WHITE PAPER

PROCESS BREAKTHROUGH MAKES FUMED SILICA EASY-TO-DISPERSE

Easy-to-disperse fumed silica technology reduces equipment demand, processing time, and expense.

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ABSTRACT

The field of coatings technology has utilized many forms of fumed silica in the last 70 years. Due to highly adaptable surfaces and structure, numerous grades have been developed over the decades to provide functional solutions to many coatings problems. Successful use of technology is contingent on adequate dispersion, which often requires some type of milling technology. Now, an innovative downstream process breakthrough has created an easy-to-disperse fumed silica design on an experimental scale to enable formulators to use technology without the need for high intensity milling.

Historically, there are many tailor made designs which resulted from fumed silica's adaptable character. These tailor made designs create performance attributes including: rheological flow control, suspension, reinforcement, scratch resistance using standard high speed dispersion which replaces more intense bead milling to achieve high efficiency.

This paper will compare performance using both forms of dispersion; standard high speed dissolver type compared to bead-mill type to demonstrate the easy-to-disperse innovation.

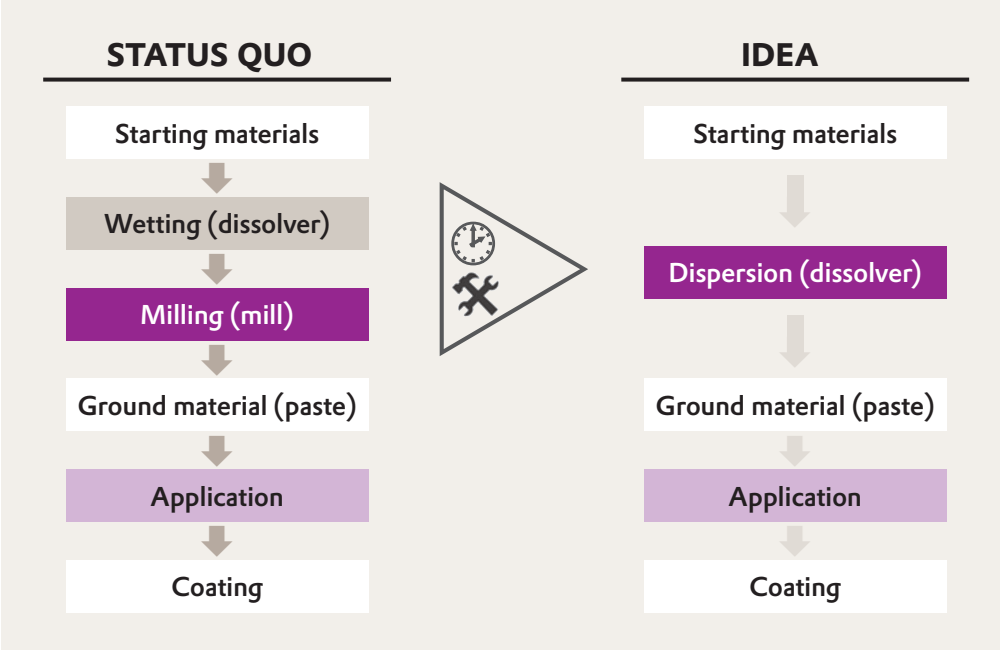
PAPER

Increasing customer focus to improve process efficiency has driven raw material innovation to reduce the complexity of the dispersion process. Using a bead mill to create the perfect dispersion is the most technically challenging and time-consuming processing step in manufacturing paints and coatings. To overcome this, raw materials manufacturers offer dispersions, preparations, and pastes in which the dispersion of insoluble solids (silica, pigments, fillers, etc.) has been optimized. Dispersions such as these, however, may also contain undefined quantities of solvents, water, binders, or additives. While formulators have no control over this, the effects of these components can have a significant influence to finished coating system.

It would be far simpler if manufacturers could use typical high speed dispersion to process the solid raw materials for the coating. Unfortunately, the particle sizes that can be achieved by dispersing materials under typical dissolver type dispersion conditions are routinely significantly above the maximum particle size accepted for use in paint and coating products.

Thanks to an innovation in the production process of fumed silica by Evonik Resource Efficiency GmbH, standard fumed silica technology routinely used by the coatings industry can now undergo wetting and dispersion-processes in a single high speed dispersion step. Where previously, it had to be carried out in two separate steps (dissolver, bead mill).

Figure 1

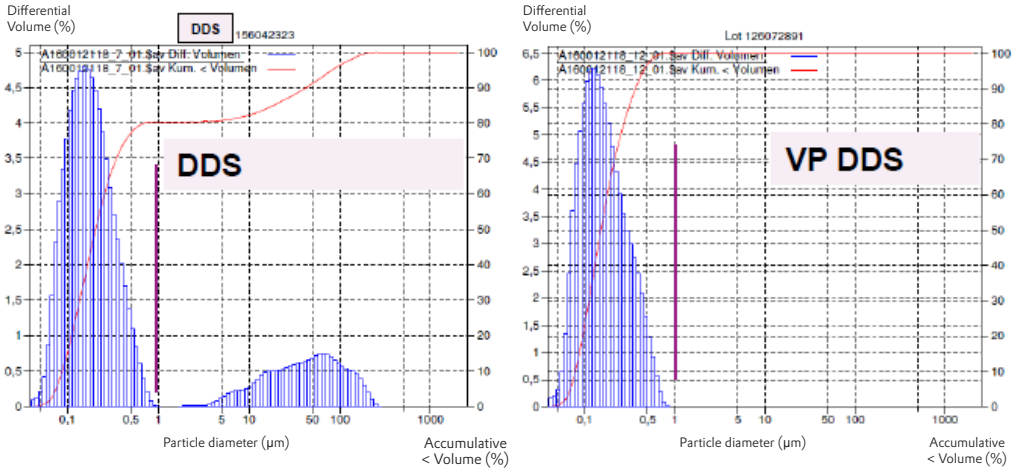


The challenge involved is not a trivial one. The formation of aggregates and agglomerates is an essential component of the flame hydrolysis process used for producing fumed silica – without them, fumed silica would not have its characteristic structure or, consequently, its effects. The resulting particle spectrum extends beyond 200 µm. However, to achieve favorable optical and application characteristics, manufacturers aim for aggregate sizes of < 10 µm.

The feasibility of the idea had already been confirmed 2 years ago when a laboratory-scale setup produced the first product samples, which were named "easy-to-disperse" (or "E2D" for short), a term that describes the unique properties of these products (i.e., readily dispersible in a dissolver). A pilot plant constructed and commissioned at the Hanau site this year has now generated the first pilot-scale product samples.

The experimental program began with VP DDS (VP RS 92), an E2D version of DDS grade (**AEROSIL® R 972**). Measurements of the particle size distribution revealed the critical difference: whereas the particle spectrum of the standard version of DDS was split into a bimodal curve, the new process yielded a unimodal distribution shifted far to the smaller size range. The elimination of coarse particles would allow paints and coatings manufacturers to avoid milling processes involving high shear forces (bead milling, for example).

Figure 2: Particle size distribution of VP DDS
HSD condisition, 15 minutes, 9 m/s



Product	d_{50}	d_{100}
DDS	0.21 µm	282 µm
VP DDS	0.15 µm	1 µm

Beckmann Coulter LS, in ethanol, 1 min ultrasound

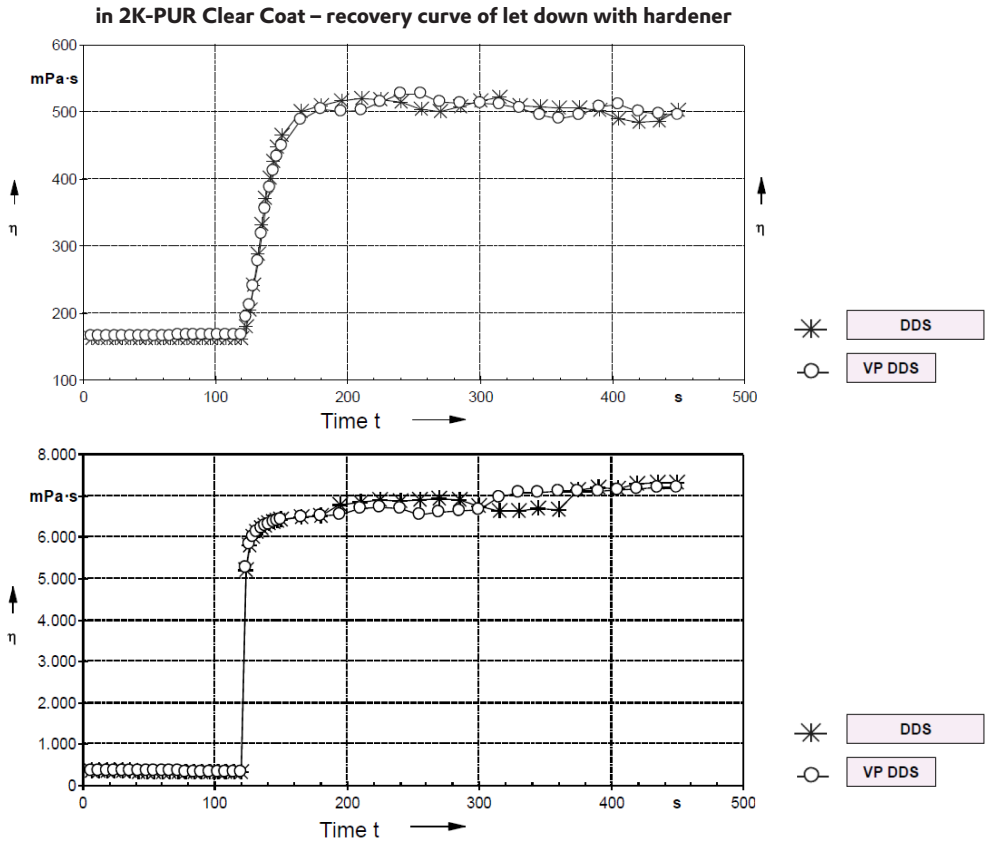
In order to test its processing characteristics, rheological effects, and optical properties within a coating system, the standard product was processed using traditional milling procedures, while the experimental product was processed exclusively in the dissolver. The results for viscosity, gloss, haze, and jetness (depth of color) were all correct within the accuracy of measurement. A significant, absolute reduction in processing time was observed as well, even as the degree of dispersion improved.

Figure 3

Product	Dispersion	Grindometer [µm]		Viscosity ground material 0.01 s^{-1} [mPa s]
		45 min Skandex	15 min dissolver	
DDS	Skandex	13	–	43,700
VP DDS	dissolver	–	10	44,000

Product	Dispersion	20° Gloss	Haze	Jetness My
DDS	Skandex	87.9	14	279
VP DDS	dissolver	87.9	13	280

Figure 4: Rheological properties of VP DDS



Now that VP DDS (VP RS 92) has been produced successfully (and is available for sampling), the pilot plant is being used for developing easy-to-disperse versions of other fumed silica grades. Up to date, various grades have been approved for sampling; VP RS 82 (which is the E2D variant of **AEROSIL® R 812**), VP RS 85 (which is the E2D variant of **AEROSIL® R 805**) and most recently VP RS 920 (which is the E2D variant of **AEROSIL® R 9200**). The main functionality difference for VP RS 920 is this technology and its base product **AEROSIL® R 9200** are used for scratch resistance. While the other grades are targeted for rheology improvement, whether thickening, thixotropy or vertical sag stability.

The use of easy-to-disperse silica decreases processing times, cleaning times, production losses, etc., while omitting the milling step reduces investment and maintenance costs – especially in clear coating production. Pigment manufacturers likewise offer products that can be dispersed with high speed dispersion technology, opening up the possibility of formulating pigmented coatings without use of a media or bead mill.

In summary, paints and coatings manufacturers have been looking for ways of making dispersion processes less complex. In regards to fumed silica technology, this innovation has met the demand in two ways. First; by reducing the number of production steps needed for processing, and second; required batch cycle time has decreased to achieve the optimum degree of dispersion. These combined efficiencies ultimately reduce production costs.

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05_2018

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