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

Quarterly Progress Report
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PROJECT STATUS:

One of the most important parameters influencing the viscosity of Coal Water Slurry systems is the particle size distribution¹. In a mixture formed of a broad distribution of particles, the void space between densely packed coarse particles will be filled by the fluid and fine particles which will act together as a lubricant between the coarse particles. This effect is very important in the resulting viscosity of the mixture, because excess of coarse particles may create an unstable suspension, and dilatancy may result due to insufficient fines to shield settling and the excessive shear between particles².

For suspension made up of a monodisperse size distribution, the viscosity of the suspension increases with decreasing particle size. In suspensions of fine particles, the surface properties are important due to the increase in surface area and thus, exerts an influence on the viscosity, while larger particle sizes contribute to the viscosity predominately through mechanical interference. As the solid volume concentration in a suspension is increased, the particle size which has the predominant effect on the rheological parameters increase.

Particle size distributions come in great variety. They may be highly peaked at a particular size fraction, very broad and discriminatory as to size or distinctly bimodal. Various mathematical correlating formulae such as the Rosin-Rammler-Bennet distribution, the Gates-Gaudin-Schumann distribution, the log-normal distribution or the Gaudin-Meloy distribution have all been used to describe the behavior of pulverized solids. None of these

models however, provide an ideal description of the behavior of such solids^{3,4,5}.

An important parameter which is closely related to the particle size distribution is the packing efficiency of the solids. As the packing concentration is increased, the viscosity will decrease, and a better lubrication between coarse particles will be achieved.

A methodology has been developed in order to determine the influence of individual particle size fractions on coal water slurry rheology. This involves the determination of the packing concentrations and rheology of the separate particle size fractions; -400 mesh, -400/325 mesh, -325/270 mesh, -270/200 mesh, -200/140 mesh, -140/100 mesh and -100/80 mesh as a function of solids loading.

Through a systematic approach, the packing concentrations of the separate particle size fractions and that of several blends of these sizes have been determined.

The packing concentrations were determined from particle size distribution measurements and a program based on truncated log-normal distribution which has been developed at the Adelphi Center for Energy Studies.

The results are as shown in Tables 1-10, and Figures 1-7.

RESULTS AND DISCUSSIONS:

The particle size distribution measurements together with the calculated packing concentrations reveal that, the packing concentrations increase as the percentage of fines (<325 mesh) increase to a value of 40%. Above 40%, the packing concentration decreases.

PLANS FOR NEXT QUARTER

A Haake RV-20 has been purchased using funds from both the current project and also from the Chemistry Department at Grambling State University. Thus, work is underway to measure the rheology of the -325 mesh as a function of solids concentration. This will be followed by creating new slurries made up by blending different weight fractions of different sizes. The limit of particle size influence on the rheology will then be determined from these rheological data.

REFERENCES:

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Table 1.

PARTICLE SIZE DISTRIBUTION (-270 MESH)	
SIZE MICRONS	WEIGHT % UNDER
188.0	100.0
87.2	100.0
53.5	99.7
37.6	92.6
28.1	77.2
21.5	62.4
16.7	50.6
13.0	38.7
10.1	27.1
7.9	18.7
6.2	12.1
4.8	6.1
3.8	2.0
3.0	0.3
2.4	0.0
1.9	0.0

PACKING CONCENTRATION: 70%

Table 2.

PARTICLE SIZE DISTRIBUTION(-325 MESH)	
SIZE MICRONS	WEIGHT % UNDER
188.0	100.0
87.2	100.0
53.5	99.6
37.6	89.2
28.1	72.6
21.5	58.5
16.7	45.9
13.0	32.6
10.1	21.7
7.9	14.6
6.2	8.3
4.8	3.2
3.8	0.8
3.0	0.1
2.4	0.0
1.9	0.0

PACKING CONCENTRATION: 71%

Table 3.

PARTICLE SIZE DISTRIBUTION(-100 MESH)	
SIZE MICRONS	WEIGHT % UNDER
188.0	100.0
87.2	55.7
53.5	38.7
37.6	33.7
28.1	29.2
21.5	25.8
16.7	22.7
13.0	19.2
10.1	15.3
7.9	11.6
6.2	8.3
4.8	5.1
3.8	2.5
3.0	1.1
2.4	0.4
1.9	0.2

PACKING CONCENTRATION: 74%

Table 4

PARTICLE SIZE DISTRIBUTION(-200 MESH)	
SIZE MICRONS	WEIGHT % UNDER
188.0	100.0
87.2	100.0
53.5	81.7
37.6	64.2
28.1	52.3
21.5	43.2
16.7	34.5
13.0	27.2
10.1	20.4
7.9	14.2
6.2	9.5
4.8	5.1
3.8	1.8
3.0	0.4
2.4	0.1
1.9	0.0

PACKING CONCENTRATION: 72.5

Table 5

PARTICLE SIZE DISTRIBUTION(-140 MESH)	
SIZE MICRONS	WEIGHT % UNDER
188.0	100.0
87.2	100.0
53.5	95.9
37.6	78.1
28.1	65.3
21.5	52.7
16.7	40.9
13.0	32.5
10.1	23.5
7.9	16.1
6.2	11.3
4.8	7.0
3.8	3.2
3.0	0.9
2.4	0.2
1.9	0.1

PACKING CONCENTRATION: 71.4%

Table 6

PARTICLE SIZE DISTRIBUTION(-80 MESH)	
SIZE MICRONS	WEIGHT % UNDER
188.0	100.0
87.2	35.00
53.5	32.1
37.6	28.7
28.1	26.6
21.5	24.3
16.7	21.3
13.0	18.1
10.1	14.3
7.9	10.4
6.2	7.2
4.8	4.3
3.8	2.1
3.0	0.8
2.4	0.3
1.9	0.1

PACKING CONCENTRATION: 80.9%

Table 7

PARTICLE SIZE DISTRIBUTION(23% -325 MESH, 77% -270 MESH)

SIZE MICRONS	WEIGHT % UNDER
188.0	100.0
87.2	81.7
53.5	54.4
37.6	45.6
28.1	36.6
21.5	31.1
16.7	27.0
13.0	22.1
10.1	17.2
7.9	12.8
6.2	8.7
4.8	4.9
3.8	2.1
3.0	0.6
2.4	0.2
1.9	0.1

PACKING CONCENTRATION: 76.9%

Table 8

PARTICLE SIZE DISTRIBUTION(17.6% -325 MESH, 18.8% -270 MESH, 63.8% 140 MESH)

SIZE MICRONS	WEIGHT % UNDER
188.0	100.0
87.2	98.7
53.5	76.1
37.6	63.2
28.1	49.2
21.5	39.4
16.7	31.2
13.0	23.4
10.1	16.5
7.9	11.3
6.2	7.4
4.8	4.1
3.8	1.6
3.0	0.3
2.4	0.0
1.9	0.0

PACKING CONCENTRATION: 72.5%

Table 9
PARTICLE SIZE DISTRIBUTION(33% -325 MESH, 67% -140 MESH)

SIZE MICRONS	WEIGHT % UNDER
188.0	100.0
87.2	99.9
53.5	77.7
37.6	65.2
28.1	53.3
21.5	44.7
16.7	37.6
13.0	30.1
10.1	22.3
7.9	15.7
6.2	10.4
4.8	5.6
3.8	2.4
3.0	0.6
2.4	0.1
1.9	0.0

PACKING CONCENTRATION: 73.2%

Table 10
WEIGHT FRACTIONS AND PACKING CONCENTRATIONS.

WT %>200 MESH	WT% -200/325 MESH	WT% < 325 MESH	PACKING CONCENTRATION.
53.7%	8.5%	37.8%	83.4%
47.7	9.4%	42.9%	83.1%
41.7	9.0%	49.3%	83.6%
43.6%	9.4%	47.0%	76.4%
53%	8.3%	39.7%	85.3%
36.2%	15.4%	48.4%	72.1%
26.5%	18.1%	55.4%	73.4%
9.6%	15.6%	74.8%	69.6%
58.1%	2.2%	39.7%	85.2%

PARTICLE SIZE DISTRIBUTION (-80 MESH)

FIGURE 1

PARTICLE SIZE DISTRIBUTION (-140 MESH)

FIGURE 2

PARTICLE SIZE DISTRIBUTION (-200/270 MESH)

FIGURE 3

PARTICLE SIZE DISTRIBUTION (-200 MESH)

FIGURE 4

PARTICLE SIZE DISTRIBUTION (-325 MESH)

FIGURE 5

PARTICLE SIZE DISTRIBUTION (-270/325 MESH)

FIGURE 6

PARTICLE SIZE DISTRIBUTION

(33 % -325 MESH & 67% -140 MESH)

FIGURE 7

END

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