

KEEPING DISTANCE

Dispersing under vacuum expansion creates paints and lacquers with high colour strength. Less titanium dioxide is necessary because of more efficient dispersion by the new technology. By Hans-Joachim Jacob, Ystral

Titanium dioxide (TiO_2) is one of the main cost drivers when producing paints and lacquers. Currently around seven million tonnes of TiO_2 are produced per year. The global market price per ton has increased by around 50 percent on average over the last few years - for high qualities it almost doubled. A new technology combines in-line dispersing technology together with a vacuum expansion method in order to use TiO, more efficiently.

T iO_2 is, with around 60%, the most important pigment in the production of lacquers, paints and printing inks. It is the basis of white and even coloured tones. It is necessary because colour pigments, only become visible if the unabsorbed spectrum is reflected, for example by TiO₂. This is also a large cost block. It has been calculated that roughly 25-40% of the production costs, depending on the application, is due to TiO₂. Europeans were previously the largest consumers of TiO₂, but this has changed. Currently Asia, primarily China, uses the most material. A single factory there produces as much emulsion paint as all of Germany's paint producers together.

RIGHT DISTANCE

 TiO_2 is very fine. The individual particles of this pigment are only around 200-400 nano-meters in size. Their most important property: They bend, diffract and reflect – in short: they scatter the inci-

dent light. The wave character of light makes each individual particle scatter the light in a sphere, which is roughly two to three times as large as the particle itself. If the distance between two particles is small enough to make the active spheres overlap, the resulting scattering of light of both particles together is barely higher than that of a single particle (*Fig. 1*). Conclusion: too small particle spaces reduce the light scattering effect.

 ${\rm TiO}_2$ particles agglomerate, they stick together. Additionally, most water-based lacquers and paints have a pH-value close to the isoelectric point of titanium dioxide - increasing the tendency even further. Des-agglomeration and subsequent stabilisation through dispersion additives is necessary. The individual particles have to be homogenised at optimum distance from each other in order to generate the maximum light scattering.

CORRECT DISPERSION

The method of dispersion under vacuum expansion aims to separate particles, destroy agglomerates and prevent re-agglomeration. Dispersion additives are required in order to keep the dispersion stable, even when the dispersion aggregate is switched off again. The requirements for an optimum dispersion of titanium dioxide are modern dispersion technology together with optimum dispersion additives and feeding the sufficient quantity at the right time by the same machine.

RESULTS AT A GLANCE

 \rightarrow Titanium dioxide is a large cost block in the production of lacquers and paints.

 \rightarrow Dispersing under vacuum expansion reduces process time and costs without affecting the quality.

 $\rightarrow\,$ The technology reduces the amount of titanium dioxide required.

 $\rightarrow\,$ Dispersing agents can be fed using this method in order to have maximum effect.

 \rightarrow The trend is towards slurries and intermediates – this is also recommended for titanium dioxide.

High speed dissolvers (HSD) have been used previously in lacquer and paint manufacturing, but they only achieve a relatively low shear gradient. High viscosities are needed, in order to generate a shear effect. These are not necessary, if processed with the "Conti-TDS" developed by ystral. It delivers a thousand-times higher shear rate. Wetting the finest powder with high viscous liquids - as in the dissolver - is illogical and difficult. The new technology solves this problem. It requieres 70-90 percent less energy for a proper dispersion and, specifically for titanium dioxide dispersion, up to 95 percent less time.

The machine is installed outside the process vessel (*Fig. 2*). As a result, it works independently of the vessel size and filling level. It can start feeding powder even at low initial liquid levels. This creates optimal dispersion conditions form the very start (*Fig. 3*). Dispersion agents are not completely added at the start, but gradually during the powder feed.

The dissolver not only disperses. It also circulates the highly viscous mass in the vessel. Only a fraction of its power is available for dispersion in a large volume. With the new method, almost the entire power serves the dispersion process (*Fig. 4*). The dispersion zone itself has a volume of less than one litre. As a result, the specific power used for dispersion is around 10.000 times higher. The machine generates a high vacuum in its dispersion zone, which inducts the powder into the liquid without dust and losses.

MORE AIR THAN EXPECTED

 ${\rm TiO}_2$ contains, like any other powder, a high amount of air. In fact, more than 75% of its bulk volume is air. The new technology uses this air. The powder particles touch each other under atmospheric pressure. The generated vacuum expands the air and widens the

Figure 1: Agglomerated TiO2 particles prevent the light scattering capacity.



Figure 2: Conti-TDS for induction and dispersing litanium dioxide from big bag.



Figure 3: Principal structure; liquid and power inlet; dispersing zone and product outlet.



140 DISPERSION PAINTS

Figure 4: Process steps for titanium dioxide optimised dispersion in wall paint production.

- 1. Begin with just
- a partial amount of the liquid 2. Induction TiO₂
- + Dosing dispersing additive3. If there is a Spacer in the formula:
- induction with TiO₂
- 4. High Shear Dispersion
- All remaining liquids
 Induction all fillers and extenders in optimum sequence with optimized pH-progression under reduced shear rate
- 7. Matting agents at the end
 8. Thickener with the last powders
- or during let down
- 9. No additional dispersion



Figure 5: Vacuum-expansion; separating the particles on the way to the dispersion zone.



Figure 6: Particle size distribution with too little dispersing additive; particle size increases during dispersion.



Figure 7: Particle size distribution with adjusted dispersing additive quantity and optimised feeding.



spaces between the particles. (*Fig. 5*). On its way into the zone of maximum vacuum, the air expands even further. This is how the liquid reaches all the spaces that are formed and wet each individual particle completely.

Powder and liquid are not simply mixed together, but the mechanical dispersion takes places with maximum turbulence and maximum vacuum exactly in the shearing field of the dispersion zone. This is the reason, why the vacuum expansion method does not need a wetting agent to wet the powder. Consequently, almost no foam is created, and the system needs less defoamer.

The excess air from the powder is separated from the dispersion by the centrifugal effect of the machine and pumped together with the liquid into the vessel. Large bubbles form and the air escapes easily.

Figure 8: Dispersing litanium dioxide with larger filler particles results in crowding and reduces the effect of the titanium dioxide.



Figure 9: Identical colour strength with 8% less titanium dioxide.



Since the wetting takes place outside the vessel, no dust is accumulated above the liquid – for example on the inside of the vessel or on its lid.

MANUFACTURING TINTING PASTES (COLOURANTS)

Titanium dioxide pigment pastes are the most frequently required pigment preparations for in-plant and point-of-sale tinting systems. The highly concentrated pastes have a TiO_2 content of 60-80 percent. They are currently made with a dissolver and milled in a mill to best possible fineness. The dissolver alone is not able to completely des-agglomerate the pigment.

The new technology is not only faster compared to the current process, but it also succeeds without a mill. Fine particle size distribution is achieved directly after adding the powder, unlike anything previously achieved even with an extra mill.

Traditionally the quality of the end product depends greatly on the quality of the TiO_2 . Experience with the new Conti-TDS has shown that it achieves a better result even with standard or cheaper TiO_2 grades. Most dissolver recipes contain lots of wetting agent, but not enough dispersing additives. The new technology does not need any wetting agent at all, but more dispersing agent. Compared with the previous production, a smaller particle size is created along with a narrower particle size distribution. The specific pigment surfaces in need to be stabilized by the dispersing agent, is enlarged. 20 percent more surface means 20 percent more dispersing additive is needed for stabilization.

Fig. 6 shows the situation during production of an unaltered traditional dissolver recipe. The entire dispersing additive has been **•**



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added at the start. In the first seconds after dispersion the particle size distribution is smaller, and then larger again as dispersion continues. This is an indicator for not sufficient amounts of dispersing additive.

Fig. 7 shows the result with the adjusted dispersing additive quantity and optimised feeding directly into the process. In this way the effect of the TiO_2 can be used more efficiently.

INCORPORATE FILLERS

Emulsion paints for interior and exterior walls contain fillers such as calcium carbonate, talcum or clay as well as TiO_2 . In the dissolver process the viscosity, of the basic liquid, is usually increased by adding a thickener at the start. The TiO_2 and all fillers are added over the surface. The powders are stirred into the liquid. This method leads to considerable fluctuations in quality. Quality checks and readjustments must be made consistently.

This is not the case with the new technology. In principle, the same recipe and the same sequence could be used. This allows a constant quality to be achieved. If the process sequence is changed, but the recipe is the same, further quality improvements and time savings of 35-70 percent are possible. A significant step is to delay the addition of the thickening agent until the end of the process or even to delay it into the subsequent let down process. As a result, the liquid is less viscous during dispersion. An optimised recipe reduces raw material costs above all.

Organic polymer based thickening agents are not shear stable. A large part of the thickening effect is irreversibly destroyed in the dissolver over the long processing time. Not with the new process. Thus

Figure 10: Higher hiding power with 8 % less titanium dioxide.



the amount of thickener can be reduced by 20 percent with constant quality and viscosity.

In order to optimise the dispersion for TiO_2 , the process should only disperse TiO_2 at the start under optimum conditions with just a fraction of the liquid. The best possible particle size distribution is achieved early in the process. The particles of the remaining fillers are up to 20 times larger than TiO_2 particles. A combined dispersion prevents optimum dispersion of TiO_2 and results in crowding of titanium dioxide (*Fig 8*). The smaller titanium dioxide particles become concentrated in the gaps between the much larger fillers. They are not homogeneous and not optimally distributed. Therefore, dispersing the titanium dioxide in part of the liquid before adding the fillers is advantageous.

HIDING POWER AND COLOUR STRENGTH

The dissolver only functions at an optimum filling level. The new technology works independently of the filling level. It can start with small amounts and the TiO_2 is optimally dispersed as a result. The other liquids, the filler and finally the thickening agents are added after the dispersion. No need for further dispersion afterwards.

Users, who have optimised their process in this way achieve both: better hiding power and higher colour strength. The previous quality can be achieved by reducing the proportion of TiO_2 , on average by 8 percent (*Fig 9* and 10). In addition, less thickening agents, wetting agents and defoamers are needed.

In formulations with very fine composite or hybrid pigments or fillers, the additional savings in $TiO_{2'}$ due to better dispersion, are limited.

TIO₂ SLURRY AND INTERMEDIATES

One industry trend moves away from co-grind production and uses slurries instead. The advantage is to disperse all powder components individually in optimum conditions, instead of adding all components at the same time with the same conditions and compromising quality. Paint producers usually produce the slurries in-house in order to be independent from one supplier and keeping sensitive recipes in-house as well. They then keep slurries in stock and the finished products are mixed from liquid slurries.

Even if the previous co-grind production is retained, it is recommended to use at least TiO_2 as slurry.

A slurry does not have to comprise a substance with just one single powder. If it contains several powders, these are called intermediates. For an TiO_2 intermediate it is positive to combine the TiO_2 with a spacer. It should reinforce the effect of TiO_2 . A typical example is a very fine clay. It ensures the individual TiO_2 particles to orient, distribute optimally and stabilise.

REFERENCES

- Winkler, J.: "Titanium Dioxide Production, Properties and Effective Usage", 2nd revised edition, Vincentz Network, Hanover, 2013.
- [2] "European Coatings TiO2–Forum Maximising white pigment efficiency", Vincentz Network, Hanover, 2018.

3 questions to Dr Hans-Joachim Jacob

How easy is it to integrate the "Conti -TDS" into a current production? The new system is often installed in a way that existing automatic powder feeding systems are further utilised. The powder is now dosed into powder hoppers instead of dissolver vessels. Control, operation and potential manual additions continue to be done from the same level. The dispersion system itself is located below the platform. Installation is possible parallel to the running production.

What has to be considered when changing to in-line dispersion under vacuum expansion? The sequence of addition should be optimized. Powders requiring most intensive dispersion are added first into a reduced amount of liquid. The remaining components are dosed later. Thickeners are added at the very end or even in the subsequent letdown step. Wetting agents to wet and disperse powders are not required.

What are the pros and cons of titanium dioxide slurries and intermediates? TiO_2 is intensively dispersed under optimum conditions. This way you reach finer and more narrow particle size distributions. Slurry can be produced for one or two weeks in advance. Dosing slurry is much easier than dosing powder. A minor drawback might be to limit the number of different TiO₂-types to a few instead of 10 to 15. This keeps the number of slurry inventory to a handable number.



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"Dosing slurry is much easier than dosing powder."

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