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TECHNICAL REPORT

December 1, 1993 through February 28, 1994

Project Title: **A COMPARISON STUDY OF COLUMN FLOTATION
TECHNOLOGIES FOR CLEANING ILLINOIS COAL**

DOE Grant Number: DE-FC22-92PC92521 (Year 2)

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ABSTRACT

The objectives of this research project are to optimize the performance of six commercially available column technologies for the treatment of Illinois Basin coal fines and to compare their performance on the basis of the recovery-grade curve and column throughput capacity. A statistically-designed experimental program will be conducted to optimize the critical operating performance values of each flotation column. During the previous reporting period, construction and installation of the six flotation columns were completed. The flotation feed sample that will be used for the tests in this investigation was collected from a coal preparation plant treating the Illinois No. 5 seam coal.

During this reporting period, the flotation feed sample was characterized on a size-by-size basis for its ash, total sulfur, and BTU content. A release analysis was also conducted to obtain the best possible recovery versus product grade curve that can be achieved by a froth flotation process for the treatment of the Illinois No. 5 flotation feed sample. Experiments were initiated on the Jameson Cell. The preliminary results indicate that the Jameson Cell achieves a separation performance that is close to the release data. The experimental program on the Jameson Cell and the other flotation technologies will be performed during the next reporting period.

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EXECUTIVE SUMMARY

Column flotation achieves superior cleaning of fine coal as compared to conventional flotation due to its ability to support a large froth depth and the use of wash water in the froth zone which allow removal of entrained impurities from the froth. In addition, the external bubble generators used in column flotation produces smaller bubbles than conventional flotation which results in an increase in the rate of coal recovery from the pulp. Utilizing these basic principles, several column technologies have been developed which produce a cleaner coal product with greater recovery values than those achieved by conventional flotation cells.

A significant difference between the column technologies is the mechanism by which the microbubbles are produced. For a given aeration rate, these bubble generators differ in the size and the uniformity of the bubble produced and, thus, in the amount of bubble surface area available for the capture of coal particles. Some columns also differ with respect to the kind of environment in which bubble-particle collisions occur. For example, one technology utilizes a complete froth column to improve the chances of bubble-particle attachment. Other columns utilize packing or baffles to reduce turbulence, thereby, decreasing the probability of a particle escaping without bubble contact. The use of self-induced air and the generation of uniform microbubbles are novel concepts of other column technologies.

Several flotation columns have been tested on an individual basis for the treatment of Illinois Basin coal fines. However, these studies were not conducted on the same coal sample and under similar operating conditions. Thus, meaningful performance comparisons between the columns cannot be extracted from the experimental data. Therefore, in this study, six commercially available column technologies will be tested "head-to-head" using the same Illinois Basin fine coal slurry. These columns will include the *Flotaire* column, the *Jameson* cell, the *Microcel*[™] column, the *Canadian* column, the *Packed-column*, and the *Turboair* column.

This research project will be conducted in two phases. In the first phase, the objective will be to optimize the critical operating parameters associated with each flotation column. A flotation feed coal slurry collected from a local coal preparation plant treating Illinois No. 5 seam coal will be used as the feed for these tests. The operating parameters to be optimized will include feed rate, aeration rate, frother concentration, and wash water rate. The optimized parameter values will be used in the second phase to create the ultimate recovery-grade curve and the maximum throughput capacity for each column technology. The results from the second phase will be used to compare the performance of the different column technologies.

The objectives of this project are: (1) to optimize the values of the critical operating variables associated with 6 commercially available flotation columns for the treatment of Illinois Basin coal fines, (2) to compare the column technologies on the basis of the recovery-grade curve, and (3) to determine and contrast the throughput capacities of each column flotation technology.

During this reporting period, a characterization study of the Illinois No. 5 flotation feed sample that will be used for the column comparison tests was conducted. The ash and total sulfur content of the flotation feed sample was found to be 28.9% and 1.34%, respectively. The calorific value of the coal was 9,993 BTU/lb on a dry basis, thus, resulting in a 2.68 lbs SO₂ per million BTU value. This represents a non-compliance coal according to the 1990 Clean Air Act Amendment restrictions on SO₂ emissions.

The results of a wet sieve analysis found that nearly 60% of the particles are less than 400 mesh (37 μ m) in size. The size-by-size ash contents also found that approximately 50% of the combustible material in the flotation feed sample is in the -400 mesh size fraction. Therefore, it appears that this sample is ideal for evaluating and comparing the ability of the various flotation column technologies to recover ultrafine coal. In addition, the -400 mesh size fraction was found to have a high ash content of 41.2%. This indicates a relatively large presence of submicron clay particles, thus, providing an excellent application for column flotation. Also, about 13% of the particles are greater than 100 mesh (150 μ m) in size, which represents a size fraction that may be difficult to float in the presence of the large amount of fines.

A release analysis was also conducted which provided the best possible combustible recovery versus ash and total sulfur rejection curves that can be obtained using a froth flotation process for the treatment of the flotation feed sample. A better separation performance was achieved for the ash-forming materials as compared to the total sulfur components. For the flotation concentrate produced under starvation conditions, an ash content of 2.65% was achieved at a combustible recovery of 11.4%. The total sulfur content was 1.04%. The floating of all the hydrophobic components into the froth concentrate resulted in a final product containing 5.17% ash and 1.33% total sulfur while obtaining a combustible recovery of 94.78%. The maximum separation efficiency value on the basis of ash rejection that can be achieved by a froth flotation process for the treatment of this coal sample appears to be approximately 77.57%. These release curves will be used to evaluate the separation performance provided by each column flotation technology.

Tests were initiated on the Jameson Cell during this reporting period. The objectives of these experiments were to become

familiar with the operation of the Jameson Cell and to evaluate the effects of the critical operating parameters. A comparison of the test results with the release curve provides a preliminary indication that the Jameson Cell is able to achieve separation performance values that approach an optimum separation for froth flotation with one cleaning stage. The best test result was a reduction in ash content from 28.9% to 8.44% at a combustible recovery of 89.2%. This corresponds to a separation efficiency of 68.1%. In addition, the Jameson Cell was able to produce a low ash product containing 4.18% at a combustible recovery of 47.3%.

Initial tests were also conducted with the Packed-Column. Training on the operation of the Packed-Column was provided by Dr. D. Yang. The experimental program for the Packed-Column, Jameson Cell, and the other column flotation technologies will be conducted during the next reporting period.

OBJECTIVES

The goal of this research project is to evaluate and compare the effectiveness of six commercially-available flotation column technologies for the cleaning of Illinois Basin coal fines. The specific objectives of the proposed work are:

1. To optimize the values of the critical operating variables associated with 6 commercially available flotation columns for the treatment of Illinois Basin coal fines;
2. To compare the recovery-grade relationships generated from the treatment of Illinois basin flotation feed coal slurries using a number of different column technologies;
3. To determine and contrast the throughput capacities of the column flotation technologies for the treatment of Illinois basin coal fines.

The flotation technologies that will be evaluated in this study will include the Microcel™ Column, the Turboair Column, the Flotaire Column, the Canadian Column, the Jameson Cell, and the Packed-Column. The specific questions to be answered by this investigation include 1) Do all flotation columns produce the same recovery-grade curve when properly operated?; 2) Does the method of bubble generation, or the type of bubble-particle attachment zone (liquid or froth) affect flotation kinetics so as to change the device throughput or reagent consumption?

To achieve the project objectives, the work has been divided into six distinctly different tasks which are briefly described in the following paragraphs:

Task 1 - Sample Acquisition: The coal samples that will be used in this investigation are flotation feed coal slurries collected from two preparation plants in which one treats Illinois No. 5 seam coal and the other treats Illinois No. 6 seam coal.

Task 2 - Sample Characterization: Both the Illinois No. 5 and No. 6 flotation feed samples will be analyzed for their solids content, particle size distribution, proximate analysis, total and pyritic sulfur content, and BTU content. In addition, a release analysis will be conducted on each sample to obtain the ultimate recovery-product ash and recovery-product sulfur content curves.

Task 3 - Operating Parameter Optimization: An experimental program based on a Box-Behnken test design will be conducted on each flotation column using the Illinois No. 5 coal sample

as the feed. The test results will be used to develop empirical relationships which describe the effect of the critical operating parameters on the process response variables. The operating variables will be optimized using these empirical expressions.

Task 4 - Recovery/Grade Testing: To determine the ultimate recovery-grade curve that each column is capable of achieving, tests will be conducted using the optimum operating parameter values corresponding to the maximum separation efficiency value as determined in Task 3. The recovery-grade curves will be generated by performing a series of tests over a range of feed rate values. After conducting these tests on both the Illinois No. 5 and No. 6 coal samples, the recovery-grade curves will be compared with those obtained by release analysis in Task 2.

Task 5 - Throughput Capacity Testing: Tests will be conducted on each column at three different feed rates. The feed rate values will be determined by selecting three yield values, which will be the same for each column, and calculating the corresponding feed rates from the empirical yield expression developed in Task 3. This will validate the empirical equation. From this data, throughput capacity values will be determined for each column and compared.

Task 6 - Data Analysis and Review: Upon completion of Tasks 1 through 5, the project data will be synthesized into a preliminary report and distributed to the column vendors for their comments and suggestions for future work.

INTRODUCTION AND BACKGROUND

Background

In mineral processing, froth flotation is regarded as the best available technique for separating fine particles. Unfortunately, conventional flotation machines become ineffective when the particle size is very small or when the flotation pulp contains a large amount of finely dispersed clay or silicious gangue. Small hydrophobic particles, such as fine coal, have a low probability of collision with air bubbles, resulting in a low recovery. In addition, fine mineral matter particles are entrained into the froth product along with the process water, resulting in poor selectivity. When processing fine particles, such as a typical flotation feed, both of these problems have to be resolved to obtain the desired separation performance.

A solution to the entrainment problem is the use of flotation columns. In such devices, wash water being added to the froth phase creates a net downward flow of water, called positive

bias, so that the flow of pulp water to the froth phase can be prevented. As a result, entrained gangue particles entering the flotation froth are rejected back into the pulp phase. Therefore, columns are useful for obtaining high product quality.

Several flotation columns have been developed in recent years to take advantage of the facts that: (1) small bubbles can increase the recovery of the desirable component and (2) the use of wash water can produce cleaner products. The main differences between the various column technologies is the method of bubble generation and, in some cases, the nature of the bubble-particle attachment zone. The various commercially available columns can be described as follows:

1. The *Flotaire (Deister) column*, a technology patented and marketed by Deister Company, Inc., uses porous venturi tubes similar to the one shown in Figure 1a. The fast moving fluid inside the smaller tubing, which is made of porous stone, removes bubbles from their nucleation sites before they grow in size.
2. The *Turboair column*, a unit developed by the U.S. Bureau of Mines, utilizes a bubble generator that disperses pressurized air in a packed bed of glass beads prior to passing the air/water mixture through a fine orifice at high speed. Figure 1b shows the aeration chamber, which is filled with glass beads. The *Cominco* sparging system is similar to the U.S. Bureau of Mines design except that the pressurized air and water are mixed at a T-joint rather than in the packed bed of glass beads. Also, the wear of the orifice is minimized by carbide inserts. The Turboair column is presently being marketed by Control International, Inc., and Pyramid Resources, Inc..
3. The *Microcel™ column*, a unit developed by the Virginia Center for Coal and Mineral Processing, uses an in-line static mixer for bubble generation (Figure 1c). Aerated slurry is passed through the mixer to create a high degree of turbulence for bubble generation. The column pulp is withdrawn through an inverted pump suction port at the bottom of the cell. The centrifugal pump discharges the pulp to a distributor ring which, in turn, feeds several spargers (i.e., static mixers). Each sparger is individually aerated by an air distribution ring. The Microcel column is presently being marketed by Control International, Inc., and ICF Kaiser Engineers.

a) Porous Venturi Tube (Flotaire Column)

b) Turbo Generator (Turboair Column)

c) In-Line Mixer (Microcel™)

d) Internal Sparger (Canadian Column)

Figure 1. Schematic representations of different microbubble generators.

4. The *Canadian column*, the original conventional-type column (Figure 2a) and commercially marketed by the Column Flotation Company of Canada, utilizes internal spargers made from perforated pipe that is usually covered with perforated rubber. A water/frother mixture and air are passed through the perforated sparger to produce the bubbles (Figure 1d). The sparger system used in the *Ken-Flote* column, which was developed at the University of Kentucky, is similar to the Canadian Column in that air and a water/frother mixture are forced through a porous frit to generate the microbubbles.
5. The *Jameson cell* is a non-conventional column which is divided into two zones, one for fast bubble-particle contacting and one for concentrate cleaning. Bubble-particle contacting in this column takes place in a downcomer where the feed slurry and air are intimately mixed. This is achieved by a high pressure feed which is forced through a small orifice in the downcomer. The jet action of the feed into the downcomer passes an opening to the atmosphere that naturally draws air into the tubes and shears the air to produce fine bubbles (Figure 2b). The concentrate laden froth is released at the bottom of the downcomer into a column where the resulting froth layer is cleaned by a countercurrent flow of wash water. The unique aspect of the Jameson cell as compared to the other flotation columns is that the air is self-inducting. The Jameson cell is patented and internationally marketed by MIM Limited.
6. The *Packed (or Static) column*, developed at the Michigan Technological University, incorporates a packed-bed column design to provide small flow passages for enhanced bubble-particle attachment (Figure 2c). The packing in the column is a stack of corrugated plates. Compressed air enters in the bottom of the column and the bubbles are generated by bubble shear through the internal packing. An additional advantage of this column is that the packing tends to provide greater support for the froth so that a complete froth column can be utilized. The Packed-column is marketed exclusively by Groupe Laperriere & Verreault Ontario Inc..

A common feature of all of the flotation columns is that generation of small bubbles relies on the shear rate of the fluid at the bubble nucleation site. In general, bubble size can be reduced either by increasing the shear rate, which can be accomplished by increasing the energy dissipation in the system, or by reducing the *surface tension*, which can be

accomplished by adding more frother. The addition of larger amounts of frother, however, can be detrimental to selectivity as a result of increased water recovery from the pulp to the froth. Reducing bubble size by increasing the shear rate is a better choice in terms of selectivity, but this alternative could result in a somewhat higher energy consumption.

Several column sparging systems rely on the addition of external water to the bubble generation circuit to increase the amount of shear (i.e., Canadian, Turboair, and Deister). However, the bubble generation water can significantly reduce the column retention time. This requires additional cell volume to maintain the same retention time. Other columns, such as the Packed, Jameson and Microcel columns, do not require the extra water for bubble generation and, thus, should require less cell volume to treat a given throughput.

Due to the production of larger bubbles by some sparger systems, a few of the column technologies require high superficial gas rates (V_g) to achieve the desired recovery rate. However, the amount of air that one can inject into a column is limited by a transition from uniform bubbly flow to churn-turbulent flow. The flotation rate at this transitional V_g value can be further improved by the addition of a larger concentration of frother to decrease the bubble size. However, past research has found that frother concentrations greater than 20 ppm have little effect on bubble size (Flint et al., 1988). Therefore, the throughput capacity and recovery values that flotation columns are capable of achieving are limited by the number and size of the bubbles produced by their bubble generation system.

EXPERIMENTAL PROCEDURES

Sample Characterization: During this reporting period, a representative sample was obtained from one of the 25 fifty-five gallon drums of Illinois No. 5 flotation feed that was collected at Kerr-McGee's Galatia Preparation Plant during the previous reporting period. This sample was acquired by placing the contents of the drum into a sump that was equipped with a pump to recirculate slurry from the bottom of the sump to the top. The sample was collected through a T-connection located in the discharge line from the pump. A high-speed mixer was used to maintain dispersion of the solids during sample collection.

The representative sample was characterized on a size-by-size basis for ash, total sulfur, and BTU content using ASTM procedures. The particle size analysis was conducted using a wet screening procedure and 8-inch sieves ranging from 28 mesh to 400 mesh. The samples from each size fraction were

filtered, dried and weighed.

A release analysis as described by Dell (1964) was conducted on the representative flotation feed sample. The counterpart of release analysis in froth flotation is the washability analysis in gravity separation. In other words, release analysis provides the best possible recovery-grade relationship achievable by a flotation process. This procedure is based on the proven fact that frother and collector dosage in coal flotation does not change the recovery-grade curve for a given coal.

The release analysis was conducted in two phases. In the first phase, the floatable (hydrophobic) components, which typically have the lowest ash content, were completely separated from the non-floatable (hydrophilic) components using 3 cleaning stages. The last two stages involved the retreatment of the froth concentrate collected from the previous stage. In the second phase, the floatable components were classified according to their hydrophobicity. The highly floatable fraction was collected first by operating under a starvation condition which was obtained using low agitation and low aeration rates. These rates were gradually increased to obtain the slower floating components. This procedure is schematically illustrated in Figure 3.

The release analysis was carried out in a 4-liter batch flotation cell using a Denver Model D-12 flotation apparatus. This device allowed the aeration rate and impeller speed to be adjusted independently as required by the release analysis procedure. Kerosene was used as the collector in all tests while MIBC was used as the frother. The samples collected from the release analysis were filtered, dried and weighed, and analyzed for their ash and total sulfur content.

Operating Parameter Optimization: The tests on the Jameson cell were initiated during this reporting period. A parametric study was conducted to determine the maximum and minimum values of the operating parameters which will provide good operating performance. These ranges in operating parameters values will then be further investigated using a statistically-designed experimental program for optimization purposes during the next reporting period.

The critical operating parameters that were studied include the superficial gas rate, frother concentration, froth depth, and wash water rate. Feed rate in the Jameson Cell must be maintained at a value providing an air-to-feed rate ratio of about 1:1. Therefore, controlling the superficial gas rate also controls the feed rate.

The Jameson Cell tests were conducted by placing approximately

Figure 3. A schematic illustration of the release analysis procedure used in this study.

25 gallons of the flotation feed sample into a sump equipped with a mixer and a recirculation system to maintain sample dispersion. Kerosene, which was used as the collector, was added directly into the feed sump at a concentration of 1 lb/ton. The frother, Dow M150, was added continuously into the feed line to achieve concentrations between 15 and 30 parts per million (ppm). The 6-inch diameter Jameson Cell was operated for a period of approximately 10 minutes prior to collecting samples of the flotation concentrate and tailings. The samples were filtered, dried and weighed, and analyzed for ash content.

RESULTS AND DISCUSSION

Sample Characterization: The ash and total sulfur content of the Illinois No. 5 was found to be 28.9% and 1.34%, respectively. The calorific value of the coal was 9,993 BTU/lb on a dry basis, thus, resulting in a 2.68 lbs SO₂ per million BTU value. This represents a non-compliance coal according to the 1990 Clean Air Act Amendment. The solids content of the flotation feed coal slurry was measured at 4.96% by weight.

The results of the wet sieve analysis are provided in Table 1. From the data, it is evident that the flotation feed sample is very fine with nearly 60% of the particles having a size less than 400 mesh (37 μ m). Approximately 13% of the particles are greater than 100 mesh (150 μ m) in size, which represents a size fraction that may be difficult to float in the presence of the large amount of fines.

The size-by-size characterization data is shown in Table 2. The -400 mesh size fraction, which accounts for the majority of the flotation feed sample, was found to have an ash content of 41.2%. This indicates a relatively large presence of submicron clay particles, thus, providing an excellent application for column flotation. Considering that this fraction represents almost 60% of the total sample containing 59.8% combustible material, one can determine that approximately 50% of the combustible coal in the flotation feed sample is in the -400 mesh size fraction. Thus, by not effectively treating this size fraction, the combustible (or energy) recovery would sharply decrease.

In addition, it is apparent that the coarser size fractions are relatively clean and, if an effective size separator is used, a clean coal product could be obtained which would reduce the amount to be treated by a froth flotation process by as much as 20%.

Table 1. The size distribution data for the Illinois No. 5 flotation feed sample collected from the Galatia Preparation Plant.

Size Fraction (mesh)	Weight (gms)	Weight (%)	Cumulative Weight (%)
+28	2.9	0.88	100.0
28 x 35	9.9	3.00	99.1
35 x 48	10.5	3.18	96.1
48 x 65	16.8	5.09	92.9
65 x 100	15.8	4.79	87.9
100 x 150	17.0	5.15	83.1
150 x 200	18.2	5.51	77.9
200 x 270	21.0	6.36	72.4
270 x 400	20.9	6.33	66.0
-400	197.1	59.7	59.7
Total	330.1	100.0	

Table 2. The size-by-size characterization data obtained for the Illinois No. 5 flotation feed sample.

Size Fraction	Ash (%)	Sulfur (%)	BTU/lb	lb SO ₂ per MBTU
+28				
28 x 35	5.88	1.34	13,512	1.98
35 x 48	5.91	1.39	13,312	2.08
48 x 65	7.21	1.39	12,958	2.14
65 x 100	8.86	1.47	13,105	2.24
100 x 150	10.2	1.48	12,977	2.28
150 x 200	11.6	1.48	12,566	2.35
200 x 270	13.7	1.50	12,809	2.34
270 x 400	17.0	1.53	12,040	2.53
-400	41.2	1.27	8,074	3.15
Total	28.9	1.34	9,993	2.68

The data in Table 2 also shows that the size fractions less than 270 mesh are the only fractions not meeting the Clean Air Act limits on SO₂ emissions. This is possibly due to the circuit arrangement at the Galatia Preparation Plant where the coarser pyrite particles tend to report to the spiral concentrator feed. An increasing amount of pyrite reports to the flotation feed as the particle size is decreased. It is believed that the production of compliance coal from this sample will be relatively easy since the coarse fractions are compliance and both the mineral matter and pyrite are almost completely liberated at this size according to previous studies.

The optimum combustible recovery versus ash rejection and total sulfur rejection curves as obtained by release analysis are shown in Figures 4 and 5, respectively. As indicated by comparing the two figures, a better separation performance was achieved for the ash-forming materials as compared to the total sulfur components. For the flotation concentrate produced under starvation conditions, an ash content of 2.65% was achieved at a combustible recovery of 11.4%. The total sulfur content was 1.04%. The floating of all the hydrophobic components into the froth concentrate resulted in a final product containing 5.17% ash and 1.33% total sulfur while achieving a combustible recovery of 94.78%. The maximum separation efficiency value on the basis of ash rejection that can be obtained by a flotation process for the treatment of this coal sample appears to be approximately is 77.57%.

These release curves for ash and total sulfur content will be used to evaluate and compare the separation performance of the 6 commercial flotation technologies being studied in this investigation.

Operating Parameter Optimization: Tests were initiated on the Jameson Cell during this reporting period. The objectives of these experiments were to become familiar with the operation of the Jameson Cell and to evaluate the effects of the critical operating parameter values. A comparison of the test results with the release curve produced for the Illinois No. 5 flotation feed sample is shown in Figure 6. This comparison indicates that the Jameson Cell is able to achieve separation performance values that approach an optimum separation for froth flotation. The best test result was a reduction in ash content from 28.9% to 8.44% at a combustible recovery of 89.2%. This yields a separation efficiency of 68.1%. In addition, the Jameson Cell was able to produce a low ash product containing 4.18% at a combustible recovery of 47.3%.

Figure 4. The combustible recovery versus ash rejection for the release analysis result of Kerr-McGee coal sample.

Figure 5. The combustible recovery versus total sulfur rejection for the release analysis result of Kerr-McGee coal sample.

Figure 6. The combustible recovery versus ash rejection from the release analysis result and Jameson Cell test data for Kerr-McGee coal sample.

Training on the operation of the Packed-Column was also conducted during this reporting period. Dr. D. Yang spent three days in our research lab. Samples collected during the tests were not analyzed but looked very promising.

The optimization experimental program for the Jameson Cell and the other column flotation technologies will be conducted during the next reporting period.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions can be drawn from the results obtained during this reporting period:

1. Approximately 60% of the particles in the Illinois No. 5 flotation feed sample have a particle size less than 400 mesh (37 μm). In addition, based on the size-by-size ash contents, approximately 50% of the combustible material is in the -400 mesh size fraction. Therefore, this coal will be excellent for comparing the ability of each column technology for recovering ultrafine coal.
2. The high ash content in the -400 mesh size fraction (i.e., 41.2%) indicates the presence of a large amount of submicron clay particles. This will tests each columns ability to reject particles reporting to the froth zone by hydraulic entrainment.
3. The Illinois No. 5 flotation feed coal is non-compliance coal according to the 1995 restrictions on SO_2 emissions. However, based on the size-by-size and release analysis data, it appears that a compliance coal will be easily produced from the feed coal using column flotation.
4. Initial test results obtained using the Jameson Cell produced separation performances comparable to the release curve.

During the next reporting period, the optimization experimental program will be conducted on each of the column flotation technologies. The project is presently on schedule according to the original project milestone chart.

REFERENCES

- Dobby, G. S. and Finch, J. A., 1986, "Flotation Column Scale-Up and Modelling," *CIM Bulletin*, pp. 89 - 96.
- Flint, I. M., MacPhail, P., and Dobby, G. S., 1988, "Aersol Frother Addition in Column Flotation," *CIM Bulletin*, **81** (913), pp. 81 - 84.
- Kennedy, A., 1990, "The Jameson Flotation Cell," *Mining Magazine*, October, pp. 281 - 285.
- Yang, D. C., 1988, "A New Packed-Column Flotation System," in Column Flotation '88', Proceedings of the Int. Symposium on Column Flotation, Phoenix, Arizona, Jan. 25 - 28, pp. 257 - 265.

PROJECT MANAGEMENT REPORT

December 1, 1993 through February 28, 1994

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Other Investigator: B. C. Paul
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COMMENTS

None.

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