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# AN INVESTIGATION OF FUELS CONTAINING COAL-OIL-WATER EMULSIONS

THIRD QUARTERLY REPORT

FOR THE PERIOD

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ABSTRACT

The assessment of five emulsifiers for the production of stable coal-oil-water emulsions and the determination of the practicability of their use in a boiler system is being investigated. Three emulsifiers are on hand, one on order, and the other to be chosen. The Sonic and Gaulin emulsification units are being evaluated and data is produced on the stability of coal-oil-water emulsions produced by these systems. Viscosity data on coal-oil-water mixtures is reported.

ACKNOWLEDGEMENT

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## OBJECTIVE OF PROGRAM

The objective of this research project is to evaluate the combustion of coal-oil-water-lime slurries prepared by five different commercial emulsifiers.

## TECHNICAL PROGRESS

### PHASE I, PREPARATION AND PHYSICAL PROPERTIES

#### 2.1.1. Task 1, Emulsification.

I. Emulsifiers

A. The Gaulin Emulsifier.

The Gaulin Corporation Model 15M-8TA emulsifier is presently under study, and the results thus far are given under Task 2 below.

B. The Sonic Emulsifier.

The Triplex model 1000A Sonic Corporation emulsifier is currently under evaluation. A variable speed drive has been incorporated on the Giant positive displacement pump of the Sonic system. A fore pump, Viking model H32R, has also been incorporated in the system at the suggestion of the Sonic representative. The pump insures that the Giant pumps chambers are full during operation. A discussion of this problem is given under Task 2 below.

C. Total Unit.

No change in status at present. A larger unit has been requested and the Total representative advised that the availability of this unit is being investigated.

D. Cottell Unit.

Due to unresolveable legal problems, Branson Ultrasonic Power Co., model 190, has been ordered to replace the Cottell unit. This unit is similar to the Cottell system and has been ordered with variable chamber volume construction. The Cottell unit purchase order has been cancelled.

E. Fifth Unit.

Information on the Funken unit has not as yet been received.

II. Fuels.

A. Coal - Water Content.

The water content of the 200 mesh coal used on this program was determined by weight loss after heating in an oven for seven hours at 180°F. The measurement yielded a value of 3.7% water. The weight gain of the same sample left in the atmosphere at room temperature for seven hours was 1.2% with an additional gain of 0.2% (total 1.4%) after an additional 20 hours under the same conditions.

2.1.2. Task II, Stability.

I. K-Scan Unit.

A. Final Validity Test, Water Peak.

A K-scan curve is shown in Figure 1 using #6 Hess oil and beaker mixing for the COM. The curve shows two peaks of capacitance verses electrode position from the bottom of the tube. The peak at the bottom is a coal peak. The nature of the peak at the mid-point along the tube was initially unknown. In view of the relatively large influence on the dielectric constant of the COM due to water, one possible interpretation was that the second peak represented a water concentration. This conclusion is also consistant with the relative densities of coal, water, and oil in a separating COM.

Using a Stack-Dean water-oil trap, a direct determination of water concentration was made on the COM. A 1" section, in the region of the second peak, representing 15% of the total test sample, was examined for water content. The average water content of this section was found to be 10.8%, compared to the initial 6% water concentration. The capacitance readings were 0.580 pF and 0.600 pF at the peak value. Since some second peak samples have a maximum value as high as 0.900pF, the K-scan method has indicated that substantial water concentration can occur in some coal-oil mixtures.

B. K-Scan Paper Presentation.

A paper describing the development and use of the K-scan unit for determining coal-oil-water emulsion stability entitled, "Use of Dielectric Properties in the Determination of COM Stability", was presented at the First International Symposium on Coal-Oil Combustion, May 8-10, 1978, St. Petersburg, Florida, sponsored by USDOE and GMC. A copy of this paper is attached as an addendum of this report.

C. K-Scan Validity Check (using a long term stability test sample).

It was of interest to determine the accuracy of the K-scan method for determining coal settling. A series of curves were experimentally produced relating percentage of coal to capacitance rise. A two-hour recycle sample from the Sonic unit containing 45% coal-200 mesh, 55% coal-#6 Gulf oil, and 5% water was scanned after 65 days at 150°F. This scan was then replotted as percent coal verses height in inches from bottom of the tube as shown in Figure 2. The sample was then frozen and sectioned in four places and coal concentrations measured by the filter paper determination method for each section. The results of these determinations are also shown in Figure 2 and are identical within experimental error to the K-scan curve. This determination validates the use of calibration curves for a particular coal-water-oil system to directly relate coal percentages verses height in a K-scan stability test.

II. Emulsion Stability Studies.

A. Sonic Unit.

1. Single Pass Studies.

Four single pass tests were made using the premixing drum as a reservoir.

a. 15% coal, 200 mesh-80% Gulf #6 - 5% water

b. 30% coal, 200 mesh-65% Gulf #6 - 5% water

c. 45% coal, 200 mesh-50% Gulf #6 - 5% water

d. 5% water - 95% Gulf #6 pre-emulsified and 30% coal, 200 mesh. (30% coal, 200 mesh-66.5% Gulf #6 - 3.5% water)

Figure 3 shows the results of the single pass tests which were carried out at 150 to 170°F. All samples separated and settled in about 24 hours at 150°F. The mix D above, where pre-emulsified water-oil was mixed with coal and passed through the Sonic unit showed no improvement over the premixed system (data not plotted). Considerable difficulty was encountered in "tuning" the unit when coal was used, due mainly to the lower flow and accompanying pressure. This problem was attributed to the increase in viscosity of the coal mixtures.

2. Multi Pass Studies.

Since the lower flow was thought to be the main problem, the 45% coal mixture (1-C above) was studied using the Sonic unit in the recycle mode. Three runs were made using 15 minute, 30 minute, and two hour recycle times. Figure 4 presents the results of these tests as determined by the K-scan unit. The data shows the recycle time has a pronounced affect on emulsion stability even though "tuning" was not achieved. The 15 minute recycle run shows complete deterioration in slightly over ten days, whereas the 30 minute recycle run reaches a plateau and slowly settles from that point. The two-hour recycle run has good stability after 50 days at 150°F. The effect of a pump-only 30 minute recycle test shows similar settling to that of the 30 minute recycle run with a slightly higher rate of coal settling.

The measured flow of all the above runs through the emulsifier was approximately one gal/min., which is about 1.7 gal/min. low from the required value for optimum pressure. Since proper operation of the unit requires a flow of 2.4 gal/min., the runs thus far made do not meet the pressure required for optimum sonolator operation. A variable speed drive has been incorporated on the Giant positive displacement pump to boost the pumping rate of the coal-oil-water mixtures. A series of pumping runs were made using #2 and #6 oil. The #2 oil followed the Giant pump specification curve but the #6 oil run was still low in pumping rate, about 50% of the specification curve. The Sonic representative was contacted, and after some discussion, the problem was attributed to the inability of the Giant pump to fill entirely with the viscous #6 oil. This would account for the low flows found in the previous emulsion study runs and is directly responsible for the problems encountered in tuning the sonolator. The problem may be solved by adding a fore pump ahead of the Giant unit to produce a head of 50 to 100 psi at the Giant input. This pressure head should insure the filling of the Giant pump cavities and thereby produce the required flows for optimum Sonolator operation. A Viking model H32R pump has been incorporated in the system as a fore pump, and is presently being evaluated.

B. Gaulin Unit.

1. Studies using 45%-200 mesh coal, 50%-#6 Gulf oil & 5% water.

The Gaulin unit was set up for both recycle and single pass operation. The funnel and pump areas were wrapped with heating tape and insulation.

Figure 5 shows the results of a 40 minute recycle run at 1500 psi and a single pass experiment at 6000 psi both carried out at 155°F. The results of these runs are compared to the same mixture that was prepared in the premixing system (stirred and heated to 155°F. for 15 minutes). Both recycle and single pass samples are stable for at least 20 days with little deterioration. The sample increases in coal concentration to 49% at a point 0.5 inch from the bottom of the sample tube in about 12 hours, and then remains constant with no change to date. The increase in the beginning of the settling test is probable due to large particle coal which settles initially leaving the remaining coal in the emulsion intact. The single pass experiments show that a Gaulin unit could be connected directly in line with a boiler fuel feed system.

2. Recycle Studies using 30% Coal-200 Mesh, 65% #6 Gulf Oil and 5% Water.

A series of tests were made using this mixture where the pressure was varied from 1500 to 4500 psi for recycle run times of up to 60 minutes. Figure 6 shows the results of these experiments. The 1500 psi 40 minute recycle sample deteriorated rapidly, completely separating in 16 hours. The 3000 psi, 40 minute test showed improved stability as did the 4500 psi, 24 minute run. Since the product of the pressure times the recycle time is a measure of the energy input, the curves in Figure 5 for the recycle runs show that stability may be proportional to this value. A 3000 psi, 60 minute recycle test was run to investigate this parameter (pressure times time). This run showed increased stability but did not produce a completely stable emulsion as might be predicted by a plot of the recycle time times pressure verses coal concentration measured at the bottom of a sample tube after 16 hours at 150°F.

The recycle runs using 30% coal have not produced an emulsion as stable as those using 45% coal.

C. Single Pass Studies using 30% coal-200 Mesh and 325 Mesh, 65% #6 Gulf Oil and 5% Water.

Using a 30% coal mixture, single pass operation of the Gaulin unit was carried out at 6000 psi and 10,000 psi using 200 mesh and 325 mesh coal. Figure 7 shows the results of these runs. Single pass operation using 200 mesh coal at 6000 psi produced an emulsion that deteriorated almost completely in eight days, whereas the same mixture run at 10,000 psi showed increased stability as measured by the K-scan unit. The curves show a distinctly slower settling rate, for the higher pressure run. The comparison being 56% verses 43% coal at the bottom of the sample tube after six days at 150°F. for the 6,000 and 10,000 psi runs respectively.

The single pass runs using 325 mesh coal carried out at 6,000 and 10,000 psi, show somewhat better stability than the 10,000 psi run using 200 mesh coal. The difference between the two 325 mesh runs is small, but does show that higher pressure produces a more stable emulsion.

None of the single pass 30% coal runs were as stable as the 45% single pass.

2.1.3. Task III, Viscosity

Figure 8 presents the viscosity data of various coal-oil-water systems. The measurements were made using a Brookfield model LVT viscometer, a type TA spindle and a helipath unit.

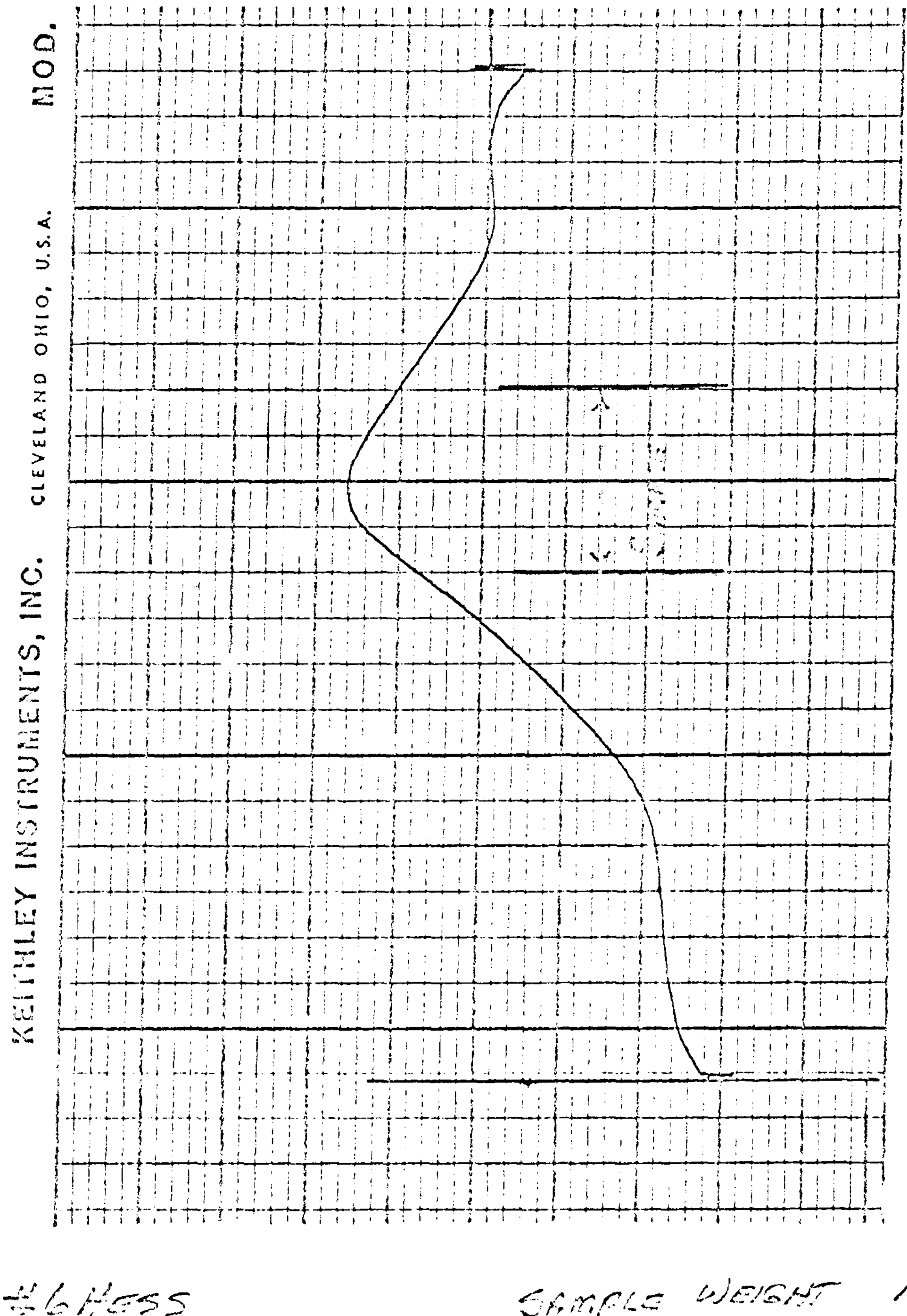
PHASE III BURNER STUDIES

The contract calls for the use of a burner for operation in the boiler range of 40 to 60 HP. This in turn yields a fuel requirement of approximately 12 to 18 gal/hr. Most companies do not manufacture burners this small. A survey of burner manufacturers was made and those contacted among others are as follows:

1. The Cohen Company - This company has an experimental burner that they feel can be properly turned down to 15 gal/min.
2. Peabody Engineering - This company does not have a burner anywhere near this range.
3. Superior Combustion - The smallest burner this company has is 80 HP.
4. Industrial Combustion - This company has no burners less than 100 HP.
5. Keeler Company - This company has nothing smaller than 200 HP.
6. North American Mfg. - This company has a burner they developed that they feel can handle coal-oil mixtures.
7. Trane Thermal - This company has burners that they feel could handle coal-oil mixtures in these ranges.

Burners manufactured by companies, 1, 6, and 7 above are being investigated further as to compatibility with the IBW 40 HP boiler system and coal-oil-water mixture burning feasibility. Upon selection, initial evaluation tests of one or more burners will be performed in the open with a registar for draft air, together with an air atomizing system.

# FIGURE I
## WATER PEAK DETERMINATION




54 % #6 HESS
40 % COAL-200M
6 % WATER

HAND MIX

K SCAN after 24 hrs

SAMPLE WEIGHT 14.9 gms
WATER FROM Sample 1.6 ml.

% WATER IN Sample 10.8 %

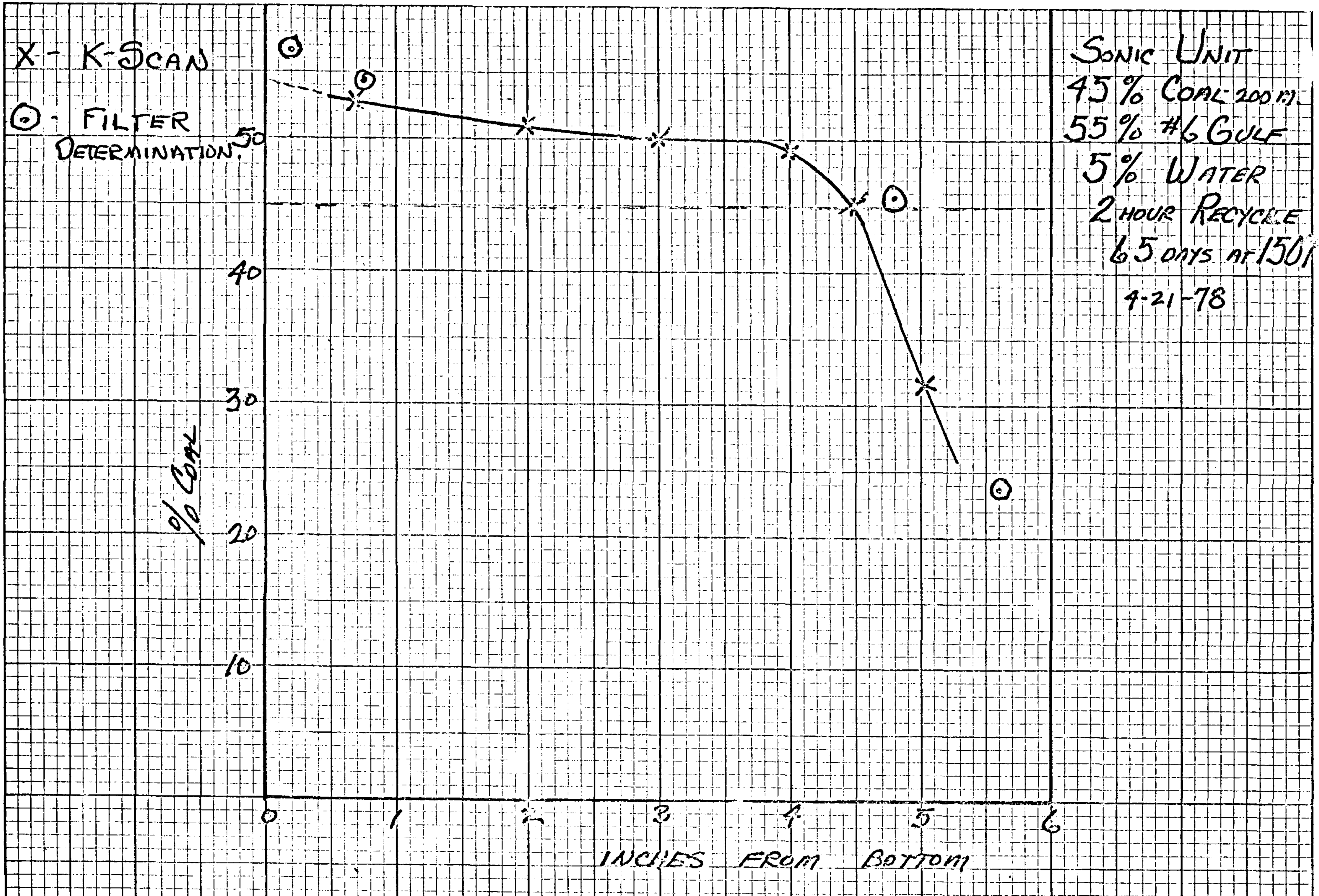



FIGURE 2. K-SCAN VALIDITY TEST

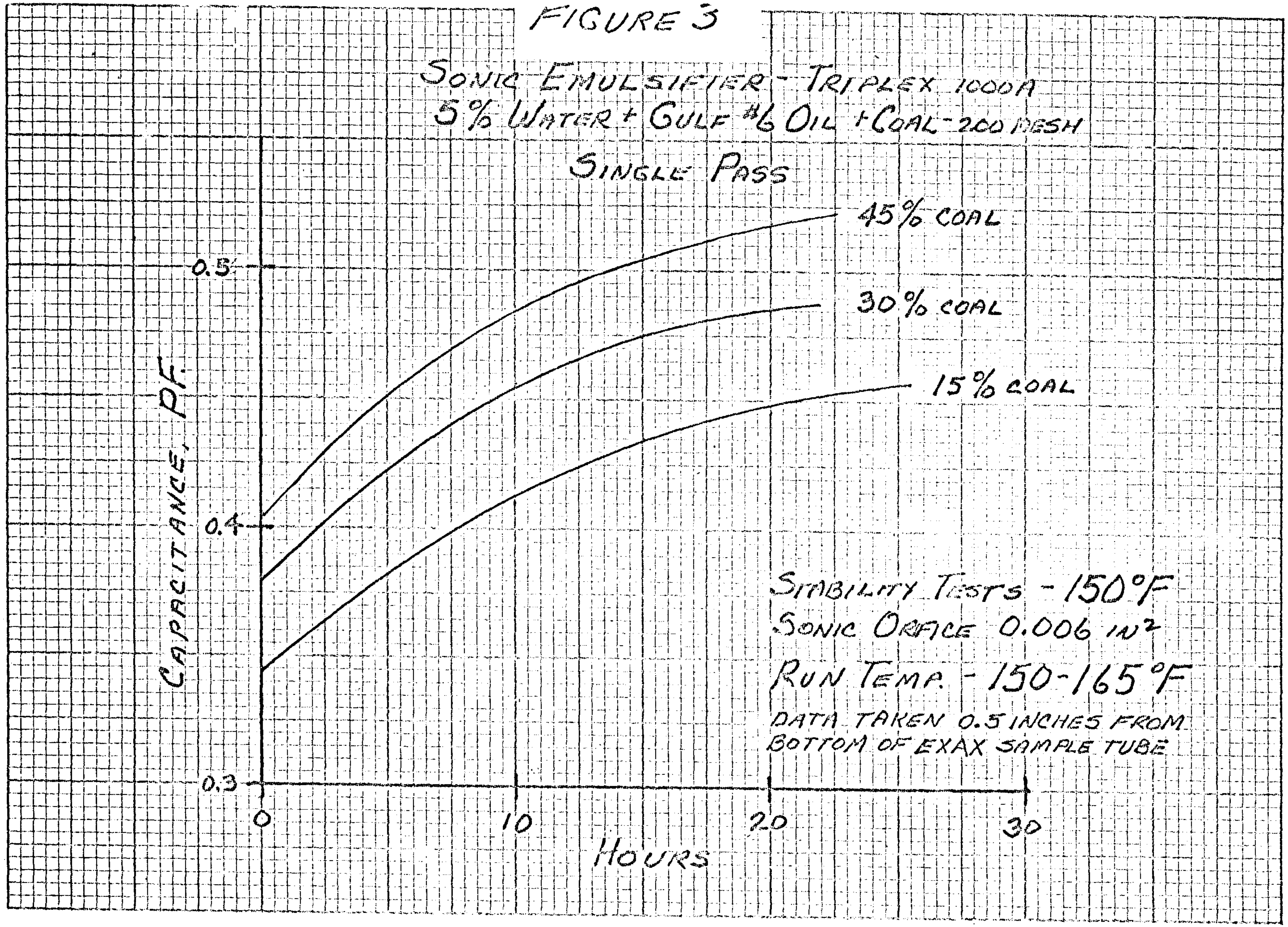


FIGURE 3
SONIC EMULSIFIER - TRIPLEX 1000A
5% WATER + GULF #6 OIL + COAL-200 MESH
SINGLE PASS
45% COAL
30% COAL
15% COAL
CAPACITANCE, PF.
0.5
0.4
0.3
0
10
20
30
HOURS
STABILITY TESTS - 150°F
SONIC ORFICE 0.006 IN²
RUN TEMP. - 150-165°F
DATA TAKEN 0.5 INCHES FROM
BOTTOM OF EXAX SAMPLE TUBE

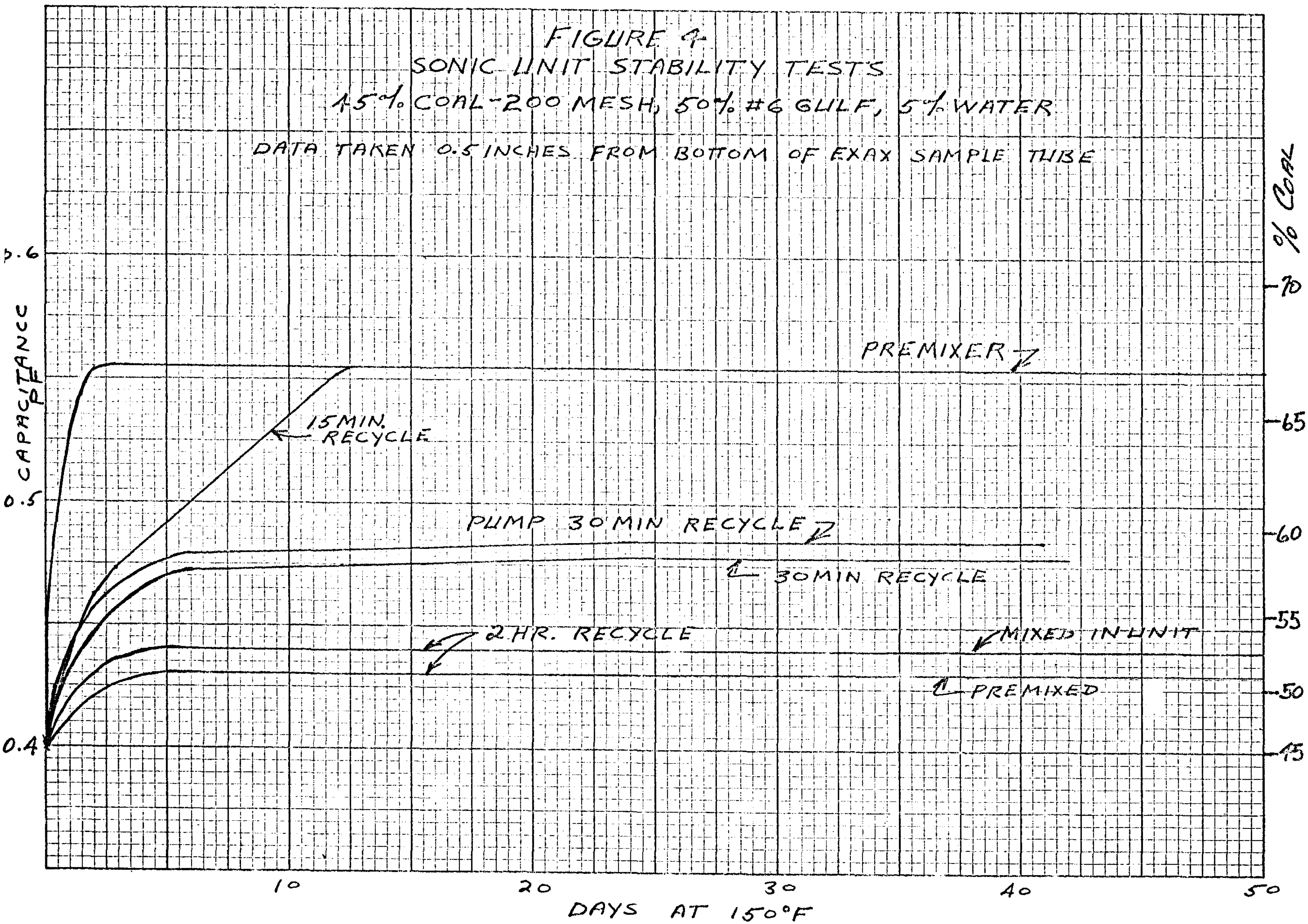


FIGURE 4
SONIC UNIT STABILITY TESTS
45% COAL-200 MESH, 50% #6 GULF, 5% WATER
DATA TAKEN 0.5 INCHES FROM BOTTOM OF EXAX SAMPLE TUBE
CAPACITANCE PF
% COAL
0.4
0.5
0.6
45
50
55
60
65
70
PREMIXER
15 MIN. RECYCLE
PUMP 30 MIN RECYCLE
30 MIN RECYCLE
2 HR. RECYCLE
MIXED IN UNIT
PREMIXED
10
20
30
40
50
DAYS AT 150°F

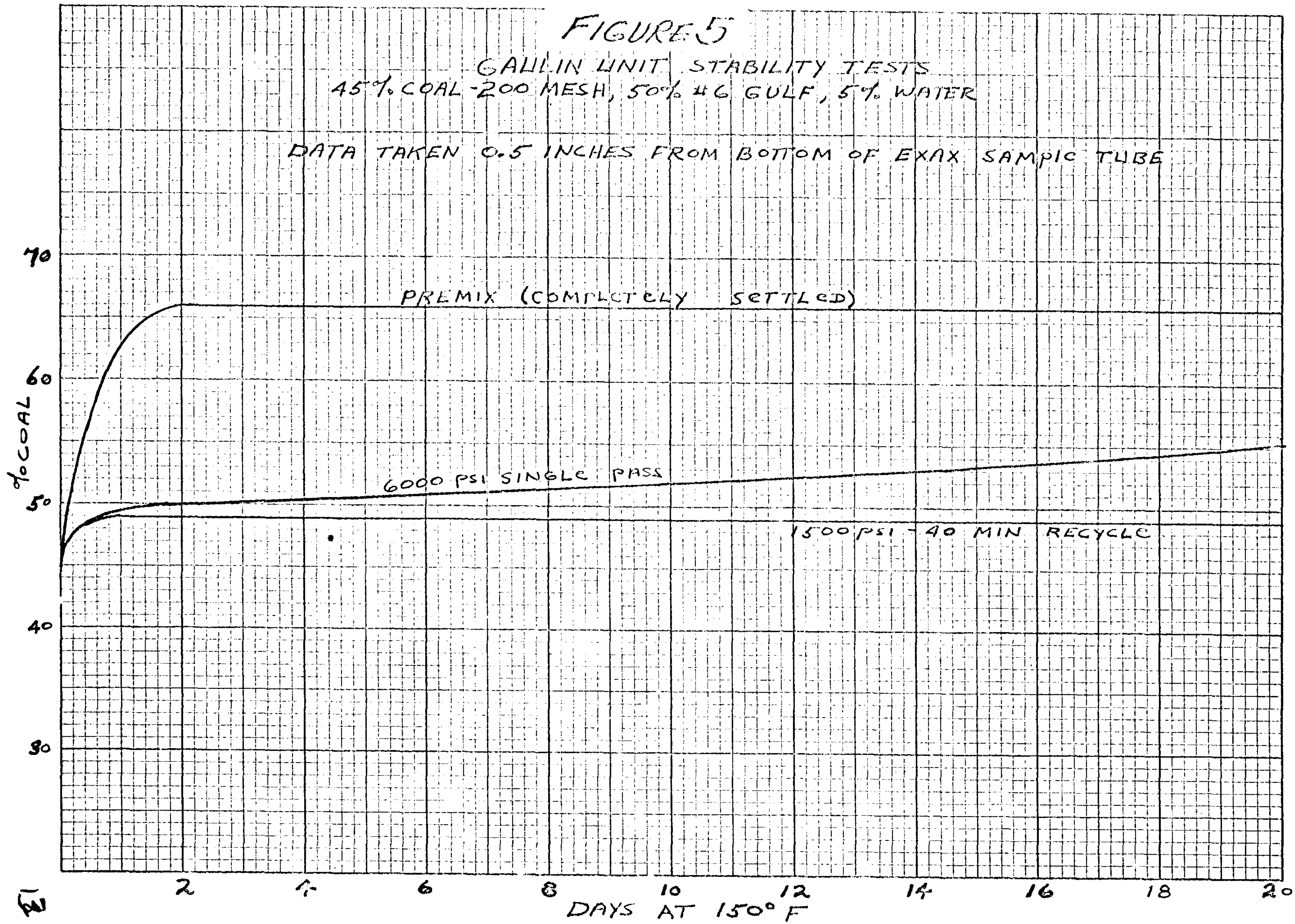


FIGURE 5
GAULIN UNIT STABILITY TESTS
45% COAL -200 MESH, 50% #6 GULF, 5% WATER
DATA TAKEN 0.5 INCHES FROM BOTTOM OF EXAX SAMPLE TUBE
PREMIX (COMPLETELY SETTLED)
6000 PSI SINGLE PASS
1500 PSI - 40 MIN RECYCLE
% COAL
70
60
50
40
30
2
4
6
8
10
12
14
16
18
20
DAYS AT 150° F

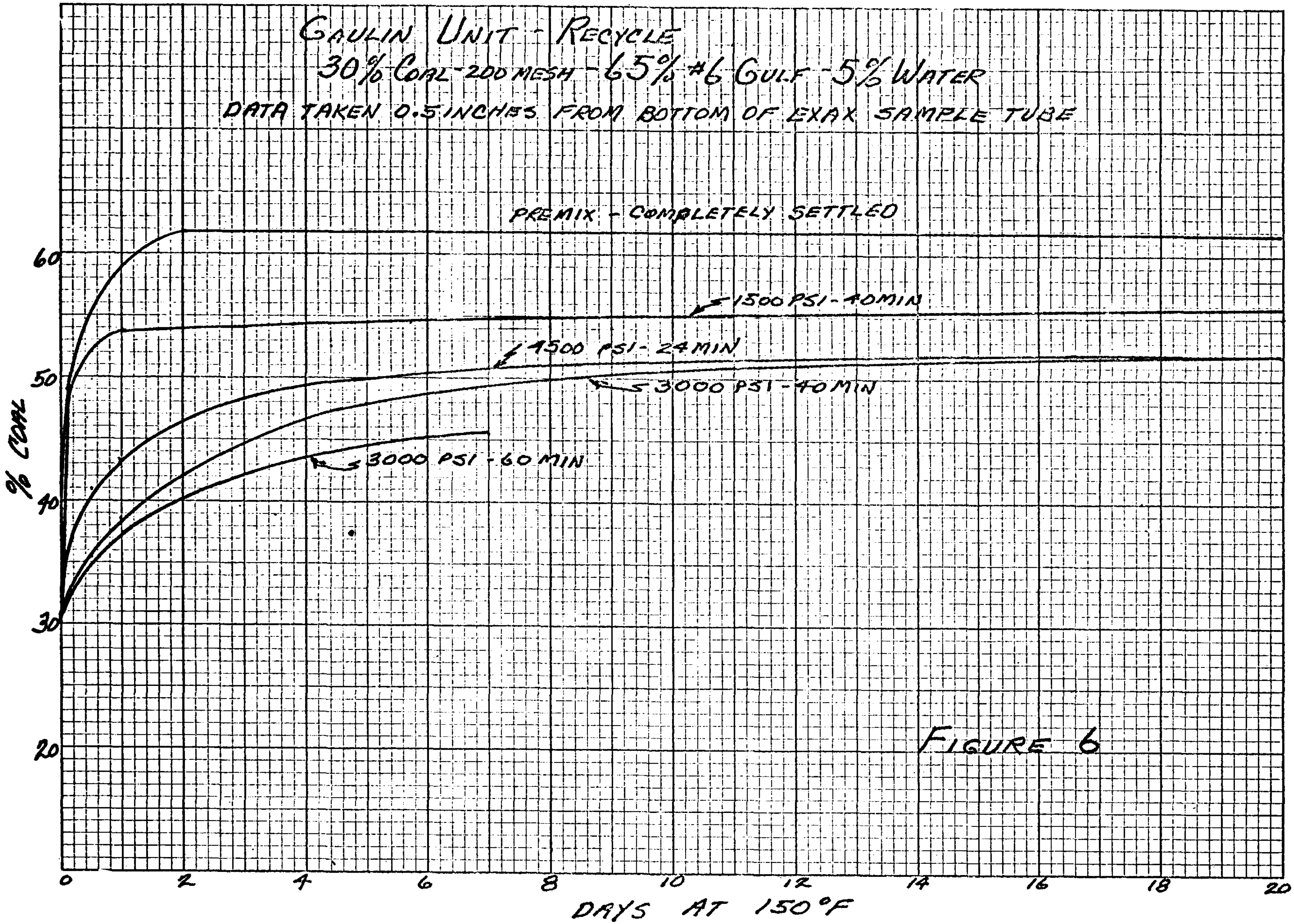
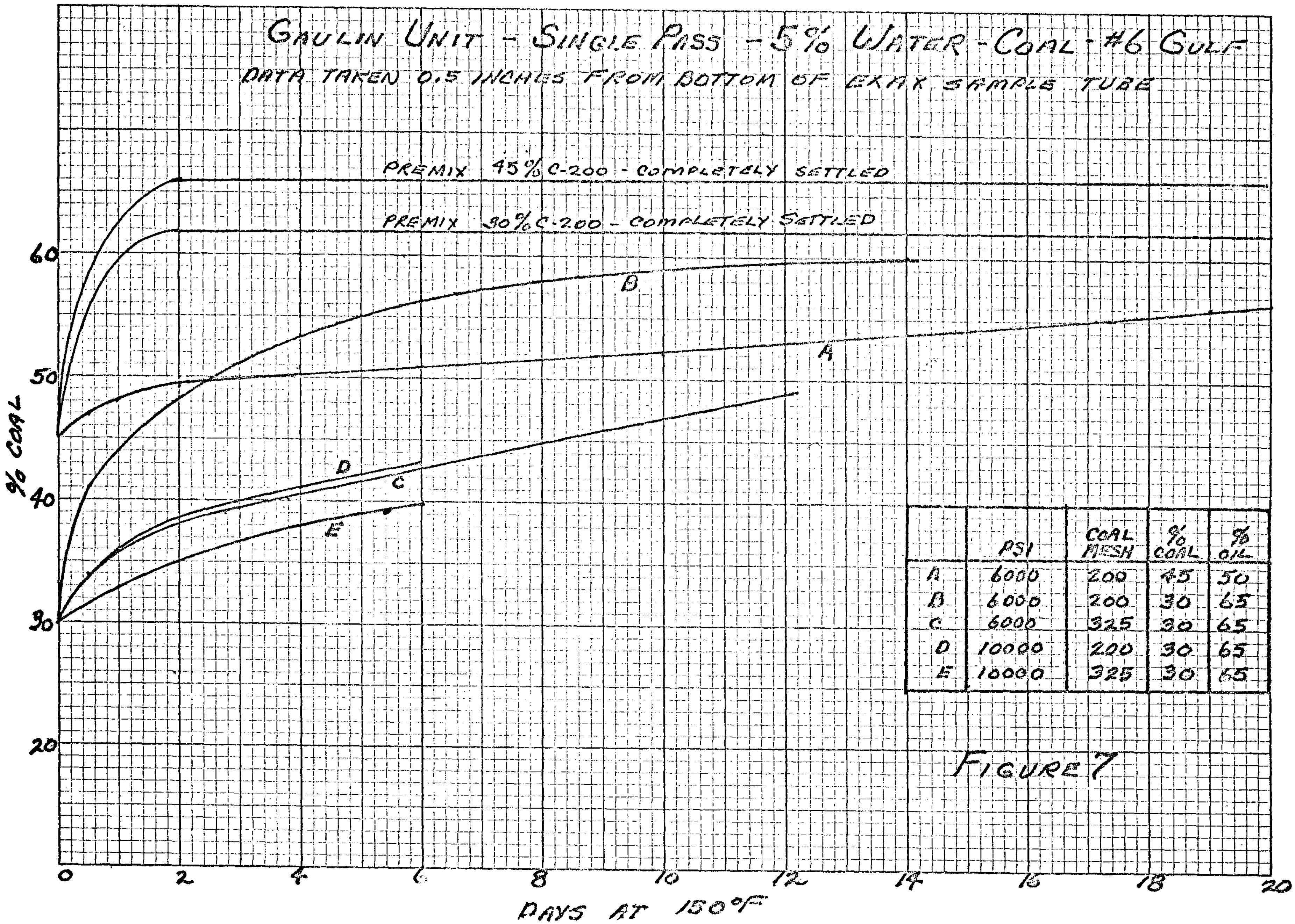
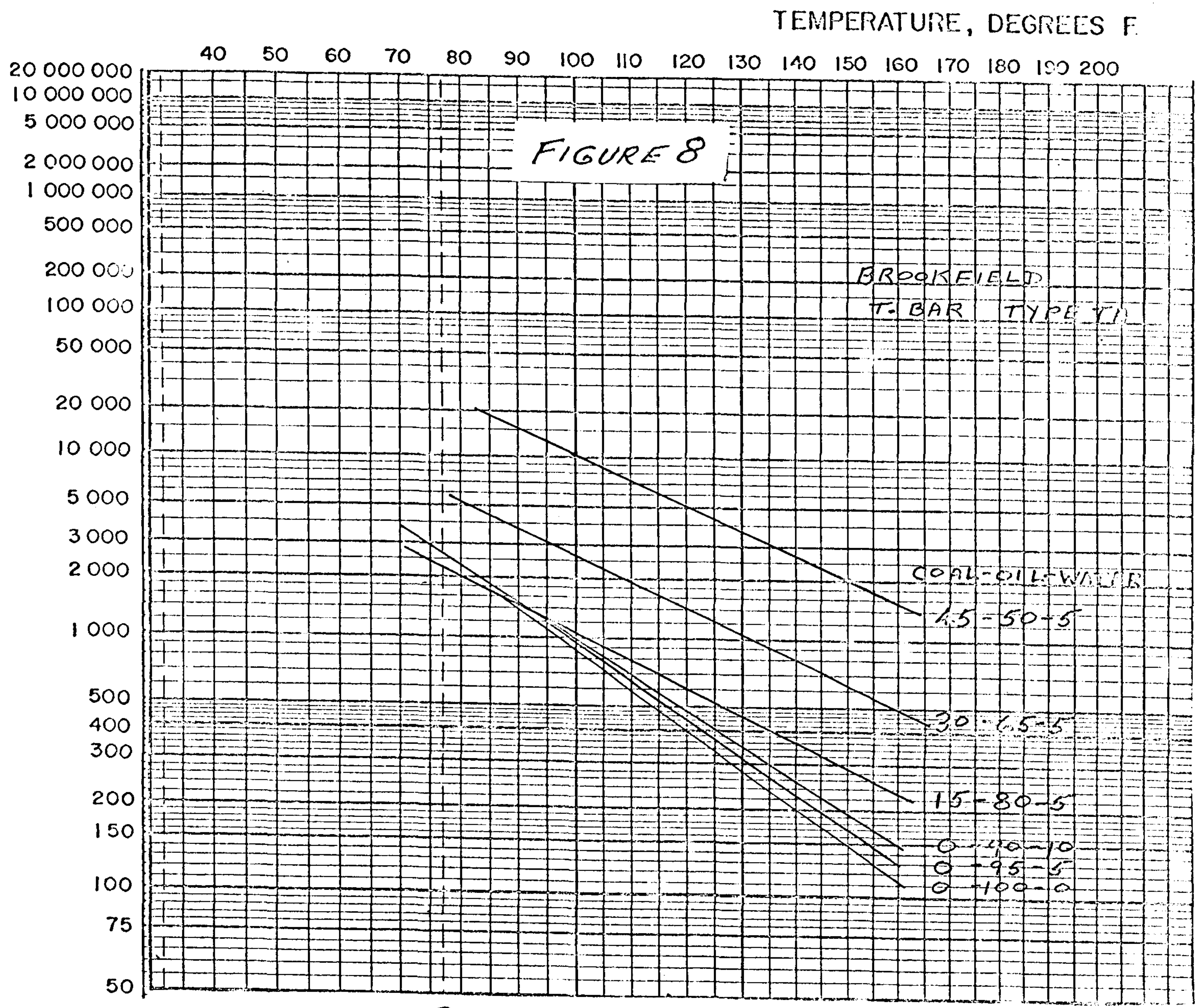

GAULIN UNIT - RECYCLE
30% COAL - 200 MESH - 65% #6 GULF - 5% WATER
DATA TAKEN 0.5 INCHES FROM BOTTOM OF EXAX SAMPLE TUBE
PREMIX - COMPLETELY SETTLED
1500 PSI - 40 MIN
1500 PSI - 24 MIN
3000 PSI - 40 MIN
3000 PSI - 60 MIN
% COAL
60
50
40
30
20
0
2
4
6
8
10
12
14
16
18
20
DAYS AT 150°F

FIGURE 6




| | PSI | COAL MESH | % COAL | % OIL |
|---|---|---|---|---|
| A | 6000 | 200 | 45 | 50 |
| B | 6000 | 200 | 30 | 65 |
| C | 6000 | 325 | 30 | 65 |
| D | 10000 | 200 | 30 | 65 |
| E | 10000 | 325 | 30 | 65 |

FIGURE 7




200 MESH COAL/#6 GULF OIL

# A D D E N D U M

## P A P E R   E N T I T L E D

## U S E   O F   D I E L E C T R I C   P R O P E R T I E S
## I N   T H E   D E T E R M I N A T I O N
## O F   C O M   S T A B I L I T Y

# USE OF DIELECTRIC PROPERTIES IN THE DETERMINATION OF COM STABILITY

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## ABSTRACT

In this paper a scanning capacitor system is described whose read-out is a function of the dielectric properties of non-destructively scanned material. It is demonstrated that these dielectric properties are related to coal particle sedimentation rates and concentration, as well as water droplet distribution in a COM. K-scan curves are presented for water-oil, coal-oil, and coal-oil-water mixtures before and during elevated temperature tests. For these tests the COM's were produced by both cavitating and non-cavitation mixing techniques. In addition, instrument sensitivity, stability, and the importance of dynamic COM stability testing are discussed. The paper concludes with a further discussion of K-scan equipment in process control.

## COAL-OIL MIXTURE PROGRAM AT GERMANTOWN LABORATORIES, INC.

Germantown Laboratories is presently under contract with the Department of Energy, Division of Power Systems, to investigate the use of commercially available mechanical emulsifiers to produce coal-oil mixtures(1). The emulsifiers are used as a complete mixing device for coal, oil, and water. Toward the end of this program additives will be incorporated, in line, to determine the sulfur removal characteristics of this type COM producing system. Each of the emulsifier units used has the ability to generate cavitation in these mixtures in order to insure highly effective mixing techniques(2).

The COM's produced in this manner are to be tested for stability, viscosity, density, and flame characteristics. Following these tests the COM's are to be used as a fuel in a hot water heater where effluent tests and a heat balance study are to be conducted.

Two different coal types are to be used in this investigation, together with different water concentrations, in combination with a #2 oil and then in combination with a "typical" (average viscosity) #6 oil. In the sulfur removal part of the program different calcium and magnesium compounds are to be used as additives.

## STABILITY OF COAL-OIL MIXTURES

The usefulness of a COM as a fuel, in part depends upon its stability or the sedimentation rates of coal and water. Although at present some general guidelines exist for COM stability requirements, no comprehensive set of criteria has been accepted. This is partially due to the large variations in sedimentation rates of COM's produced by different methods and with different compositions. It is also due to the different stability requirements of different end users or systems. Stability variations with temperature shear and vibration, however, that occur in transportation, routine storage or down time, and that are required for pumping and uniform burn, remain the defining requirements. COM sedimentation testing has therefore centered about obtaining improved stability while industry standards are in the process of resolution. The testing methods themselves vary considerably. They include the use of probes, aspirators, pendulums, filtration, ultrasonics, x-ray, and gamma rays. Many of these methods require destruction of the COM test sample, are very time consuming in their use and are neither precise nor accurate. Destructive testing procedures also have the disadvantage of preventing a dynamic display of the sedimentation process. For a program that requires the screening of a great many test samples with an incisive presentation of the sedimentation process and that further requires reasonable precision and accuracy most of these methods are not suitable.

In a program where COM's are produced by mechanical emulsifiers a considerable number of samples require dynamic stability testing. It was therefore found necessary in the program conducted by Germantown Laboratories to develope a stability testing device that automatically and non-destructively scans a COM sample while properties of the components of a coal-oil mixture.

## THEORY OF THE K-SCAN APPARATUS

The fact that properties of the medium surrounding charged particles in part determine the electric field strength is discussed in texts on electricity and magnetism(3). The insertion of a dielectric material between the plates of a capacitor increases its capacitance. If the dielectric completely fills the region in which there is an electric field the ratio of capacitance with the dielectric constant of the medium. If material fills only a part of the space where the electric field exists between the plates of a capacitor the dielectric constant of the material can only be calculated where relatively simple geometries exist. When considerable and complex electric field fringing occurs simple calculations are not adequare to determine the dielectric constant of the medium. An "effective" dielectric constant may be introduced however if different materials are inserted with the same geometry.

The dielectric constant of some materials are functions of temperature and the frequency of the applied electric field. Materials with polar molecules for example have dielectric constants that depend on temperature and frequency. Water molecules are polar and as a dielectric water has a dielectric constant of 81 in an electrostatic field and about 1.8 at optical frequencies. Ionic crystals have dielectric constants that are also frequency dependent.

## K-SCAN INSTRUMENT SYSTEM

The K-scan instrument system operates with a single pair of electrodes each 0.5" high x 1.5" long. Each electrode is curved to form approximately a 90° section of arc and is placed in a recess on the inside surface of a plastic guide tube. The long axis of the guide tube is placed vertical to the ground. A plastic rod is connected to a mechanical drive mechanism that raises and lowers the rod inside the guide tube to form an elevator platform. The COM is placed in a cylindrically shaped flat bottom glass tube that rests on the elevator platform. In operation the elevator raises and lowers the glass cylinder containing the COM past the electrodes. In this way a section of the COM behaves as a dielectric whose dielectric constant changes the capacitance of the capacitor.

In practice 100 cc of a COM is placed in a calibrated color comparison tube with a 2.85 cm i.d. and a 3.15 cm o.d. (Kimble EXAX #45310, 50-100 cc). This tube is then positioned on the elevator in the guide tube. The capacitor-guide tube in turn is located in an oven so that readings may be taken on COM's at various temperatures. The oven also behaves as a Faraday shield. The capacitor electrodes are fed to a capacitance meter with digital read-out (Boonton Model 72BD). This meter has four capacitance ranges from 2.000 pF fs to 2000 pF fs, has an accuracy ± (0.25% rdg + 0.2%fs), and operates at 1.0 MHz. An additional capacitance meter output is fed to a strip chart recorder.

The position of the test sample may be set by manual control of the electric drive or may be elevated or lowered past the electrodes automatically. In the latter mode a scan of the entire dielectric profile of the COM is obtained on the strip chart recorder. The scan may also be sequenced automatically for different intervals such as a scan every two hours at a scanning rate of 1.5"/min. The strip chart recorder is also automatically turned on and off in conjunction with the mechanical scan. A schematic of the K-scan instrument system is shown in Figure 1 and an actual chart record of the change in dielectric constant of a COM along the axis of a test tube is shown in Figure 2.

## K-SCAN OPERATION

In operation, the K-scan equipment has allowed rapid determination of the stability of COM's repeatability and sensitivity have been excellent and some new information on the characteristics of COM sedimentation has been obtained, using this method.

### Effective K

The capacitance of the sensing electrodes is obtained by first disconnecting both condenser leads and zeroing the capacitance meter. The leads are replaced and the capacitance of the sensing capacitor is then read directly from the capacitance meter. In the design that has been used in the present units the measured capacitance is 0.400 pF. Calculated values using an approximation method gave a value of 0.150 pF. Due to the considerable fringing in this design these two values are compatible.

When the EXAX tube is inserted, the capacitance increases by 0.080 ± 0.002 pF along the entire length of the glass tube, except at the bottom. At the bottom, the capacitance reading is further increased by 0.015 ± 0.002 pF due to the thickness of the glass bottom of the tube together with the effect of the top of the plastic elevator platform entering the electric field. The effective K is therefore 1.2 along the length of the EXAX tube.

If the tube is now filled with distilled water at room temperature there is an additional increase of 1.200 pF in the capacitance. This gives an effective K of about 3.5 for water in this system. This value is to be expected for water at the operating frequency of 1.0 MHz.

Different oils yield different values of effective K at room temperature. K. H. White - Oceola oil for example increases the capacitance above the glass tube value of 0.180 pF. This gives an effective K of 1.4 for this oil.

Effective values of K for coals are not determined by directly filling EXAX tube with coal. The influence of coal as a dielectric is obtained through the use of calibration curves.

Calibration Curves

A crucial feature of this type sedimentation detection is the extent to which the read-out changes with changes in the coal concentration of a COM. The ratio of the change in the capacitance meter read-out to percentage coal concentration changes, is defined as the sensitivity of the system. To obtain values of sensitivity, calibration curves are obtained by plotting the variation in capacitance as the coal burden is increased in a COM. Figure 3 is a calibration curve using EXXON #2 oil and 200 mesh Pittsburgh seam coal. At the frequently used value of 40% coal the sensitivity is approximately 4 mpF/1.0% coal. Figure 4 shows a similar curve using Gulf #6 oil. The sensitivity using this oil is about 2 mpF/1.0% coal at the 40% coal burden level. A 2.5 mpF/1.0% coal sensitivity was also obtained using K.H. White oil in a COM composition of 40% coal, 6% water, and 54% oil.

To further indicate the sensitivity of this system a sedimentation curve was obtained by positioning the electrodes at 0.75" from the bottom of the tube. The curve in Figure 5 shows the change in capacitance with time as the coal settled to the bottom of the tube with a 30% initial coal burden. For an eight hour sedimentation time the curve shows a 4% increase in coal concentration, with a sample at room temperature.

WATER PEAK DETERMINATION

During some initial work in this program use was made of a Hess #6 oil. This oil actually has a viscosity of a typical #5 oil. Therefore, coal sedimentation rates using this oil should be higher than when using oils with more typical #6 oil viscosities. In Figure 6 K-scan curves are shown, using #6 Hess oil and beaker mixing for the COM, with time as a parameter. The curves show the development of two peaks of capacitance verses electrode position from the bottom of the tube. The peak at the bottom is a coal peak. The nature of the peak that moves toward the mid-point along the tube was initially unknown. In view of the relatively large influence on the dielectric constant of the COM due to water one possible interpretation was that the second peak represented a water concentration. This conclusion is also consistant with the relative densities of coal, water, and oil in a separating COM.

Partial verification of this assumption was obtained with the K-scan and coal concentration curves that appear in Figure 7. The K-scan in this case was done on a plastic tube that was sectioned at the end of the temperature run. Coal concentration was then determined by the filtration method on selected sections along the tube. The coal concentration curve is essentially parallel to the K-scan curve except in the region of the second peak.

Using a Stack-Dean water-oil trap a direct determination of water concentration was made on a similarly prepared COM. A 1.0" section, in the region of the second peak, representing 15% of the total test sample, was examined for water content.

The average water content of this section was found to be 10.8%, compared to the initial 6% water concentration. The capacitance readings were 0.580 pF and 0.600 pF at the extremes of the section and 0.660 pF at the peak value. Since some second peak samples have a maximum value as high as 0.900 pF, the K-scan method has indicated that substantial water concentration can occur in some coal-oil mixtures.

One of the mechanical emulsifiers used in this program is a Sonic Corporation Triplex Model 1000A. The COM composition that produced the water peak was passed through this particular emulsifier. K-scan comparison results, with time as a parameter, of beaker mixing verses emulsifier mixing are shown in Figure 8. The water peak with emulsifier mixing did not appear. This is a consistent with the ability of this type emulsifier to produce small water droplets that do not readily coalesce to form a large water concentration.

Effect on COM Stability by Emulsifier Mixing

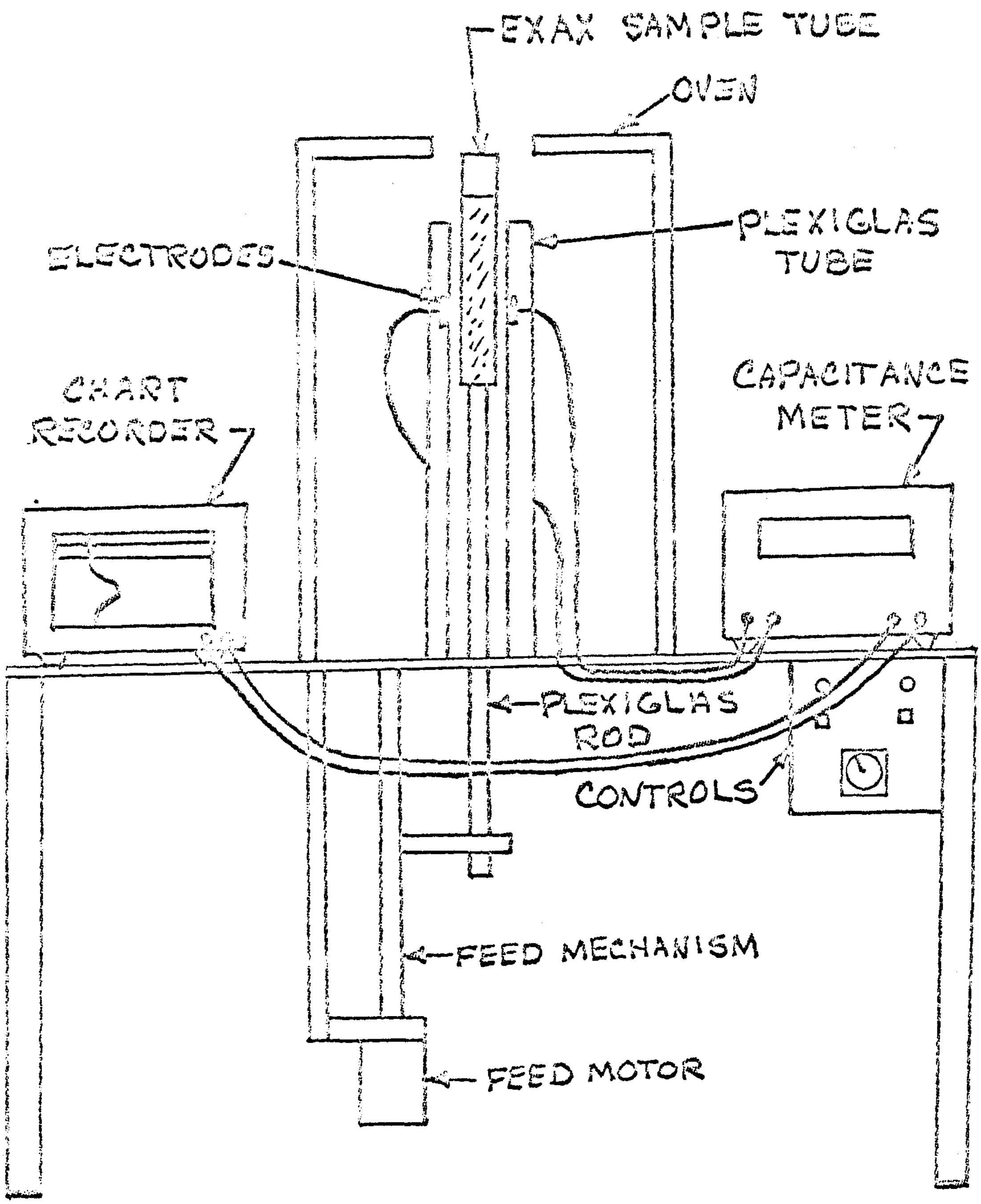
The K-scan stability testing system is now routinely used in the COM program at Germantown Laboratories. In addition to its use in demonstrating improved water stability of a COM by using a mechanical emulsifier, the K-scan system has been used to demonstrate improved coal stability. Figure 9 shows K-scan curves of COM stability where the COM's were made with single pass and multiple pass operation of the Sonic unit. Decidedly decreased sedimentation rates are indicated on the K-scan with multipass operation. The use of this type of stability testing system is scheduled for operation with all of the mechanical emulsifiers that are to be investigated in this program.

## CONCLUSIONS

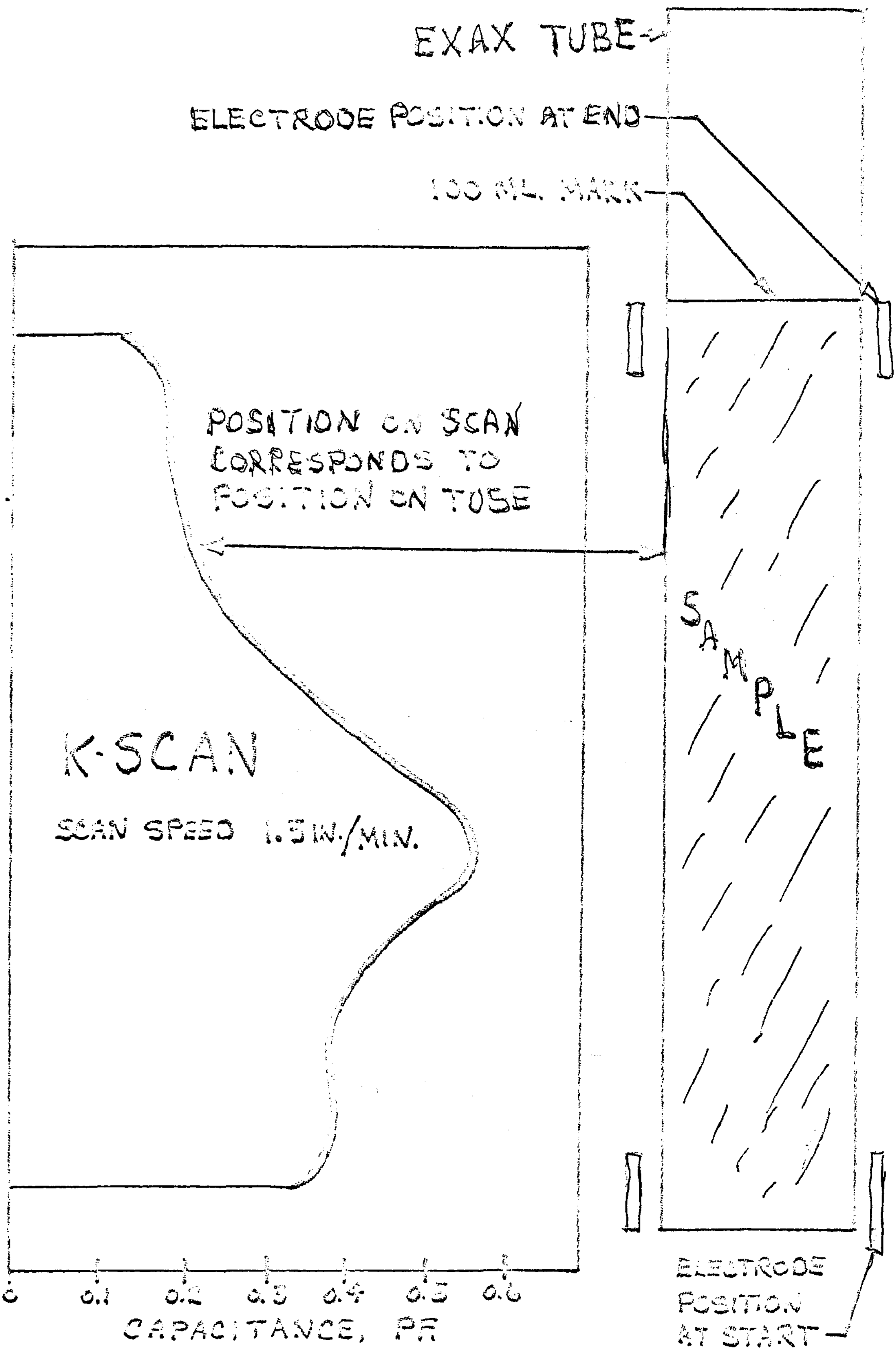
In our program we were confronted with stability testing of a great many samples of COM's. In addition, a testing method was required that would dynamically permit some insight into the COM sedimentation process, so that judicious decisions could be made concerning program developments. The K-scan method has met these requirements to date. More correlation work, however, is required for more complex K-scan curves. This is not a particular requirement for two component systems such as water mixtures produced by different methods.

It has been suggested that the K-scan method might be used as a process control device in systems using COM's as fuels[4]. In such cases feed-back loops are nominal accessaries to these devices. Multi-frequency units may also be used to extend the versatility of K-scanning.

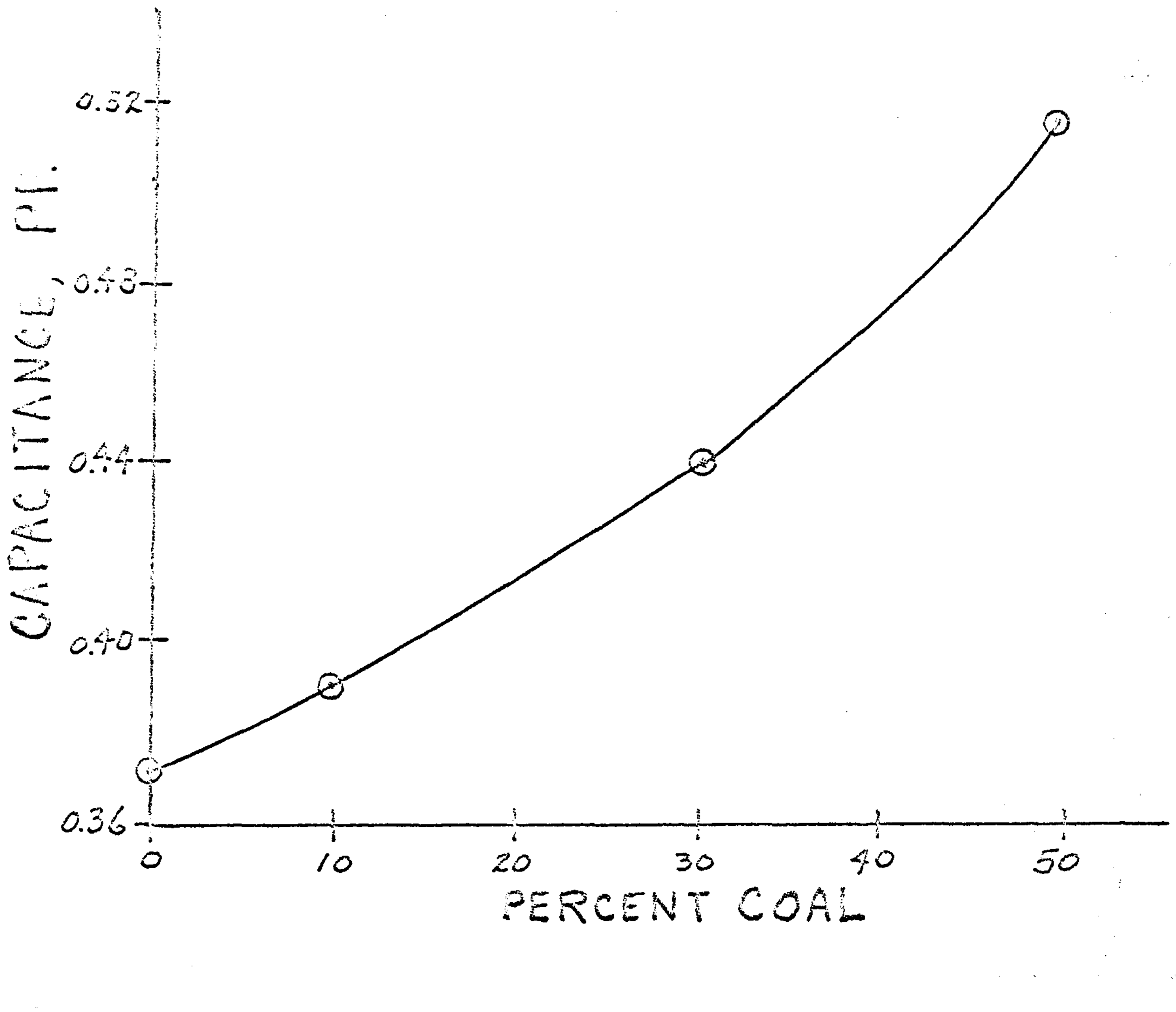
Cherry, N. Figure 1. K-Scan Equipment Schematic.



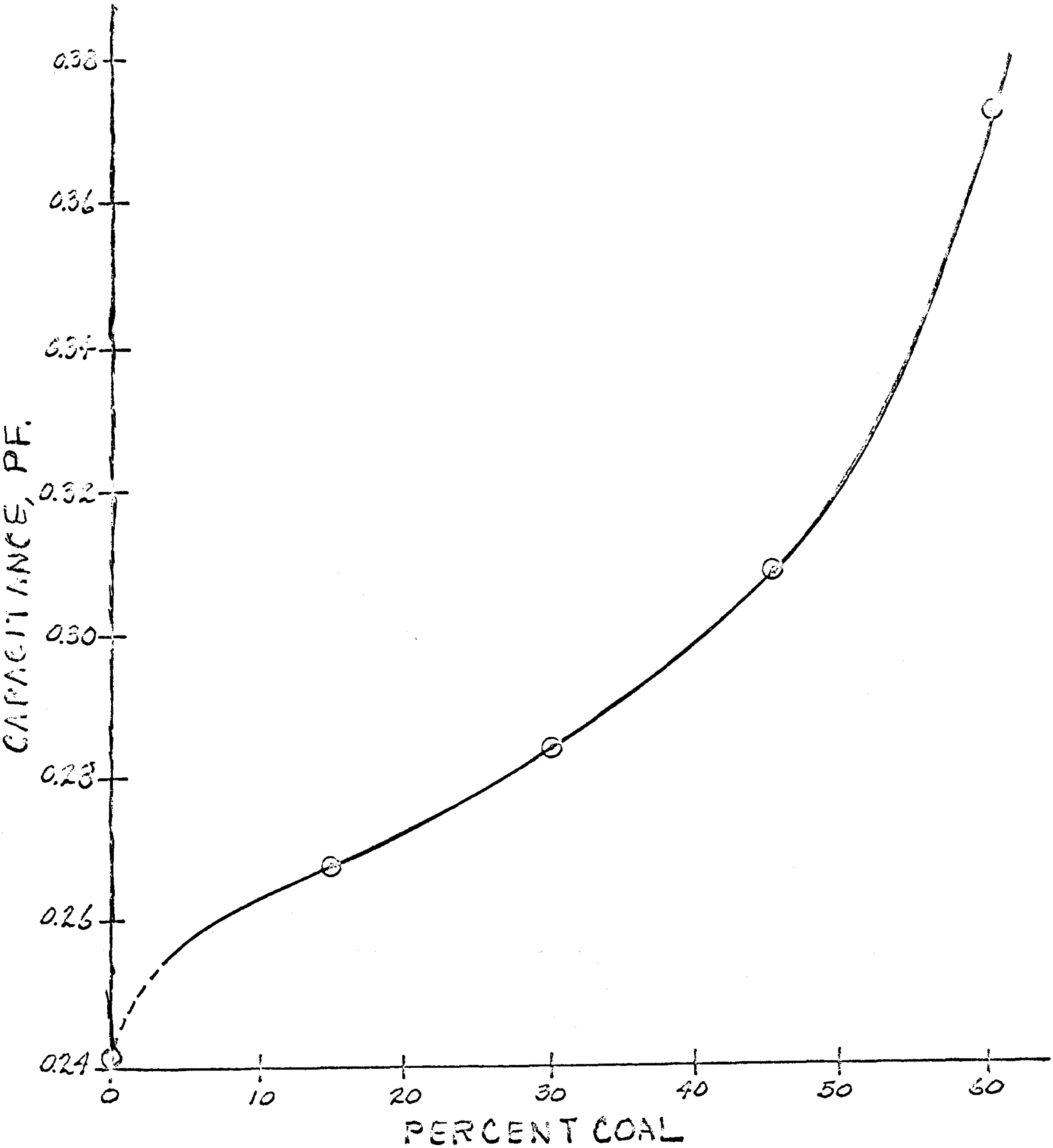
Cherry, N. Figure 2. K-Scan Along Tube Axis.



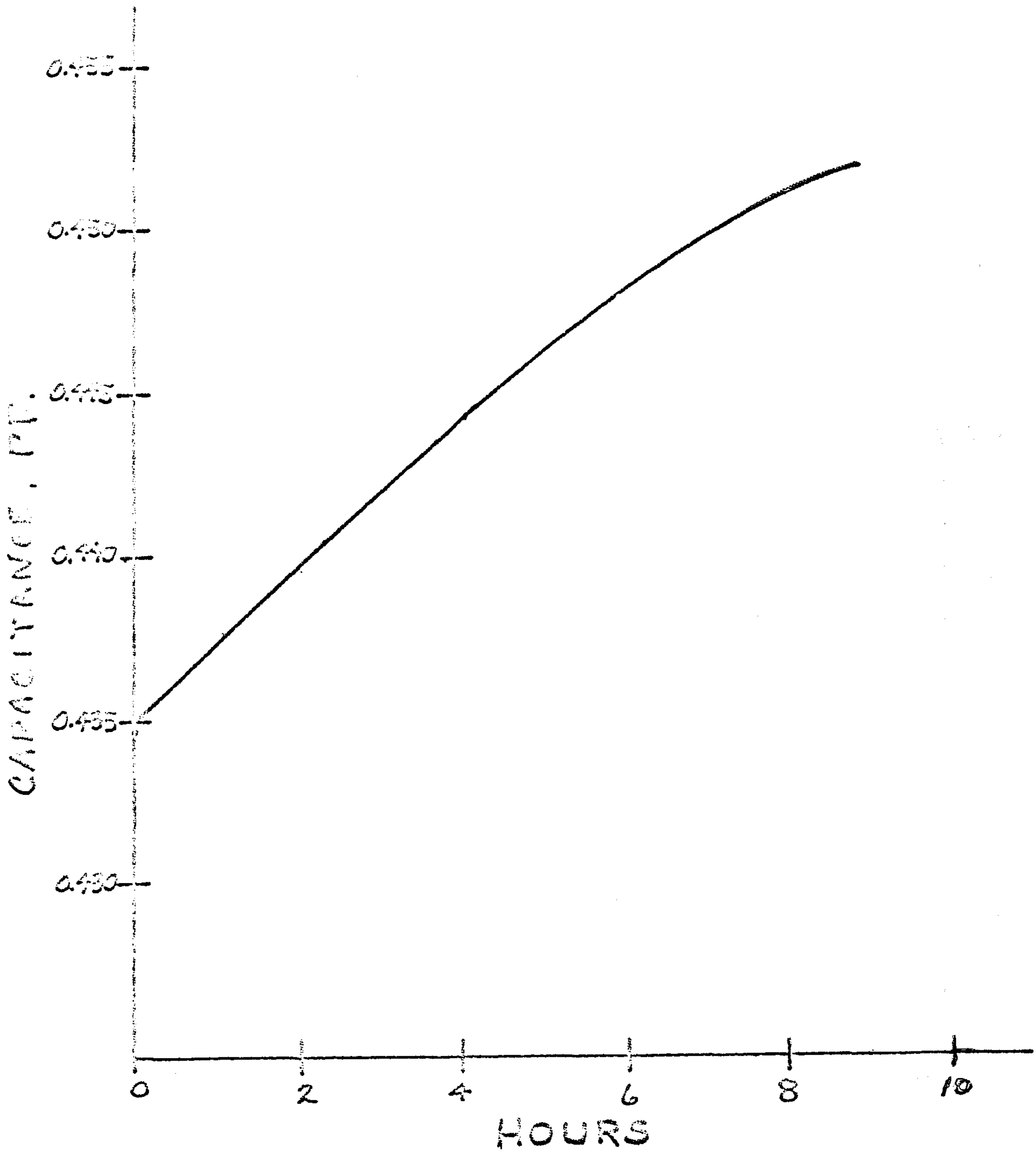
Cherry, N. Figure 3. Capacitance vs Coal Concentration in EXXON #2.



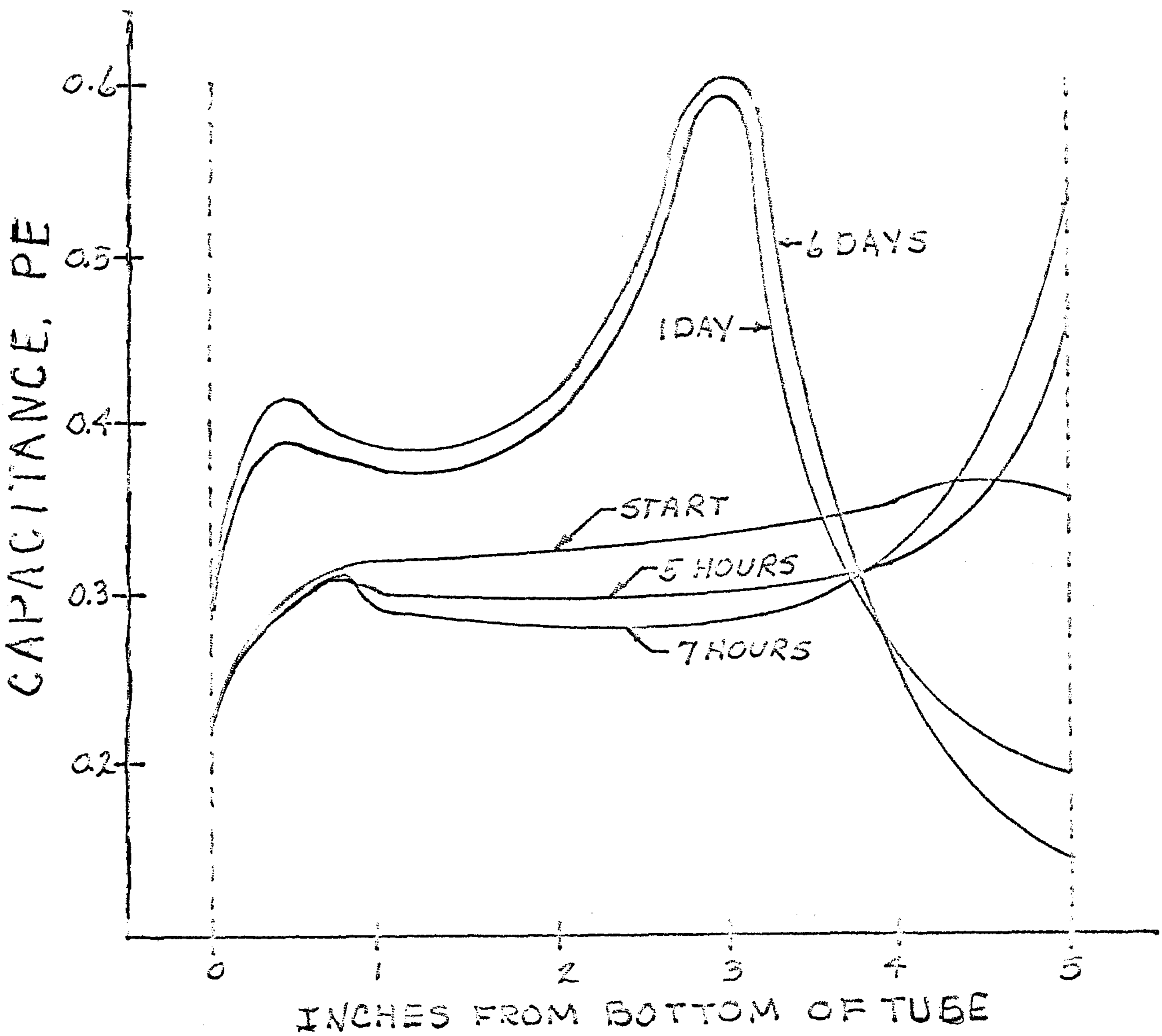
Cherry, N. Figure 4. Capacitance vs Coal Concentration in Gulf #6.



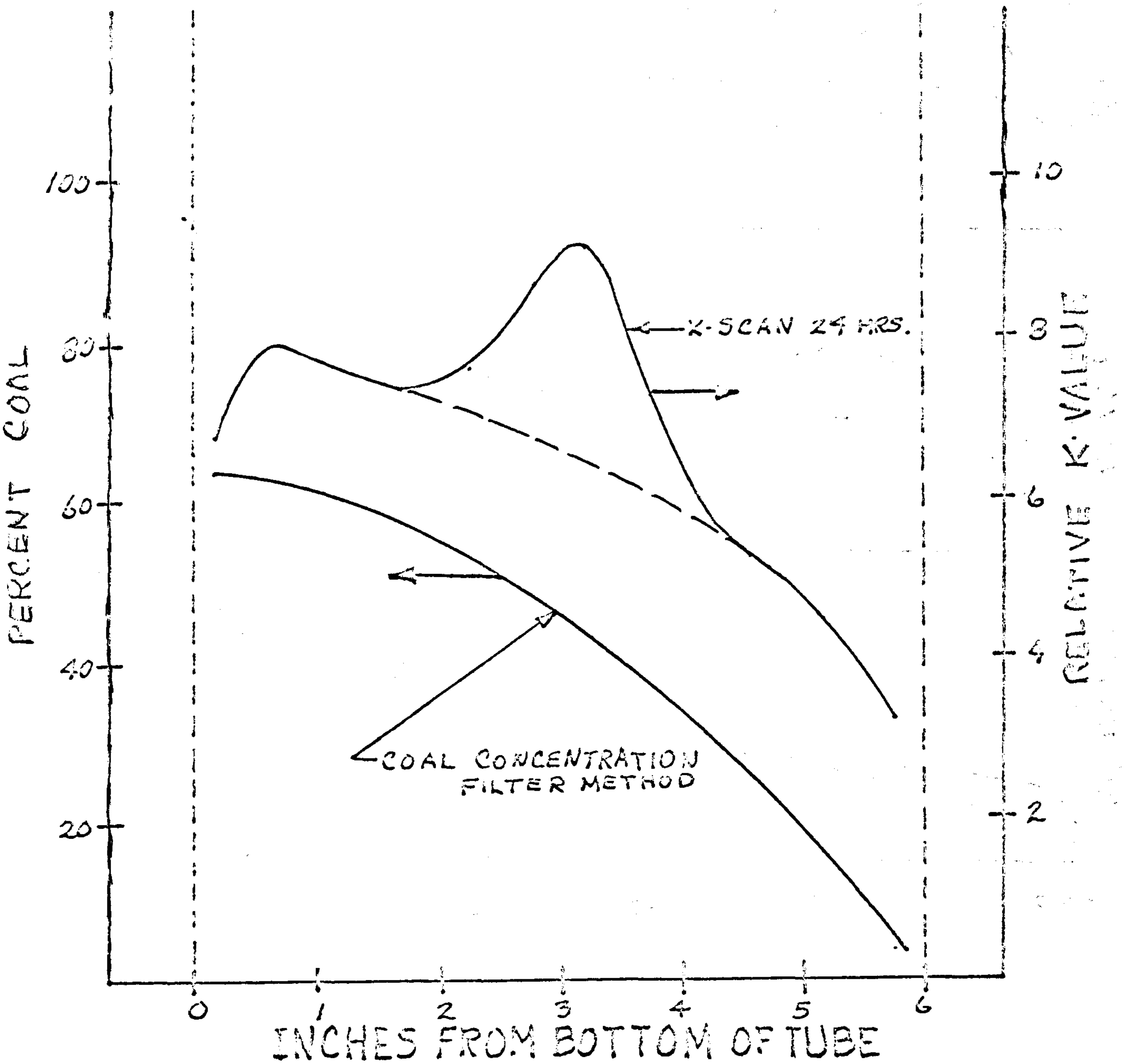
Cherry, N. Figure 5. Sedimentation Rate, 30% Coal - 200 Mesh in EXXON #2.



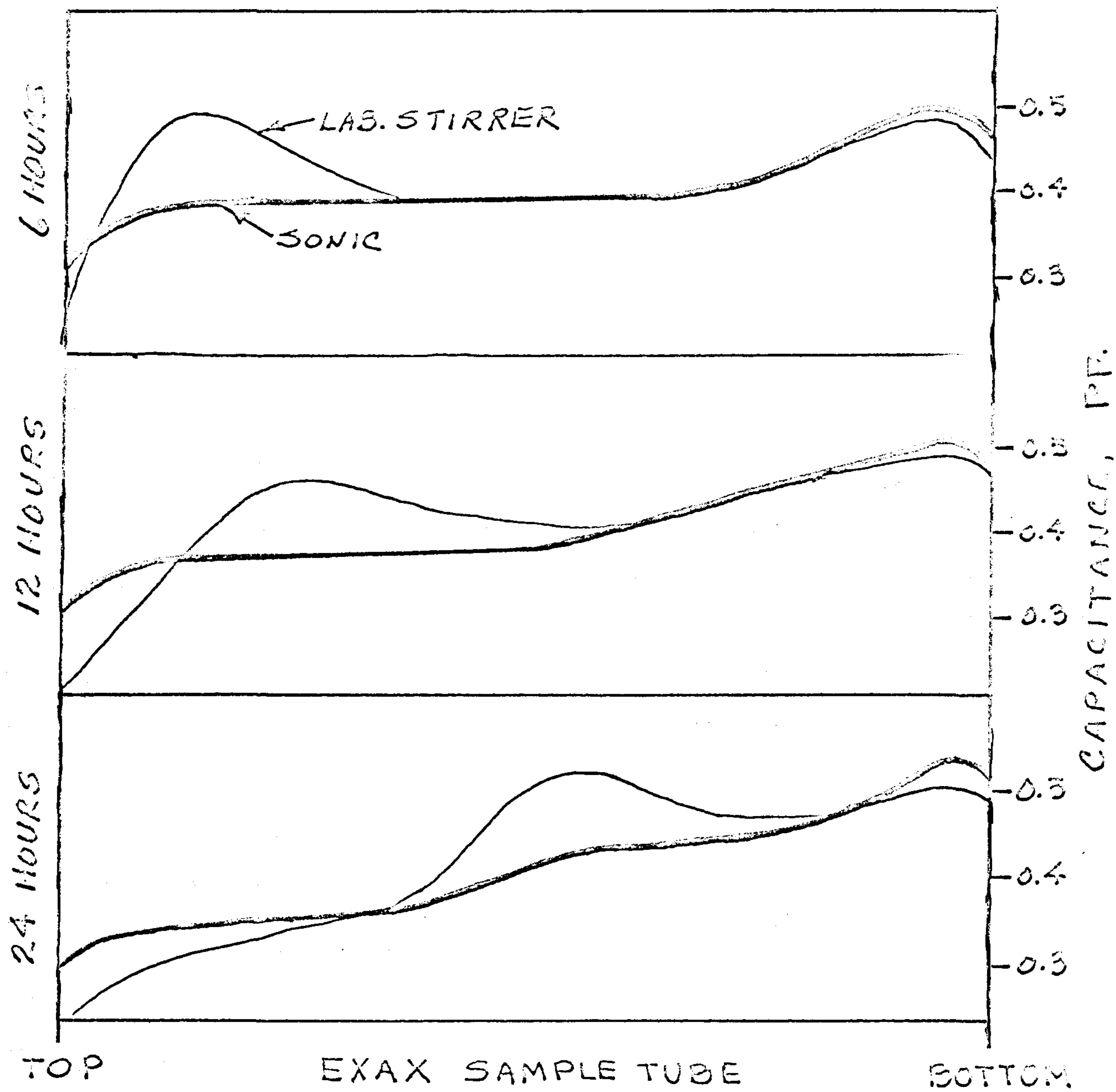
Cherry, N. Figure 6. Double Peak K-Scan.
(40% Coal - 200 mesh, 6% water, 54% Hess #6)



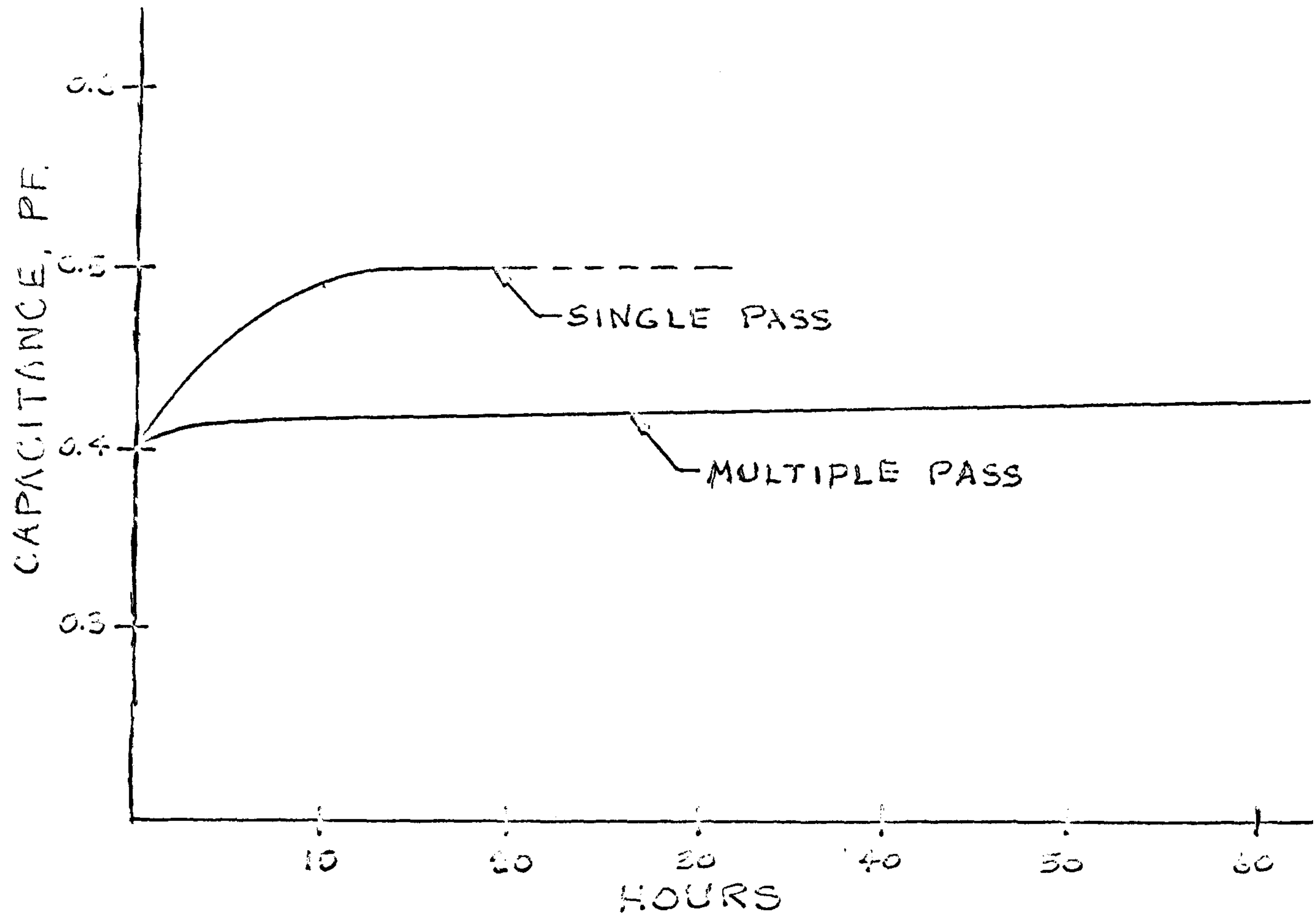
Cherry, N. Figure 7. Comparison of Coal Concentration and Double Peak K-Scan. (40% Coal - 200 mesh, 6% Water, 54% Hess #6)



Cherry, N. Figure 8. Effect of Sonic Emulsifier on the Elimination of the Water Peak.
(40% Coal - 200 mesh, 6% Water, 54% Hess #6)



Cherry, N. Figure 9. Multipass Effect on Sedimentation Rate of Coal with Sonic Emulsifier.
(45% Coal - 200 mesh, 5% Water, 50% Gulf #6)

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