TITLE: AQUEOUS BIPHASE EXTRACTION DATE: April, 1998

FOR PROCESSING OF FINE COALS

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I. ABSTRACT

OBJECTIVE : The objective of this research is to develop an aqueous biphase extraction process for the treatment of fine coals. Aqueous biphase extraction is an advanced separation technique which relies on the ability of an aqueous system consisting of a water-soluble organic polymer and an inorganic salt or another water-soluble organic polymer to separate into two immiscible aqueous phases. Differences in the hydrophobic/hydrophilic properties of particulates can then be exploited to effect selective transfers to either the upper polymer-rich phase, or the lower salt-rich phase. An additional goal is to develop an improved coal-pyrite separation technique based on aqueous biphase extraction. The experimental program involves phase diagram determination, phase separation rate measurements, partition measurements, and washing experiments.

WORK DONE AND CONCLUSIONS:

- The first stage of this research project was focused on phase diagram determination, since it is believed that successful utilization of this technique in processing of fine coals largely depends on the selection of appropriate aqueous biphase systems. Phase diagrams were obtained by determining the phase compositions of the upper phase and the bottom phase with acid-base titration and refractive index measurements. The aqueous biphase system containing polyethylene glycol (PEG) and sodium carbonate (Na_2CO_3) was studied. The phase diagrams for PEG-2000, 3400, 4600, 8000 and Na_2CO_3 have been determined (the phase diagram for PEG-2000 and Na_2CO_3 is shown in Fig. 1), and the results showed that, the higher the molecular weight of the polymer, the lower the concentration of PEG and Na_2CO_3 needed for phase separation. When the initial compositions of the biphase systems were different, the tie lines in phase diagram changed. Because phase diagrams for PEG and sulfate or phosphate are already available in the literature, it was not necessary to determine the phase diagrams.

- Batch partition experiments have been done for pyrite particles (<53 μm) in PEG-2000/ Na_2CO_3 and PEG-4600/Na_2SO_4 systems. When there was no pretreatment of pyrite, almost all the pyrite particles stayed at the interface of the PEG-2000/Na_2CO_3 system. The longer pyrite was pre-stirred in the aqueous biphase system, the greater the proportion of the particles that went into the bottom phase, and the lower the proportion that stayed at the interface. For the PEG-2000/Na_2CO_3 aqueous biphase system, almost all the pyrite particles stayed in the bottom phase when the pH values were 9-13. However, there was no formation of biphase system when the pH value was less than 9 for PEG and Na_2CO_3. For PEG-4600/Na_2SO_4 systems, most of the pyrite particles stayed in the bottom phase when pH 9 was exceeded; most of the pyrite particles went into the upper phase when the pH was less than 9 (as shown in Fig. 2). For PEG-4600/Na_2SO_4 systems, the higher the concentration of water in the total composition, with the same ratio between PEG and Na_2SO_4, the less pyrite particles stayed at the interface, for pH equal to 7 or 9.

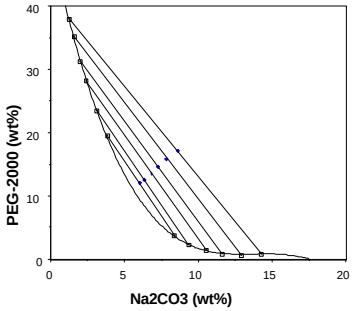

Fig. 1. Phase diagram for the PEG-2000/Na_2CO_3 system

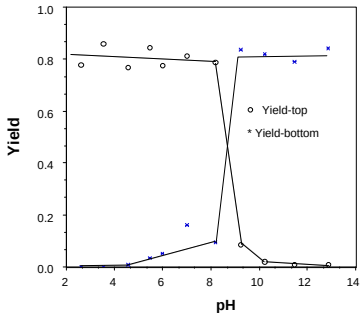

Fig. 2. Effect of pH on pyrite partition in the PEG-4600/Na_2SO_4 system

SIGNIFICANCE TO FOSSIL ENERGY PROGRAM: Ever-stringent environmental constrains dictate that future coal cleaning technologies be compatible with micron-size particles. For supper-clean coal production, the degree of liberation needed to separate coal from mineral matter, including pyrite, requires grinding to 10 μm or below. In addition, large amounts of fine coal are discharged to refuse ponds because current coal cleaning technology cannot adequately treat such finely divided materials. This research program, based on aqueous biphase extraction, seeks to develop an advanced coal cleaning technology uniquely suited to micron-size particles.

PLANS FOR THE COMING YEAR : Work in the coming year will involve the following experiments: (a) Pyrite partitioning in polymer/inorganic salt aqueous biphase systems and the effect of biphase composition, solid pretreatment, solid concentration, solid particle size, temperature, collectors, promoters and depressants, (b) Partition of fine coal particles, metal oxides (e.g. Fe_2O_3, Al_2O_3), silicates and clays in aqueous biphase systems and the effect of the above other factors, (c) Washing experiments.

II. HIGHLIGHT ACCOMPLISHMENTS

- Determination of phase diagram for PEG/Na_2CO_3 aqueous biphase systems

- Partitioning behavior of pyrite particles in PEG/Na_2CO_3 and PEG/Na_2SO_4 systems and the effect of pretreatment time, pH, and phase composition.

III. ARTICLES AND PRESENTATIONS

1. X. Zeng, W. McGaulley, and K. Osseo-Asare, "Pyrite Partition in Aqueous Biphase Systems", 72nd Colloid and Surface Science Symposium, American Chemical Society, University Park, PA, June 21-24, 1998.
2. X. Zeng, and K. Osseo-Asare, "Liquid-Liquid Equilibrium in the Water+Polyethylene Glycol+Sodium Carbonate System", (to be submitted to J. Chem. Eng. Data)