Designing for Fibrous Materials

Material Flow Solutions, Inc.

   

Many biomass energy conversion projects are initiated, but few actually make it to the final phase. The reason for this phenomenon is the lack of consideration give to the material handling end of the process. Biomass is inherently light-weight, complicating the handling aspect of energy creation by the sheer magnitude of the volumetric flow rate required to obtain the necessary tonnage. Although biomass materials do not usually have intrinsic cohesion caused by significant adhesion of individual particles, they do possess large strength values due to fiber interlocking, elastic wind-up effects, and the pulling of fibers from the mass during a shear event. In some cases the elastic properties of biomass materials result in very large arching dimensions (in excess of 25-feet). However, that same material – when placed in the proper bin configuration – can flow without hang-up from an outlet only a couple of feet in diameter. Extreme care must be taken when handling these very elastic materials to assure that the pseudo-cohesive characteristics do not cause problems in the feed system. It can be seen that proper design of biomass feedstock goes hand-in-hand with proper process design.

Measuring and interpreting flow properties relative to the handling and reaction processes is at the heart of understanding, and consequently designing, biomass feedstock. Reducing hang-up behavior with biomass is complicated. Although both arching and rathole behavior are directly proportional to unconfined yield strength, these hang-up tendencies are inversely proportional to the bulk density on the material. Loose packed densities are often very light, resulting in excessively large arching and rathole dimensions, even if the unconfined yield strength values are not large. However, biomass densities can change by 200% to 400% as pressure is applied to the bulk. Additionally, biomass materials are inherently anisotropic, exhibiting different properties in different directions. Consider unconfined yield strength as the resistance to shear as bulk material attempts to initially yield or flow. With biomass, the resistance to shear depends on whether the material is shearing in the direction of the grain or against the grain. For example, shearing straw against the cut fibers results in large pseudo-strength as the straw fibers act like small springs, elastically deforming the mass during shear. However, inducing shear along the straw grains requires each grain to overcome only the frictional behavior of straw particles sliding past straw particles. Very little elastic deformation occurs.

At Material Flow Solutions we can measure the material properties of fibrous biomass particles as large as 8x8x2 inch cakes at both ambient and elevated temperature conditions. We will assist you in interpreting the measured flow properties in relation to your mandated process so as to design the optimal particle size to achieve the desired goal.

Picture courtesy of: http://www.eere.energy.gov http://www.akgbioline.com http://www.warrenbaerg.com

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