DENSE MEDIA CYCLONE OPTIMIZATION

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Partition Enterprises

Precision Testing Laboratories

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ABSTRACT

The test data obtained from the Baseline Assessment that compares the performance of the density traces to that of different sizes of coal particles is now complete. The experimental results show that the tracer data can indeed be used to accurately predict HMC performance. The following conclusions were drawn: (i) the tracer curve is slightly sharper than curve for coarsest size fraction of coal (probably due to the greater resolution of the tracer technique), (ii) the E_p increases with decreasing coal particle size, and (iii) the E_p values are not excessively large for the well-maintained HMC circuits. The major problems discovered were associated with improper apex-to-vortex finder ratios and particle hang-up due to media segregation. Only one plant yielded test data that were typical of a fully optimized level of performance.

DENSE MEDIUM CYCLONE OPTIMIZATION

Principal Investigator:
NETL Project Manager:

Gerald Luttrell
David M. Hyman

Prime Contractor:
Partners:

Virginia Tech
Massey Coal Services
Partition Enterprises
Precision Testing Laboratory

Total Project Cost:
DOE Share:
Participant Share:

\$320K
\$154K
\$166K

Project Period:
Project Start Date:

18 months
14 Dec. 2000

Background

- ❑ Heavy media cyclones (HMCs) are high-tonnage devices used to upgrade 50-0.5 mm particles.
- ❑ Used in $\approx 80\%$ of U.S. coal plants (installed capacity $> 85,000$ tph).
- ❑ Small increase in HMC efficiency can greatly improve profits.
 - 1 percentage point = \$45 MM/yr
 - Poor performance is not unusual
- ❑ Problems often corrected by low-cost changes to circuitry or O&M practices.

Project Objective

- ❑ To develop engineering tools to improve HMC performance.
- ❑ These include:
 - Low cost density tracers to rapidly assess HMC efficiency (used by plant engineers)
 - Process models to predict influence of operating and design variables (used by plant designers)
 - Model-based expert system to provide a user-friendly interface for trouble-shooting HMC problems (used by equipment operators)

Photo Library

A common cause of HMC yield loss is floats overload. This occurs when the media flow is too small to carry all of the low-density coal out the vortex finder overflow. It can be corrected by increasing pressure, reducing apex diameter, reducing feed rate of raw coal installing HMCs of greater volumetric capacity.

Another cause of HMC yield loss is surging. This occurs due to media thickening and buildup of middlings that eventually discharge with low-ash coal to the underflow. It can be corrected by using a larger apex (common), finer magnetite, and alternative bleed arrangements. Both “floats overload” and “surging” are difficult for operators to detect using traditional approaches.

Project Cost Summary

Accrued Costs: \$108,802 as of 3/31/02 (\$89,264 Direct; \$19,538 Indirect)

Invoiced Costs: \$104,745 as of 2/28/02(\$100,810 Paid, \$3,936 Outstanding)

Source	First Year		Second Year		Third Year		Totals	
	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	Task Site Reports Completed Most Circuit Modifications Completed
3 - Follow-Up Assessment	May '02	(Continue to project end)	Follow-Up (Monthly) Sampling Campaigns Underway
4 - Sample Analysis	May '02	---	Float-Sink/Ash Analyses Completed (Microtrac Analyses Underway)
5 - Data Analysis/ Simulation	May '02	---	Data Analysis Underway, Simulation Coding Underway
6 - Expert System Development	May. '02	---	ES Program Coding Underway, Operators Checklist Completed
7 - Concept Assessment	June. '02	---	---

**Dates modified to reflect no-cost time extension.*

Key Accomplishments

- ❑ Baseline testing and float-sink analyses now completed for all five plants.
 - Includes seven different HMC circuits.
- ❑ Size-by-size partition analyses completed for all circuits (see following slides).
 - Elk Run
 - Green Valley
 - Liberty
 - Long Fork
 - Omar

Key Accomplishments

	Cutpoint	Ep
Coal -16 +8mm	1.42	0.019
Coal -4 +2mm	1.41	0.035
Coal -1 +0.5	1.49	0.103
32mm tracer:	1.43	0.011

Comments

- Apart from a glitch in the curve for $-4+2$ mm coal, these results are typical of good operation.

Key Accomplishments

	Cutpoint	Ep
Coal -16 +8mm	1.38	0.012
Coal -4 +2m	1.38	0.026
Coal -1 +0.5	1.49	0.071
32mm tracer:	1.39	0.005

Comments

- The low pivot point suggests that the ratio of spigot diameter to vortex finder diameter is too small.

Key Accomplishments

	Cutpoint	Ep
-16 +8mm	1.72	0.021
Tracers 32mi	1.75	0.012

Comments

- Tracer cutpoints are slightly higher than coal indicating absorption of water and/or of float-sink liquids by coal.

Key Accomplishments

	Cutpoint	Ep
Coal -16 +8mm	1.34	0.021
32mm Trace	1.37	0.010

Comments

- Tracer cutpoints are slightly higher than coal indicating absorption of water and/or of float-sink liquids by coal.

Key Accomplishments

	Cutpoint	Ep
Coal -16 +8mm	1.54	0.020
Coal -4 +2mm	1.56	0.038
Coal -1 +0.5mm	1.68	0.110
32mm trace	1.51	0.015 but some retention from 1.46 to 1.54

Comments

- Small ratio of spigot to vortex finder and retention at 1.48-1.52 SG (implies surging loss of coal to rejects).

Key Accomplishments

	Cutpoint	Ep
-16 +8mm	1.59	0.024
-4 +2mm	1.59	0.045
-1 +0.5mm	1.61	0.110
16mm tracer:	1.60	0.016

Comments

- High pivot point indicates that the spigot to vortex finder ratio is too large (16 mm tracers used).

Key Accomplishments

	Cutpoint	Ep
-16 +8mm	1.63	0.024
-4 +2mm	1.66	0.036
-1 +0.5mm	1.90	0.122
32mm tracer:	1.65	0.021 but retention from 1.46 to 1.54

Comments

- Another case of small ratio of spigot to vortex finder diameter and tracer retention around 1.68-1.70 SG.

Good News!

- ❑ Tests comparing density traces and coal particles now completed.
- ❑ The trace data can be used to accurately predict HMC performance.
 - Tracer curve slightly sharper than curve for coarsest size fraction of coal.
 - Difference attributed to the greater resolution of the tracer technique.
 - Increasing E_p with decreasing coal size.
- ❑ E_p values are not excessively large for the well-maintained HMC circuits.

Good News!

- ❑ Preliminary task reports provided to all plants.
 - Recommends modifications to circuitry and operating practices.
- ❑ Follow-up assessments being performed at all plants.
 - Currently conducted on a monthly basis.
- ❑ Website being prepared to distribute project findings and software.
 - VT will provide future support for website.

Project Recognition

- 2002 - International Conferences
 - “Optimization of Heavy Media Cyclone Circuits,” Proceedings, 2002 Meeting of the Society for Mining, Exploration and Metallurgy (SME), February 25-27, 2002, Salt Lake City, Utah.
 - “Operating Guidelines for Heavy Media Cyclone Circuits,” Proceedings, 19th International Coal Preparation Conference and Exhibition (Coal Prep 2002), April 30-May 2, 2002, Lexington, KY. (Proceedings In Press).
 - “An Assessment of Industrial Heavy Media Cyclone Circuits,” 19th Annual International Pittsburgh Coal Conference, September 23-27, 2002, Pittsburgh, PA. (Abstract Submitted).

Project Recognition

- ❑ 2002 - Short Courses and Workshops
 - Operating and Maintenance Standards for Heavy Media Cyclones," Half-Day Workshop, Sponsored by Massey Coal Services, Charleston, WV, February 1, 2002, 7 attendees.
 - Operating and Maintenance Standards for Heavy Media Cyclones," Half-Day Workshop, Sponsored by Massey Coal Services, Charleston, WV, February 15, 2002, 13 attendees.
 - Operating and Maintenance Standards for Heavy Media Cyclones," Half-Day Workshop, Sponsored by Massey Coal Services, Charleston, WV, March 1, 2002, 14 attendees.
 - Operating and Maintenance Standards for Heavy Media Cyclones," Half-Day Workshop, Sponsored by Massey Coal Services, Charleston, WV, March 22, 2002, 13 attendees.

Commercialization Outlook

❑ New Funding

- Spin-off project recently funded by CAST to develop “smart” density tracers.
- Makes use of recent advances in electronic transponder identification technology.
- Will allow a single person to conduct a complete HMC efficiency test in just minutes.

❑ Marketing Agreement

- Agreement in place for Precision Testing Laboratories to market tracers in the U.S. coal industry.
- Technical support to be provided by VT and Partition Enterprises.
- All parties providing cost-sharing funds and personnel to develop the new “smart” tracers.