Improved pigment concentrates

A new dispersant for waterborne coatings provides enhanced stabilisation

Steffen Onclin
Harald Frommelius
Paula Gómez Perea
Elena Martínez
Shailesh Shah

The proper dispersion stabilisation of pigments is not only important for the final properties of a coating, it also helps pigments to be used as efficiently as possible. Peak performance on a broad range of pigments can be achieved using a dual-dispersant approach. Two complementary dispersants were each designed to have an optimum performance with a selected group of pigments and at the same time to guarantee inter-compatibility.

Good dispersing agents should provide excellent dispersing power and the stabilisation of different pigment classes. This results in low mill-base viscosities and high colour strength in the final paints.

When pigment concentrates are stored and dispensed, low viscosity and long-term stability become particularly important. To keep in line with the trend towards more sustainable coatings, dispersing agents must contribute to the fulfilment of the most stringent emission requirements for VOC levels, so that the paints produced can carry eco-labels.

The correct design of dispersing agents can go a long way to achieving overall top performance in a broad range of coating systems.

The classical way to stabilise inorganic pigments in aqueous systems is through electrostatic stabilisation (see Figure 1). This highly effective mechanism is mainly used in low performance applications, for example, matt interior and façade paints, because dispersing agents carrying a high charge density can potentially have a negative influence on resistance properties. On the other hand, in the case of organic pigments, better application results are obtained when stabilisation takes place using steric hindrance and non-ionic interactions. [1]
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Electrosteric stabilisation, on the other hand, combines both mechanisms, steric and electrostatic. Recently, a new type of polymer has been developed that relies on electrosteric stabilisation with enhanced steric character. These “enhanced electrosteric” dispersing agents are prepared by controlled, free-radical polymerisation technology (CFRP) and are designed to give broader compatibility across a wide range of coating systems.

Precise design

Dispersing agents need to fulfil two main requirements. Firstly, they should have a strong affinity for the pigment surface and secondly, they should provide robust stabilisation against flocculation. These demands can be fulfilled most effectively if the architecture of the polymer is controlled at the design stage. CFRP enables the precise design of polymer structures. Although non-controlled, free-radical polymerisation can lead to good dispersing agents, polymers with a highly defined architecture can be more efficient, resulting in improved colorant stability and broader system compatibilities [2], [3], [4]. With CFRP technology, well-defined block copolymers may be prepared that are designed optimally to fit pigment and resin chemistry.

Results at a glance

- A new dispersant, using controlled free-radical polymerisation technology, has been developed for waterborne application. The new product is an electrosteric dispersant with enhanced steric character, which provides broad compatibility and improved pigment stabilisation.
- The new dispersing agent is particularly effective with inorganic pigments, including difficult to disperse pigments, such as transparent iron oxides.
- The new product shows benchmark performance with inorganic pigments, but additionally good application results can be obtained with many organic pigments, giving it an all-round character.
- The new dispersing agent complements the performance of a current steric stabilising CFRP dispersant which is recommended for many demanding organic pigments and achieves a high level of jetness for carbon blacks (5).
As illustrated in Figure 2, dispersing agents designed with CFRP consist of two defined blocks that are prepared by sequential polymerisation of monomers or monomer mixtures. Typically, a longer stabiliser block is formed initially. This needs to be compatible with the relevant paint system. The anchoring block contains functional groups which interact strongly with the pigment surface to allow for efficient and stable adsorption. For demanding applications such as organic pigments, the anchoring block normally contains aminic groups, which can be further modified if required. It is preferable to use this new technology to design high-performance dispersing agents, because well-defined structures lead to anchoring groups with a higher efficiency. This in turn increases adhesion to the pigment surface, improves flocculation resistance and brings enhanced colour development. Additionally, it allows for precise control of the polymeric backbone to achieve good stabilising properties through the optimum compatibility achieved.

Enhanced electrosteric stabilisation

A new dispersing agent was developed using CFRP technology, which shows positive results on inorganic pigments. It relies on an enhanced electrosteric stabilisation mechanism. Both the charge density of the stabiliser block and the number of steric components were studied systematically. It was found that higher levels of steric components in the stabiliser block are beneficial to the performance of the final coating.

The newly developed dispersant, “Dispex Ultra PX 4575”, (referred to later as D1) complements the performance of a current steric stabilising CFRP dispersant, “Dispex Ultra PX 4585” (referred to later as D2). The two dispersants were tested on a range of pigments using four commercially available products as benchmarks. These are referred to as: B1, B2, B3 and B4. B1, B3 and B4 are styrene maleic anhydride-based copolymers and B2 is an acrylic block copolymer.

The following data illustrates test results with three different pigment types as examples.

Firstly, transparent iron-oxide colorants. Figure 3 shows the mill-base viscosity of yellow transparent-iron-oxide pigment concentrates. D1 shows low viscosity at the lowest dosage level, whereas the benchmark products B2 and B4 only perform well at higher dosage levels. With benchmark product B3 and D2, it was not possible to prepare a paste that could be handled. The pigment concentrates were subsequently let-down in a 2-pack, PUR clear coat and the transparency and gloss levels were measured. Figure 4 shows lowest scattering delta E values, and therefore the best transparency, for D1. This indicates an excellent stabilisation of the finely ground pigment as well as a good compatibility with the let-down resin system. The results mentioned above are further illustrated with an application photo of a drawdown of two tinted clear coats prepared with the new dispersant and benchmark product B4 (Figure 5).

Also, tests on transparent iron oxide red pigments demonstrated that D1 performed the best, followed by B1 and B4. The other benchmark products B2, B3 together with CFRP dispersant D2 showed some weaknesses in terms of viscosity and stability of the colorants.
The second pigment type is bismuth vanadate, which is the pigment of choice to replace lead-containing inorganic pigments in high-end industrial applications. This material provides good colour saturation and durability, combined with high opacity. Optimally dispersing this pigment is important, because it makes it possible to achieve complete hiding at lower film thicknesses. The rheological behaviour of pigment concentrates containing 60 % bismuth vanadate was examined. Figure 6 shows that low-viscosity concentrates with good storage stability could only be achieved with the two CFRP dispersants. All the benchmark products tested were not able to produce pigment concentrates of low viscosity at the tested pigment concentrations. The poor rheological performance of the pigment concentrates containing the current industry benchmarks is also reflected in the colour development in an industrial stoving system (Figure 7). D1 shows good colour development, while the other tested dispersants either could not be tested, because of very viscous pigment concentrates, or showed poor colour strength.

Thirdly, carbon-black pigments were also tested to ascertain broad applicability of the new product. Figure 8 shows the viscosities of pigment concentrates containing 35 % of carbon black. Again, the CFRP products provide low-viscosity concentrates that are minimally affected by warm storage.

Broad compatibility

The compatibility and colour strength of the pigment concentrates were tested in a number of architectural and industrial systems. Figure 9 shows the results in an industrial self-crosslinking system. Already at a low dosage level, D1 provides good colour strength in combination with excellent compatibility. Only D2 and one benchmark product provide better colour development, although at higher dispersant dosages. A range of further pigments and systems were tested to assess the application performance of D1. Such pigments include additional transparent iron oxides, a number of opaque inorganic pigments and several organic pigments. It was generally observed that the peak performance of the new product is with inorganic pigments, providing low viscosities at low dispersant concentrations, combined with a broad compatibility in industrial and architectural paint systems. But also with organic pigments, D1 shows good performance, giving the product an all-round character. Best results with selected organic pigments, however, are obtained with D2.

REFERENCES

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