

# DENSE MEDIA CYCLONE OPTIMIZATION

**Report Type:** Quarterly Technical Progress Report

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**DOE Number:** DE-FC26-01NT41061

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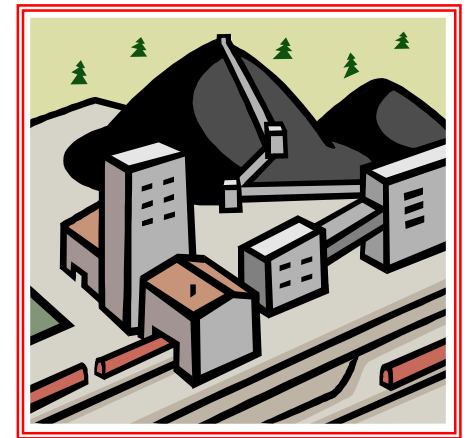
Blacksburg, VA 24061

**Other Participants:**

Massey Coal Services

Partition Enterprises

Precision Testing Laboratories



October - December 2001 Quarterly Report

Heavy Media Cyclone Optimization - Virginia Tech

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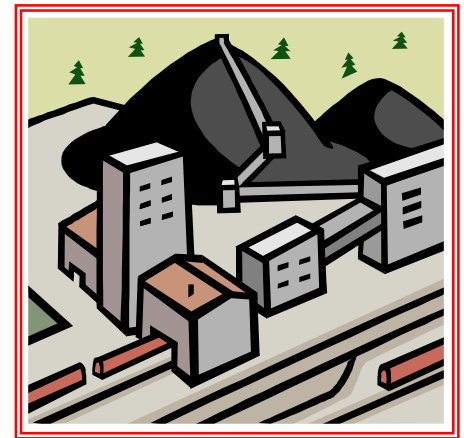
# ABSTRACT

During the past quarter, float-sink analyses were completed for four of seven circuits evaluated in this project. According to the commercial laboratory, the analyses for the remaining three sites will be finished by mid February 2002. In addition, it was necessary to repeat several of the float-sink tests to resolve problems identified during the analysis of the experimental data. In terms of accomplishments, a website is being prepared to distribute project findings and software to the public. This site will include (i) an operators manual for HMC operation and maintenance (already available in hard copy), (ii) an expert system software package for evaluating and optimizing HMC performance (in development), and (iii) a spreadsheet-based process model for plant designers (in development). Several technology transfer activities were also carried out including the publication of project results in proceedings and the training of plant operations via workshops.



# Dense Medium Cyclone Optimization (Proposal #60)

- **Principal Investigator:** Gerald Luttrell (Virginia Tech)
- **NETL Project Manager:** David M. Hyman
- **Partners:** Massey Coal Services  
Partition Enterprises  
Precision Testing Laboratory
- **Total Project Cost:** \$320K
  - DOE Share: \$154K
  - Participant Share: \$166K
- **Project Period:** 18 months  
\*after no-cost time extension
- **Project Start Date:** 14 Dec. 2000



# Background

- **Heavy Media Cyclones (HMCs)**
  - Serves as the “workhorse” in the coal industry for removing waste rock from valuable coal
    - In the U.S., HMCs represent an installed capacity of >85,000 ton/hr
  - Problem - Improper operation can result in large losses of recoverable coal to the waste product
    - losses estimated to be more than \$45 million annually



# Project Objectives

- To develop a set of three basic engineering tools to improve the efficiency of heavy medium cyclone (HMC) circuits:
  - low cost tracers to rapidly assess HMC performance
  - mathematical process models to predict the influence of changes in operating and design variables on HMC performance
  - model-based expert system to provide operators with a user-friendly interface for evaluating, optimizing, and troubleshooting HMC circuits



# Photo Library



Computer-based interface used to monitor and control the heavy media bath and heavy media cyclone circuits at one of the four project test sites.



Photograph showing the internal condition of one of the heavy media cyclones (ceramic lined) that was inspected by the project team during the first phase of the in-plant test program.



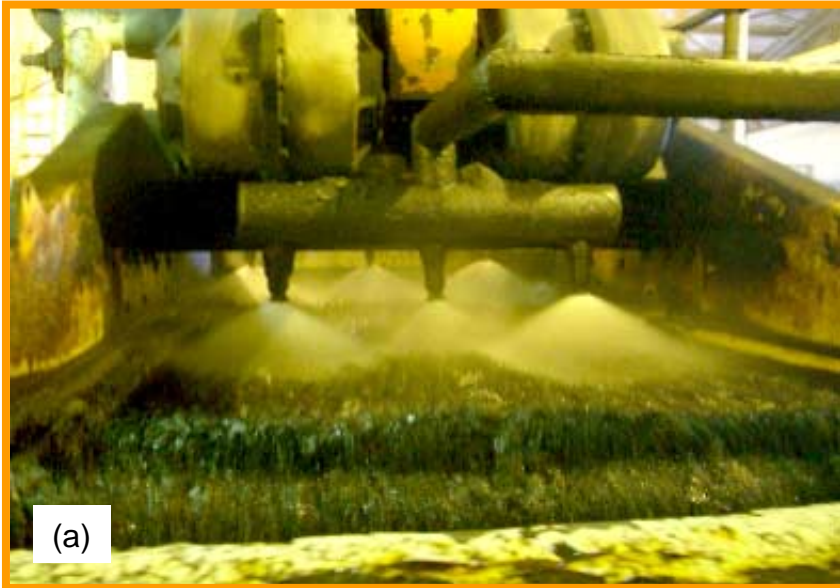
# Photo Library



Improperly designed feed distributions can result in unequal solids loadings and result in poor heavy media cyclone performance. Density traces were used in this project to identify such problems at several of the test sites. Photographs show (a) an overhead distributor and (b) an up-flow distributor used to feed twin parallel heavy media cyclones.



# Photo Library



Inadequate water pressure on water sprays used for drain-and-rinse screens can result in poor rinsing of media (ultrafine magnetite) from the clean coal and refuse products from heavy media cyclone circuits. Poor rinsing will increase media consumption and adversely impact circuit stability/control. The photographs show (a) effective rinsing and (b) inadequate rinsing at two of the project test sites. Guidelines for proper operation of water sprays have been developed as part of this project.

# Project Cost Summary

Accrued Costs: \$96,874 as of 1/14/02 (\$77,361 Direct; \$19,513 Indirect)

Invoiced Costs: \$90,695 as of 11/30/01(\$87,004 Paid, \$3,691 Outstanding)

|             | First Year |        | Second Year |        | Third Year |        | Totals |        |
|-------------|------------|--------|-------------|--------|------------|--------|--------|--------|
| Source      | Plan*      | Actual | Plan*       | Actual | Plan*      | Actual | Plan   | Actual |
| Participant | \$79K      | \$79** | \$87K       | ---    | 0          | ---    | \$166K | \$79** |
| DOE         | \$96K      | \$96   | \$58K       | \$1K   | 0          | ---    | \$154K | \$97K  |
| Total       | \$320K     | \$180  | 0           | ---    | 0          | ---    | \$320K | \$176K |

*\*Budget after no-cost time extension*

*\*\*Does not include costs encumbered for sample analysis*

## KEY:

Plan = Planned costs for the full year.

Actual = Actual costs through the reporting period.



# Milestones and Status

| Major Milestone               | Description of Planned Activity   |
|-------------------------------|---|
| 1 - Baseline Assessment       | Initial inspection and testing to establish existing performance of DMC circuits at four selected plant sites.  |
| 2 - Circuit Modification      | Modification of plant circuits and/or operating practices based on information from the Baseline Assessment.    |
| 3 - Follow-Up Assessment      | Secondary inspection and testing to establish technical and economic benefits of recommended modifications.     |
| 4 - Sample Analysis           | Detailed float-sink testing of representative samples from the DMC circuits at the four selected plant sites.   |
| 5 - Data Analysis/Simulation  | Detailed analysis of density tracer and float-sink test data (including mass balancing and simulation studies). |
| 6 - Expert System Development | Development of mathematical routines and expert rules that can be used by operators for DMC optimization.       |
| 7 - Concept Assessment        | Technical and economic evaluations of the project work (including preparation of technical reports).            |



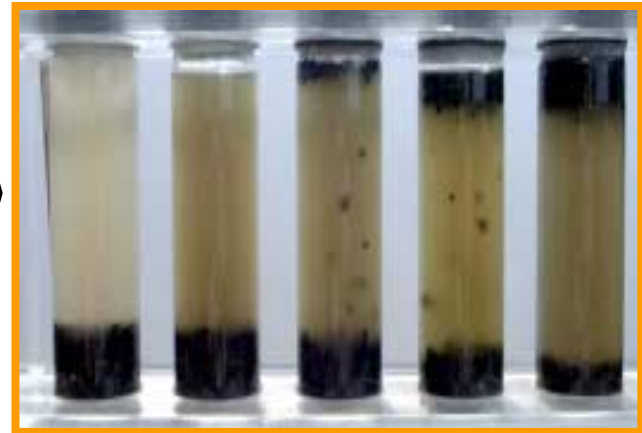
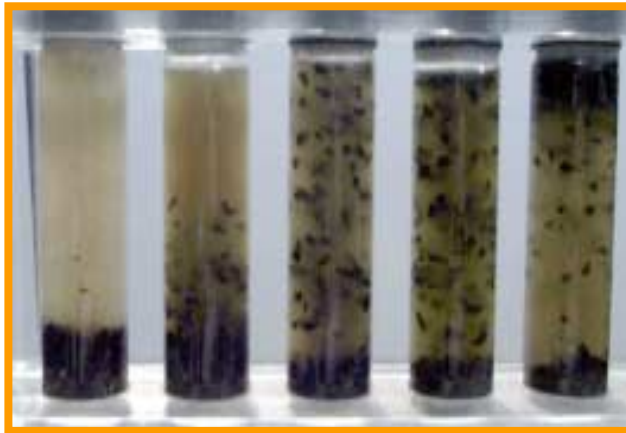
# Milestones and Status

| Planned Milestone             | Scheduled | Completed | Current Status  |
|-------------------------------|-----------|-----------|---|
| 1 - Baseline Assessment       | July '01  | July '01  | Completed All Baseline Tests (5 Plant Sites and 7 Circuits)                   |
| 2 - Circuit Modification      | Sept. '01 | Oct. '01  | Provided Draft Report, Detailed Report Pending (After Float-Sink Completed)   |
| 3 - Follow-Up Assessment      | Oct. '01  | ---       | Delayed Pending the Completion of the Sample Analysis (Float-Sink Tests)      |
| 4 - Sample Analysis           | Nov. '01  | ---       | Analysis Completed for Sites A, D & E, Sites B & C Delayed (Complete 2/15/02) |
| 5 - Data Analysis/Simulation  | Nov. '01  | ---       | Data Analysis Underway, Development of Simulation Routines Continuing         |
| 6 - Expert System Development | Nov. '01  | ---       | ES Rule Base Nearly Completed, Operators Checklist Completed                  |
| 7 - Concept Assessment        | Dec. '01  | ---       | ---   |



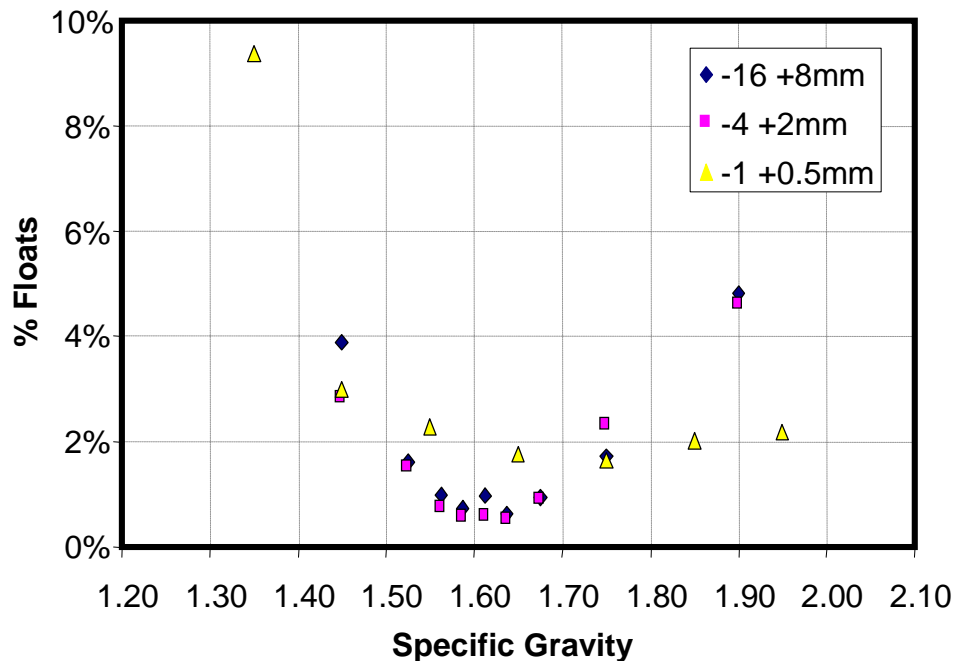
# Key Accomplishments

- **Float-sink analyses completed for four circuits (all scheduled to be finished by 2/15/02).**
  - Circuit A1 - Completed\*
  - Circuit A2 - Completed\*
  - Circuit B1 - In Progress
  - Circuit B2 - In Progress
  - Circuit C - In Progress
  - Circuit D - Completed\*
  - Circuit E - Completed\*



# Key Accomplishments

- Float-sink data evaluated to identify potential problems. Some float-sink tests repeated.



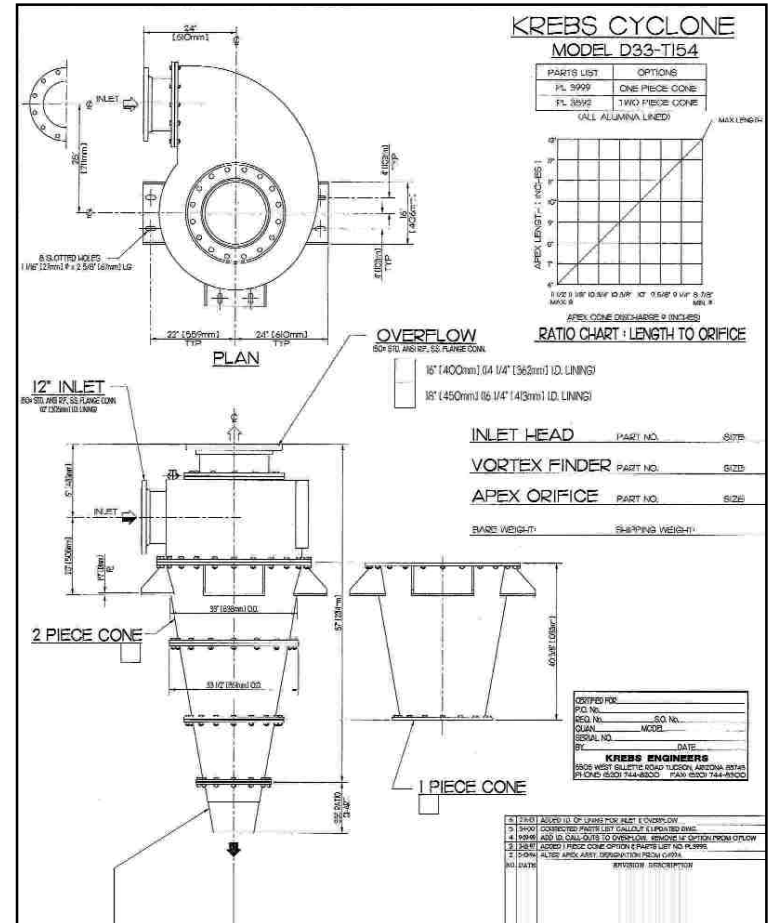
## Potential Problems

Sizes: 16x8 mesh  
4x2 mesh

Density: 1.60x1.625 SG  
1.70x1.80 SG

## Key Accomplishments

- **On-site field work was continued.**
  - Engineering schematics obtained for each bank of HMCs.
  - Measurements of HMC geometry completed.
  - Detailed inspections completed at all plants .
  - Flowsheet diagrams prepared/verified for each plant circuit.



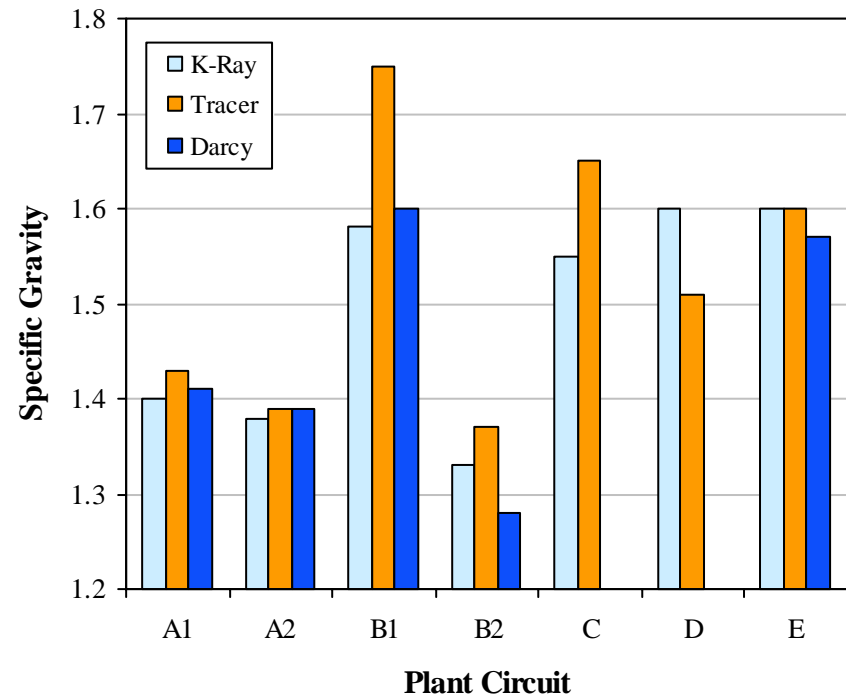


# Good News!

- **Corrected plant control problems created by improper instrument calibration.**



Improper calibration of K-Ray resulted in poor control of plant SG. K-Ray and Darcy readings should be identical, while tracer readings should be 0.05-0.10 SG units higher than Darcy reading (see figure at right).



# Good News!

- Website is being prepared to distribute project findings and software to the public.
- This includes:
  - Operators Manual for HMC operation and maintenance (already available in hard copy).
  - Expert System Software for evaluating and optimizing HMC performance (in development).
  - Mathematical Process Model for plant designers (in development).
- Website should be on-line by late March.



# Project Recognition

- **International Conferences**

- “Optimization of Heavy Media Cyclone Circuits,” Accepted for publication and presentation, 2002 Meeting of the Society for Mining, Exploration and Metallurgy (SME), February 25-27, 2002, Salt Lake City, Utah (Preprint Submitted/Accepted).
- “Operating Guidelines for Heavy Media Cyclone Circuits,” Accepted for publication and presentation at the 19th International Coal Preparation Conference and Exhibition (Coal Prep 2002), April 30-May 2, 2002, Lexington, KY (Abstract Accepted).



# Project Recognition



- **Short Courses and Workshops**

- “An Introduction to Coal Preparation,” One-Day Short Course, Sponsored by Coal Prep 2001 International Exhibition and Conference, Lexington, KY, April 30, 2001, 66 attendees.
- Operating and Maintenance Standards for Heavy Media Cyclones,” Half-Day Workshop, Sponsored by Massey Coal Services, Chapmanville, WV, February 9, 2001, 18 attendees.
- “Operating and Maintenance Standards for Heavy Media Cyclones,” Half-Day Workshop, Sponsored by Massey Coal Services, Chapmanville, WV, March 9, 2001, 11 attendees.
- “Operating and Maintenance Standards for Heavy Media Cyclones,” Half-Day Workshop, Sponsored by TECO Coal Company, Dunbar, KY, June 12, 2001, 14 attendees.
- Operating and Maintenance Standards for Heavy Media Cyclones,” Half-Day Workshop, Sponsored by Massey Coal Services, Chapmanville, WV, July 6, 2001 and August 17, 2001.



# Project Assessment

## (Internal DOE Use Only)

- **Open Issues and/or Problems**
  - A six month no-cost time extension was required to accommodate the unexpectedly slow turn around time for laboratory float-sink analyses.
- **Overall Assessment**
  - All other work elements are continuing to progress well.
  - Data obtained to date indicate significant financial benefits to the industrial cost-sharing partners.
  - Project expenditures within approved budget limits.
  - Several publications/workshops have resulted from this project.

