High-speed rotary bell atomization of Newtonian and non-Newtonian fluids

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Abstract

The atomization of liquid paints with high-speed rotary bells represents the most important application technique in the automotive industry, delivering paint films with highest quality in terms of color, effect and gloss. At this type of atomizer, a very thin film (thickness between 15 and 25 µm) is formed on the inner surface of rotating bell under the effect of centrifugal forces, which finally disintegrates at the bell edge in the form of a free film or liquid jets. In practice, a large variety of paint qualities is atomized. Hence, the present contribution deals with the effect of different flow behaviors. Namely, a solvent based, almost Newtonian paint (automotive clear coat) is compared with a waterborne, non-Newtonian paint (automotive base paint).

A 20 ns Nanolight system and a SPRAYTEC Fraunhofer diffraction system were used to investigate the disintegration process and the final size distribution as a function of the application parameters, i. e. paint flow rate and bell speed. As expected, the bell speed is the most important parameter influencing the atomization for both systems, Newtonian and non-Newtonian paints. In Fig. 1, measured size distributions of clear coat and base coat at two different bell speeds are compared. Obviously, the Newtonian clear coat with a constant viscosity around 85 mPas delivers a finer spray, although the shear-thinning base coat system has a significantly smaller apparent viscosity. However, for both systems Sauter mean diameters around 10 µm are obtained at practically relevant application parameters, confirming the efficiency of the atomization process.

Unfortunately, the results in terms of mean diameters are only partly confirmed by former investigations using water-alcohol-sucrose mixtures up to viscosities around 40 mPas [1]. In Eq. 1, the Sauter mean diameter is expressed in terms of the *Re* and *We* number and the flow number *q*. Bell diameter and bell speed are used as characteristic length and velocity, respectively.

$$D_{32} = 0.60 \cdot Re^{0.056} \cdot We^{-0.58} \cdot q^{0.41} \qquad (1)$$

Although the general dependencies might be very similar, the absolute Sauter mean diameters are theoretically underestimated by a factor of 2. More investigations are necessary to consider the effect of polymeric components and solid content.

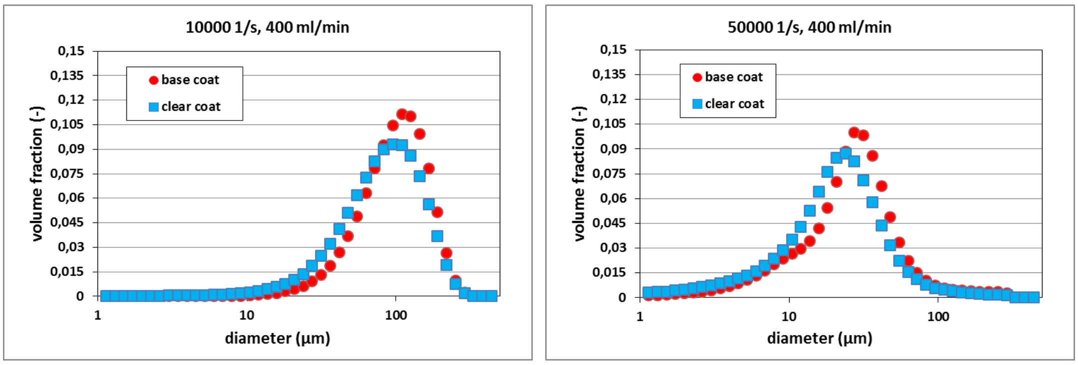

Fig. 1: Comparison of measured size distributions for 2 different bell speeds at a paint flow rate of 400 ml/min

[1] J. Domnick, M. Thieme: Atomization characteristics of high-speed rotary bell atomizers, Atomization and Sprays, Vol. 16, No.8, 2006