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From: Tom Cawley [txc5@psu.edu]
Sent: Thursday, April 08, 2010 7:29 AM
To: Robert Fulton
Subject: Bio Fuel Powder Observations
Attachments: GeldartFluidizationCohesivePowders.pdf

Robert,

I apologize for missing my promised response date. I still have not had a chance to do the additional tests we talked about. I will do them within the next couple of days. I would like to pass along a few comments from the testing I performed so far.

When considering a powder as a fuel in a high pressure combustion system, the mode of transport of the powder must be carefully considered before the ideal fuel properties are specified. As we have discussed in the past, my research group has had great success handling somewhat cohesive powders in high pressure combustion power systems. In the case of our fuel feed system, a slight degree of cohesion is actually beneficial because it enables dense-phase fluidization of the powder in a way that is not typically possible with other powders. A small degree of cohesion stabilizes the expanded bed of powders and allows it to be handled like a liquid. A higher degree of cohesion results in bed fracture and channeling. A lower degree of cohesion results in spouting or localized rather than bulk fluidization.

The measurements I performed on your fuel were simple handling and bulk density measurements similar to those described in the attached reference. In general, I found the powder to be somewhat cohesive on inspection but still easily handle-able in glassware and plastic funnels, beakers and graduated cylinders. I did not notice any significant electrostatic behavior. My assumption was that the basic surface chemistry of the particles was the origin of its cohesiveness. I performed bulk density measurements on the powder as outlined in the attachment and obtained a Hausner ratio of 1.31.

This parameter value generally leads to a classification as a marginally cohesive/fluidizable powder. The bulk of our experience with fuel powders is with this same classification of powders and, as mentioned before, we have had great success supporting high pressure combustion with these fuels.

I may have mentioned in our phone conversation that we modify the surface chemistry of our powders to suppress cohesive forces and stabilize the powders with respect to adsorption of atmospheric moisture. My suspicion is that a similar process may be applicable to your fuels to enhance their utility. If done properly, this technique can be inexpensive and should not effect thermo-chemistry or occupational exposure concerns. I believe you told me that you have some control over particle size

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distribution as well which may be an alternate route to manipulation of the fuel properties.

In summary, the powder I studied handled fairly easily compared to my experience with other powders that have been proven to be viable in high pressure combustion systems. Some degree of specialization of the fuel feed system will probably be necessary for integration with a combustion power system. Some modification of fuel properties may also be advantageous.

I still plan to perform additional flowability/fluidizability testing and also some qualitative combustion tests. I will let you know what I find.

Thanks
Tom