Making Fire - Fire Without Matches - Magic Fire

One of the classical tricks in chemistry roadshows is making fire without matches. There is a huge range of reactions available for this and it is just a matter of taste and preference which ones to choose. These demonstrations are mainly based on the reactions of strong oxidisers with flammable organic substances. Here we utilise the reaction of alcohol (methanol or ethanol) and chromium(VI) oxide. The exact reaction is quite difficult to represent but the following scheme is one of the possibilities:

$$2\ CrO_3 + C_2H_5OH + {}^3/_2\ O_2 ==> Cr_2O_3 + 2\ CO_2 + 3\ H_2O \qquad (2.1)$$

The red chromium(VI) oxide is reduced to green chromium(III) oxide. We produce more chromium(III) oxide in experiment 13 by the thermal decomposition of ammonium dichromate and use it in experiment 14 to catalyse the oxidation of ammonia. Another teaching point which can be made from this experiment is showing why strong oxidants should be stored separately from flammable organics.

The second experiment ("flammable water") is a slightly more complicated. It is based on the reaction of potassium with water as a source of ignition,

$$2\ K + 2\ H_2O ==> 2\ KOH + H_2 \qquad (2.2)$$

The water reacts violently with potassium producing enough heat to ignite the hydrogen evolved which, in turn, ignites the diethyl ether.

Safety. Diethyl ether has a high vapour pressure (440 mm Hg at 20C) and density (2.55 {air = 1}) and a low auto ignition temperature (not flash point!) of between 180 and 190C. Air/ether mixtures containing >1.85% v/v of diethyl ether vapour are constitute an explosive hazard. Explosive peroxides (ethylidene peroxide polymers') may be formed on exposure to air and light, and particularly when evaporated to dryness. These peroxides have been known to form around the stoppers of containers of diethyl ether that have been left unopened for long periods. Although not relevant to this experiment it is worth pointing out that ether is a good electrical insulator and when very dry (saturated ether contains 1.2% water at 20C), shaking etc. can produce sufficient static electricity to cause ignition of the vapour.

Diethyl ether is mildly irritating to skin and mucous membranes. Inhalation of high concentrations causes narcosis[1].

Potassium reacts violently with water, and the heat produced is sufficient to ignite the hydrogen evolved. Contact with skin causes thermal and caustic burns. On heavily oxidised material there is a danger of violent explosion when cutting with a knife due to the combination with the superoxide (dioxide) with organic material (e.g. oil). Old stocks of potassium should be disposed of by dissolving the uncut lumps in propan-2-ol.

Chromium(VI) oxide: contact with combustible materials may cause fire. Contact with skin causes severe burns. Spread soda ash over spillages and mop up, cautiously , with plenty of water. [3]

NOTE. Potassium metal and Chromium(VI) oxide mixtures will spontaneously explode. We have our own safety protocol when we carry out these experiments. However we strongly advise that, if you wish to repeat them, you separate them in time and in space!