FINAL TECHNICAL REPORT
September 1, 2006, through February 29, 2008

Project Title: **INTEGRATED PRESSURE MODULATION FOR FINE COAL CLEANING AND DEWATERING**

ICCI Project Number: 06-1/2.1A-4
Principal Investigator: Vivak Malhotra, Southern Illinois University
Project Manager: Dr. Francois Botha, Illinois Clean Coal Institute

ABSTRACT

Most coals undergo preparation, which entails particle size reduction, coal cleaning to reduce ash content, and coal dewatering prior to shipping the product to coal burning power plants. In the coal preparation process, significant amounts of coal fines (< 150 μm) and coal ultrafines (< 50 μm) are generated. Because these fines are difficult to dewater, they often are discarded in waste ponds. This translates into a major economic loss to the coal industry not only because of the fuel value lost but also substantial economic resources are required to manage coal wastes in an environmentally-sound manner. Therefore, there is an urgent need to develop a technology which can recover fines and ultrafines from run-of-mine coal and from coal waste ponds. This technology should also substantially reject ash and significantly increase BTU value of the coal by achieving enhanced dewatering. In 2006, we proposed to develop a new approach of pressure modulation, in conjunction with oil agglomeration, to recover coal fines and ultrafines from the rejects of coal preparation plants.

Because no off-the-shelf technology was available for undertaking pressure modulation of coal-water slurries containing large fractions of fines (< 150 μm), a considerable effort of the project was devoted towards designing, fabricating, and testing a 15 gallon vessel where pressure modulation could occur. Our effort to achieve dewatering of the fine coal using conventional approaches, as expected, was not successful. Frequently, we observed deep dewatering of the coal waste, but these results were often not repeatable. However, when coal-water slurries were pressure modulated and subsequently oil agglomerated, we were successful in achieving enhanced dewatering of coal fines and ultrafines. For run-of-mine coal fines, we successfully reduced the moisture content to as low as 6 wt% and increased the carbon content to 91 wt%. Our technology was not only effective for the run-of-mine coal but also was equally adept in reducing the moisture content of the fine coal recovered from the waste ponds to < 10 wt%. More significantly, our technology successfully removed 75% of the mercury from coal.

Pages 1 to 27 contain proprietary information

EXECUTIVE SUMMARY

Objectives: The main objectives of our proposed research were to: (1) design and develop a tandem pressure modulation vessel for treating coal-water slurries, (2) optimize the treatment of coal-water slurry for deep coal cleaning, (3) enhance the stripping of volatile metals using our pressure modulation vessel, (4) achieve substantial dewatering of coal fines and ultrafines, and (5) produce pelletized coal suitable for transportation.

Introduction: Over the years, various technologies have been proposed, tested, and became commercially available to clean coal. According to Mohanty and Wiltowski of Southern Illinois University, the most common commercial fine coal cleaning technologies available and in commercial use are: (a) Denver and Wemco sub-aeration flotation cell, and (b) MicroCell*TM*, Jameson CPT, and Turbo flotation columns. In addition to these technologies, the other coal cleaning technologies available are selective flocculation and oil agglomeration, especially for fine coal cleaning.

Most of the coal preparation plants use conventional froth flotation technology for fine coal (i.e., < 150 micron) cleaning. Almost all coal mining technologies generate substantial amounts of fine and ultrafine coal particles. In fact, it is believed that approximately 4 million tons of fine and/or ultrafine coal are produced in Illinois every year. The current technology to recover fine and ultrafine coal particles via commercial coal cleaning devices and then subsequently to dewater them is neither very selective nor very economical. Therefore, significant quantities of these fines and ultrafines are lost to waste streams. This translates into a substantial loss to the Illinois coal industry. It should be mentioned that this loss merely reflects actual carbon loss, and additional costs are involved in disposing of these fines in an environmentally-sound manner and in maintaining the slurry ponds. Therefore, if a technology could be developed which selectively recovers these fines and ultrafines, while rejecting the ash, then it could have a significant effect on the coal mining industry in our state. Moreover, additional enhancement in the BTU value with lower sulfur, nitrogen, and toxic metal content of prepared coal potentially will make Illinois coal more economically competitive with Appalachian coal. Therefore, we proposed to develop a new technology, based on our pressure modulation approach, to achieve deep reductions in the mercury and moisture contents of crushed run-of-mine (ROM) coal and coal recovered from coal-waste ponds. In the process, we were also interested in increasing the carbon content of the recovered coal.

Experimental Approach: Four types of coal samples were obtained from a mine located in the southern Illinois region, i.e., (1) raw coal or run-of-mine (ROM) coal, (2) cleaned, coal-water slurry (this coal had been cleaned but not dewatered), (3) premium, dewatered cleaned coal and (4) coal-water waste slurry recovered from settling ponds. The samples were collected in 55 gallon drums.

Because our approach of pressure modulation involves instrumentation which generally is not used in coal preparation and coal processing, a significant time of the project was devoted to the design and fabrication of our experimental setup consisting of a 15 gallon

pressure modulation vessel. Our pressure modulation vessel was tested under various conditions and with different coal loads, and the system was found to be effective in carrying out pressure modulation of coal-water slurries.

Results and Conclusions: Major conclusions of our project are listed below:

1) The coal recovered from the coal waste stream had a much higher concentration of ultrafine particles than crushed ROM coal. Therefore, it was expected that it would be much harder to achieve deep moisture reduction for waste coal than ROM coal. This was born out by the subsequent experiments.

2) The filtration, vacuum drying, or centrifugal dewatering was ineffective for dewatering ultrafine coal. Also, these procedures did not produce repeatable results.

3) The pressure modulation of the waste coal-water slurry reduced the mercury content of the recovered coal though no chemicals were used during the pressure modulation. Figure 1 shows how the modulation time affected the mercury concentration of the recovered coal.

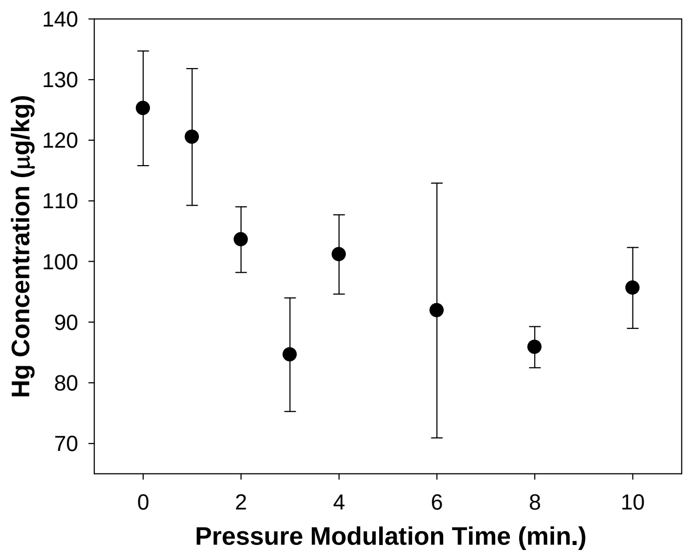

Figure 1. Effect of pressure modulation time on the coal wastes' mercury content.

4) Our process of pressure modulation in the presence of a slurry chemical conditioner achieved deep reductions in the moisture and mercury contents of the ROM coal. In fact, when we combined modulation treatment with oil agglomeration, we were able to reduce the moisture content of ROM coal to 6 wt% while we succeed in increasing its carbon content to 91 wt% (see Figs. 2 and 3).

5) A number of strategies were attempted for reducing the moisture content of the coal-water slurries recovered from waste ponds. The mercury concentration varied significantly in the waste coal, depending upon when the samples were collected. For waste coal, we often achieved a significant reduction in mercury and water contents, but the results were seldom repeatable.

6) We were able to achieve repeatable results for waste coal in which we carried out pressure modulation in the presence of a chemical solution, and the coal was recovered by oil agglomeration. Using chemical solution and 2 wt% oil in our dewatering arrangement, we were able to reduce the mercury content by 75% while achieving a

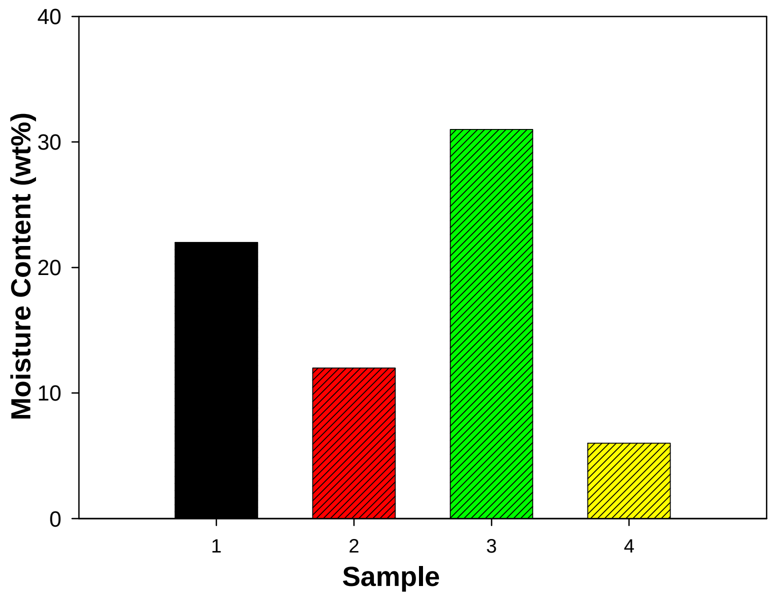

Figure 2. Effectiveness of our pressure modulation and oil agglomeration approach in dewatering run-of-mine (ROM) coal and waste coal.

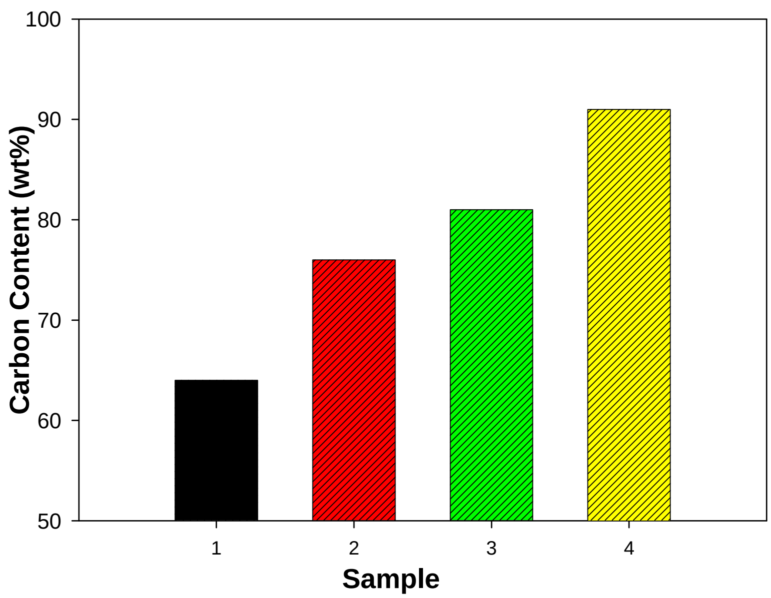

Figure 3. The effect of pressure modulation and oil agglomeration on the carbon content of the run-of-mine (ROM) coal and waste coal.

moisture content as low as 12 wt%. We also succeeded in increasing the carbon content of coal recovered from waste streams to 76 wt%.

7) Using slightly higher oil concentration for agglomeration, we were successful in reducing the moisture content to as low as 9 wt% for coal recovered from coal waste.

The remainder of this report contains proprietary information and is not available for distribution except to the sponsor(s) of this project.