287b Error Analysis of Focused Beam Reflectance Measurements

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The Focused Beam Reflectance Measurement (FBRM) technique is becoming a popular procedure for measuring particle size in multiphase flows (Ruf et al., Part. Part. Sys. Char., 2000). Part of its popularity is due to the simplicity of the method. A laser is rotated in the multiphase flow, and when the beam intersects with a particle, some of the light is backscattered. The total amount of time the detector experiences backscatter multiplied with the rotation speed of the laser yields a measure of the length of the intersected particle – denoted as a chord of the particle. After numerous intersections, a chord length distribution (CLD) can be generated. This CLD will be strongly dependent upon the shape of the particle, with very different distributions generated from spheres, ellipsoids, or cubes, for example. Altering the particle shape will also change the way the CLD is converted into a volume distribution, also known as a particle size distribution (PSD). Modeling techniques such as the population balance method can be used to predict how PSDs evolve in time due to breakage, agglomeration, growth, or nucleation of particles and measurements are necessary to validate those models (Ramkrishna 2000).

In this study, we investigate the various errors that may occur during an FBRM measurement and how those translate into errors in the PSD. Particle trajectory information from previous two-dimensional and three-dimensional DEM simulations of particles are used to represent the multiphase flow (Lasinski et al., Phy Fluids, 2004). The FBRM laser beam is then simulated, and CLDs are generated. Then the PSDs are calculated, and compared with the true PSDs used in the simulation.

Errors investigated in this study include: i) the assumption that a particle is stationary (zero velocity) while the laser intersects the particle, ii) the error associated with intersecting a particle on multiple occurrences, iii) the error from converting a CLD into a bidisperse (or multi-disperse) PSD. These errors will be determined as functions of the independent parameters: the rotation speed of the laser, the volume fraction or number density of particles, the ratio of the particle diameter to the laser diameter, the breadth of the particle size distribution, the velocity profile of the particles, and if there is a preferential orientation of the particles in the flow. To date there has been very little investigation of these errors in the literature.

An evaluation of how all these errors and assumptions affect the validity and reliability of FBRM measurements will be made.