TITLE: ELECTROKINETIC DENSIFICATION OF COAL FINES IN WASTE PONDS

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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 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 are also addressing 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 electric 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 research focus to date has been on determining the effects of suspended solids and electrolyte concentration on the rate of water clarification and the resulting power requirement. It has been determined that an increase in the suspended solids concentration decreases the asymptotic power levels, but increases the suspension conductivity and the time necessary for clarification. Similarly, an increase in the electrolyte concentration decreases the asymptotic power levels, but increases the suspension conductivity and clarification time.

Additional research efforts have been focused on the design, construction, and testing of an apparatus for continuous electrophoretic sedimentation of colloidal contaminants. This apparatus is based on a previously designed batch system which contains rotating carbon rods for the anode. The anode rotation was found to be necessary so that the sedimenting particles may be cleaned from the surfaces of the electrodes. The process was made continuous by adding the contaminated water near the anode and removing the clarified water near the cathode. An outlet line for the removal of accumulated sediment was also incorporated in the sump area below the anode. Preliminary experiments have been successful with flowrates near 40 ml/min.

Theoretical analysis of the electrophoretic velocity of concentrated suspensions has been carried out to predict the effects of the system parameters on the sedimentatin rate and on the power requirements.

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:

- Complete theoretical work on the electrophoretic motion of concentrated aqueous colloidal suspensions.
- Compare predicted sedimentation rates and power requirements with laboratory data to test the model for scale-up to commercial systems.
- Determine the effect of the clay/coal concentration ratio on sedimentation rates and extent of separation.
- Compare the measured time-dependent local electric field with theoretical calculations.

II. HIGHLIGHT ACCOMPLISHMENTS

- A novel continuous electrokinetic system has been designed which incorporates rotating anodes to prevent fouling and increase the degree and rate of separation.
- Determined that increasing the suspended solids concentration or the electrolyte concentration may decrease power levels, but increases the time necessary for clarification.
- Preliminary numerical studies relating to the rate of electrophoretic sedimentation along with 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. A paper on the analysis of electrophoretic motion in concentrated suspensions is in preparation and another on experimental is planned.