

CIMCOOL[®]

Technical Report

Milacron Marketing LLC | Cimcool Fluid Technology | Cincinnati, Ohio 45209

CLEANING 101: Cleaner Basics

The first step in cleaning is to identify the contaminant to be removed. There are two basic categories of contaminant, organic and inorganic.

- ❖ Organic contaminants are those based on carbon, such as oils, fats, carbohydrates, proteins, molds, yeasts, and animal wastes. As a general rule these should be removed with an alkaline cleaner (pH>7.0) cleaner.
- ❖ Inorganic contaminants are substances that are not organic, or non carbon based, such as scale and lime deposits, rust, corrosion, and oxidation. These types of soils typically are removed with an acidic cleaner (pH<7.0).

Ways Contaminants Are Removed

All cleaners remove contaminants from a substrate by one or more of the following ways:

Solvent action

Enables the cleaner to dissolve oils present on the substrate surface.

Saponification

Conversion of organic oils and fatty acids (drawing compounds) into water-soluble soaps that can add to cleaning efficiency.

Detergency

Surface active agents, or surfactant, reduce the interfacial tension between solution and contaminant, enabling cleaning solutions to better penetrate and displace contaminant from the substrates surface.

Emulsification

Surfactants in the cleaning solution suspend contaminants in the aqueous phase for easy rinsing. Emulsification also prevents the oils/soils from recombining and migrating to the surface of the cleaning solution. This may not be important if you are interested in a product that splits oil from the cleaning solution. In this case a skimmer must be a part of the cleaning system.

Breaking down soil into fine particles, with the result that they are dispersed throughout the cleaning solution. The oil/liquid solution is maintained as a dispersion or suspension, preventing the soils from re-depositing.

Basics of Cleaner Composition

Water is the most common solvent used for cleaning. Even though it is one of the most environmentally friendly cleaners available, alone it does a poor job removing greases and soils. To improve cleaning efficiency, additional components must be formulated into a product, such as surfactants, builders, wetting agents, dispersants, chelating agents, saponifiers, and additives.

Water has a property called surface tension that is caused by the attraction between the molecules of the liquid by various intermolecular forces. The molecules at the surface of water are surrounded partially by air and partially by water. These surface molecules would be much more stable if they were in the interior of the liquid where all their hydrogen bonds could be fulfilled. Therefore, water normally tends to have the smallest surface possible, i.e. it has a high surface tension, in order to achieve the lowest possible energetic state.

In the cleaning process, surface tension must be reduced so water can spread and wet the surface of the substrate.

Decreasing surface tension of a solution will increase wetting ability. Increasing the wetting ability will allow a cleaner to penetrate small spaces and get under the soil to help lift it from the substrate. Therefore, increasing the cleaning power of the product.

Chemicals that are able to do this effectively are called surface active agents, or surfactants. Surfactants work on the boundary layer (interface) between the contaminant/soil and the cleaning solution to make water "wetter". Each surfactant molecule has two chemical groups; one attracted to water (hydrophilic or water loving) and the other attracted to the contaminant (hydrophobic or water hating).

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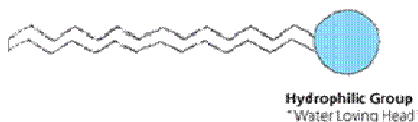
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Hydrophobic Group
"Fat Loving End"



In a cleaning solution, the hydrophobic end of the surfactant orients toward the contaminant and the hydrophilic end projects into the solvent, i.e. water, surrounding and reducing the size of the contaminants and allowing them to become soluble or be suspended within the cleaning solution.

Surfactants perform other important functions in cleaning, such as

- Loosening, emulsifying, and holding soil in suspension until it can be rinsed away.
- Providing alkalinity, which is useful in removing acidic soils.
- Enable the cleaning solution to fully wet the surface being cleaned so that dirt can be readily loosened and removed.
- Clean greasy, oily, particulate, protein, and carbohydrate-based stains.
- Helpful in removing dirt and in keeping soils emulsified, suspended, and dispersed so they don't settle back onto the surface being cleaned.

In addition to surfactants most cleaners also incorporate builders into their formulations to aid in cleaning effectiveness. Builders play a dual role in cleaners; they separate minerals to soften the water as well as help breakdown, emulsify and disperse grease and oils from the surface of the substrate.

Caustics, (KOH, NaOH), are the most common type of builder. They are considered to be highly alkaline (pH 12-14) and work with surfactants to breakdown fats and oils as well as to disperse particulates. This type of builder is not safe for use on soft metals like aluminum and zinc.

Carbonates are mildly alkaline (pH 9.0-9.5) and are mainly used to neutralize acidic contaminants. They are generally safe on soft metals and provide a reserve alkalinity to the other alkaline builders in the formulation.

Phosphates have a moderate alkalinity (pH 9.5-11.5) and provide more detergency than other alkaline builders. They provide some protection for soft metals and tie up hard water ions, preventing them from interfering in the cleaning process.

Silicates provide moderate to high alkalinity (pH 11-12.5) and contribute to detergency. They inhibit attack on soft metals, but they become insoluble at a pH less than 10. In addition, they neutralize acid soils and condition hard water. They do tend to form scale at higher temperatures. Sodium silicate is commonly used as a corrosion inhibitor in cleaning solutions.

Chelating agents, or sequestering builders, are very effective in counteracting water hardness. Hardness in water is caused by the presence of mineral salts, mostly calcium, magnesium, iron, and manganese. The mineral salts can react with the cleaner to form insoluble precipitates, soap film or scum, which does not rinse away easily. Because the cleaner will leave behind an alkaline residue an acid cleaner will be necessary for cleaning.

Chelating agents are able to "tie up" the hard minerals that are found in water and free up the cleaning agents to work on the actual contaminants. They can interfere with the ability of other chemicals to removed emulsified oils and dissolved metals from solution which can lead to waste disposal problems.

Some cleaners also have added solvents, which dissolve oily soils. Solvents are added because after the alkali builders saponify grease and oil, they begin to oxidize and become hard to remove. Solvents inhibit this process and provide added emulsification. This keeps oil and grease separated so they will not recombine. This type of solvent is generally glycol based.

Consult with your regional CIMCOOL[®] Technical Service Engineer for specific recommendations, or call CIMCOOL[®] Technical Service at 1-513-458-8199