FE-2689-2
Distribution Category UC-90b

AN INVESTIGATION OF FUELS CONTAINING COAL-OIL-WATER EMULSIONS

SECOND QUARTERLY REPORT

FOR THE PERIOD

1 JANUARY 1978 - 31 MARCH 1978

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April 1978

Work Performed Under Contract EF-77-C-01-2689

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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. All ancillary equipment has been set up and one emulsifier evaluation underway with the second unit ready for experimentation. The K-scan stability apparatus has been automated and final validity test successfully completed. Viscosity data on water-oil mixtures is reported.

ACKNOWLEDGEMENT

The authors wish to acknowledge the helpful discussions held with Mr. William Fedarko of the Department of Energy, Washington, D. C. and the able assistance of Edward W. Smith and William J. Murphy of the Germantown Laboratories staff.

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. Physical Plant.

The building erected for this program has been completed. All equipment, tankage and apparatus received to date has been installed and is in use.

2.1.1. Task I, Emulsification.

I. Emulsifiers.

A. The Gaulin Emulsifier.

The Gaulin Corporation model 15M-8TA emulsifier is scheduled for evaluation following the completion of the investigation of the Sonic unit (B below).

B. The Sonic Emulsifier.

The triplex model 1000A Sonic Corporation emulsifier is currently under evaluation. A description of the experiments is given in Task 2, Stability, below.

C. The Cottell Unit.

This unit has not been received as yet but expected shortly.

D. The Total Unit.

The Total unit has been received and is scheduled for evaluation following the Gaulin unit.

E. The Fifth Unit.

Information on a Funken unit emulsifier manufactured by Ahiehi-Gotanida of Tokyo Japan, has been requested and will be evaluated upon receipt.

II. Ancillary Equipment.

A. Premixing System.

A large variable speed mixer (1/2 hp.) has been set up using a 30 gallon drum with an appropriate drum heater for premixing the COM. The mixture is gravity fed into the Sonic and Gaulinunits.

B. Pumps.

No decision has been made on the purchase of a positive displacement pump for use with the Total and Cottell units. It may be possible to use the pump supplied with the Sonic unit for the above two units.

C. Tankage.

Two 1000 gallon oil tanks are in place, one for #2 oil the other for #6. The #6 oil tank is equipped with two internal electrical heaters.

D. Oil.

1. #2 oil, 1000 gallons of #2 Exxon heating oil is on hand.

2. #6 oil, 1000 gallons of #6 Gulf oil is on hand. Properties of #6 Gulf are listed in Table I.

E. Coal.

Two lots, 1000 pounds each of 200 mesh and 325 mesh Pittsburgh seam coal are on hand.

2.1.2. Task 2, Stability.

I. K-Scan Unit.

A. Final Validity Tests.

Two separate samples of a 40%-200 mesh coal, 54% #6 Hess oil and 6% water mixture were made up using the hand mixing system and placed

TABLE I

PROPERTIES OF #6 GULF OIL

DENSITY,	°API (60°F), 12.8 Sp. Gravity (60°F) 0.981
FLASH POINT,	200+ °F
VISCOSITY,	180 FFS @ 122°F (388 CS)
POUR POINT,	+30°F
SULFUR CONTENT,	2.2%
WATER & SEDIMENT,	0.05%

in plastic tubes of the same approximate size as the EXAS sample tubes. One was used for control and the other was allowed to separate at 150°F. K-scans were made on both samples initially and after 24 hours on the second sample which was kept at 150°F. The second sample was sectioned and analyzed for coal concentration by the filter method at the peaks and valleys as indicated on the K-scan. The results of these determinations are shown in Figure 1 and compared to the K-scan. If the second peak on the K-scan, attributed to water, is neglected the two curves are essentially the same in appearance thus showing the K-scan data to be accurate and equal to the filter method. This set of experiments has yielded the necessary information to warrent the use of the K-scan method for determining emulsion stability for this program.

B. Long Term K-Scan Test.

A third sample of the above mixture was tested using the K-scan unit for a period of 57 hours at 150°F. Figure 2 shows the results of this test. The coal concentration at the bottom of the tube increased as expected and reached a plateau. The second peak, attributed to water, produced some unexpected results. The peak K-value of the water and the distance of the peak from the bottom of the tube are plotted in Figure 2. The results are as yet unexplained. The water peak moves down from the top of the tube, decreasing in K-value and suddenly at 19 hours disappears and at the same time reappears some 1 1/2 inches closer to the bottom of the tube. This new water peak then moves up the tube increasing in K-value, levels off after 30 hours and remains constant for the rest of the experiment. This phenomenon is being studied.

C. #6 Hess Oil/Coal Mixture Test.

A 40% 200 mesh coal-60% #6 Hess oil mixture was made using the bench scale apparatus (small laboratory stirrer) at 150°F. A sample of this mixture was K-scanned for 22 hours. Figure 3 shows the results of this K-scan, and is plotted in two ways, first, capacitance (coal concentration) versus time, and, second, the height of the coal layer versus time. The coal concentration reached a plateau after 4 hours and remained constant with the height of the coal layers increasing with time.

II. Emulsion Studies.

A. K-Scan Calibration.

A series of #6 Gulf oil - 200 mesh coal mixtures were made up using a laboratory stirrer, mixed at 150°F. Figure 4 shows the variation of capacitance with coal concentration.

B. #6 Hess Oil Studies Using the Sonic Emulsifier.

Some preliminary studies were carried out using #6 Hess oil because of the delay in receiving the heaters for #6 Gulf oil storage tank. A 10% water-#6 Hess oil mixture was made up on the premixing system at 150°F and then passed through the Sonic unit. The Sonic unit was run at 500 psi and considerable trouble was encountered in "tuning" the unit with the mixture. A sample was taken and a K-scan was run on both this sample and a sample from the premix drum. Figure 5 compares the water peaks of these samples versus time. The sample from the Sonic was twice as stable as the premix sample. Later experiments with #6 Gulf oil indicates that this Sonic run was not optimized. However, it does show that stability was increased by the use of the Sonic unit.

Since so many previous studies were carried out using a 40% 200 mesh coal-54% #6 Hess Oil-6% water mixture, it was of interest to determine the effect of a single pass through the Sonic unit this mixture. Although considerable problems were encountered in tuning the unit, the mixture was run at 150°F and a sample taken. Figure 6 compares the K-scans of this sample to that of the bench preparation (stirring only) at 6, 12 and 24 hours. The most significant result is the absence of the water peak, however the overall settling rates are about the same.

C. #6 Gulf Oil-Water Studies Using the Sonic Emulsifier.

With the completion of the 1000 gallon storage tank and the delivery of #6 Gulf oil evaluation of the Sonic emulsifier was initiated. The #6 Gulf oil fits the typical #6 oil curve and was chosen previously as the material to be used for emulsifier evaluation. It was found that this oil could be tuned easily in the Sonic unit and experiments were started using 5 and 10% water mixtures. Using several different orfice sizes (pressures from 300 to 1000 psi) a number of runs were made using a 5% water-#6 Gulf oil mixture). The samples of these runs were K-scanned and all showed no change from the initial condition after 72 hours at 150°F. Samples were also taken from the premix drum and after the positive displacement pump (before the Sonalator). The K-scans of these samples showed water separation after 3 to 5 hours at 150°F. Evaluation of 200 mesh coal-#6 Hess oil-5% or 10% water mixtures is currently underway.

2.1.3. Task 3, Viscosity.

The viscosity of #6 Gulf oil, 5% water and 10% water mixtures are presented in Table II. This data was taken using the Brookfield viscometer at these temperatures - 100°F, 122°F, 150°F.

TABLE II VISCOSITY

#6 GULF

OIL MIXTURE	TEMPERATURE °F	VISCOSITY CENTIPOISE
#6 Gulf	100	860
	122	388
	150	143
#6 Gulf + 5% Water	100	900
	122	398
	150	154
#6 Gulf + 10% Water	100	980
	122	420
	150	199

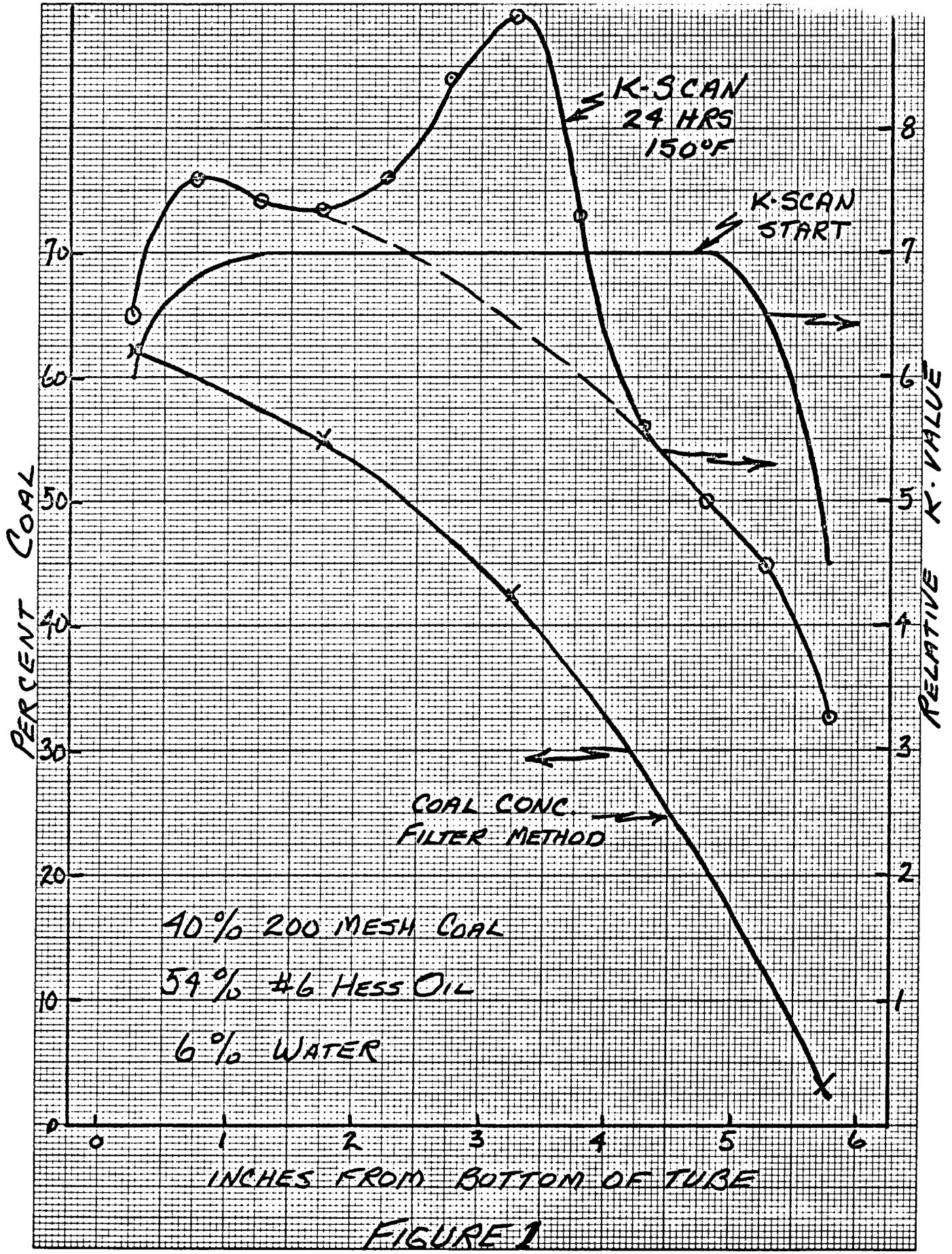

K-SCAN
24 HRS
150°F
K-SCAN
START
COAL CONC.
FILTER METHOD
40% 200 MESH COAL
54% #6 HESS OIL
6% WATER
PERCENT COAL
RELATIVE K. VALUE
INCHES FROM BOTTOM OF TUBE
0
10
20
30
40
50
60
70
1
2
3
4
5
6
7
8

FIGURE 1

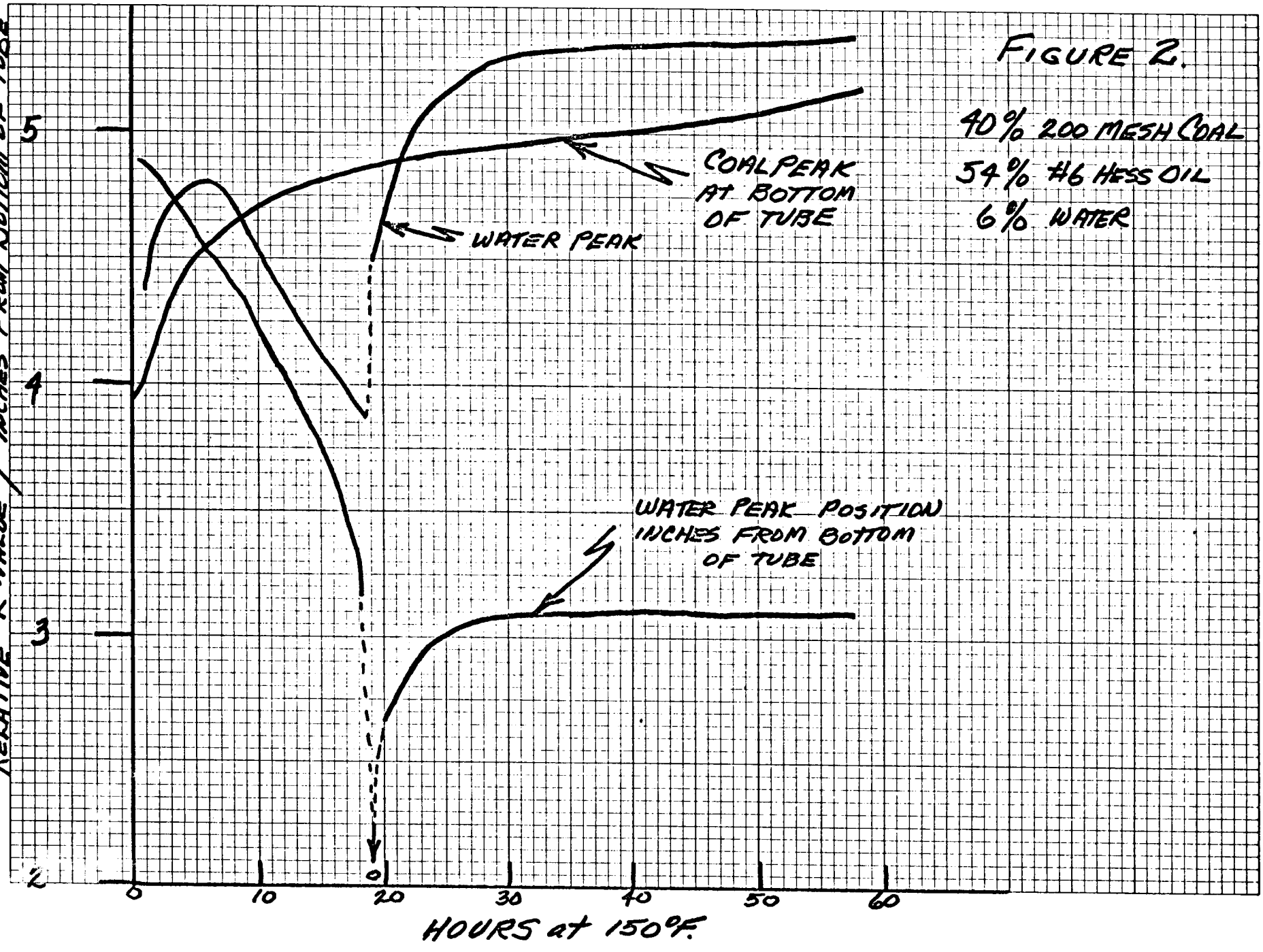


FIGURE 2.
40% 200 MESH COAL
54% #6 HESS OIL
6% WATER
COAL PEAK AT BOTTOM OF TUBE
WATER PEAK
WATER PEAK POSITION INCHES FROM BOTTOM OF TUBE
RELATIVE K-VALUE / INCHES FROM BOTTOM OF TUBE
HOURS at 150°F.
0
10
20
30
40
50
60
2
3
4
5

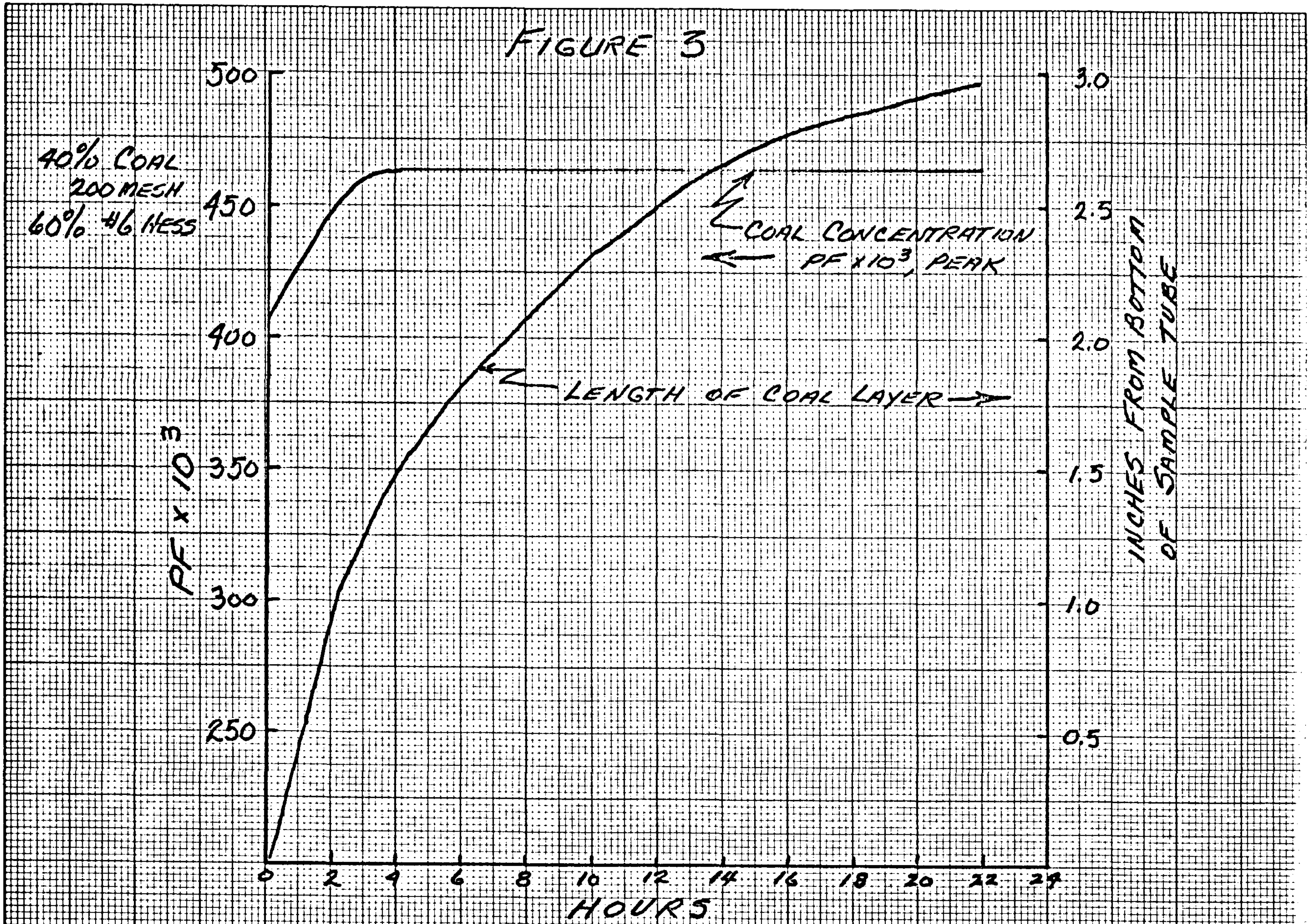
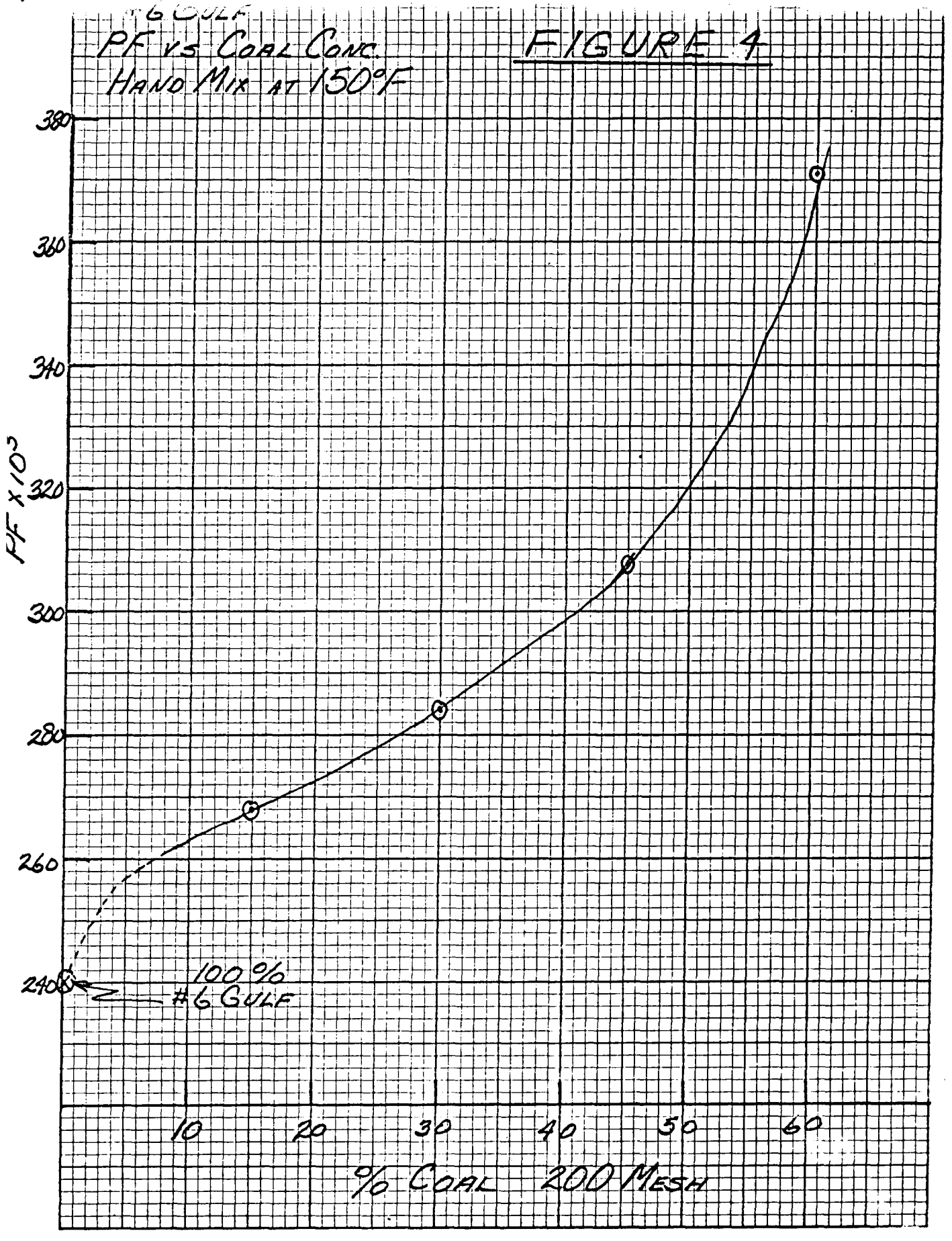


FIGURE 3
40% COAL
200 MESH
60% #6 HESS
COAL CONCENTRATION
PF x 10³, PEAK
LENGTH OF COAL LAYER
PF x 10³
INCHES FROM BOTTOM OF SAMPLE TUBE
HOURS
500
450
400
350
300
250
3.0
2.5
2.0
1.5
1.0
0.5
0
2
4
6
8
10
12
14
16
18
20
22
24


#6 GULF
PF vs Coal Conc.
Hand Mix at 150°F
FIGURE 4
380
360
340
320
300
280
260
240
PF x 10³
100 %
#6 Gulf
10
20
30
40
50
60
% Coal 200 Mesh

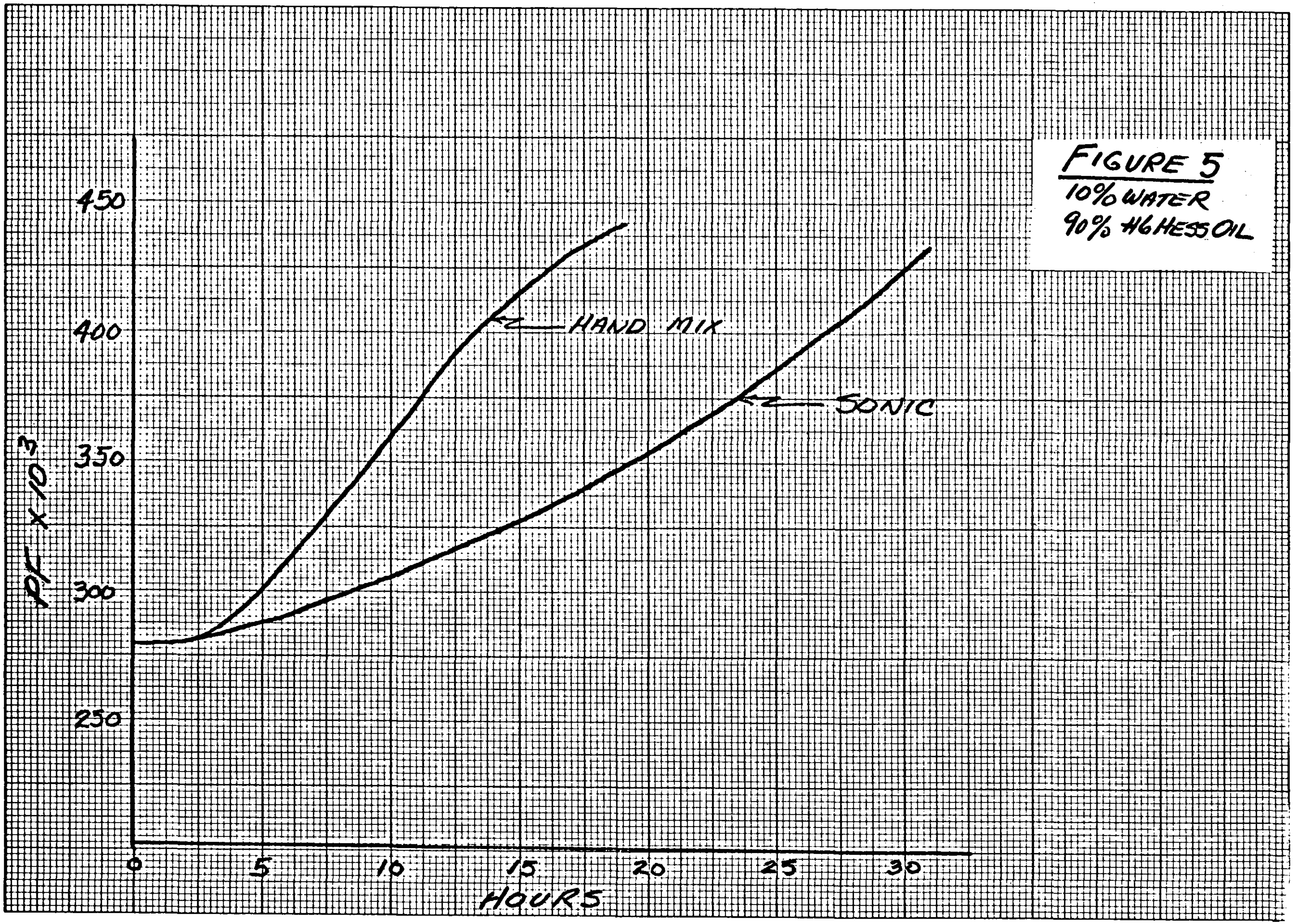


FIGURE 5
10% WATER
90% #6 HESS OIL
HAND MIX
SONIC
450
400
350
300
250
0
5
10
15
20
25
30
HOURS