TITLE: **COAL CLEANING VIA LIQUID-FLUIDIZED BED CLASSIFICATION (LFBC) WITH SELECTIVE SOLVENT SWELLING**

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ABSTRACT

OBJECTIVES

This proposal is directed at a scoping investigation of an innovative concept for coal cleaning -- liquid-fluidized bed classification (LFBC) with selective particle modification using “solvent swelling.”

Under liquid-fluidized conditions with water, particles segregate according to their density and size, vertically in height in the fluidized bed. For particles denser than the fluidizing medium (as in coal beneficiation), the lighter/smaller particles accumulate near the top of the bed, and the heavier/larger particles populate the bottom of the bed. This behavior is somewhat related to the principles upon which coal cleaning with jigs are based. Unlike in jigs, however, in LFBC the bed expansion caused by fluidization is *continuous,* and particles attain a *unique location in height* in the column due to their density and size as a result of a balance of both drag and buoyancy forces. Essentially, the void fraction of the bed adjusts itself so that the local interstitial liquid velocity exerts enough drag on the particles to counteract their settling velocities. These characteristics suggest a number of reasons why LFBC can be used to improve physical coal cleaning. LFBC works best on particles in the “fine” particle range (e.g.,

3/8” to 20 mesh) which has been cited as the desirable range for improved physical coal cleaning. LFBC also operates extremely well on “near gravity” material (e.g., s.g. of 1.05 - 1.6), which is difficult for most other physical coal cleaning systems, such as jigs. In addition, since the particle bed is fully fluidized, at steady-state a number of different density fractions, rather than just two, as in most other physical coal cleaning systems, can be removed continuously by hydraulic flow to simple gravity separators for recovery.

“Sharpness” of separation in a LFBC can be enhanced with selective particle modification *via* “solvent-swelling” techniques. Exposure of coal particles to a swelling solvent will cause those with a higher organic content to swell to a greater extent than those with a higher mineral matter (inorganic) content. For coal cleaning in a LFBC this means that solvent swelling will expand the spatial extent of the classification of the organic matter-containing particles at the expense of the mineral matter-containing particles. In addition, a correlation between swelling performance and organic sulfur content will be investigated. If such a correlation is established, it will be possible to exploit it to further enhance LFBC coal cleaning performance.

ACCOMPLISHMENTS TO DATE

Four coals from the Penn State Coal Bank were selected based primarily upon their distribution of sulfur between inorganic and organic forms: (Illinois #6, Kentucky #9, Ohio #5, and Pittsburgh). The coal samples were sieved to two different size cuts (53-105 µm and 105-149 µm). Coal particle size distributions were determined *via* image analysis methods. Each coal size and type were tested for degree of swelling in methanol and acetone. A maximum swelling ratio of 1.4 was found for Illinois #6 in acetone, and acetone was found to be more generally effective for swelling than methanol. Leaching of the solvent from swollen coal particles into distilled water was not found to affect the swelling index on the time scale of a few hours.

A 5-cm diameter liquid fluidized bed apparatus has been modified for the coal fluidization studies. Initial work has focused on fluidization of the fine coal particles. This involves the complete disengagement of air bubbles using sonication and surfactants.

Separation in the LFBC will be conducted in two stages. In the first stage, a coarse separation will be performed between the heaviest material (i.e., high mineral matter content) and the lighter material, which will be removed by hydraulic flow. The light fraction collected in this manner will then be immersed in the swelling solvent. The solvent-swollen particles will then be separated from the bulk solvent and fluidized in water in the same manner as for the unswollen particles. The two fractions collected from this column will then be analyzed with respect to ash and sulfur content.

ARTICLES, PRESENTATIONS, AND STUDENT SUPPORT

Journal Articles and Conference Presentations

- None yet.

Students Supported Under This Grant

- Debbie Choi, Undergraduate student in Chemical Engineering, Division of Engineering, Brown University. Conducted independent study project and senior thesis on this topic.