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Clarification of Hydrolyzed Biomass

Effective processing of sugar streams often requires clarification of hydrolysate. This is a challenging separation to perform. The density of the solids is near that of the liquid, making centrifugation and other separations based on density difference inefficient. In addition the level of suspended solids is quite high. It varies with the type of biomass but is on the order of 8% dry weight, which corresponds to a volume fraction of about 25%, or more if the biomass contains higher concentrations of lignin. This large volume fraction of solids makes it hard to concentrate the solids further while minimizing the loss of sugar solution. Pall Corporation, in collaboration with its partners in the National Advanced Biofuels Consortium (NABC), has shown that high quality permeate may be produced in a cost effective manner using a crossflow filtration system.

Biofuels production often begins with the conversion of the cellulose and hemicellulose in biomass into simple sugars. There are several ways of accomplishing this, all of which produce a sugar solution that contains a significant amount of suspended solids, predominately lignin. Downstream conversions benefit from clarification of this sugar stream; the degree of clarification depending on the requirements of the downstream process. Although there is some variation from technique to technique and from one set of conditions to another, the particle size distribution of the solids in a hydrolyzed biomass feed stream is consistently very wide with a significant amount of material less than 1 micron (µm) in diameter.

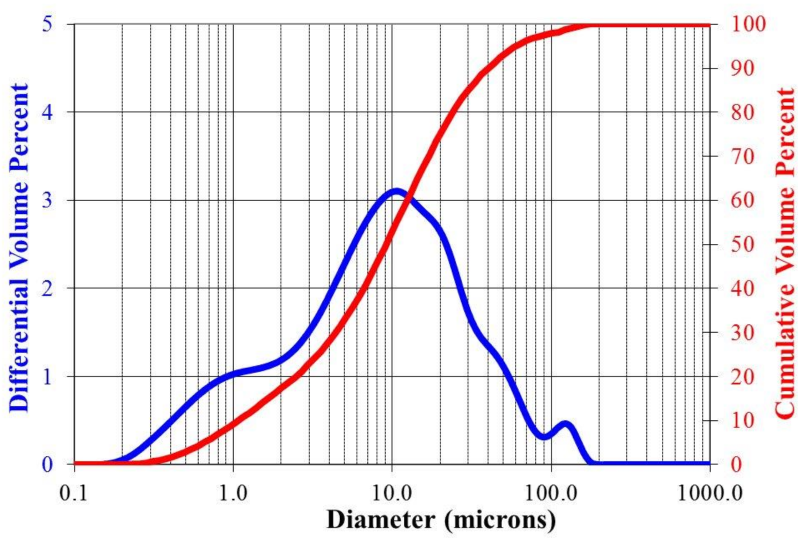

Figure 1. The large fraction of very small particles in the hydrolyzed biomass presents the greatest challenge to clarification because small particles produce a dense filter cake. A typical distribution is seen in this particle size distribution of hydrolyzed corn stover produced by the National Renewable Energy Laboratory (NREL) in 2012.

Figure 1 is a volume distribution which tends to emphasize the large particles; it takes a lot (125,000) of 0.2 µm particles to equal the volume of one 10 µm particle. The blue curve is the differential distribution and the red curve is the cumulative distribution. Clearly 10% of the volume of the suspended solids is due to particles less than 1 µm in diameter. This large population of small particles has a profound effect on how and how well these solids can be removed from the liquid stream. These constraints are best met by a crossflow filtration system.

Figure 2. A pilot scale ZHF test unit. Initial work using Pall SeitzSchenk® Centrifugal Discharge (ZHF) Filter technology showed that suitable effluent quality could be generated but with less than desirable process economics.

Pall Corporation constructed, shipped, and installed at NREL's facilities in Golden, Colorado, a crossflow filtration system based on the ZHF work and small scale laboratory crossflow testing. The system is designed to produce 2000 liters of sugar solution, filtered to less than 0.1 µm, in 5-10 hours. This process can be scaled up to commercial scale. It is anticipated that the testing at NREL will lead to additional improvements to the design.

Figure 3. Hydrolysate is currently being produced for processing in this crossflow system. Small scale testing and Pall's knowledge of crossflow suggests that this process will be able to produce a high quality permeate in a cost effective manner.