Transport Effects in Fibrous Suspensions

E. Tozzi, D. Lavenson, M. McCarthy and R. Powell
Department of Chemical Engineering and Materials Science
University of California Davis

Magnetic resonance imaging (MRI) is used to study the dynamics of fibrous suspensions, which are important in many industrial processes especially pulp and paper processing and cellulosic biofuel production. MRI allows real, opaque systems to be studied. This talk will briefly review the MRI methodology for concentration, velocity profile and rheological measurements. Results for a variety of fibrous suspensions will be presented. Processing of fibrous biomass requires adequate characterization of the fluid mechanics and rheology of fiber suspensions. Due to the large size of biomass particles, fast settling, entanglements and migration occur. Direct imaging of velocity profiles provides a way of characterizing flow in the presence of such non-idealities. We used magnetic resonance imaging to measure velocity profiles of cellulosic fiber suspensions flowing in a horizontal tube. Pressure drop was also recorded. We observed a strong influence of fiber length, concentrations and flow rates on velocity profiles and pressure drops. Various types of flow were observed including immobile layers at the bottom of the pipe, mobile networks that translate as a plug and also velocity profiles that suggest smooth concentration gradients along the vertical direction. The concentration effects were best described by the use of a crowding number, with large changes in pressure and velocity profiles occurring in a narrow range of crowding numbers. Qualitative differences between the behavior of the long fibers and the short and medium fibers demonstrate a strong effect of fiber aspect ratio on rheology.