The Periodic Table of Fireworks

by Josh Nicks

Be it Bonfire Night or New Years' Eve, the dazzling colours we associate with fireworks in the night sky are all a product of chemistry. Fireworks are not really any different to a typical chemical system, albeit slightly more "energetic". This article hopes to explain how fireworks are made, and how the periodic table of elements can become a spectrum in the sky.

The first ingredient in fireworks is gunpowder, which provides the energy required to set the firework off, and to produce the colour. It is a combination of charcoal, sulfur, and potassium nitrate (or saltpetre). The potassium nitrate acts as an oxidising agent, while the charcoal and sulfur act as the fuels. The combustion of the mixture and the 'burning time' associated with it can be adjusted by changing the size of gunpowder pellets used, or varying the levels of moisture present.

The second necessary component is a 'binder', which is used to hold the components together and to reduce the sensitivity to both shock and impact - thus reducing the risk of accidental explosions. These are typically an organic compound, which can act as fuel after ignition, such as dextrin.

Arguably the most interesting and most necessary components to fireworks are the metal salts used to give them their distinct colours.

The heat of combustion causes the ground state electrons in these metals to be promoted to an excited state. When these unstable excited states relax, they release this energy in the form of light. The colour of the light depends on the specific energy levels associated with the metal, and thus changes based on the element used!

However, the metal is not the only important option. As they are used as salts, it is also important to choose the right anion. Sometimes it is ideal to use an anion with excess oxygen, such as chlorates, perchlorates or nitrates, in order to aid conbustion. However, perchlorates and chlorates are highly toxic. Part of the Portius groups research here in Sheffield focuses on the synthesis of more environmentally friendly energetic materials, and could serve as a route away from using these toxic salts.

Red - Strontium
e.g. Strontium Nitrate, Strontium Carbonate and Strontium Sulfate

Orange - Calcium
e.g. Calcium Chloride, Calcium Carbonate and Calcium Sulfate

Yellow - Sodium
e.g. Sodium Nitrate and Sodium Oxalate, just like lampposts!

Green - Barium
e.g. Barium Nitrate, Barium Carbonate, Barium Chlorate and Bairum Chloride.

Blue - Copper
e.g. Copper (I) Chloride, Copper Carbonate and Copper Oxide.

Purple - Strontium and Copper
e.g. Take your pick from above. Copper cmixtures are unstable at high temperatures, so blue and purple are hard to pull off!

Silver - Magnesium and Aluminium
Both look silver when white hot.

1. bit.ly/2Qe2xF0