IFPRI Project Abstract

Dynamic and thermodynamic structural investigation of capillary suspensions

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Project Objective:

Structure and function and inherently related. Using a model system for dense and capillary suspensions, we will investigate the microstructural changes during interesting rheological transitions, e.g. yield, using confocal microscopy. Capillary suspensions, particles suspended in a bulk fluid with a small amount of immiscible secondary fluid added to form a percolating network of capillary bridges between the particles are of particular interest as they show a wide range of rheological behavior.

Approach:

Changes to the microstructure of a suspension of fluorescently labelled silica particles are investigated using a confocal microscope equipped with a linear shear cell. The same shear profiles are repeated on a commercial rheometer to obtain force measurement data. The particle positions and radii are determined using a combination of edge detection with Hough transform.

Recent Results:

We demonstrated (and validated) the approach with an experiment showing the change in the secondary fluid volume. The semi-local measures captured the changes in structure and rheology. An experiment with different volume fractions showed a transition from capillary-dominated behavior to granular-like behavior with particle loading. During the shutdown, we improved the measurement protocols and particle detection software.

Next Steps:

We observed a curious behavior this year where the roughness of the behavior influenced the bridge type that could be formed. This will be investigated next year. We will also use non-porous particles to repeat the experiments at different solid fractions and, by including the detection of the secondary fluid bridges to create weighted graphs, we should hopefully link this to the forces between particles and clusters. Finally, using a fast confocal rheoscope, we can get more information about the changes during the shear, more closely linking the stress measurements with the structure.