistry/resource/res00000711/the-methane-rocket#!cmpid=CMP00000941

Credits

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