



62. The spontaneous combustion of iron

Topic

Reactions of metals, oxidation, effect of surface area on reaction rate, or general interest.

Timing

About 2 min.

Level

Introductory chemistry.

Description

Iron(II) ethanedioate decomposes on heating to give carbon dioxide, carbon monoxide and finely divided iron(II) oxide and iron. On exposure to the air this is oxidised rapidly and exothermically to iron(III) oxide giving a 'sparkler' effect.

Apparatus

- ▼ One boiling tube.
- ▼ Heat-proof mat.
- ▼ Bunsen burner.
- ▼ Test-tube holder.
- ▼ A little mineral wool.
- ▼ Glass rod (optional).

Chemicals

The quantities given are for one demonstration.

- ▼ About 2 g of **iron(II) ethanedioate** (iron(II) ethanedioate-2-water, ferrous oxalate, $\text{FeC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$).
- ▼ A little limewater (saturated calcium hydroxide solution, $\text{Ca}(\text{OH})_2(\text{aq})$) (optional).

Method

The demonstration

Place about 2 g of iron(II) ethanedioate in a boiling tube, plug the top loosely with a little mineral wool and heat the yellow solid over a roaring Bunsen flame. The mineral wool is to stop any dust escaping when the salt is heated. Water of crystallisation is given off and the steam condenses around the rim of the boiling tube. The solid 'seethes' as carbon dioxide and carbon monoxide are given off and the yellow powder turns grey. Continue heating, shaking occasionally, until all the yellow colour is gone and the powder has stopped 'seething'. At this stage it is possible to test the gas in the tube by holding a drop of limewater on a glass rod at the mouth of the tube. It will go milky showing that carbon dioxide is present. Alternatively use a delivery tube to bubble the gas through a beaker of limewater. The gas does not appear to burn.

Now remove the mineral wool plug and pour the solid product onto a heat-proof



mat from a height of about half a metre. Freed of its protective blanket of carbon dioxide and on contact with the air, the finely divided iron and iron(II) oxide mixture is rapidly and exothermically oxidised to red iron(III) oxide and the powder glows red hot.

The finely divided mixture is referred to as pyrophoric *ie* capable of burning spontaneously on exposure to air.

Visual tips

The pouring would look most spectacular in a darkened room.

Teaching tips

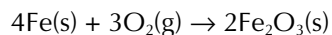
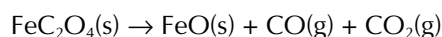
This is a good illustration of the effect of surface area on reaction rates; the rate of reaction can be compared with that of rusting and also of sprinkling iron filings into a Bunsen flame. Firework sparklers contain finely divided iron.

Theory

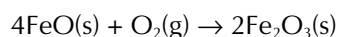
The reactions can be written as



and



and



Extensions

Lead(II) 2,3-dihydroxybutanedioate (lead(II) tartrate) and tin(II) ethanedioate (tin(II) oxalate) are reported to undergo similar decompositions to produce pyrophoric products.

Further details

If the iron ethanedioate is heated in a suitable vial, the pyrophoric product can be sealed inside with a glass-blowing torch. The vial can later be broken open and the oxidation of the powder demonstrated.

Iron(II) ethanedioate can be prepared by mixing solutions of iron(II) sulphate and sodium ethanedioate and filtering and drying the resulting precipitate.

Safety

Wear eye protection.

The room should be well ventilated because of the carbon monoxide generated.

It is the responsibility of teachers doing this demonstration to carry out an appropriate risk assessment.