

Matches

Today we take for granted that we can light a barbecue, camp fire or picnic stove with a match – in other words we can have instant fire wherever and whenever we need it. Before the match was invented, lighting a fire could be very difficult indeed and could involve rubbing sticks together next to dry kindling or using a magnifying glass to concentrate the Sun's heat.

Sulfuric acid-based matches

One of the earliest matches was the so called Promethean match – named after Prometheus, the Greek Titan who stole fire from the Gods and gave it to mankind. We would hardly recognise it as a match today – it consisted of a glass vial wrapped in paper that had been impregnated with sulfur, sugar and potassium chlorate(V). To produce a light, the vial was crushed (sometimes with the teeth!) and the paper ignited. The reason that this match worked was that it contained both a fuel and an oxidising agent. Potassium chlorate(V) decomposes easily to produce oxygen, and the paper, sugar and sulfur act as fuels. The sulfuric acid appears to have acted as a means of mixing the solid reactants and also, possibly as a catalyst.

Charles Darwin (the father of theory of evolution) wrote in *The Voyage of the Beagle*:

'I carried with me some Promethean matches which I ignited by biting; it was thought so wonderful that a man should strike fire with his teeth, that it was usual to collect the whole family to see it.'

However wonderful, these were not really very practical or safe sources of flame, largely because of the liquid acid.

The 'Lucifer'

Later, in 1826, a pharmacist in Stockton-on-Tees called John Walker was experimenting with combustible materials (one of his sidelines was selling gunpowder to the locals). He is supposed to have had a glob of a mixture on the end of a mixing stick and tried to clean the stick by scraping it along the hearth. The stick ignited. He eventually perfected a mixture containing antimony(III) sulfide, potassium chlorate(V) gum and starch.

The chemical reaction that occurs on striking the match is:



Walker sold these matches from his shop under the less-than-snappy name of Sulphurate Hyper-Oxygenata Frict which was soon shortened to Friction Lights. However, he did not patent his invention and, in 1830, a Londoner called Samuel Johnson copied the idea, patented it and sold the matches under the name of Lucifers. The term 'Lucifer' appears in the First World War marching song, *Pack up your troubles*, whose chorus runs:

Pack up your troubles in your old kit bag
And smile, smile, smile.
While you've a lucifer to light your fag,
Smile boys, that's the style.
What's the use of worrying,
It never was worthwhile. So:
Pack up your troubles in your old kit bag
And smile, smile, smile.

The availability of these matches appears to have led to a significant increase in smoking.

Modern matches

The heads of modern 'strike anywhere' matches, ones that can be struck on a piece of sandpaper stuck to the box or any other rough surface, have the approximate composition:

Reactants:

potassium chlorate(V) (KClO_3) 20%, tetraphosphorotrisulfide (phosphorus sesquisulfide, P_4S_3) 9%

Fillers/moderators:

ground glass 14%, iron(III) oxide (Fe_2O_3) 11%, zinc oxide 7%, glue 10%, water 29%

Safety matches are ones that can only be struck on the side of the box and are therefore safer than strike anywhere ones. The striking surface is composed of powdered glass and red phosphorus, and the match head of antimony(III) sulfide and potassium chlorate(V).

When a safety match is rubbed against the striking surface, the friction generates enough heat to convert a trace of stable red phosphorus into its allotrope white phosphorus which spontaneously ignites on exposure to air, generating heat. This is enough to begin to decompose the potassium chlorate in the match head to produce enough oxygen to ignite the antimony(III) sulfide and start the combustion.

In both types of match, the wooden stick is soaked in a solution of ammonium phosphate, a flame retardant, to prevent the stick burning away too quickly.

On a personal note, the author can vouch for the advantages of safety matches. Many years ago a smoker friend was descending a steep path in the Peak District when he slipped onto his backside and set off a whole box of strike-anywhere matches that he had in his back pocket. His cries of pain were piteous and he was unable to sit down for several days!