

# Burning milk powder – the effect of surface area on reaction rate

## Topic

Rates of reaction.

## Timing

About five minutes.

## Level

Pre-16, but it could be done as a spectacular general interest demonstration.

## Description

A pile of dried milk powder will not ignite even if a roaring Bunsen flame is played onto it. However, if the powder is sprinkled onto a flame, a spectacular fireball is produced because of the increased surface area.

## Apparatus

- Bunsen burner.
- Heatproof mats.
- Metre rule.
- Wooden splints.
- Sellotape
- Two stands with bosses and clamps.
- Eight 1 cm × 1 cm × 1 cm wooden cubes. These are often called Tillich's bricks and the maths department may have a supply if science does not. If these cubes are not available, any eight cubes of the same size will do. (Optional)

## Chemicals

Powdered milk from a grocery shop. Tesco's own brand works well, but not all brands are as effective. It is worth checking that the brand you have works before trying the demonstration with a class.

## Method

### Before the demonstration

Attach a wooden splint to the end of a metre rule using Sellotape so that most of the splint projects beyond the end of the rule.

### The demonstration

Protect the bench with heatproof mats – enough to cover approximately 1 m<sup>2</sup> of bench. Place a little milk powder in a pile on a heatproof mat or metal tray. The pile should be compact and form a cone about 1 cm high and 2 cm in diameter. Now aim a roaring Bunsen flame at the pile of powder, using



the hottest part of the flame just beyond the blue cone. The milk powder will char but will not continue to burn once the flame is removed.

Now use the two stands and clamps to support the metre rule horizontally about 5 - 10 cm above the bench so that the spill is above the heatproof mats. Light the spill.

From a height of about  $\frac{1}{2}$  m, pour milk powder onto the lighted spill. A small fireball will form as the powder comes into contact with the flame. Take care to transfer the milk powder from the full container to smaller vessel first to avoid setting the entire tin alight. The higher the powder is sprinkled from, the bigger the fireball, so it is wise to experiment starting from a small height until you can produce a fireball that is large enough to be spectacular but small enough for you to be comfortable with.

There will be some 'fallout' of burnt powder so have a brush or vacuum cleaner ready to clear up the bench. It is possible for large fireballs to reach the ceiling, so this may require protection.

## Teaching tips

Some students may have difficulty with the idea that a powder has a greater *total* surface area than the corresponding solid since each speck of a powder clearly has a very small surface area. The following model may help.

Use eight Tillich's bricks to make a  $2 \times 2 \times 2$  cube. Find the surface area by counting the exposed squares – it will be  $24 \text{ cm}^2$ . Now dismantle the cube into eight bricks and again find the total surface area of the bricks – it will be  $48 \text{ cm}^2$ . Alternatively chalk over the outside of the  $2 \times 2 \times 2$  cube and then dismantle it into the eight smaller cubes. Each will have three of its six sides chalked and three newly-exposed sides.

## Theory

Milk powder contains carbohydrates and fats which will burn in air to release energy.

## Safety

- Both demonstrator and audience should wear eye protection.

Your employer's risk assessment should be consulted before carrying out this activity.

Take care to ensure that no lampshades, ceiling hangings or any other flammable materials are within reach of the flames. A preliminary fire-alarm check is advised.

This activity is covered by model (general) risk assessments widely adopted for use in UK schools such as those provided by CLEAPSS, SSERC, ASE and Department's for Education. Bear in mind, however, that these may need some modification to suit local conditions.

Please advise pupils not repeat this experiment at home.

## Credits

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