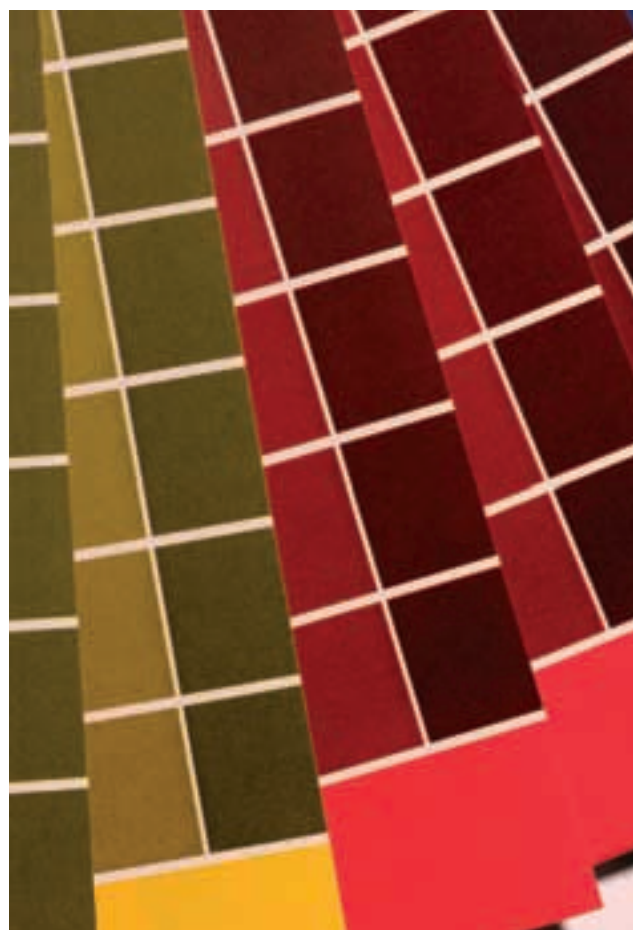


NEW DISPERSANTS Allow Formulation of

Who hasn't reached for wallpaper, paint, and paint brush to spruce up the children's room? Who hasn't looked for the right color of paint or even had a completely unique color mixed at the building supply store, because commercial ready-made products were always just a bit different from the desired tinge? Without knowing, these do-it-yourself specialists worked with so-called pigment concentrates that are extremely important to the paints and coatings industry. Their production and processing requires the consideration of a multitude of factors to ensure that, in the end, ceilings and walls, wood, metal, and concrete have the right finish.



Universal Pigment Concentrates



In order to manufacture these kinds of pigment concentrates, wetting agents and dispersants are obligatory for the incorporation of pigments and fillers. Along with pigments, wetting agents, and dispersants as key formulation ingredients considerably determine the appearance and physical-chemical properties of coatings. Pigments are the most expensive component in paints or coatings, which can be used economically through the application of dispersants. Because of their reactive surface, the dry pigment powders tend to form aggregates and agglomerates, which can have a negative impact on color intensity, purity, shine, or hiding power. Dispersants guarantee a distribution of pigments as uniform as possible without sedimentation and re-agglomeration, high and long-term stability of the dispersions, and good processability, when they are adsorbed evenly and permanently to the pigment surfaces under the proper application of shear energy.

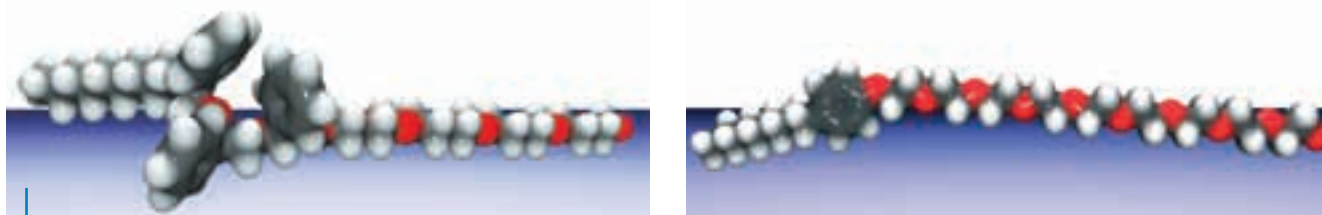
In the past, alkylphenol ethoxylates (APEs), among others, were used to handle these tasks in universal pigment concentrates, but their use is increasing-

ly viewed as environmentally harmful. With the TEGO Dispers 65X family of additives, a mixed team made up of employees of the former Oligomers & Silicones Business Unit – whose activities, in line with Degussa's reorganization, were allocated to the Care & Surface Specialties and Coatings & Colorants Business Units as of January 1, 2006 – has developed a path-breaking, environmentally safe alternative, and thereby won the Degussa Innovation Award 2005 in the New Products category.

Since this technology is suitable not only for do-it-yourself products in the home improvement industry but also meets the higher requirements of trade and industry, the market relevance of the new additives is remarkably high. Their efficiency lies above all in the universality of their range of applications: The new dispersants do not reveal any drawbacks – neither with regard to any of the pigments currently used, nor the various solvents employed in the manufacture of the paint. The concept is equally suited for tinting water-based as well as solvent-based paints and coatings. While water-based paints and coatings already dominate the market in Northern and Western Europe, solvent-based systems still play an important role in Germany, the United States, and Asia. This is why pigment and solvent universality was a particularly important requirement during the development.

Universal: The new dispersants can be used for both water-based and solvent-based systems, and for all pigments currently used





Organic pigments can be dispersed far better with TEGO Dispers 65X (left) than with conventional fatty alcohol ethoxylates (right), thanks to the aromatic ring structures, which show a high pigment affinity for hydrophobic pigment surfaces

Styrene oxide – the key to success

For the new product idea, Degussa combined its existing experience in the manufacture of polyethers with the use of unique aromatic epoxides. The company possesses proven expertise in this area, having used ethylene oxide, propylene oxide, and butylene oxide, but so far no styrene oxide, as monomer building blocks for commercial applications. The use of styrene oxide, however, turned out to be essential for the new additives. Compared to conventional fatty alcohol ethoxylates, the aromatic ring structures in these dispersants show significant improvement particularly with regard to organic pigments, and outperform the established APE products clearly. This is a result of the more variable introduction of pronounced donor centers by using styrene oxide in the structural sequence. Degussa recognized the importance of styrene oxide for polyether structures at an early stage, though it had been used far differently by industry. Based on a secured IP position, styrene oxide can be successfully used in a variety of future commercial applications.

After the basic synthesis pathway was found, further development on the process continued in direct cooperation with one of the world's largest manufacturers of paints and coatings. Process milestones were mutually defined, the results regularly presented and discussed, and plans modified, when necessary. One focal point of the project was the synthesis work: To meet the ever more challenging demands of the customer with regard to pigments, for example, or drying behavior, Degussa had to supply continuously modified structures.

Degussa's application engineers and developers also assisted the customer with their formulation know-how by developing customized pigment paste formulations

and testing them in a variety of commercial and self-formulated paints and coatings. For some systems they even positioned additional coadditives in a module system and thereby gained extensive knowledge about the interplay of the components of the end formulation. This cooperative approach was the only way to implement a completely new additive concept in an industry that had grown accustomed to the use and more favorable price of APEs since the 1960s. The acceptance of Degussa polyethers was aided eventually by the ongoing debate over APEs, which makes a ban on the substances, at least in Europe and North America, appear likely.

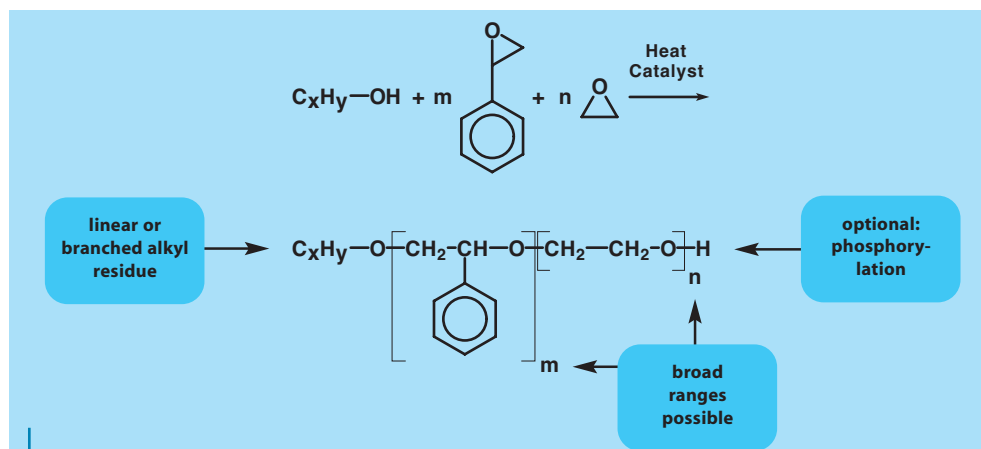
An all-purpose family of additives

As a result of these development efforts, which began in the year 2000, the Oligomers & Silicones Business Unit is already marketing three products from the TEGO Dispers family: TEGO Dispers 650 is a 100 percent product for organic pigments, that is liquid at room temperature. Alternatively Tego Dispers 651 is available for inorganic and organic pigments (30 percent polyether phosphate in a water-based solution, neutralized). Because of its terminal acid group, Tego Dispers 655 (100 percent activity) is particularly suited for inorganic pigments. And there are still other types that were specially developed for individual customers. This makes Degussa the first company worldwide to successfully offer products based on styrene oxide on a commercial scale.

A clear advantage of the new technology is its high degree of variability, and the thereby accessible range of achievable structures that make the polyethers so widely applicable. A variety of methods is available for adjusting and customizing the polyether molecules. In contrast to conventional polyethers, they can be varied not



Architectural coatings are just one example of the many uses for the new dispersant. Because of their high structural variability, the polyethers can be customized for any application



Structural diversity: Because the polyethers can be varied both aliphatically and aromatically, their water repellency can be selectively tuned across a broad spectrum.

The terminal OH group can also be anionically modified through phosphorylation, for example

only through the choice of starting alcohol, and therefore the length of the alkyl segment, but also through the use of the styrene oxide. This opens access to a host of aromatic structures that exceed even the characteristics profile of APEs. In addition, the molecular weight is significantly more variable in the context of a broad HLB (hydrophilic lipophilic balance) spectrum. Most importantly, the molecules can be designed to be significantly more hydrophobic than has been possible with existing polyethers.

In addition performance can also be tuned by using additional monomers. Primarily the water repellency in the decisive structure segment of the dispersant allowed it to be designed for universal use in solvent-based coatings, because in addition to the rather uncritical water-based coatings and alkyd paints based on white spirit, isoparaffin systems also had to be tintable. The terminal OH group, which can be anionically modified through phosphorylation, for example, offers another way to shape the structure.

Successful transfer to commercial-scale process

Such a far-reaching changeover to a new product requires the highest level of supply security for customers. The polyethers were first produced in a closed reactor with a capacity of 1.4 cubic meters. Successful upscaling to a loop reactor in 2005 increased the volume by a factor of 20. Because the handling of styrene oxide calls for an especially high level of safety, not only the production facilities were established at the Essen site, but also storage capacity and transport units were arranged to secure the feedstock's supply chain. Degussa has about € 1 million invested in the storage logistics alone.

The investment is based on legitimate commercial expectations. The market for dispersion additives worldwide continues to grow, and Degussa was one of the first companies to offer an alternative to APEs. Because the company's solution can be used for both water-based and solvent-based systems, as well as for all pigments currently used, it's reasonable to expect that

Degussa technology will play a surpassing role in the substitution of APEs. The development has taken Degussa to the top position in the market for suppliers of dispersants, whose volume experts calculate will be several thousand metric tons of additives in 2008. Degussa will achieve a significant market share here, since the competitive and patent situation is quite favorable.

Moreover, considerable synergies have been realized within the Group: The Swiss Construction Chemicals subsidiary Conica is the worldwide leading

producer of sports and industrial flooring made of custom-tailored polyurethane and epoxy resin systems. Tracks normally have the typical red color reminiscent of good old cinder. There are exceptions, however, such as the Olympic stadium in Berlin, in which the entire surface around the lawn was designed in the traditional "Hertha blue." The new dispersants are used to color these kinds of flooring systems. The Colortrend Team, which offers complete pigment pastes for its customers, and the Colorants Support Laboratory in Marl, are also benefiting from the development of the new dispersants.

Thanks to innovative products, Degussa is the first company worldwide to have commercialized polyethers based on styrene oxide. This makes it the clear front-runner in dispersants for universal pigment concentrates. Suitable for both water-based and solvent-based applications, the dispersants significantly reduce the complexity of manufacturing and storing paints and coatings. Consequently paints and coatings manufacturers have already shown keen interest in the development. TEGO Dispers 65X is clearly positioned as an alternative to APEs in all areas of application. Currently, 450,000 metric tons of APEs are still produced worldwide, and used for a wide variety of applications – not only in paints and coatings, but also in detergents and plastics, for example, and in paper chemistry and agricultural chemistry. In a corporation like Degussa, therefore, these novel structures have a promising future in manifold areas of application. Based on the considerable advantages of the new method, reorientation in the participating industries has already begun. ■

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