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Cleaning: what is it, why do we do it and what can we do it with?

Cleaning agents: for many of us a necessary evil. After all, the customer often asks for something to be delivered clean. But what exactly is clean? That brings us back to the basic question: what is cleaning, why exactly do we do it, and what can we do it with?

Cleaning means the removal of unwanted material. Unwanted because people must always ask themselves what is the purpose of the cleaning and what are the criteria. For example, at first glance a few litres of water in a tank does not appear to be a problem and you would not immediately describe it as a residual load. After all, water is a harmless and non-poisonous substance. However a couple of litres of water could result in the development of considerable heat in loads of, say, 98% sulphuric acid. Water with a small amount of organic substance (such as a cleaning agent) can cause a tank container with hydrogen peroxide to explode. A few litres of water (condensation) in a petrol tanker will have unpleasant consequences for the car owner who gets this in his tank. A few ppm (parts per million, mg/kg) of pollutant in a raw material for plastic (foil) can cause holes to develop in the foil during production. The question is always to which extent the material present is unwanted. So if the pollutant is permissible, cleaning is in fact unnecessary.

What is clean

Unfortunately 'clean' cannot be measured. Of course numerous agreements and procedures are used to indicate whether a surface is suitable for a particular application.

- Visually or optically clean and free of corrosion is far and away the most commonly-used criterion in cleaning. However there are numerous colourless (organic) pollutants that are not visible to the naked eye.
- The methanol test, in which a square metre is rinsed with pure methanol.
- The 'blacklight' test (for revealing organic pollutants).
- There are numerous bacteriological tests designed specifically for the food and pharmaceuticals sector.

Types of pollutant and their 'solution'

All substances, and therefore all pollutants, can be divided into two main groups: organic and inorganic. These terms have been used for many years and represent the difference between, on the one hand, substances that are composed mainly of carbon and hydrogen, and on the other, substances that are not composed of carbon and hydrogen. With this a distinction was made between substances formed only by the living world (organic) and substances formed only by means of synthesis (inorganic). We now know better and are able to synthesise many organic substances.

Inorganic pollutants

Inorganic pollutants are usually solid (powdery). They are removed using acid cleaners. Familiar examples of these pollutants are scaling (calcium carbonate), silicates, plaster, rust and urine scale.

Dissolving of scaling in acid

$CaCO_3$	+	2 HCl	➔	$CaCl_2$	+	CO_2 (↑)	+	H_2O
calcium carbonate		*hydrochloric acid*		*calcium chloride*		*carbon dioxide*		*water*

Organic pollutants

Most organic pollutants are liquid and are often oily or greasy. They are removed with solvent-containing cleaners or with water-based alkaline cleaners. Familiar examples of organic pollutants are oils and greases, synthetic resins and polymers, as well as atmospheric pollution (Traffic Film).

Below is a brief explanation of the basis of the most common water-based cleaning agents.

Acids

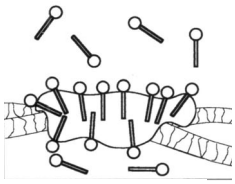
As already mentioned, acids are used to remove inorganic substances. The type of acid chosen will depend on the surface. In general that means that strong acids such as hydrochloric acid (HCl), nitric acid (HNO_3), sulphuric acid (H_2SO_4) and phosphoric acid (H_3PO_4) cannot be used on metals such as aluminium, zinc, copper and nickel. This is because these metals dissolve quite violently under the formation of hydrogen gas. This can form an explosive mixture with oxygen (in the air!). In such cases the addition of rust inhibitors, often complex organic amines, offers the answer. Strong acids are generally used in industrial cleaning.
Weak acids such as citric acid, formic acid and sulphamic acid can be used on metals such as aluminium, zinc, copper and nickel. These weak acids affect these metals as well, but much less seriously. Also these acids are more agreeable to work with. For this reason weak acids are used for cleaning in the institutional sector in particular.

Caustic solutions

As already mentioned, alkaline substances are mainly used for degreasing. This is based on the 'saponification' of fatty acids, which in themselves are not water-soluble. The reaction with an alkaline substance creates water-soluble molecules (‘soaps’), which make the grease contamination easy to remove. Alkaline substances are also used for the neutralisation of acids, for example in waste water purification. Familiar alkaline substances are caustic soda, lime potash, sodium hypochlorite solution and lime.

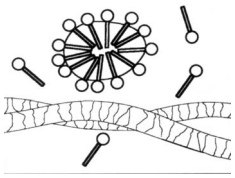
Surface-active substances

Nearly all cleaning agents contain surface-active substances. These are complex molecules that can lower the surface tension of a liquid. They are composed of a (usually short) water-soluble part (water-loving, hydrophilic) and a (usually long) oil- and fat-soluble part (water-hating, hydrophobic).



Greasy dirt is loosened....

If a pollutant, liquid or solid, will not dissolve in water the surface-active substances can enclose microscopically small particles. The hydrophobic part of the molecule dissolves, as it were, a piece of the pollutant, in the course of which the hydrophilic part has turned to the water. If the make-up of the hydrophobic part matches the type of contamination, stable, microscopically small particles can be formed.

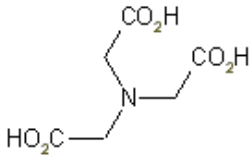


And continues to float in the solution

The oil/fat part is now completely surrounded on the outside by hydrophilic parts. These parts continue to float in the water and are called micelles. A cleaning solution containing these fat particles in suspended form is called an emulsion. Using this technology, even non-water-soluble solvents can be made emulsifiable. These solvents can then be thinned with water for cleaning. So the water serves as a vehicle for conveying the actual solvent to the contamination.

Complex binders

The purpose of complex formers is to bind the hardness present in the water (dissolved calcium and magnesium) so that no deposits (calcium carbonate) can occur in the (cleaning) installation, particularly at high temperatures. Complex formers also combat the formation of lime scum on the wall (often the result of calcium soap deposits) during cleaning. Familiar complex binders are EDTA, NTA, phosphates and phosphonates.



Water-soluble solvents

These substances have excellent degreasing properties, as well as good to excellent biodegradable properties. However, it should be borne in mind that even water-soluble solvents can be highly inflammable. Familiar examples are alcohols, glycol ethers and lactones.

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