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TITLE: ELECTROKINETIC DENSIFICATION OF
COAL FINES IN WASTE PONDS

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PI: E. James Davis

STUDENTS: Timothy Johnson (Ph.D. student) and Gail Furches (UCR Intern)

INSTITUTION: University of Washington
Department of Chemical Engineering, Box 351750
Seattle, WA 98195-1750
(206) 543-2250

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I. ABSTRACT

OBJECTIVE: The objective of this research is to demonstrate that electrokinetics can be used to remove colloidal coal and mineral particles from coal-washing ponds and lakes without the addition of chemical additives such as salts and polymeric flocculants. In this experimental and analytical study we shall elucidate the transport processes that control the rate of concentrated colloidal particle removal, demonstrate the process on a laboratory scale, and develop the scale-up laws needed to design commercial-scale processes. We shall address the fundamental problems associated with particle-particle interactions (electrical and hydrodynamic), the effects of particle concentration on the applied electric field, the electrochemical reactions that occur at the electrodes, and the prediction of power requirements.

WORK DONE AND CONCLUSIONS:

It has been demonstrated that heavily contaminated water from a coal-washing facility in Centralia, Washington can be clarified by applying an electrical field to the colloidal suspension. The Centralia Mining Company, a subsidiary of PacificCorp, provides coal for two 665 MW coal-burning power plants operated by PacificCorp Power Supply. Water is used to wash the coal during beneficiation to remove fine coal dust and clay particles, and the resulting suspension has a solids content as high as 1%. The colloidal particles typically have mean diameters of 1.8 μm and zeta potentials of ~ -25 mV, so electrokinetic treatment is feasible.

The focus of the research to date has been the design, construction and testing of a novel apparatus for electrophoretic sedimentation of colloidal contaminants. A frontal view of the apparatus is shown in Figure 1. A carbon composite sheet serves as a relatively conventional cathode, but the anode consists of a set of rotating carbon rods driven by a stepper motor, which controls the rate of revolution of the anodes. A scraper blade in the sump below each anode removes the agglomerated particles that become attached to the carbon rods. The rotation carbon rods minimize the build-up of a resistive cake, therefore lowering the power requirements for separation. A low rotational speed of the carbon rods increases the rate of separation as well as the final compactness of the sediment.

Hydrogen is evolved at the cathode in normal operation, and care must be taken to avoid oxygen evolution at the anodes, for oxygen bubbles moving upward through the suspension prevent sedimentation. Hydrogen is collected in the upper chamber shown in the figure. A laser beam passes through the chamber for turbidity measurements, but only after substantial sedimentation occurs can such measurements be made. The chamber is also equipped with a multichannel probe for measuring the vertical electric field. Computerized data acquisition instrumentation and

software have been prepared for the acquisition of the overall applied voltage, the local electric field, and the turbidity.

Figure 1. The electrophoretic cell used for sedimentation.

SIGNIFICANCE TO FOSSIL ENERGY PROGRAM: Coal-washing facilities represent a significant source of water pollution in coal-producing areas. The removal of coal and mineral fines by electrokinetic methods produces clean process water which can be recycled without the addition of flocculating agents, salts and other chemicals. Thus, there is no detriment to wildlife or water supplies if discharged into natural streams or groundwater. The process designed has several advantages including simplicity, potential for scale-up and low power requirements.

PLANS FOR THE COMING YEAR:

- Develop a continuous process to replace the batch process currently operating.
- Determine the effects of electrolyte concentrations and chemical species (valency) on the electrophoretic sedimentation rate and power requirements.
- Determine the effect of the clay/coal concentration ratio on the degree and rate of separation.
- Compare the measured time-dependent local electric field with finite-element theoretical calculations.
- Develop theories for the electrophoretic motion of concentrated aqueous colloidal suspensions which can be compared to experimental data and used for large-scale system design.

II. HIGHLIGHT ACCOMPLISHMENTS

- A novel electrokinetic system has been designed which incorporates rotating anodes to prevent fouling and increase the degree and rate of separation.
- Effective sedimentation of the colloidal clay and coal particles has been demonstrated. It has also been established that after electrophoretic sedimentation begins the electric field can be turned off and gravitational sedimentation dominates. This greatly reduces the power consumption of a batch process.
- The cathode has been modified to facilitate the escape of hydrogen gas produced by electrolysis, and the conditions required to avoid oxygen evolution at the anodes have been explored.
- Preliminary parametric studies relating to the rate of electrophoretic sedimentation along and the power requirements have been carried out.

III. ARTICLES AND PRESENTATIONS

Two presentations of research results to the scientific staff of PacificCorp Power Supply to develop interaction with the industry.

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