FINAL TECHNICAL REPORT
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Project Title: **NOVEL COAL DEWATERING APPROACH**

ICCI Project Number: 05-1/ER12
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ABSTRACT

Raw coal, irrespective of rank, is often subjected to coal cleaning using various physical and chemical processes. Unfortunately, cleaning processes typically add a substantial amount of water to the coal. This is in addition to the inherent moisture already in the coal. Any water in the final cleaned coal product reduces its BTU value, thus adversely affecting its economic prospects. The dewatering of cleaned coal, especially fine cleaned coal, has proven to be a long, festering problem for coal producers. In this exploratory project, pressure modulation in the presence of heavy crude oil and/or vegetable oil was studied to determine if it would facilitate moisture reduction from fine (<150 μm) coal-water slurry. Experimental results suggest that both crude oil fractions and vegetable oil substantially reduced the moisture content of the fine coal product. Moisture content values less than 18% for fine (<150μm) coal were obtained. Generally, higher crude oil or vegetable oil concentration in the coal-water slurry resulted in lower moisture content. However, the decrease in moisture was non-linear, i.e., for higher concentrations of crude oil or vegetable oil, the reduction in moisture was not proportionate to that observed for lower oil fractions. It was also found that the sequence in which pressure modulation was applied to the coal-water slurry had an impact on the final moisture content of the coal.

Pages 1 to 15 contain proprietary information

EXECUTIVE SUMMARY

Objectives: The main emphasis of this research was to: (1) establish the viability of pressure modulation technique to dewater coal-water slurries, (2) explore the effectiveness of pressure modulation in depolymerizing maltene and asphaltene fractions for adsorption on coal surfaces, and (3) establish parameters needed to scale up the process.

Introduction: Coal preparation entails particle reduction and separation to reject inherent ash in coal. The resultant coal is in a wet slurry form requiring dewatering by filtering or thermal drying. Thus, the challenge of coal dewatering is as old as coal preparation itself. The coal dewatering problem is much more acute when fine coal is involved. High moisture content in the final clean coal product has deleterious effects on heating value besides generating handling problems, e.g., high agglomeration and freezing.

In the early 1990s, the PI extensively studied the fundamental interactions between coal, especially Illinois coal, and water. Various models and mechanisms were proposed by which water was retained by the coal. The investigator, making use of that fundamental knowledge, proposed a novel approach in which shockwaves are created in the coal-water slurry in the presence of hydrophobic active ingredients of heavy crude oil and vegetable oil. Because these heavy crude fractions readily wet coal and because shockwaves will facilitate the agglomerates' rupture and force the infiltration of heavy crude fractions into the pores of coal, clean coal with moisture content less than 20 wt% are produced. Moreover, the process substantially increases the BTU value of the coal and substantially reduces the toxic metal content.

Experimental Approach: Because this exploratory project was directed towards developing dewatering technology for fine (< 150 μm) coal, pulverized clean coal samples were obtained from two power plants burning high sulfur Illinois bituminous coal. The pulverized coal was further ground to obtain fine (< 150 μm) coal. Coal-water slurries were prepared from the ground coal and dewatering was attempted using pressure modulation technique in the presence of crude oil and vegetable oil.

Experiments examined whether pressure modulation of coal-water slurry could be an effective approach in dewatering coal, especially fine (< 150 μm) coal. Heavy crude oil and vegetable oil were used as dewatering facilitators. It is believed that the addition of heavy oil and/or vegetable oil will not only reduce moisture content but also will increase the overall BTU value of dewatered coal. Various treatment approaches were attempted by varying modulation parameters and the concentration of dewatering facilitators.

Results and Conclusions:

1. Experimental results suggest that pressure modulation of coal-water slurry in the presence of vegetable oil may be an effective tool for dewatering fine coal. Results indicate that the larger the vegetable oil concentration in the coal-water

slurry, the lower the final moisture content of the coal will be. Moisture content values less than 18% for fine (< 150 μm) coal were obtained.

2. The longer the coal-water slurry was subjected to modulation, the larger was the reduction in the moisture content of the dewatered coal. However, it appears that four minutes of pressure modulation of the coal-water slurry would be adequate for achieving significant moisture reduction of the dewatered coal.

3. Heavy crude oil treatment of the coal-water slurry, followed by pressure modulation, resulted in very low moisture content of the dewatered coal when the coal, after treatment, was left on a mesh for eight hours to air dry. It should be noted that no forced air was circulated through the coal during the drying time. For a 5% crude oil treatment, moisture content as low as ~ 4 wt% was observed.

4. It was observed that because of very high viscosity of heavy crude, it was sometime difficult to make a homogenous mix of coal and crude, resulting in coal lump formations. However, the addition of the vegetable oil to the slurry along with the crude oil significantly reduced not only the viscosity of the crude oil, but also achieved a significant reduction in moisture.

5. Final moisture content of the coal was not only dependent on the strength of pressure modulation but also on the sequence of treatment which played a crucial role in achieving deep dewatering of the coal.

6. Vacuum filtering gave poor results and was judged unsuitable when using crude oil or vegetable oil. However, vibrational drainage and drainage at low pressure were effective in achieving lower moisture content.

7. It appears that pressure modulation of cleaned coal lowers overall mercury content of the coal even without any chemical facilitator. Further studies should explore whether higher mercury reduction can be achieved if pressure modulation is done on raw coal.

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