How to Boost Floor Cleaners

INTRODUCTION

Floor care is traditionally seen as a labour-intensive task using harsh chemicals. To minimize cleaning efforts is not only the desire of end-customers in consumer household care but even more important in Industrial and Institutional cleaning markets where labour is a predominant cost factor. At the same time increasing impact from environmental awareness in developed markets like Europe and the US has made the whole cleaning industry re-evaluate how to accomplish cleaning tasks.
Hard-surface floors are getting more and more popular in households as well as commercial and institutional facilities because they are becoming easier and less costly to maintain (1). Flooring types such as concrete, ceramic tile and stone are now being widely used. Ceramic tile floors have grown steadily in market share over the last decade, due to the greater availability of colours and styles, and because of the low maintenance they require. Unlike resilient floors, some ceramic tile, such as the glazed type, don't require repeated applications of floor finish and buffing to maintain an acceptable shine. In many facilities, ceramic tile floors have replaced resilient coverings due to reduced maintenance, and the durability and attractiveness of the product. Ceramic tile floors are increasingly popular in lobbies, hallways, lunchrooms and restrooms. But only proper floor maintenance will ensure an attractive appearance and extend the useful life of flooring.
Based on these trends outlined above there is a need for floor cleaners to fulfil the following criteria:

- Time-saving and "easy to use" which is a general driver amongst cleaning product categories. This implies a high cleaning efficacy and efficiency. This is an additional challenge on new substrates as floorings as they appeared where existing cleaners in the market do not work sufficiently.
- Biodegradability has become a basic necessity in markets like Europe and NAFTA.
- Comply with increasing demands for natural raw materials.

Extensive work has been done to understand the problems of cleaning floor tiles. (2) The technology of making tiles without glazing with a water-tight but still structured surface is now state of art for all kinds of floors both in public and private areas. The structure reduces the danger of slipping on tile floors and is therefore widely used. The structured surface of porcelain tiles can show discolouration in daily use. In practical terms, the cleaning of porcelain tiles consumes more than twice the time for the same size PVC floor. This data would indicate that the existing cleaning products from a thermodynamic point offer acceptable cleaning but the time they need to penetrate into the tile structure is not acceptable, leading to the idea that the kinetic performance has to be improved. This lead us to believe that the kinetics of the cleaners has to be drastically boosted. From the composition of a floor cleaner it is evident that the surfactants have a role to in determining the speed at which cleaning is done. The boosting surfactant should reduce the time which the cleaner needs to penetrate the dirt loaded surface and to remove the dirt. Special surfactants were identified that fulfilled the criteria such as ethoxylated quats, but this first concept had to be abandoned as these materials do not meet the requirements of the Detergent Regulation EC 648/2004. Therefore a new technology was needed to provide faster wetting on the surface and at the same time fulfilling the biodegradation criteria and the other demands from industry such as easy handling, cost-effectiveness, low foaming, no foam residues and long-term shelf life.

RESULTS

Many low foaming surfactants were tested, especially those with a short lipophilic chain as they would be expected to remove grease and dirt quickly. Various different head groups were tested on porcelain tiles in ordinary cleaning tests, using as well the results from computer modelling (2, 3).
Surprisingly, the material of choice was found to be a sorbitan ester, recently launched as TEGOTENS® SD 100. This type of surfactant is not usually considered to be a quick foam booster but more of a classic emulsifier for cosmetics and other emulsions. Sorbitan esters are used as emulsifiers in food and pharmaceutical products. (4) These materials are well documented in respect to their toxicological and ecological profile. They are considered safe surfactants and can be made from plant sources (5). The new sorbitan ester TEGOTENS® SD 100 comes as a nearly 100 percent active, light yellow in colour with a viscosity of about 6 Pa s. which is pumpable. It has a flash point of 210°C so there is no need for special handling. It can be used in a broad pH range between 5 and 14 which makes it an excellent boosting additive for cleaners. It is low in foam and does not leave any foam residues.
Having a look at the surface tension curves reveals some really surprising properties for the new sorbitan derivative TEGOTENS® SD 100, as shown in figure 1. Compared to both organic and silicone based nonionics, the lowering of the surface tension in the especially important area of 0.1- 0.01 g/l of active matter, where floor cleaners are usually dosed, is superior to the standards, which is a beneficial effect to make use of (6).
This effect can be used in formulations as shown in figure 2, where the sorbitan ester TEGOTENS® SD 100 is combined in a standard formula with an anionic surfactant, REWOPOL® D 510 NC (sodium ethyl hexyl sulphate), an amphoteric surfactant TEGOTENS® AM VSF (sodium caprylamphopropionate), a non-ionic (undeceth-6), and a sequestrant system. The formula with

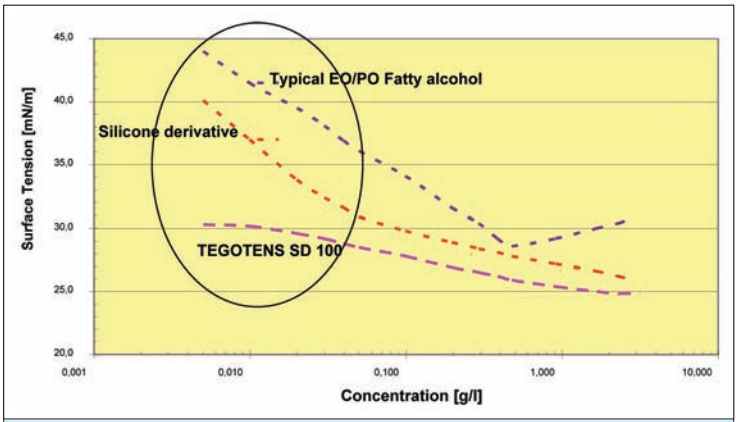

Figure 1. Surface tensions of different surfactants

Floor Cleanser (PF 03 d)			
No.		percent-active	(percent)
1.	TEGOTENS® SD 100	2.0	2.0
2.	TEGOTENS® AM VSF	3.0	6.0
3.	REWOPOL® D 510 NC	2.0	5.0
4.	Undeceth-6	3.0	3.0
5.	Trilon M liquid, 40 percent		6.0
6.	Potassium hydroxide, 45 percent		5.0
7.	Water		73.0
Manufacturing: Blend all ingredients while stirring. Ready-to-use dilution: 1.2percent in water			

Figure 2. Test formula with TEGOTENS® SD 100

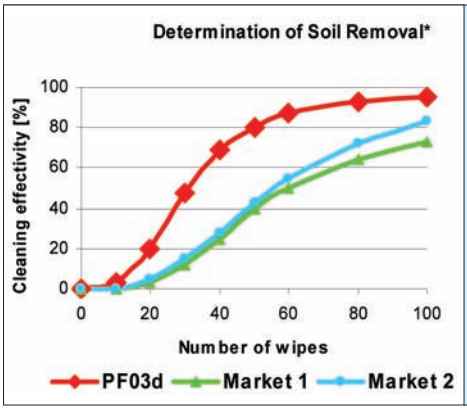

Figure 3. Gardner test results

10 percent active surfactant matter was diluted to 1.2 percent as commonly recommended for household cleaners and compared with market products in a Gardner test on a porcelain tile as substrate (Sheen Wet Abrasion Scrub tester REF 903 PG, Granifloor 2000 tiles from Villeroy & Boch). With TEGOTENS® SD 100 as booster the dirt removal was achieved perceivable quicker, 80 percent efficiency was reached after 46 strokes compared to about 100 strokes with market products.
From this test it is evident that the boosting effect of TEGOTENS® SD 100 provides significant advantage as the same formula with the non-ionic surfactant (undeceth-6); replacing the sorbitan ester did not differ at all from the commercial products. In accordance with our earlier work (2) we tested the formulation with a high speed camera system to observe the behaviour in more detail. The time resolved curve of the dynamic contact angle of the test formula was compared again with a market product on a porcelain tile. Figure 4 shows that the test formula has immediately after contact already a contact angle θ below 25° and after 3 seconds below 20°, whereas the market product starts at θ = 37° and is still at 23°.
The strong kinetic effect is reflected in these charts. Further testing revealed that the sorbitan ester is most active when combined with amphoteric surfactants like the amphopropionate in the example above or with amphoacetate or betaine type surfactants. These should be present in formulations in a similar ratio as the TEGOTENS® SD 100 for maximum benefit. Especially floor cleaners formulated as microemulsions have been proven to be efficient on floors as the oil phase is especially well suited to solubilize greasy dirt. We have formulated a microemulsion which makes use of the boosting cleaning power of TEGOTENS® SD 100. The formulation is shown in figure 5. At a level of 0.6 percent in water the formulation achieves a contact angle on porcelain tiles at 5 seconds of q = 19.6°. This concentration has therefore an extremely high efficiency, it is transparent in all rates of dilution and stable. The oil phase, TEGOSOFT® DEC, a diethylhexyl carbonate is a good solubilizer for fatty dirt and provides a nice shine on the floor which is an additional benefit.

CONCLUSIONS

Our test results demonstrate that TEGOTENS® SD 100 can significantly speed up wetting of formulations applied to different surfaces. The product combines excellent cleaning performance with a good eco- and tox-profiles and low foam behaviour.
These results brought us to the next step of developing a blend of

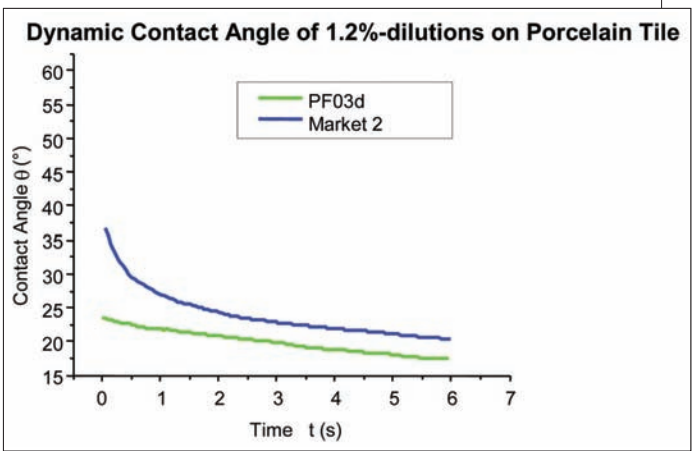

Figure 4. Dynamic Contact Angle of 1.2 percent diluted on Granifloor 2000 tiles

All Purpose Cleanser, microemulsion		
No. 101420-6		percent
1.	TEGOSOFT® DEC	7.0
2.	TEGOTENS® G 826	11.0
3.	Glyceryl-monolaurate	6.0
4.	TEGOTENS® SD 100	3.0
5.	SAS, Na-Salt, 60 percent	3.0
6.	Dipropylenglykolmethylether	7.0
7.	Dipropylenglykol-n-butylether	5.0
8.	Water	58.0
Ready-to-use dilution: 0.6percent in water Contact Angle (5sec.): 19.6°		

Figure 5. Microemulsion Formulation

TEGOTENS® SD 100 and other surfactants to replace the existing blends of ethoxylated quats and other surfactants which were widely used in vehicle cleaning and other Industrial & Institutional cleaning applications. Current replacement products based on biodegradable surfactants do not yet give the required kinetic effect. A blend based on TEGOTENS® SD 100,under the future trade name REWOPOL® SC 200 will be launched shortly.

REFERENCES AND NOTES

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