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SCIENCE

KITCHEN SINK CHEMICALS EXPLAINED

Every home has an armoury of liquids to combat stains and leave surfaces germ-free. But how do they do their job?

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WASHING POWDER

THE WATER BOOSTER

The main purpose of washing powder is as a 'surfactant' – a substance that reduces the surface tension between water and fabric. You can think of it as making the water 'wetter'. It breaks down the repulsive forces between the water and the fabric, allowing the water to come into closer contact with the fabric and increasing its ability to remove particles of dirt. Surfactants perform a similar function with droplets of oil or fats, surrounding them and making them soluble in water. At one time, soap was the most common type of surfactant. Nowadays, however, most washing powders contain detergent, which is more effective than soap, especially in hard water.

Biological washing powders also contain enzymes. These are molecules that speed up various reactions in living organisms. Their use in laundry is effectively digesting the fats, proteins and starch that make up many common stains. 'Optical brighteners' are usually found in washing powders too. These are fluorescent dyes that absorb ultraviolet radiation from sunlight and emit blue light. This makes fabric appear whiter.

BLEACH

THE STAIN REMOVER

Bleach is a general-purpose cleaning product that disinfects and removes colour from organic stains. However, the same reaction that removes stains also damages organic fibres, so today bleach is far more likely to be used as a toilet cleaner thanks to its antimicrobial properties.

Bleach is commonly a solution of a pale yellow-green chemical called sodium hypochlorite. This breaks down 'chromophores', the parts of some molecules that absorb certain wavelengths of light so that only some are reflected, giving colour. Until recently, little was known about sodium hypochlorite's antimicrobial action, but it's now thought it causes a microbe's proteins to unfold, destroying them.

Sodium hypochlorite decomposes slowly in water, releasing chlorine, which explains bleach's characteristic smell. The reaction is slowed by the presence of an alkali, so bleach also usually contains a small amount of sodium hydroxide. Conversely, acid speeds up this reaction. For this reason, and because chlorine gas can cause serious lung damage, bleach should never be used in combination with other cleaning agents.

DID YOU KNOW? High-concentration surgical alcohol is used to disinfect skin before injections

ANTISEPTIC

THE MICROBE KILLER

These can be used on living tissue to treat cuts and grazes. One of the first household antiseptics was phenol, otherwise known as carbolic acid, a constituent of carbolic soap. Phenol is an alcohol of benzene, which is a hydrocarbon – a compound containing just carbon and hydrogen atoms. One of the hydrogen atoms in the benzene molecule has been replaced by an oxygen-hydrogen group. This binds to proteins present on the bacteria's cell membrane, disrupting the membrane and therefore destroying the cell.

Many more recent household antiseptics have a similar chemical composition to phenol. TCP, for example, is a mixture of several compounds known as 'halogenated' phenol. They have been little studied but are assumed to act in a similar way to phenol, damaging microbial membranes. These, and other modern antiseptics, are more effective than phenol and are less toxic.

DRAIN CLEANER

THE FAT DEMOLISHER

One of the most popular types of drain cleaner is made up of either solid sodium hydroxide or a solution of this highly alkaline substance. Also known as caustic soda, it breaks down the fat and hairs that are a common cause of blockages. The chemical reaction between sodium hydroxide and insoluble fats is referred to as saponification. It splits the large fat molecules into smaller soap and glycerine ones that are soluble and can therefore be washed away. The generation of soap by saponification further helps the cleaning process. Many chemical reactions are exothermic – they generate heat – and that's the case when sodium hydroxide is dissolved in water. So to make a solution, the chemical should be added gradually to plenty of water. Adding water to the solid is dangerous. Because there is not much water initially to absorb the heat, the small amount of water could boil, causing hot, corrosive liquid to spit.

WINDOW CLEANER

THE VANISHING DIRT REMOVER

A key requirement of window cleaner is to remove dirt and grime without leaving a residue behind. Some household cleaners contain solids dissolved in water that would remain on the surface of the glass as a visible film when the water evaporates. But window cleaners usually contain an alcohol, either ethanol or isopropanol, dissolved in water. This is effective at removing common marks such as fingerprints that contain fats and amino acids. Their effectiveness is increased by the addition of a surfactant that makes insoluble substances soluble in water. Any alcohol remaining on the glass soon evaporates.

Another common ingredient is ammonia, which becomes ammonium hydroxide in a solution. The benefit of this cleaning agent is that ammonia, being a gas, cannot remain on the glass surface. Because ammonia has a pungent smell, window cleaners often include a fragrance to mask the ammonia's odour.