FEATURE

Large industrial laundry testing

The following article is based on a talk given by John W. Birckbichler of Ecolab's Textile Care Division, St. Paul, Minnesota.

In the industrial market, the methods for developing a detergent system are many and varied. The initial step in any product development project is to evaluate the corresponding market segment, keeping in mind the various fabric and soil types, product compositions, water temperatures and conditions, and the chemical and physical parameters desired of the product. There also is a wide spectrum of quality levels and environments in which a detergent system must perform. All of these factors must be taken into consideration.

Fabric and fibers

In developing a detergency system, it is of prime importance to determine the fabric type prevalent in that market segment. In the industrial market, 65/35, 50/50 and 80/20 polyester/cotton fabrics are the predominant types (1). There are also 100% cotton fabrics found in shop towels, the piles of some walk-off mats and dust items and in industrial garments. Certain mats also contain nylon piles and rubber backings. In addition, an occasional industrial laundry processes clean-room work which is 100% polyester. These items require special systems.

One must develop a detergent system that takes into consideration the oleophilic nature of the polyester fiber as well as the hydrophilic nature of the cotton component in the blends of fabrics present. For 100% cotton fabrics, we must decide on a wide-application product or one that is more specific. This information is very important to ensure the detergent system will have a positive impact on these materials.

Soil types

It is of prime importance to determine the soil types that the system will be used to process (2). Hydrocarbon-based soils as well as paints, varnishes, inks, carbonaceous materials, clays, grass and protein substances are prevalent in industrial soils. All of these soils will be acted upon in different ways by the detergent system.

In the case of the oils or oleophilic-type soils, a lower E.O. (ethylene oxide) moderate carbon chain surfactant is appropriate. For the hydrophilic types, a high to moderate E.O. ratio surfactant, such as 6.5-12 average E.O. ratio with a moderate carbon chain from 9 to 19, will suffice. Clays will be removed from the fabric surface by the surface active agent, but must be kept in suspension by either the surfactant or builder system.

The predominant surfactants of choice for the industrial market are nonionic. Therefore, it is important to develop a detergent system that will perform on all these soil types, both hydrophobic and hydrophilic.

Each market segment will have different soil types that must be determined. Thus, each requires not only a different surfactant system but also a different builder system to perform appropriately.

Surfactant system development

Once a particular soil type has been evaluated, the surfactant system must be determined and tested against the soil(s). Because there are over 6,000 surfactant agents currently mentioned in the literature and more being generated, it is of prime importance to screen these surfactants to determine their efficacy on soil types of choice (3).

As stated earlier, the major surfactant class in the industrial market are the nonionics. There is also the possibility of combining surfactant systems, a practice which has proven to be beneficial. This vastly increases the possibilities and the complexity of the system, and allows increased soil removal and suspension. It also multiplies the range of the system relating to soil removal.

Based upon the physical characteristics of the detergent system (built or unbuilt, liquid or dry), different manufacturing techniques and builder systems must be used (4). For example, with a dry-blend product, a dedusting material or adsorbent may be necessary. On low surfactant-content systems, it is almost always mandatory to use a dedusting oil. This is normally a severely hydro-treated grade oil which does nothing more than keep down the dust level of the product when the material is produced and used by the end user. If a system is highly built with surfactant, an adsorbent that will provide a large surface area on which the surfactant can adsorb will be required.

There also is the possibility of using a surfactant with a high solidification temperature. These materials can be heated and then blended into the builder system. As the system cools, they will solidify and produce a free-flowing product.

Coupled with these considerations is the physical form of the final product. It is important to evaluate the physical form of all of the raw materials in any product, particularly any dry-blend product, because of the possibility of particle segregation. Hydration is a potential problem, especially with phosphates and highly caustic materials. These can cause caking and product reversion into undesirable substances in the finished product. Therefore, screening of these raw materials is very important.

Obviously, these problems—except for the phosphate reversion—will not be evidenced in liquid systems, but there are other problems of the same magnitude. Stacking, compaction and "over the road" testing are mandatory for all dry-blend products; it is useless to develop an exquisite industrial product if the components separate before the product reaches the end user.

If a liquid system is desired, a different set of parameters must be addressed. Viscosity and stability of the system must be examined with freeze/thaw and elevated temperature testing. Are there separation problems when the product ages? Product degradation must be evaluated. Some products exhibit a "curing" stage, in which improved detergency is achieved within a prescribed period of time. These areas must be addressed and evaluated before any product can be released for sale.

The processing of the finished product allows many other possibilities, ranging from a simple dry blend, through agglomeration, spray drying, emulsification and homogenization. There are also special forms such as flakes and solids.

Initial tests

These tests are commonly performed in a Launder-O-Meter, where temperatures can be controlled and as many as 20 different liquor concentrations can be used at once (5). Multiple runs will be conducted on several soil types which can be purchased from testing firms or other organizations (6,7) or specific soils can be generated in the laboratory under controlled conditions and standards. The handling of soils and swatches used in these tests is important in that it must be done on a uniform basis, not only for soil application but also for aging parameters. If soils and swatches are not produced in a uniform, consistent basis, accurate results cannot be obtained from the experiments. It is common to prepare several hundred of these laboratory soil swatches at one time.

The fabric-to-liquor ratio should be the same in all tests so that baseline data can be obtained. The ratio of 9:1 is recommended for detergent systems, but it may be necessary to raise this to 14:1, depending upon the testing equipment available.

Once laundered, the swatches must be handled identically, especially in rinsing and time spent in the wash liquor. Soaking in the wash liquor will affect the detergency system. Therefore, time is very important and all steps must be judiciously planned throughout the experiment. This initial screening will reduce the possible surfactant types and minimize the overall time required for the testing.

The rinsing apparatus consists of an appropriate metal holder onto which a sieve screen is placed. The swatches are removed from the Launder-O-Meter canister and dumped onto the screen, which allows the water to flow away but retains the fabric and any accompanying mechanical action equipment. The swatches can then be retrieved and rinsed in a nearby beaker.

The builder system

There are only a limited amount of builders commonly used in industrial applications (8). These are metasilicate, carbonates, zeolites, phosphates, caustics and polymers. Other additives used to improve the overall performance of the system are optical brighteners, soil suspenders, soluble silicates, dedusting oils, adsorbents and dyes. Fillers such as sodium chloride and sodium sulfate also can be used.

Based upon the physical form required and the cost parameters that are to be used for these systems, the components will vary in their amount and type (9).

Once the builder system has been determined, a new series of tests will be conducted in the Launder-O-Meter with the surfactant on the same soil types, fabric compositions and wash formulas. This set of screening tests will further determine the builder system and finished product composition. The same test procedures outlined previously will be applicable for these evaluations.

By this time, product composition possibilities will be narrowed to four to six choices. It is now important to do an economic analysis of the remaining compositions to determine if the systems will be efficacious for the market. This evaluation will consist of determining the entire cost of manufacturing the product should it go to market now. All raw materials, production and packaging costs, as well as overhead and profits, must be evaluated. This step alone may eliminate one or more potential products, as it is not logical to develop a system that is more expensive than the market can support.

Controlled wash tests

It is logical to produce a small batch of the material (200-300 pounds, for example) and evaluate the system using a scaled-down model of equipment typically used in the particular market. These tests are conducted using laboratory-type soils and test swatches and goods of appropriate counts and types. These swatches will be processed and evaluated at intervals of one, five, 10 and 20 cycles, according to the prescribed experimental design (10).

This type of testing, evaluating the performance of the product on actual soils encountered in the market, will further eliminate several of the potential products. At this stage, it is best to evaluate several different colors as well as white and different styles, since this is typical of the market.

In-house testing

At this stage, actual soiled goods from an appropriate source are obtained and processed under controlled conditions in the laboratory using equipment typical of the industry. These soiled goods can be obtained from any local industrial laundry source and provide a scaled-down version under laboratory control of the exact conditions to be expected in the field. This step provides information that can be used to "fine tune" the finished product prior to its release into the market.

When obtaining field samples, it is important to maintain consistency, at least initially, and to obtain enough soiled goods to conduct a complete series of tests. This will ensure that the results are as accurate as possible.

The system of choice is to randomly sort the soiled goods into several appropriately sized wash loads and process them as soon as possible, because time has an effect on the setting of the soils into the fabric.

The preferred evaluation technique at this stage is to use a panel and standard soil swatches. Garments are selected randomly and cut in half. One-half of the garment is washed with the experimental material, and the other is held as a control. At the end of the processing period, all items are sewn back together and reviewed by a panel of 18 to 20 individuals. It is best if none of those taking part are aware of the testing. These tests are also best conducted in a solo situation to reduce bias.

Panel results are then tabulated and evaluated. Test results are coupled with reflectance and tensile strength evaluations conducted in the laboratory on the test swatches.

Field test

The final test series is conducted in an actual account. These tests will require careful observations by the technician assigned to the project in order to obtain accurate results. It is important that appropriate samples are obtained and tests conducted. This is the most difficult phase of all of the testing, but also the most important, because it will finally determine if the product can gain market position. In this stage, the test will be evaluated not only by the development team but also by the end-use customer of the product and his or her customer.

The time required for this stage will depend upon the product; it normally takes 30-90 days. Minor modifications can now be made to the "finished" product. If all goes well, this test account will be the first of many to use this newly developed product.

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