

Long-lasting Effect Polymers For Hard Surface Cleaning

Hard surfaces cleaners must do more than remove dirt and grime. Consumers expect products to repel dirt and improve gloss with less effort than ever. Cognis researchers detail how a new class of polymers makes it all possible.

Dr. Thomas Albers and Dr. Christine Wild

*Cognis GmbH
Monheim, Germany*

HARD SURFACE CLEANERS must work harder than ever. The days of just cleaning a surface are long gone. Users expect convenient, inexpensive products that reduce the time and effort needed for cleaning in private households as well as in the I&I industry.

In addition, expectations for visually recognizable benefits have grown. A streak-free, glossy surface supports the impression of it not just being clean but hygienic, pure and safe for consumers. More time for leisure activities for consumers or reduced expenses for cleaning staff in institutional cleaning are achieved by less frequent and easier cleaning with reduced mechanical force. Special additives such as polymers are finding greater use in cleaners to achieve user-friendliness and long-lasting cleaning effects, such as less resoiling and easier cleaning over time. The efficiency of polymers depends not only on their

structure but also on the kind of surface to be cleaned.

Challenges for Cleaners

One major challenge for hard surface cleaners is the various surfaces that must be cleaned. Surfaces can be characterized by their surface energy. This surface energy provides information on the polarity and charge of the material. It helps to predict the behavior of cleaning ingredients on different surfaces.

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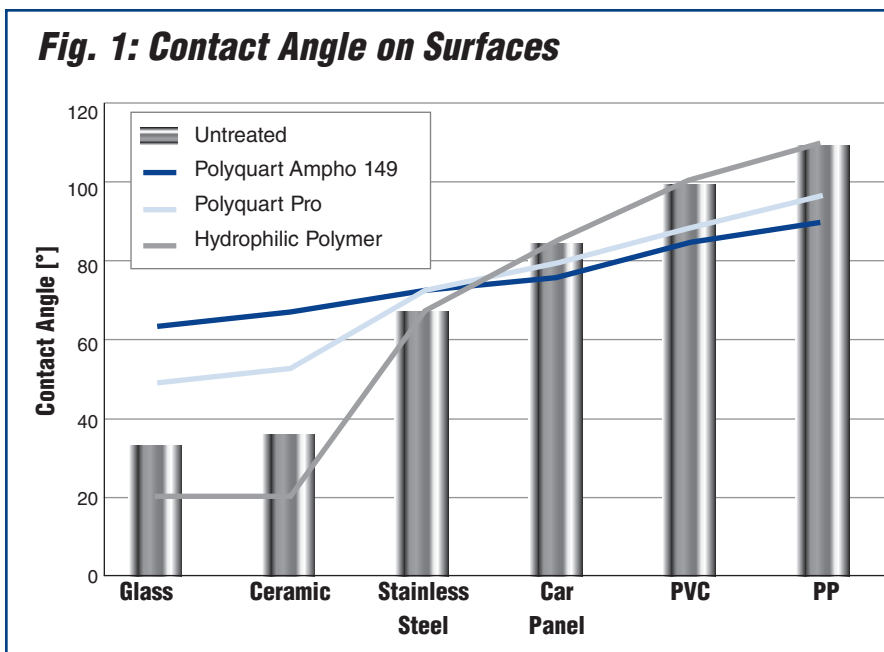
Common hard surfaces with different surface energies include glass and ceramic; metals, such as stainless steel or aluminum; and plastic materials such as SAN, melamine or polypropylene. Glass and ceramic have hydrophilic surfaces with relatively homogenous and consistent characteristics, whereas many plastic materials have hydrophobic surfaces with greater roughness and inhomogeneity.

The surface energy can be calculated based on contact angle measurements. The contact angle of water describes directly the hydrophilicity of surfaces; this has been measured on various surfaces (see Fig. 1 next page).

Another challenge in hard surface cleaning is the influence of different kinds of soiling. Soils are mainly composed of solids such as dust and other particles, mineral salts such as lime and rust and organic substances such as oil, fat and soap.

Just as with surfaces, soils too may be classified by their hydrophilic character. The various possible combinations

Fig. 1: Contact Angle on Surfaces



of soiling and surfaces result in different behavior regarding adhesion. Greater adhesion of the soiling makes cleaning more difficult. This can be overcome by surface modification with surface active polymers. They change the adhesion properties of soils and facilitate cleaning.

Hard Surface Cleaner Polymers

Polymers with specific characteristics and functionalities can be designed depending on the type of monomers, their molar ratios, molecular weight and molecular weight distribution

chosen for polymerization. Thus, polymers can be produced with customized hydrophilic or hydrophobic properties.

Polymers in hard surface cleaners have the ability to disperse soil, complex minerals and adjust viscosity. Nowadays, polymers are under discussion for hard surface cleaners to provide secondary cleaning benefits, which may include, for example, immediate visible effects such as enhanced gloss. Expectations have now changed with regard to additional long-lasting benefits, the challenge here being to provide these benefits

without build-up effects of the polymer over time (Fig. 1).

Polymers can be classified in the same way as surfactants with respect to anionic, cationic, nonionic and amphoteric substances. The structure is an important aspect in surface modification.

Nonionic and anionic polymers do not provide long-lasting effects because hard surfaces are normally negatively charged and thus the affinity of those polymers is very low. Cationic polymers show affinity to hard surfaces, but are limited in use due to incompatibility with many surfactants and other ingredients. There is also a limitation in the pH range for the final formulation.

Polymers with amphoteric structure also show significant affinity to surfaces and can easily be formulated in hard surface cleaners. Whereas the cationic charged part of the polymer is responsible for the adhesion of the polymer on the surface and hence provides the long-lasting effect, the nonionic and anionic parts, which are oriented toward the environment, influence the hydrophilicity of the modified surface.

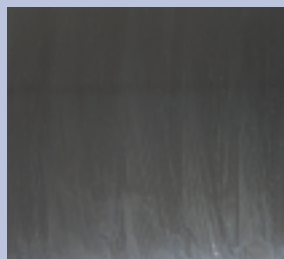
Hydrophilic amphoteric polymers can reduce the contact angle of water on polar surfaces such as glass and ceramic and improve the wetting performance. Specially designed, hydrophobically modified, amphoteric polymers raise the contact angle on polar surfaces and reduce the contact angle of non-polar surfaces such as plastic materials; whereas hydrophilically modified amphoteric polymers have virtually no effect on non-polar surfaces. Modification of surfaces with amphoteric polymers in aqueous cleaners provides various immediate and long-lasting visible benefits.

Polyquart Ampho 149 and Polyquart Pro are hydrophobically-modified amphoteric polymers, compatible with all types of surfactants. Whereas Polyquart Ampho 149 is stable from pH 3-10, Polyquart Pro has been designed for applications ranging from pH 1-13.

Immediate Effects

Primary cleaning performance is the

Fig. 2: Gloss in Leave-on Application on Ceramic Tile



**Fatty alcohol ethoxylate—
formulation without polymer**



**Fatty alcohol ethoxylate—
formulation with Polyquart**

most important immediate and visible effect. Excellent primary cleaning is achieved by an optimized combination of surfactants, acids or bases and other auxiliaries. Fatty alcohol ethoxylates, for example, are commonly used in hard surface cleaners. However, they reduce the gloss, leave visible residues on surfaces and require thorough rinsing with water.

Convenient, ready-to-use spray cleaners or wet wipes with low levels of salt or acids can be based on fatty alcohol ethoxylates as the single surfactant, if amphoteric polymers are added to the formulation in order to avoid unwanted side effects. Glass, ceramic tiles and shiny metals will maintain their original shine (Fig. 2).

Quick and spotless drying is another requirement for convenient cleaners. After rinsing, the water film does not drain homogeneously on surfaces that have not been cleaned with formulations including special polymers. Water droplets are left on the surface and these are subsequently visible as spots when the surface is dry.

Surfaces modified by hydrophobically-designed amphoteric polymers provide a uniform and quick water drain due to the higher contact angle. Water drains within seconds and without leaving spots on vertical surfaces that have been cleaned with formulations containing these hydrophobic polymers. There is no need for dry-wiping after cleaning. This benefit is also visible on cars cleaned with such formulations.

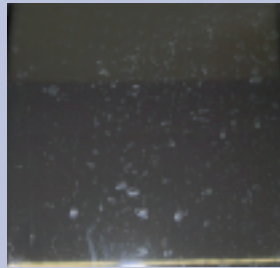
Surface modification with hydrophilic polymers allows a homogeneous but slow water drain which may take minutes upon rinsing with water.

Long-Lasting Effects

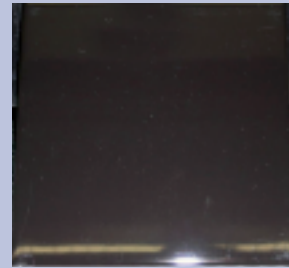
Saving time in hard surface cleaning can best be achieved by attaining long-lasting effects. Long-lasting gloss, soil release or less resoiling and easier cleaning next time are features of convenient cleaners.

Normally, solids such as rust or limescale adhere to

Fig. 3: Less Resoiling



Untreated and rinsed with water



Pre-cleaned with formulation including Polyquart, soiled and rinsed with water.

the surface meaning frequent cleaning is required. A simulation trial for testing adhesion of mineral residues highlights the obvious difference after prior modification. In this experiment, mineral salt solutions are sprayed on ceramic tiles and then solidified directly on the tile. The solidified soil can easily be removed just by rinsing with water. Even after several rinses with water, it is possible to prevent limescale build-up on hydrophobically modified ceramic tiles (Fig. 3).

Lime soap or burnt-on fat are soils which are difficult to remove. They often require a long contact time and

higher concentrations of cleaners as well as additional mechanical force. Surface modification with amphoteric polymers provides a protective layer on the surface. The polymer film between the soiling and the surface decreases the adhesion of soiling and facilitates easier cleaning next time.

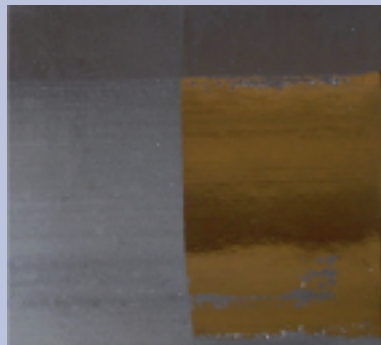
One test method to demonstrate the so-called "Easy-To-Clean-Again" effect uses burnt-on lime soap. Experiments have shown an obvious effect with the use of hydrophobic amphoteric polymers (Fig. 4).

Summary

Secondary cleaning effects such as gloss and quick drying can be obtained by surface modification with specially designed polymers in hard surface cleaners. In addition, specially designed hydrophobic amphoteric polymers show long-lasting benefits in terms of gloss retention as well as quick and spotless drying.

This effect is still noticeable after repeated rinsing with water due to the improved affinity of these special polymers to various types of hard surfaces. They can provide reduced adhesion of soils on many surfaces. Hard surfaces become less quickly resoiled and cleaning is much easier next time. ●

Fig. 4: Easy-to-Clean-Again Effect



Left: soiled tile, then cleaned with water and sponge. Right: pre-cleaned tile including Polyquart, soiled and cleaned with water and sponge.