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

Quarterly Progress Report
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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, several CWS were prepared and their low shear rheological properties (i.e. rheology as a function of concentration, constant shear and, additive type, stability and slip effect) performed. The stability was determined using a settling column to study the shift in mass of the CWS as a function of time.

Low shear testing of the slurries were used to determine the effect of yield stress on the concentration of the slurries.

RESULTS

Figure 1 shows the sedimentation plot of 65, 63, 60 and 55% CWS of Elkhorn #3 at a pH of 9.5 and containing 0.5% A-23 by weight. The experiment was performed in a settling column having three equally spaced ports from which samples can be with drawn for analysis. In this study, samples were withdrawn periodically from the upper port only and the coal content determined as a function of time for several hours.

The data obtained was used to fit an equation of the form:

$$S(t) = S_o e^{-kst}$$

Where S(t) =is the coal content from the upper port at time, t.

S_o = is the initial Coal Content

k_s = is the sedimentation constant.

Several plots of ln S(t) vs. t, were made from the data and the slope and correlation coefficient determined. For each slurry concentration, four studies were made and the mean sedimentation constant determined. The mean sedimentation constant determined for each concentration is as listed in Table 1. The sedimentation rate was found to increase with decrease in initial CWS concentration.

Low Hear Testing:

The rheological properties of several CWS were evaluated. The slurries contained one of the following additives or a combination of these:

1. Coal master A-23-S, Diamond Shamrock Chemical Co., Anionic high molecular weight condensed polynuclear hydrocarbon.
2. A-23 from Henkel Corporation
3. MCG-23ALS from Morrison Group Corporation

The shear stress/shear rate dependence of the test slurries were determined using MV3, MV2P, MV1, MV1P sensors. This slurries were prepared using coals of different PSD's. Considerable slip effect was noted in the slurries containing larger sized fractions. Table 3 lists the rheological properties of PSOC-1531.

65% solid content slurries containing 75% particle size fractions retained on 100 mesh screen, showed significant change in flow patterns when the sensor was changed from MV3 to MV2P. Rheological evaluations showed a change from dilatancy (MV2P) to pseudoplastic (MV3). The data in Table 2, were obtained from slurries prepared from coal sized fractions passing through 140 mesh. There was no significant change in the flow patterns for these slurries when the sensors were varied. Figures 2 and 3 show the flow behavior of 68.6% CWS using MV2P and MV3 sensors respectively and the rheological data is contained in Table 2. Table 4 contains rheological data on PSOC-1472. The data shows that this coal does not slurry very well.

PLANS FOR THE NEXT QUARTER

Atomization of the CWS and simulated fluids will begin.

Table 1

SETTLING CONSTANTS OF CWS

Coal Content	Settling Constant
65	$-0.055 \pm .003$/day
63	-0.065 ± 0.007/day
60	-0.085 ± 0.005/day
55	-0.112 ± 0.01/day

Table 2

RHEOLOGICAL PROPERTIES OF CWS.

COAL SAMPLE PSOC-1527, pH=9.5

Additive	R^2	n	τ_o	K	Coal Content (%)	η_{100} mPas
0.4% MCG	0.95	0.701	32.29	3.14	68.6	1243**
0.4% MCG	0.95	0.750	19.55	1.81	68.6	812
0.4% A-23	0.86	0.943	26.87	0.505	67.7	771**
0.4% A-23	0.92	0.831	17.56	1.30	67.7	804

Table 3

RHEOLOGICAL PROPERTIES OF CWS.
COAL SAMPLE PSOC-1531, pH=9.5

Additive	R^2	n	τ_o	K	Coal Content (%)	η_{100} mPas
0.4%A-23	0.73	1.100	36.16	0.15	65.1	684*
0.4%A-23	0.95	0.735	20.61	1.49	65.1	662
0.4%A-23	0.25	0.768	43.88	0.80	65.2	817*
0.4%A-23	0.87	0.712	21.35	2.00	65.2	780
0.4% A-23	0.75	1.200	11.11	0.049	64.7	274**
0.4% A-23	0.96	0.646	20.49	1.514	64.7	510
0.4%MCG	0.72	1.005	34.61	0.193	62.8	571**
0.4%MCG	0.85	0.722	6.47	2.447	62.8	813
0.4%LG	0.38	0.926	35.85	0.111	60.1	373**
0.4%LG	0.90	0.553	18.34	2.950	60.1	542

Table 4

RHEOLOGICAL PROPERTIES OF CWS.

COAL SAMPLE PSOC-1472, pH=9.5

Additive	R^2	n	τ_o	K	Coal Content (%)	η_{100} mPas
0.4%A-23	0.52	0.29	44.26	35.2	45	1473**
0.4%A-23	0.92	0.56	10.83	6.61	45	909
0.4%LG	0.38.	0.28	44.10	45.5	43	1945**
0.4%LG	0.89	0.74	12.52	2.75	43	987
0.4%A-23	0.73	0.54	58.17	4.92	49	1017**
0.4%A-23	0.94	0.63	5.89	4.13	49	801
0.4LG	0.94	0.63	9.02	6.30	46.2	1198
0.4%MCG	0.97	0.59	7.31	5.88	41	923*
0.4%MCG	0.65	0.38	50.86	15.0	43	1147**
0.4%MCG	0.90	0.66	10.81	5.00	43	1114
0.4%MCG	0.96	0.64	21.24	11.3	48	2531
0.4%LG	0.93	0.56	21.34	5.05	54	900*
0.4%A-23	0.46	0.26	45.03	55.0	45	2063**
0.4%A-23	0.92	0.61	10.48	7.29	45	1472
0.4%A-23	0.47	0.30	45.39	55.8	47	1970*
0.4%A-23	0.95	0.61	9.58	6.71	47	1202
0.4%A-23	0.81	0.36	35.54	16.7	56	1209***
0.4%A-23	0.96	0.65	7.35	4.39	56	1057
0.4%A-23	0.67	0.38	43.22	17.6	42	1255***
0.4%A-23	0.97	0.75	10.89	1.90	42	686
0.4%A-23	0.76	0.35	52.03	22.7	45	1560***
0.4%A-23	0.95	0.64	6.04	1.92	45	465

NOTE:

The items marked ** refer to evaluations made with MV2P sensor
The items marked *** refer to coal fractions between -60/+140 mesh
The items marked * refer to coal fractions retained on 100/+140 mesh screen
LG- Lignin Sulfonate

FIGURE 1

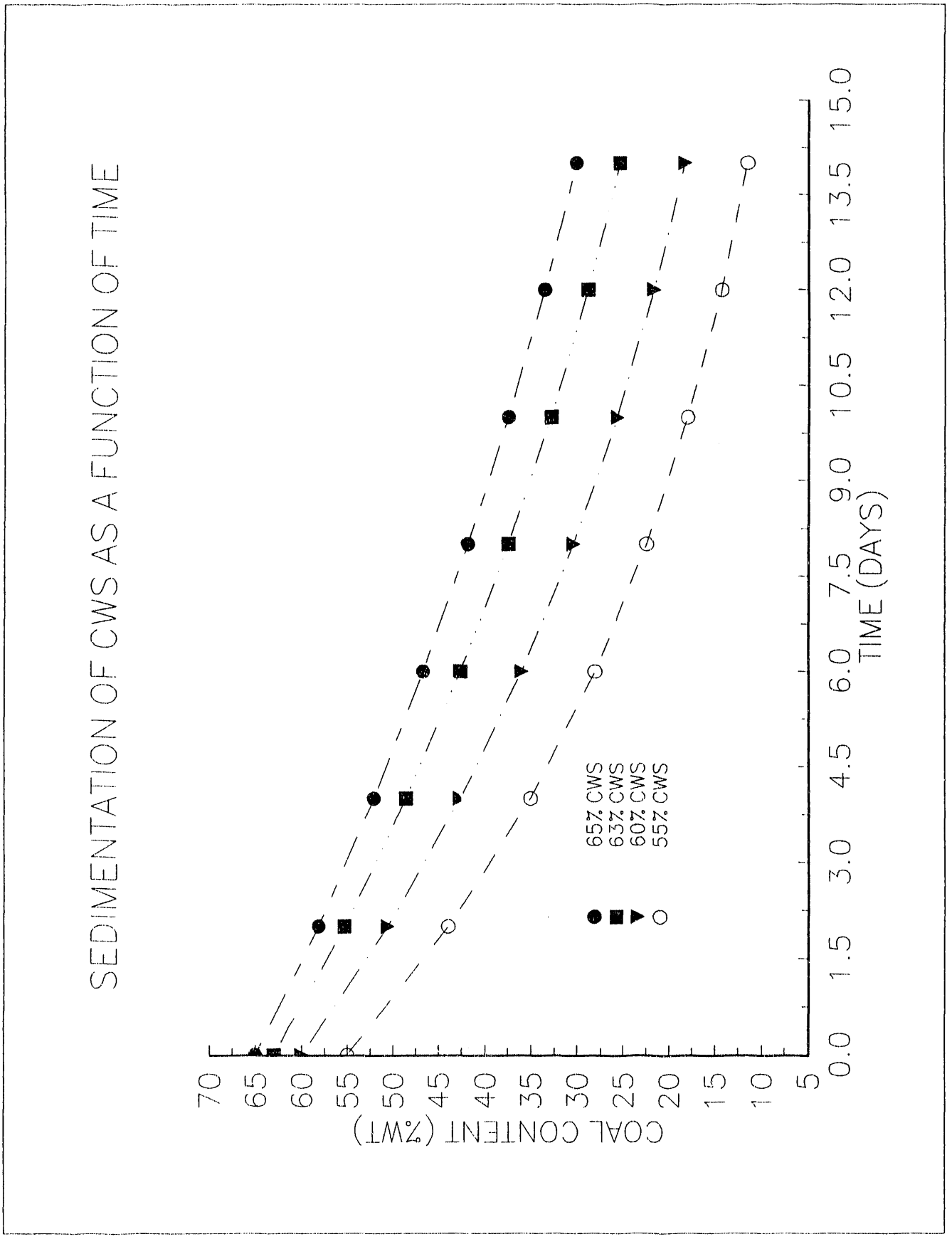

SEDIMENTATION OF CWS AS A FUNCTION OF TIME
COAL CONTENT (%WT)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0.0
1.5
3.0
4.5
6.0
7.5
9.0
10.5
12.0
13.5
15.0
TIME (DAYS)
65% CWS
63% CWS
60% CWS
55% CWS

FIGURE 2

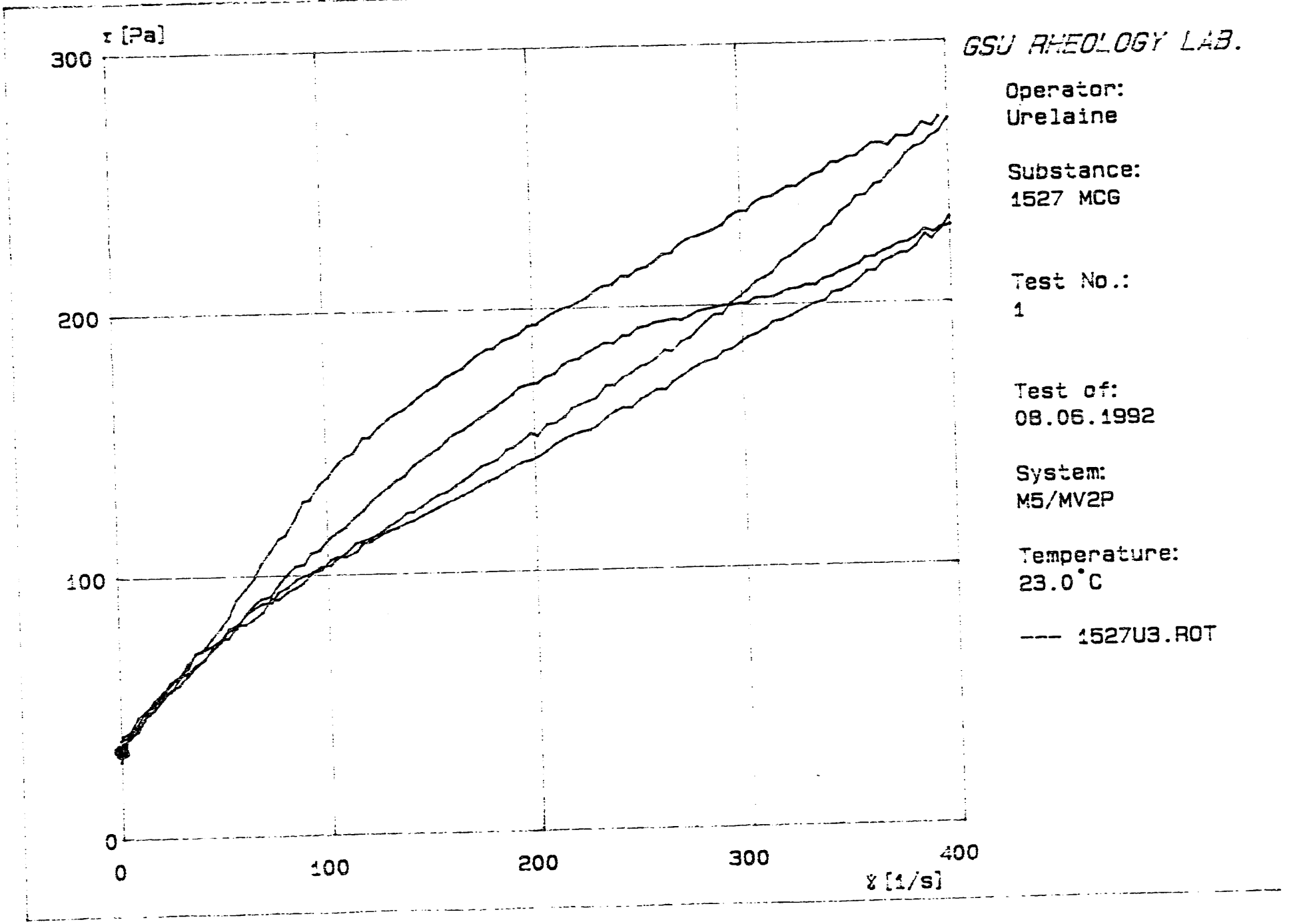
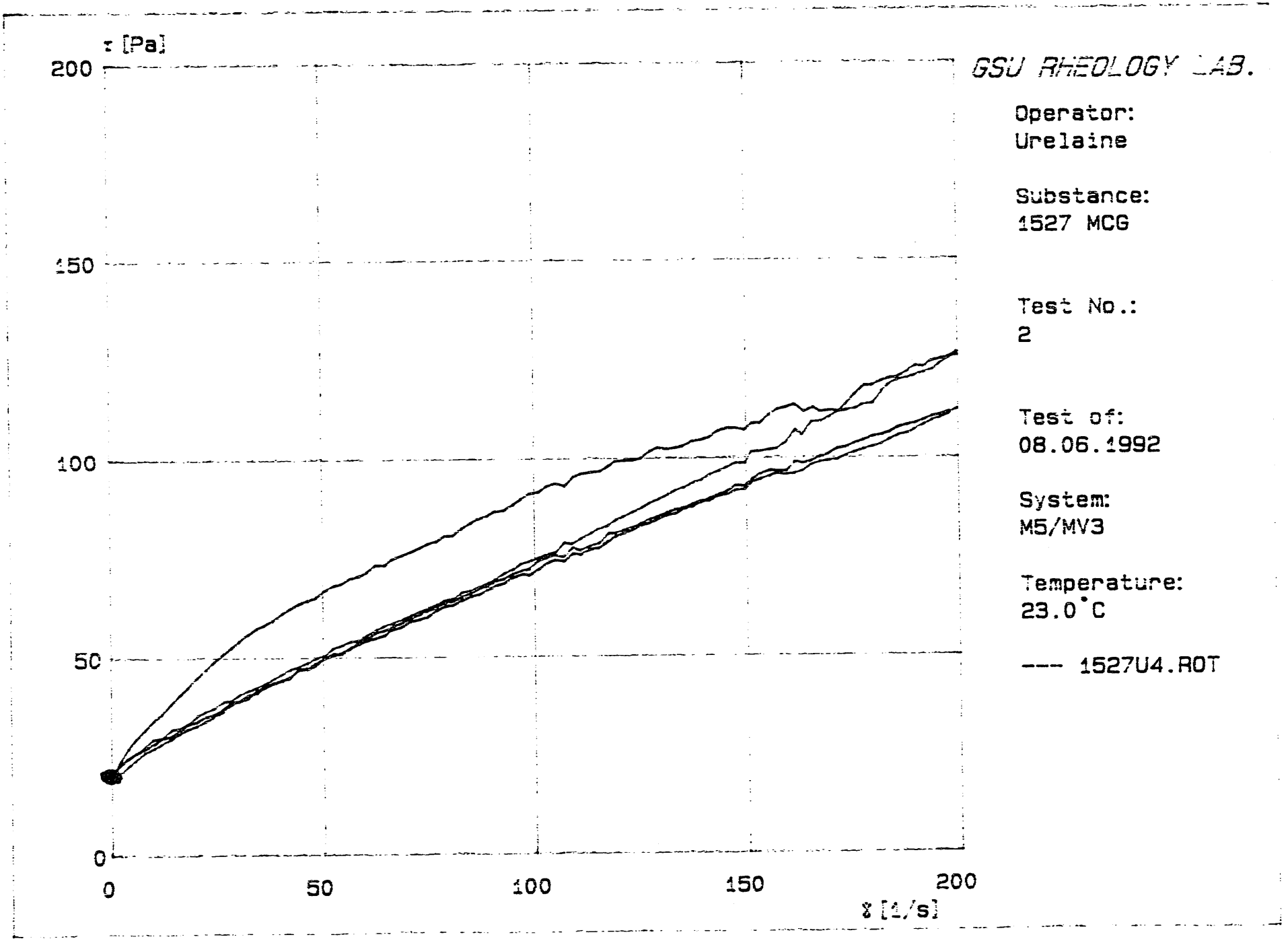

τ [Pa]
300
200
100
0
0
100
200
300
400
γ̇ [1/s]
GSU RHEOLOGY LAB.
Operator:
Urelaine
Substance:
1527 MCG
Test No.:
1
Test of:
08.06.1992
System:
M5/MV2P
Temperature:
23.0°C
--- 1527U3.ROT

FIGURE 3


τ [Pa]
200
150
100
50
0
0
50
100
150
200
γ̇ [1/s]
GSU RHEOLOGY LAB.
Operator:
Urelaine
Substance:
1527 MCG
Test No.:
2
Test of:
08.06.1992
System:
M5/MV3
Temperature:
23.0°C
--- 1527U4.ROT

END

DATE FILMED

10/7/92