DOE/PC/91292--T15

RHEOLOGICAL PROPERTIES ESSENTIAL FOR THE ATOMIZATION OF
COAL WATER SLURRIES (CWS).

Quarterly Progress Report
December 15, 1994-March 15, 1995

FRANK OHENE
Department of Chemistry
Grambling State University
Grambling, LA 71245

Technical Project Officer
U. S. Department of Energy
Pittsburgh Technology Energy Center
P. O. Box 10940
Pittsburgh, PA 15236

Work Performed for the Department of Energy Under
Contract #DE-FG22-91PC91292

DISCLAIMER

"This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference therein to any specific commercial product, process or service by tradename, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of the author expressed herein do not necessarily state or reflect those of the United States or Government or any agency thereof."

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

MASTER

RECEIVED
DOE/PC/91292
50 MAY 25 PM 3:09
ACQUISITION & INFORMATION

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

OVERALL OBJECTIVE:

The overall objective of this project is to perform experiments to understand the effect of high shear and extensional properties on the atomization of coal-water slurries (CWS). In the atomization studies, the mean drop size of the CWS sprays will be determined at various air-to CWS. A correlation between the extensional and high shear properties, particle size distributions and the atomization will be made in order to determine the influence of these parameters on the atomization of CWS.

Work Done

During the past quarter, further rheological testing were performed on CWS samples that had been prepared and stored for a period of three months. The testing included low and high shear measurements as well as dynamic oscillatory measurements. The CWS tested were PSOC-1527 from Middle Kittaning, PSOC-1472 from Lower Banner and PSOC-1475 (Elkhorn #3). These tests were performed in order to delineate any differences in rheological properties due to aging, and how this differences will influence subsequent atomization of the slurries.

The test results obtained on PSOC-1527 and 1472, showed slight variations in their rheological behavior when compared to previously obtained data on the same samples [1]. The data obtained on PSOC-1475, however showed no significant variation. The rheological data are shown in Tables 1 and 2.

Stability.

All the samples formed a hard-pack mass after the three month

storage period. The samples were easy to re-disperse. However, samples containing more than 2% additive, A-23M, formed a solid hard cake after this period, and it was difficult to redisperse. All the samples remained completely dispersed during the duration of the rheological studies.

Rheological Studies

The Rheological properties of the CWS were determined using a Haake RV20-M5 (Low Shear), RV20-CV20 (Viscoelasticity) and HVA-6 capillary (High Shear) rheometers. The linear viscoelasticity was measured by subjecting the sample through a small amplitude oscillatory test

The variation of G' , G'' and $\tan(\delta)$ as a function of frequency for the CWS examined, were compared to literature data shown in Figures 1-3. Comparison of the curves labeled in Figures 1-3 are as follows [2]:

- (1) Unlinked molecules, low molecular weight
- (2) Unlinked molecules, high molecular weight
- (3) Partly cross-linked molecules or substance with yield point
- (4) Fully cross- linked substance

Figures 4-6 show oscillatory shear measurements of the CWS samples studied, and Figure 7 is a comparison of their G' values as a function of frequency. The G' data for the CWS examined show characteristics which fall between the curves labelled 2 and 4 in Figure 3. The G' values for PSOC-1472 and 1527 show a strong inter particle-particle interactions compared to that of PSOC-1475.

Table 1.

RHEOLOGICAL PROPERTIES OF CWS (Freshly Prepared).COAL SAMPLE PSOC-1527 & 1472 ($\Phi_{th}=76.5\%$)

Coal	R^2	n	τ_0	K	$\frac{\Phi_{exp}}{\Phi_{th}}$	η_{100} (mPas)
PSOC1472	0.95	0.98	13.41	0.56	82%	484
PSOC1472	0.97	0.93	14.5	0.82	85.3	763
PSOC1472	0.99	0.81	54.34	10.43	78.2	302
PSOC1472	0.97	0.85	37.2	0.06	77.3	286
PSOC1527	0.98	0.92	0	1.18	85.0	502
PSOC1527	0.99	1.12	3.24	0.24	80.2	400
PSOC1527	0.94	0.64	0	1.14	78.8	220
PSOC1527	0.99	0.85	4.02	.35	76.1	214.6

 Φ_{th} is the theoretical calculated packing.

Table 2

RHEOLOGICAL PROPERTIES OF CWS (Stored for a Three-Month period).COAL SAMPLE PSOC-1527 & 1472 ($\Phi_{th}=76.5\%$)

Coal	R^2	n	τ_0	K	$\frac{\Phi_{exp}}{\Phi_{th}}$	η_{100} (mPas)
PSOC1472	0.98	0.84	20.1	1.20	85.3	578
PSOC1472	0.99	0.81	56.34	18.3	78.2	412
PSOC1527	0.98	0.87	8.56	2.18	85.0	604
PSOC1527	0.99	1.35	13.24	3.24	80.2	512

 Φ_{th} is the theoretical calculated packing.

References

1. Ohene, F., Quarterly Progress Report Contract #DE-FG22-91PC91292, September 15-December 15, 1994.
2. Parr Physica Rheology Lectures, March 1993, Houston.

Figure 1. Loss Factor Curves ($\tan \delta$).

Figure 2. Loss Modulus Curves (G'').

Figure 3. Storage Modulus Curves (G').

Figure 4. Oscillatory Data. PSOC-1472 CWS (63%).

Date: 15.04.95, 16:17 Operator: Sample:
Sensor system : Q45 System : CU20

Figure 5. Oscillatory Data. PSOC-1527 CWS (60%).

Date: 15.04.95, 16:14 Operator: Sample:
Sensor system : Q45 System : CU20

Figure 6. Oscillatory Data. PSOC-1475 CWS (61%).

Figure 7. G' Data. PSOC-(1475, 1472 and 1527) CWS.

Date: 15.04.95, 17:12 Operator: Ohene Sample: 75AA1
Sensor system : Q45 System : CU20