Powdered Latexes for Cementitious Applications

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Polymeric powders are used as additives to improve flexibility, adhesion and hydrophobicity of cementitious formulations in the construction industry. Spray drying is a widely applied technique in industry to produce dry polymeric powders from polymer dispersions and solutions. The spray droplet size distribution transforms into the final grain size distribution altered due to agglomeration and coalescence of particles along their drying pathway through the tower. The final powder particle size distribution has consequences for some application properties, dust generation, powder flowability and handling.

Whereas the annual production of polymeric powders is in the order of millions of tons, information about droplet formation, break-up, drying and coalescence, momentum distribution between droplets and air, and spatial variations of the droplet size distribution within the spray is fragmentary. Therefore empirical measurements to understand the interplay of various factors and their influence on the final droplet size distribution within the spray are key to producing powders with desired properties. The initial droplet size distribution is greatly affected by properties of the dispersion (e.g., rheology and surface tension), by operating parameters (e.g., injection rate, pressure, temperature), and the nozzle's geometry. Shear rates of the liquid in the swirl within the nozzle and at the orifice may be in excess of 40000 or even 100000 s^{-1}. The material's non-newtonian high shear rheology greatly influences liquid sheet formation at the orifice, and, along with its extensional rheology, affects stretched droplet break-up and formation. Using these data and feed rates, pressures, surface tensions, etc. a PLS model can be created that enables one to estimate average droplet sizes from material properties and physical parameters of the spray drying procedure.

Applications in the construction industry require that the powder is redispersible in water. Therefore, a water-soluble protective colloid such as polyvinyl alcohol is added to the dispersion, which prevents the polymer particles from film forming during the drying process. Spray drying of dispersions of a low glass transition temperature polymer results in soft and sticky powders prone to severe blocking effects. The addition of hard, anti-caking agents such as minerals or fly ash to the jet protects the powder grains from sticking to each other during drying.

The polymer itself as well as the water-soluble protective colloids interfere with the cement clinker material during hydration and setting of the formulation. Water soluble polymers may complex Calcium ions in the aqueous phase or poison nucleation of hydrate crystals at grain surfaces. The influence of powdered latexes on hydration kinetics and application properties of cementitious formulations will be discussed.