

**TITLE:** DEVELOPMENT OF AN ON-LINE COAL WASHABILITY ANALYZER

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## 1. ABSTRACT

**OBJECTIVE:** The primary objective of the proposed research program is to develop a CT-based, on-line coal washability analyzer. A secondary objective will be to demonstrate the capabilities of the analyzer by comparing efficiency data from traditional float-sink tests conducted at three preparation plant sites with efficiency data generated by the washability analyzer. The scope of the proposed research program involves several tasks including (i) the acquisition and preparation of test samples for use in testing and calibrating the analyzer, (ii) the development of appropriate hardware and software necessary to adapt a CT analyzer for use in determining coal washability, (iii) the testing and modification of the analyzer using well-characterized coal samples, (iv) the evaluation of the analyzer's performance under simulated plant conditions, and (v) an evaluation of the technical and economic feasibility of implementing the CT-based washability analyzer on a commercial basis. Researchers from the University of Utah and Terra Tek Inc. will perform tasks related to the development, calibration and testing the analyzer, while technical personnel from Virginia Tech and selected coal companies will provide the required coal samples, evaluate the industrial capabilities of the analyzer, and promote system commercialization.

## **WORK DONE AND CONCLUSIONS:**

- The development of the CT-based washability analyzer requires well-characterized test samples for use in calibration and preliminary testing. In this regard, samples of feed coal were collected, sized and subdivided into narrow specific gravity classes for use in the development and calibration of the CT analyzer. Approximately 40 size/density fractions were generated by this procedure. Detailed coal analyses (e.g., ash, sulfur, etc.) have not yet been performed the size/density fractions since this is a destructive procedure. These analyses will be performed after all analyzer development and calibration work has been successfully completed.
- The Philips Tomoscan 60/TX CT scanner located at Terra Tek Inc. is being used for this study. Plastic containers are used as the sample chamber. To use the CT measurements for coal washability analysis, it is necessary to do a calibration step with known density materials or directly determine the density using dual-energy scans. Both methods were evaluated during this period. In the first experiment, coal particles of known density (measured by He pycnometry) were arranged in a container as a coal phantom for dual-

energy CT scans. These dual-energy settings were 100 and 130 KeV. Figure 1 presents one of the calibration curves obtained before and after test sample scans together with the regression equation from which the actual density scale was established.

- Experimental test program is in progress to evaluate the CT scanner using coal samples under carefully-controlled laboratory conditions. The test program will be subdivided into four separate series of tests, single size/single gravity, single size/multiple gravity, multiple size/single gravity, and multiple size/multiple gravity. Comparison of the mean density by sink-float analysis and by x-ray CT for the 1/2x1/4 inch sample with 8 different densities is shown in Figure 2. Result show good agreement of the density measurement by sink-float analysis with that by x-ray CT analysis.
- Two approaches (namely 3-D and 2-D mass density distribution analyses) were developed to facilitate the separation and classification the density distribution of the coal particle bed. Test results show that the algorithms work in a promising way (Figure 3). The software package, Volume Slicer, was developed for displaying and managing the 3-D data sets. Volume Slicer allows the user to download the sequence of the original 2-D images and to examine the tomographic plane at different positions and from different view points (angles).
- Field data have been collected for different coal seams to identify promising commercial applications of the proposed CT washability analyzer. Information obtained to date indicates that the technology may be very useful for the optimization of critical coal blending operations.

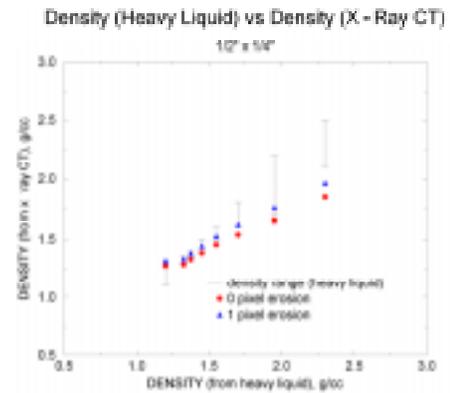
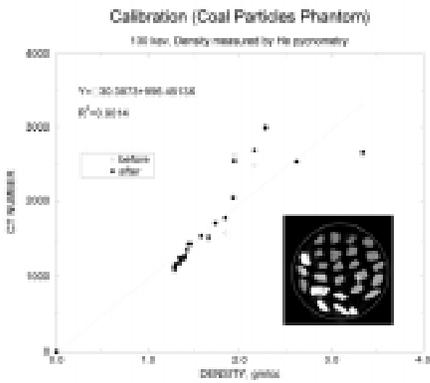


Figure 1. Calibration curve for x-ray CT using coal phantom shown as inlet.

Figure 2. Comparison of the mean density of single size/single gravity test as determined by sink-float analysis with that obtained by x-ray CT analysis.

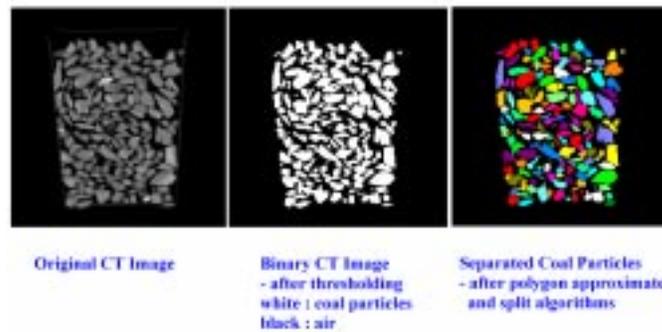


Figure 3. Image sequence shows the results for the separation of coal bed particles in contact using the algorithm for 2-D mass density analysis.

## 2. ARTICLES, PRESENTATIONS, STUDENTS

- ARTICLES:** J.D. Miller and C.L. Lin, "Characterization of Mineral Particle Populations by X-Ray CT", Conference Proceedings *Frontiers in Industrial Process Tomography II*, Engineering Foundation, April 8-12, 1997, Delft Technical University, Delft, Netherlands, p. 9-14.
- J.D. Miller and C.L. Lin, "Computed Tomographic Techniques for the Analysis of Multiphase Mineral Processing Systems", *XX International Mineral Processing Congress*, Aachen, Germany, Vol. 1, p.151-161, 1997.
- PRESENTATIONS:** J.D. Miller and C.L. Lin, "Review of Tomographic Techniques for the Analysis of Multiphase Systems", for presentation at NSF Workshop in South Africa, June, 1997.
- STUDENTS:** Ataullah Mirza-Baig and Altaf Khan(University of Utah)  
David Brafford and Jaisen Kohmuench (VPI&SU)