

The howling/screaming jelly baby

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The Howling / Screaming Jelly Baby:

Reacting a 'jelly baby' with molten potassium chlorate

Supplementary Risk Assessment (to meet the COSHH and / or Management Regulations)

(To supplement Model Risk Assessments in other CLEAPSS publications, such as *Hazcards*, the *Laboratory Handbook*, *Recipe Cards* and various guides and guidance leaflets. This will eventually be incorporated into one of those publications.)

Details of operation:

15 g of reagent-grade potassium chlorate(V) is weighed into a Pyrex boiling tube. The tube is clamped at a slight angle to the vertical. The apparatus is surrounded by safety screens and the potassium chlorate(V) is heated until it melts. The demonstrator, wearing a face shield and heat-resistant gloves, uses tongs to drop a jelly baby into the melt.

(The above details are similar to those in various publications, including those of the Royal Society of Chemistry, the 21st Century Science project and the Salters' Chemistry Club Handbook.)

Schools are advised *not* to deviate from the details described in this risk assessment. If any variation is required, members should contact CLEAPSS for a Special Risk Assessment.

Substance(s) possibly hazardous to health, etc:	(a) Potassium chlorate(V). (b) Jelly babies are a form of confectionery, with stated contents of sugar, glucose syrup, water, gelatine, citric acid, flavourings, colours.
Classification under CHIP3 Regulations 2002:	(a) OXIDISING and HARMFUL (R9: Explosive when mixed with combustible material; R20/22: Harmful by inhalation and if swallowed). (b) -
Particular risks / precautions:	See CLEAPSS <i>Hazard 77</i> . Bretherick's <i>Handbook of Reactive Chemical Hazards</i> (6 th edition, 1999, Butterworth) states: "Potassium chlorate: Although most explosive incidents have involved mixtures of the chlorate with combustible materials, the exothermic decomposition of the chlorate to chloride and oxygen can accelerate to explosion if a sufficient quantity and powerful enough heating are involved...". Potassium chlorate with sugars: A stoichiometric mixture with sucrose ignites at 159 °C and has been evaluated as a rocket propellant. Dry powdered mixtures with glucose containing above 50% chlorate explode under a hammer blow. Pyrotechnic mixtures with lactose begin to react exothermically at about 200 °C, when the lactose melts and carbon is formed...". A recirculatory fume cupboard caught fire with this experiment. It appears that the sparks were sucked onto the prefilter which is made of paper. The result is shown overleaf.
Workplace Exposure Limits:	-



Burnt prefilter!

Risk assessment

Potassium chlorate(V) is notoriously unstable. The thermal decomposition of potassium chlorate(V) has been a common activity in school science in the past. Catalysed by manganese dioxide, it demonstrates catalysis in a clear and striking manner, although problems have arisen when the manganese dioxide has been impure or charcoal (very similar in appearance) has been used in its place. Nevertheless, the use of potassium chlorate(V) in schools is well established and guidance on safe use in some contexts is given on the relevant CLEAPSS *Hazard*.

This activity involves the use of a jelly baby which is not covered by the *Hazard* or similar safety texts. Most of the texts used by education employers as model risk assessments warn of the risk of dangerous or unstable mixtures with sugars and recommend that such mixtures should not be made. A jelly baby contains sugars but it is a single lump rather than crystals or powder, thus the surface area exposed (and hence the rate of reaction) is less. In addition, the sugars will be diluted by the water present, further reducing the rate of reaction and making an explosion much less likely.

The conclusion is that, notwithstanding the general advice that chlorate / sugar mixtures should not be made in schools, jelly babies present a safe but spectacular demonstration of the power of potassium chlorate as an oxidising agent and the energy stored in foodstuffs, **provided that certain safety precautions are adhered to.**

- The activity must be carried out only by teachers who should practice it in advance. They should NOT be tempted to increase the scale of the operation.
- Make sure that there are no fire alarms that use smoke sensors in the laboratory (or in the corridor if the door is opened to disperse the fumes). Laboratory fire alarms should use heat sensors as recommended by the DCSF in *Science Accommodation in Secondary Schools*, BB80.
- Teachers must take steps to prevent theft of the chemicals, in case pupils are tempted to repeat the activity outside school.
- In case of explosion, the apparatus should be surrounded by safety screens (or in part by a wall). A closed / sealed apparatus must NOT be used.
- This reaction should be carried out on the open bench with the windows open. Fume cupboards are NOT designed to cope with this amount of smoke in such a short time and smoke will leak out. Ejected molten liquids have been known to melt plastic or crack glass windows. The sparks have ignited the prefilter in recirculatory fume cupboards.

- The reaction is very vigorous and molten potassium chlorate(V) and decomposition products are likely to shoot out of the boiling tube. The safety screens should be arranged to prevent the ejected particles from scattering around the room and especially from landing on combustible objects. There should be heat-resistant mats to protect the bench.
- Bench mats and safety screens may be spattered with potassium chlorate(V). After the reaction, this should be carefully washed away with plenty of water, to prevent the possibility of inadvertent combustion.
- Spectators must be several metres away from the demonstration and should wear eye protection.
- The demonstrator will, inevitably, be closer to the demonstration than the spectators and should make use of the additional protection provided by a face shield.
- **The demonstrator's hand is at some risk during the few seconds when the jelly baby is being dropped in to the melt, even if tongs are used. Heat-resistant gloves should be worn.**
- **As impurities can cause an explosion, care should be taken to ensure that the potassium chlorate(V) is pure (use reagent grade) and that the boiling tube is clean (and free, for example, from traces of carbon).**
- **Clamps used should not have rubber grips, as these may melt because of the heat of the reaction and so permit the boiling tube to move.**
- **Do not substitute sodium chlorate(V) for potassium chlorate(V). It does not work (it has the wrong melting point).**

This risk assessment was produced on 6th November 2008. You are advised to check for any update on the CLEAPSS web site.

Notes:

COSHH stands for *Control of Substances Hazardous to Health*. The regulations require that an assessment of risk must be made before substances hazardous to health are handled. The substances covered are the reactants, the products and any intermediate or side products that are very toxic, toxic, harmful, corrosive or irritant. Just because a substance carries no hazard label does not mean that it is completely safe.

The *Management of Health and Safety at Work Regulations* require a similar risk assessment for substances with other hazard classifications or activities involving hazardous procedures.