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Cohesion, Cracking, Dilation, and Flow – Rheological Behavior of Cohesive Pharmaceutical Powders[1]

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Cohesive powders can be loosely defined as systems where the attractive forced between particles exceed the average particle weight. Cohesive powder flow is interesting from a wide range of reasons. Their main characteristic, intermittence, is evidenced both in the interruption of flow out of hoppers (a mundane issue causing great annoyance to industrial practitioners) and in the sudden avalanching of snow and dirt that has terrified and terrified mankind since the dawn of time. At the present time, our ability to predict either of these phenomena (and many more involving cohesive powders) is very limited, primarily due to an incomplete understanding of their constitutive behavior. To wit, consider just a simple fact: ***a flowing powder never has constant density***. Equations describing the relationship between velocity, shear, stress, and density are rudimentary at best. Computational and experimental approaches for characterizing flow behavior are in their infancy. In this talk, I will describe some recent progress achieved at Rutgers by our group. New instruments have been developed to determine simultaneously powder density and cohesive flow effects. Extensive measurements have been carried out focusing on pharmaceutical blends. These results have been used to fine-tune computational models that accurately predict dilation, flow in drums, and flow in hoppers. Impact of these observations for pharmaceutical manufacturing applications will be discussed in some detail.

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