✂ Hard Surface Cleaners

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ABSTRACT

Three key points for hard surface detergent making are: knowledge of raw materials, understanding of product application, and use of adequate test methods. The enormous variety of hard surface cleaner applications leads to a wide spectrum of product types. The importance of intimately knowing cleaning equipment and technique cannot be overstated for the hard surface detergent formulator.

INTRODUCTION

The three key factors involved in preparing hard surface cleaners include: a good knowledge of the raw materials, a thorough understanding of the application, and adequate laboratory and field test procedures for evaluating the finished formulation.

A "hard surface" is defined to include everything from battleships to sidewalks to eggs, with the exclusion of fabrics and dishware. This includes a great variety of hard surfaces. A short, comprehensive presentation is impossible; therefore, this overview is discretionary.

The first requirement–knowing the raw materials–is common to all formulators. Other reports in this symposium directly address raw materials. The detergency properties of alkaline salts are common to all products. In industrial hard surface cleaners, strong caustics are common whereas milder alkalies are used in fabric care, warewashing and home-use products. Likewise, acidic products for hard surface detergents are as strong as possible; concentrated mineral acids are most commonly used. The surfactant choices in this area seldom are concerned with "mildness." Instead, stability in or on strong alkalies and acids, foam characteristics and detergency are important. Raw material suppliers and various literature sources offer many generic formulations for various hard surface applications. These are useful as starting points. Typical formulations for floor cleaners, window washers and acid descalers will not be presented because these can readily be found elsewhere. Instead, key considerations in the making of hard surface cleaners will be emphasized.

The second requirement–understanding the intended product application–is of greatest importance. It has two parts: what is cleaned, and how it is cleaned. These items can be more important than the soil in question. For the substrate, corrosion potential and regulatory aspects must be considered. How this substrate is cleaned is what makes hard surface cleaning unique. It is critical and cannot be overstated that a product must be made to suit the cleaning technique.

Common hard surface cleaning methods include clean-in-place (CIP) circulation/spray methods, high pressure (up to 1,000 psi)-low volume (1 gpm) cleaning, foam cleaning, and soak/circulation (COP) cleaning. Manual cleaning–bucket and brush or mop methods–is becoming decreasingly important because time and labor costs are excessive. Automated cleaning is increasing in importance and hence products targeted for that application are growing more important.

Fully built liquid concentrates are the product of choice for automation: liquid, because they are automatically pumped from drums or bulk storage tanks into wash solution tanks; concentrated, because water occupies valuable space; and fully built, because minimal products mean minimal problems. Because these liquids are as concentrated as the laws of solubility allow, a formulator must thoroughly understand the interaction of materials in solution. In this case, the formulation depends on stability as much as product performance.

The connection between cleaning technique and product composition necessitates product characteristics not directly associated with detergency. For example, where foam is detrimental, defoaming surfactants are commonly used. Usually, low cloud point nonionics are employed. It is often difficult to formulate stable liquid alkaline concentrates with these defoaming properties. With the trend toward lower temperature cleaning, older defoaming products successful at 70 C are ineffective at 45 C, which presents an interesting challenge.

Foam cleaning is on the rise. Alkaline liquid concentrates, often chlorinated, are the product of choice. The highest foaming surfactants are found among the anionics, but the work-horse of the field, LAS, is not readily incorporated into concentrated products. Other anionic surfactants such as phosphate esters, ether sulfates, and some other sulfated materials are useful, along with the amine oxides and the amphoteric class surfactants. The role of detergency is subservient to the role of foam performance and product stability in foam cleaning products. Product use concentration generally is 1-10 oz/gal, and foam consistency ranges from a thick, dry, luxurious foam to thin, wet foams. Chlorinated products are preferred to prevent protein-film formation, but the stability of hypochlorite in the presence of surfactants bears investigating.

The principles behind foam cleaning are not totally resolved. The foam prolongs contact time with the substrate and soil, remaining in contact with the surface for 5-10 min before it is rinsed away. A hot, high-pressure rinse should follow for best results. Foam cleaning is actually low-temperature cleaning, as the foam temperature quickly drops to ambient conditions. Part of foam cleaning's success is psychological.

The foam device operator has visual proof-of-application and proof-of-rinsing, ensuring a more thorough cleaning job than might otherwise be effected. Until recently, two or three products were mixed together to achieve the proper foam results. An alkaline detergent, a high-foaming anionic (generally LAS) surfactant, and sodium hypochlorite were mixed together or injected simultaneously into the wash solution. Now, a single "built" detergent is preferred. Foam devices can be developed as portable units suited for small jobs, or central systems capable of covering entire walls in a matter of seconds. Acids can be foamed as well as alkalies.

Central, high-pressure cleaning systems use liquid detergents. These products can be the nonfoaming CIP type or the high-foam type, depending on customer preference and target areas. Alkaline, neutral (solvent-type), or acidic products can be used here. Employee safety is a concern as the very high pressures involved produce a mist of detergent solution in the air. This may limit concentrations of highly alkaline products.

In the cases just given, making a hard surface cleaner depends as much on the product application method as on the target soil. Of course, there must be a link to laboratory product testing. This link is the third key requirement for making hard surface cleaners.

To test means to measure. Measurements must be interpreted and evaluated. The goal is to measure detergency, but detergency can be a subjective term. An arbitrary definition is "the return to original appearance by the removal of soils." Armed with this definition, one then should scientifically measure the removal of soil from surfaces. In the laboratory, soil can be weighed or measured indirectly by various means: infrared, ultraviolet, and visible spectroscopy or radioisotope residue studies. However, it is by no means true that surface cleanliness, as judged by appearance, parallels or corresponds to soil removal—especially when corrosion, filming, or other alterations occur.

Laboratory tests strive for reproducibility and accuracy. To this end, tests must standardize soils, soiling methods, soil aging, substrates and cleaning methods. This last item is most difficult to develop for hard surface cleaning.

The correlation between lab results and field results determines the worth of the tests, measurements and interpretations.

There is a serious lack of good test methods for evaluating most hard surface detergents. In part, this is due to the wide variety of product applications. Test procedures for evaluating hard surface cleaners do not enjoy the luxury of common instrumentation such as is possible with dishwashers or laundry machines. Another problem stems from size. It is difficult to scale down properly a 1,000-psi pressure wash or a 4-story evaporator to dimensions a laboratory can handle. Furthermore, with each laboratory test standardization parameter, test results become less representative of real-life conditions. Unwarranted, undiscerning acceptance of laboratory test measurements and interpretations causes tunnel vision.

What is gained by laboratory testing? Certainly formulas can be screened for performance and inferior products eliminated. Relative cleaning efficiencies are determinable. Hard water tolerance, foam characteristics, and esthetics (odor, appearance) can be judged. Product stability testing, especially for liquids, must be rigorous. Phase separations, hypochlorite stability, and the formation of precipitates upon long-term storage at or near freezing and at elevated temperatures must be considered. Freeze/thaw recovery is important. The rate of thawing is critical in this test—slow thaw rates reveal more problems than faster rates.

Product development time must be wisely used. The balance of laboratory vs field work is not absolutely resolvable. For hard surface cleaners, it is always desirable to have laboratory data supporting product performance. The value of these data varies. The success of a product depends on how one approaches this test program.

An example of data handling that typifies this problem for hard surface cleaners concerns liquid alkaline CIP products intended for use in the milk processing industry. In the laboratory, it is easily demonstrated that caustic soda is the most effective material for removing milk soils from stainless steel. However, in the field, plants using only caustic products eventually develop an undesirable milk tank appearance. White films, blue films and water spotting marks gradually appear. These secondary problems are not directly associated with detergency, i.e., soil removal, and so are missed in the test approach. In fact, one must sometimes trade-off short-term detergency optimization for longer term total performance. It is a wise formulator who can judge accordingly.

There are other considerations beyond the key three already discussed. Manufacturing limitations are important. Spray towers, ribbon blenders, storage bins, heating and cooling systems, and packaging units must be familiar to a detergent maker. Hard surface liquid cleaners packaged in large, opaque units—55-gal drums or 2,000-gal bulk tanks—are ususally never seen by the user, so minor color variations and minor flocculents are not serious problems. Field test kits are important in this product market. Customers and service representatives need to be able to determine use concentrations in automated systems, rapidly and conveniently. Product concentration is usually determined using small, easy-to-understand titration kits. The alkalinity or acidity is titrated with standardized reagents to a color indicator endpoint.

Product safety and toxicity are, of course, always concerns. Hard surface cleaners intended for industrial use are not as mild as bath soaps. Hot, strong caustics and mineral acids are common. Precautionary labeling is more altering: POISON, DANGER, CAUTION and WARNING are label keywords.

Regulatory concerns play a large role in making hard surface cleaners. For example, products intended for use in the food industry commonly are used in USDA-inspected plants or plants using USDA authorization standards. Authorization guidelines prohibit or restrict the use of fragrances and hazardous or harmful compounds, such as heavy metals, chromic acid or oxalic acid.