

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

**DATE:** May 1997

**AUTHORS:** J.D. Miller, PI  
jdmiller@mines.utah.edu  
Phone: (801) 581-5160  
Metallurgical Engineering  
215 WBB  
University of Utah  
Salt Lake City, Utah 84112

G.H. Luttrell, Co-PI  
luttrell@vt.edu  
phone: (540) 231-4508  
Mining and Minerals Engineering  
100 Holden Hall  
Virginia Tech  
Blacksburg, Virginia 24061

C.L. Lin, Co-PI, University of Utah

L.B. Owen, Co-PI, Terra Tek Inc.

L. Fish, Co-PI, Cyprus-Amax Coal Company.

**GRANT NO.:** DE-FG22-96PC96215

**PERIOD OF PERFORMANCE:** September 1, 1996 to March 31, 1997

## 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 Cyprus Amax will provide the required coal samples, evaluate the industrial capabilities of the analyzer, and promote system commercialization.

## WORK DONE AND CONCLUSIONS:

- Effort for the subtasks assigned to VPI&SU is now underway to complete the preparation of size and density fractions of Stockton seam coal from Cyprus' Lady Dunn plant, Cannelton, West Virginia., for use in the development and calibration of the CT-based washability analyzer. In addition, a field meeting was held with technical representatives from Cyprus Amax to discuss potential sites for obtaining the required coal samples and to identify promising commercial applications of the on-line washability analyzer.
- Software has been developed to isolate particles of a 3-D packed bed of coal particles as established from x-ray CT data. To determine the size and mass density distributions, detection of surface boundaries and classification of the particle population will be critical. Particle contact inside the sample chamber is one of the problems which must be solved for on-line coal washability analysis. The frame work for software development to analyze the packed 3-D coal particles has been prepared during this reporting period. The major data processing steps and the corresponding algorithms for mass-density distribution (coal

washability curve) are given in Figure 1. The algorithms include phase segmentation for data reduction, surface extraction (watershed algorithm) to separate contacting particles, labeling for particle classification, and volumetric grade classification for the 3-D CT data set. Initial results indicate that this approach can be used to separate the particles in contact, as shown in Figure 2. Two consecutive original x-ray CT images (numbers 6 and 7) are shown in the left hand side of Figure 2. The separated particle images are shown in the right hand side of Figure 2.

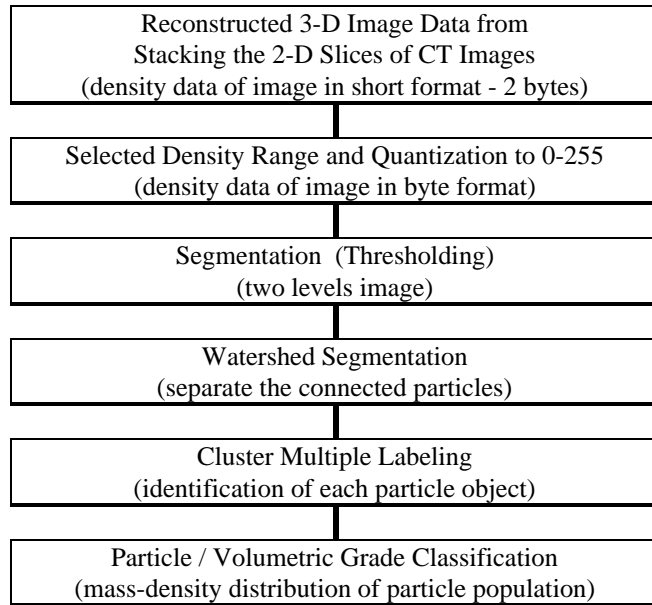


Figure 1. Major steps for the determination of the mass-density distribution of a particle population from 3-D image data collected by stacking 2-D slices generated by x-ray computed tomography.

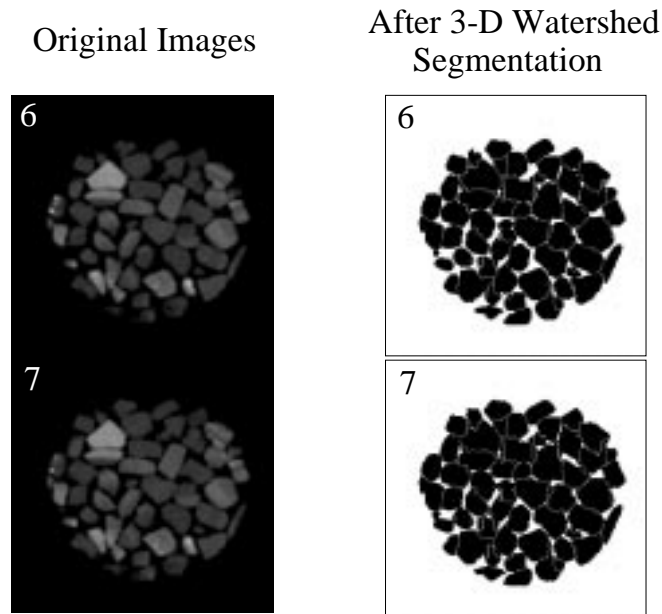


Figure 2. Preliminary results for 3-D analysis of packed bed coal particles.

## 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.
- 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:** Codi Nowlin (University of Utah)  
Jaisen Kohmuench (VPI&SU)