

Numerical and Experimental Investigation of the Disintegration of Polymer Melts in an Ultrasonic Standing Wave Atomizer

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Powder coatings are used in many different areas and are gaining increasing importance because of the neglectable emission potential concerning volatile components. So far, the production of powder coating particles is done by energy-costly milling of polymers, which leads to sharp-edged particles of irregular shape. A novel advantageous alternative is the disintegration of polymer melts in an ultrasonic standing wave atomizer. For this purpose, an ultrasonic standing wave field is generated between two transducers. The distance between the transducers is adjusted to achieve resonance with usually three to five pressure nodes. Polymer melt is injected into this ultrasonic field via a nozzle and disintegrates due to the acoustic forces, giving almost spherical particles with diameters of about 5–100 μm . The production of powder coatings by disintegration using an ultrasonic standing wave atomizer (SWA) avoids disadvantages of other techniques, but still needs intensification to reach industrial standards.

Therefore, the goal of our research is to achieve a better understanding of the polymer strand disintegration in an ultrasonic wave field. This is done by means of numerical simulations based on continuum mechanical modeling and well-defined experiments for validation. The simulations employ a one-way coupling, where the commercial *Computational Fluid Dynamic*-tools *Fluent* and *CFX*, respectively, are used to compute the nonlinear acoustic field. The calculated acoustic forces are incorporated in the Volume of Fluid-code *FS3D* to compute the disintegration process. These ultrasonic forces acting on the liquid's surface are modeled as appropriate momentum fluxes, approximating the real gas-liquid jump conditions. The model is validated by comparing droplet breakup in levitator experiments and numerical simulations of the atomization process.

The simulations allow a qualitative description of droplet deformation and atomization in a single axis standing wave levitator (SWL). Taking into account back-effects of a droplet on the ultrasonic field, quantitative predictions of droplet radii with respect to sonotrode amplitude are possible, mirroring the real behavior very well. Because of the much higher complexity, numerical simulation of liquid strand disintegration in an SWA cannot take into account effects of the liquid phase on the ultrasonic field. Therefore, so far simulations only allow for a qualitative description of the disintegration process. Nevertheless, significant trends in strand disintegration can be observed as it is demonstrated by particle size distributions. The latter are important for industrial use, reflecting the correlation between variations in operational parameters, material properties, and particle sizes. Therefore, based on these results optimizations of our laboratory plant and the process itself are now possible.