399e Granular Flow of Wet Solids in a Four Bladed Mixer

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Bladed mixers are commonly used in a variety of industries, ranging from the bulk chemical to the food and pharmaceutical industries. In the majority of these processes, agitated mixers are utilized to homogenize a mixture of solid particles, to enhance chemical reactions or to improve heat and mass transfer. Despite their extensive use, the flow of granular materials in agitated devices and the mechanisms, by which particle motion is generated, are still not fully understood. The majority of past studies focused on dry granular materials. However, the more complicated and more frequently encountered case of agitated granular material in the presence of significant moisture has received less attention. Little is known about velocity fields and flow patterns of wet materials and their impact on particle properties and particle size changes (particle breakage and agglomeration). Therefore, the aim of this study is to elucidate some basic features of the solid flow patterns and velocity profiles of wet granular materials in mechanically agitated beds.

In this work, we use Particle Image Velocimetry (PIV) to measure instantaneous, average and fluctuating velocity fields at exposed surfaces, for both dry and wet near-monodisperse art sand in a vertical, cylindrical mixer, agitated by four 45º pitched blades. When the material is dry, we observe that the free surface of the granular bed deforms, rising where the blades are present, and falling between blades passes. While average velocities are predominately azimuthal, instantaneous velocities tracked in time reveal three-dimensional particle circulations, including significant periods of particle motion in the opposite direction to that of the blades, indicative of bed penetration. When moisture is added to the solid particles, the flow dynamics change from a regime dominated by the motion of individual grains to a regime controlled by the motion of small clumps that forms as a result of the cohesive forces. This transition from "granular" to "correlated" particle flow is characterized by reduced particle-particle collision frequency, exhibited by a sharp decrease in the granular temperature at the free surface. This transition is also characterized by an increase in bed porosity, which is attributed to increased cohesiveness due to liquid bridges.