

FINAL TECHNICAL REPORT
September 1, 2002, through August 31, 2003

Project Title: **DESIGN, FABRICATION, AND TESTING OF AN AUTOMATED
MOTORLESS/ROTORLESS (M-R) CELL FOR USE WITH THE
ISGS WASHER**

ICCI Project Number: 02-1/4.1B-1
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ABSTRACT

Fine-grained coal is currently discarded during coal cleaning at most operations. A new motorless and rotorless (M-R) flotation cell that can clean fine-grained coal and produce product at a more rapid rate while consuming less energy than conventional cells was designed, fabricated, and tested. The cell, which was constructed from off-the-shelf components, contains no moving parts. Intense mixing of the slurry is achieved by recycling the material without using power-consuming mixing rotors. The cell is fully automated and was fitted with a specially configured ISGS washer during testing. Cells of this new, simple design have the potential to reduce capital, operating, and maintenance costs of coal cleaning plants, and hence the costs of processing fine coal. The work performed here is an important step in developing an innovative system to process coal tailings in a commercial plant. The M-R cell can be further developed to an industrial-scale version in about two years by integrating the results of this project with previous work conducted by the ISGS research group.

EXECUTIVE SUMMARY

Illinois coal mines have been steadily closing because they cannot produce coal that is cleaner and cheaper than their competitors. The coal produced is not of the desired quality, in part because the processing methods used to upgrade the coal cannot generate a marketable product at a reasonable cost. Both the inefficiency of current processing methods and their high capital and operating costs are responsible for this problem. This predicament has forced Illinois coal producers to recover the easily cleanable coarse coal from the mined-out material and discard the rest. This rejected fine coal increases the costs of production and poses potential environmental problems.

During the last two decades, methods to clean fine coal have improved and new methods have been introduced that provide customers with cleaner coal. The method commonly used at present to remove pyrite and other minerals from fine coal on an industrial scale is froth flotation, either in subaeration cells or flotation columns. The operation of either of these systems is relatively expensive, and they are limited in the quality of the products produced and/or their throughput. As a result, few plants process coal to recover the fines and substantial amounts of fine-grained coal are discharged into tailings.

To process fine coal more effectively, and to reduce the associated processing costs, a motorless and rotorless (M-R) flotation cell was developed to provide a greater throughput of material while consuming less energy than conventional subaeration cells. The M-R cell was made relatively inexpensively from off-the-shelf components and contains no moving parts. Thorough mixing of the slurry was achieved without using power-consuming rotors. The prototype cells were fitted with the ISGS washer.

It was expected that the M-R flotation cell would be capable of effectively processing fines, and would decrease the costs of fine coal recovery while enhancing the quality of the product. Its use can also reduce the total cost of producing coal by generating additional revenue from the sale of material that is now discarded, reduce the costs of maintaining and reclaiming the waste impoundment area, and reduce potential environmental problems resulting from the coal tailings impoundment. The expected reduction in total production costs and the production of a better quality of product should help Illinois coal to compete with coal from other states.

In froth flotation processes, hydrophobic particles (coal) are selectively collected on air bubbles and buoyed to the surface of the slurry because of differences in the specific gravity of the aqueous phase and the coal-air aggregate. There are several steps that lead to flotation of the desired particles on the air bubbles in the froth. For the collection of coal particles on air bubbles to take place, the air bubbles and coal particles must collide with each other often enough to establish contact and adhere to each other. The success of the flotation process therefore depends on the probability of collision between the air bubbles and coal particles. In froth columns, this is limited to the distance of counter-current flow. Even if the rising air bubbles and sinking solid particles collide in flotation columns they may move away, and not adhere to each other during such encounters. Therefore, the throughput of these columns is relatively limited. Mechanized flotation

cells with their violent mixing action enhance the probability of these encounters because they not only provide an opportunity for counter-current encounters, but also impart greater kinetic energy to the moving particles and air bubbles. The force and intensity of the collisions facilitates attachment of the air bubbles and hydrophobic particles to each other. Consequently, the throughput of mechanized flotation cells is greater than that of columns, but the better mixing in mechanized columns is achieved at the cost of reduced quality of the product, the product being contaminated by hydrophilic particles that are mixed into the froth by the turbulence. In the M-R cell, mixing is achieved by a recycling mechanism that can be used to reduce the turbulence in the cells by changing the direction of the flow of the mass.

During this project, M-R cells were designed, manufactured, equipped with the ISGS washer and tested. M-R cells were tested in combination with the ISGS froth washer on the recovery of fine coal from the fine refuse stream of an existing Illinois coal processing plant. Unlike a flotation column, which also lacks moving parts, the mixing of the air bubbles and slurry in the M-R flotation cell is not limited to counter-current flow of the ascending air bubbles and descending solid particles. Active and more intensive mixing of the phases takes place in the M-R flotation cell without the use of a rotor and/or electric motors. The rate of production of clean coal from the new cell is faster than that of the flotation columns. Under optimum conditions, it was found that the performance of the M-R cell equipped with the ISGS Washer surpassed the best performance of any flotation device, and with the least consumption of power.

Reduction of capital and operating costs in a coal washing plant will reduce the cost per ton of clean coal produced. Because the new M-R cell can produce cleaner coal at a faster rate than the flotation machines currently in use in coal cleaning plants, the number of flotation machines required to process a given tonnage of material can be reduced. This will reduce the capital and operating costs of the plant and increase the profits. Lower maintenance costs for the M-R cell when compared with mechanical subaeration cells will result from reduced labor and down time for maintenance.

The work described in this report is an important step in developing an innovative system to process fine coal tailings in a commercial coal cleaning plant. The M-R cell is fully automated and can be further developed to industrial-scale versions in about two years.

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