

CIMCOOL[®]

Technical Report

Milacron Marketing Co. | Global Industrial Fluids | Cincinnati, Ohio 45209

The Role of Phosphates in Cleaners

What Are Phosphates?

Phosphates are naturally occurring compounds that are a combination of mineral phosphorous, hydrogen, and oxygen. These compounds are important nutrients for plants and animals as well as a key component in many types of cleaners and fertilizers. Even though phosphates are found everywhere, too much can be a bad thing. Because phosphates are considered nutrients, high concentrations can disturb the balance of an aquatic environment, causing plants, such as algae, to grow rapidly. The discharge of phosphates into waste treatment and sewage systems is regulated. As a result, some industrial facilities are placing restrictions on the content of phosphate in the cleaners that they use.

Phosphates in Cleaners

Phosphates have been referred to as an all-purpose chemical in the cleaner industry. They are usually the key ingredient in detergent formulations ranging from liquids to free-flowing powders. When formulated into cleaning products, phosphates are considered to be builders.

An important functional property of phosphates is that they contribute to the overall detergency of a cleaner by providing and controlling alkalinity. Having the proper pH can assist in removal of fatty soils, protection against corrosion, suspension of soils in water and prevention of the redeposition of soils on the surfaces being cleaned.

To make the cleaner as effective as possible throughout the washing process, it is essential that the pH of the bath remains stable. Since alkaline-based cleaners are able to remove soils that are on the acidic side of the pH scale, the pH of the cleaning solution may fall slightly, especially in industrial cleaning processes where the baths are kept for several days or weeks. Due to their buffer capacity, phosphates neutralize this variation and maintain an optimal pH in the bath. In addition, the alkalinity provided by the phosphate helps the cleaner attack impurities by strengthening the action of the other ingredients.

Hard water can be an issue in many industrial cleaning applications because it is able to cause scale that can clog pipes and other industrial equipment. Phosphates are able to soften water by deactivating water hardness minerals through sequestration (holding metal ions) or precipitation (removing metal ions from solution as insoluble materials). Sequestration of calcium and magnesium ions to soften water is pH dependent and weakens drastically below 9.5. Phosphates counteract the effect of dissolved iron, calcium and magnesium ions that are present in hard water by preventing them from combining with other components of the formulation. This action allows the cleaner to function properly. As a result, the required cleaner concentration is decreased.

Phosphates are also used to prevent calcium and magnesium scale from forming on parts and/or washer systems. Phosphates exhibit an anti-redeposition property that helps to break up large particles of dirt into smaller ones, which are easier to wash from the surface of the substrate. They also prevent fine dirt particles from combining, which helps them remain suspended in solution. This property also prevents dirt from settling back onto parts during the washing cycle as well as emulsifies grease and oil that are found in the system.

Other important aspects of phosphates; they help in the efficient manufacture, storage, and use of detergents by stabilizing the detergents' properties. Phosphates are highly soluble compounds, therefore they also aid in dissolving the cleaner into solution and are considered to be much easier to rinse.

Why Target Phosphates?

In the 1970's, the US government recognized the problem with phosphorous pollution. It was found that residues from fertilizers and cleaners were causing excessive growth of algae in fresh water lakes and streams. This nutritional enrichment is referred to as eutrophication. Phosphates have the ability to enter back into the environment unchanged through sewage from both detergents and human waste and could cause oxygen depletion in waterways. When growth of aquatic plants is over stimulated they seasonally die and rot, using up the oxygen dissolved in the water. Fish die of oxygen deficiency and are for a time replaced by scavengers.

As the plant growth cycle periodically repeats, the resource value of rivers and lakes decrease.

Bodies of water themselves become displaced because of the accumulation of plant life and the depletion of fish. The lake first becomes a marsh or a swamp, then into a bog; later dry land. This process occurs naturally as lakes mature. It has been estimated that the eutrophication, which has occurred over the past several decades because of man's pollution would require thousands of years to take place under natural conditions.

Elimination of phosphates from detergents alone may be insufficient to solve the eutrophication problem. Phosphate alternatives absorb calcium ions, but not magnesium. In addition, the rate of absorption is much slower for these alternatives, making them much less efficient. Their use, without any other change in the cleaner formulation would result in generally poor detergency and a severe increase of re-deposition

Phosphate Replacements

Phosphates fulfill a number of different functions; therefore it is difficult to replace them with one ingredient. Product reformulation requires the incorporation of multiple new raw materials to replace one. No other single chemical offers all, or even most, of the properties that phosphates do. In fact, a phosphate free cleaner is usually a different type of formulation all together.

Phosphate-free cleaners in general contain some or all of the following chemicals:

- ❖ **Zeolites** are principle builders that are artificial and insoluble compounds that are based on aluminum and silicate. They are known to increase soil suspension as well as increase sludge volumes in sewage treatment, which makes disposal much more difficult. Zeolites are usually found in powdered cleaners.
- ❖ **Polycarboxylates** are non-biodegradable long chain petrochemicals that are used to reduce build up of calcium and magnesium salts which result from poor ion removal properties of zeolites. In addition, these raw materials have been found to be difficult to remove in waste treatment. They may also accumulate in sludge.
- ❖ **Reinforced surfactant packages.** These systems can increase the biological demand in water (BOD).
- ❖ **Sodium carbonate** is used to maintain alkalinity. The problem with this raw material is that it has low solubility characteristics; therefore it has limited use in liquid cleaners.
- ❖ **Other chelants such as citrates, gluconates, NTA or EDTA** can mobilize heavy metals. They work well in removing calcium and magnesium ions as well as copper and iron, which can potentially cause other problems in waste treatment systems.

Phosphate-free cleaners may also contain chemicals that are considered to be harmful.

Consult with your regional CIMCOOL[®] Technical Service Engineer or call CIMCOOL[®] Technical Service at 1-513-458-8199 for specific product recommendations. CIMCOOL[®] Technical Service Engineers recommend both phosphate containing and phosphate-free products as required for your application.