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CORRELATION OF STABILITY/RHEOLOGY RELATIONSHIP WITH COAL
PROPERTIES AND CHEMICAL ADDITIVES.

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INTRODUCTION:

Coal-water slurry (CWS) is being considered as a near term replacement for oil in both industrial and utility applications. Selecting an economical, yet technically compatible feedstock for producing highly loaded CWS is important to the commercialization of CWS technology (1). Previous work has shown that the dispersing additives can represent a significant portion of CWS preparation cost (2).

In an effort to establish a criteria for designing and preparing CWS for utilization, the relationships between coal properties and slurry quality must be determined. These relationships will enable the prediction of potential CWS quality for the particular coal candidate from some characteristic(s) of the coal.

The coal content at a given viscosity varies for different coal(3). Thus, to develop a viable coal selection strategy using chemical surfactants as additives, the adsorption of these surfactants by the coal particle surface must be established. This work therefore, intends to screen a number of chemical surfactants and dispersants which can be used in the preparation of coal water slurry. The information derived from this screening together with the coal properties will be used to help develop a prescription to predict the stability of coal slurries.

OVERALL OBJECTIVE:

The overall objective of this project is to perform experiments to evaluate the necessary boundary conditions in the preparation and utilization of Coal Water Slurries (CWS) and also develop a data base for the conceptual analysis of a prescription to predict slurry quality for a given coal candidate.

PROJECT STATUS.

All the items of equipment have been received with the exception of the "Settling Column" which is currently under construction at Louisiana State University, Baton Rouge, Louisiana.

The heats of immersion measurements on Elkhorn #3 (PSOC-1475) as a function of:

Particle size (mesh size range)

Hexadecyl trimethyl ammonium bromide (CTAB) concentration

A function of pH

were made during this past quarter.

Also, the characterization of the surfactants with regard to the determination of the critical micelle concentration (CMC) is continuing. Collection of data from the literature in order to help develop a correlation between the coal properties and the slurry quality is in progress.

HEATS OF (IMMERSION).

The experimental procedure is described in the first quarterly report.

RESULTS.

The average values of the heats of immersion measurements as a function of particle mesh size, CTAB concentration and pH from five measurements and at 95 % confidence level are as shown in Tables 1-3.

Fig. 1 is a plot of the heat of immersion as a function of particle size range. The plot shows that the heat of immersion is dependent on the particle size range. The heat of immersion (on per gram basis) decreases as the particle size decreases. The wetting studies were made using 2% by weight of coal master A-23 (a naphthalene sulfonate) in water. The pH of this was measured to be 8.25 and the surface tension was determined to be 63.8 dynes/cm. In this measurements, the coal samples were found to be completely wet by the solution compared with the measurements in distilled water, where minimal wetting occurred (3).

Heat of Immersion as a Function of Surfactant Concentration.

Heat of immersion measurements were made as a function of hexadecyltrimethyl ammonium bromide (CTAB), a cationic detergent. The results are as shown in Table 2 and Fig. 2. The results show that there is a decrease in the heat of immersion as the concentration of the surfactant increase. A plot of surface tension measurements of these solution as a function of the heat of immersion (Fig. 4) show that the heat of immersion also decreases as the surface tension decreases.

Fig. 3 is a plot of the sedimentation rate of 3 grams of finely ground Elkhorn #3 325 x 400 mesh size in varying concentrations of CTAB. This plot shows that there is a threshold

concentration after which wetting occurs. Comparison with fig. 2, shows that the threshold concentration corresponds to a heat of immersion of approximately -12 cal/gm.

Heat of immersion as a Function of pH.

The effect of pH on the heat of immersion as a function of pH was determined. The pH was altered by the addition of HCl or NaOH to water. The pH range of 1.4 to 9 was considered. In these measurements, the coal was not completely wetted, however, the extent of wetting of the coal particles increased with increase in pH. The results are as shown in Table 3 and fig. 5.

DISCUSSION

Data obtained from the heats of immersion measurements suggests that the pH, particle size and surfactant concentration do play a significant role in the wetting time of the coal particles.

The maintenance of particles in a suspension as individual primary units or their combination into aggregates, agglomerates, or flocs depend on their interaction forces that operate between them. The principal forces that play a significant role in the stability of CWS can be thought of as Electrostatic, Van-der Waals forces and Steric Interactions.

The decrease in the heat of immersion with decrease in particle size, may be related to increased Van-der Waals forces which obviously depend on the surface area of the particles. Also, the decrease in the heat of immersion with pH, may be related to the increase in the surface potential as the pH is increased. Comparison of the surface tension with the heat of immersion (Fig. 4) provides a method of characterizing the wettability of the coal particles in CTAB solution.

WORK PLAN FOR THE NEXT QUARTER.

Heat of immersion as a function of oxidation time of the coal particles and also as a function of the moisture content will be made. Also, the heat of immersion measurements in combination of nonionic surfactants (Igepal) and dispersants such as naphthalene sulfonates will be made. Zeta Potential measurements of the coal slurry will be made as a function of pH in order to determine the

relationship between the surface potential and heats of immersion.

The experiments on adsorption of CTAB molecules on the coal particles surface will be completed and slurry preparation will begin.

TABLE 1.
HEAT OF IMMERSION AS A FUNCTION OF PARTICLE SIZE

PARTICLE SIZE	HEAT OF IMMERSION
Mesh (opening)	Cal gm ⁻¹
20 (0.841 mm)	-12.1518 + 0.6142
80 (0.177 mm)	-21.6330 + 0.4216
100 (0.149 mm)	-26.6026 + 0.4864
140 (0.105 mm)	-32.9184 + 1.0527
200 (0.074 mm)	-54.6264 + 2.0301
325 (0.044 mm)	-80.5604 + 1.5836

TABLE 2.

HEAT OF IMMERSION AS A FUNCTION OF CTAB CONCENTRATION (% W/W)

CONCENTRATION (%W/W)	SURFACE TENSION (DYNES/CM)	HEAT OF IMMERSION (Cal gm ⁻¹)
0.012	48.6	1.9786 + 0.4696
0.0623	44.3	-5.1512 + 0.3657
0.100	39.2	-30.1064 + 1.4391
0.150	33.2	-39.3600 + 0.094
0.200	32.5	-44.6950 + 0.8246
0.300	31.5	-46.34 + 0.3314

TABLE 3.

SEDIMENTATION RATE AS A FUNCTION OF CTAB CONCENTRATION

CONCENTRATION (% W/W)	TIME (HOURS)
0.0	>168
0.1	>168
0.5	>168
0.8	24
0.10	0.25
0.15	0.00139

TABLE 4.
HEAT OF IMMERSION AS A FUNCTION OF pH

pH	HEAT OF IMMERSION
	(Cal gm ⁻¹)
1.42	10.305 + 0.712
3.2	5.9751 + 0.3577
4.8	4.1411 + 0.2184
6.2	-0.583 + 0.2485
7.5	-2.78 + 0.2485
8.8	-10.40 + 0.72

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FIG. 1. HEAT OF IMMERSION AS A FUNCTION OF PARTICLE SIZE RANGE.

FIG. 2. A PLOT OF HEAT OF IMMERSION AS A FUNCTION CTAB CONCENTRATION.

FIG. 3. A PLOT OF SEDIMENTATION TIME AS A FUNCTION OF CTAB CONCENTRATION.

FIG. 4. A PLOT OF HEAT OF IMMERSION (B) AND SURFACE TENSION (A) AS A FUNCTION OF CTAB CONCENTRATION.

FIG. 5. A PLOT OF HEAT OF IMMERSION AS A FUNCTION OF pH.

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