FUEL RESEARCH INSTITUTE OF SOUTH AFRICA

TECHNICAL MEMORANDUM NO. 17/1958

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TESTS CARRIED OUT ON THE DREWBOY WASHER DURING THE PERIOD FEBRUARY TO AUGUST, 1958.

As in the case of the Barvoys Washer, the series of tests carried out on the Drewboy washer at the pilot plant during this period was designed to obtain some preliminary data relating to the influence of the principal variables on the performance of the unit.

The variables studied were:-

(a) Load
(b) Specific gravity of separation and hence the viscosity
(c) The type of medium.

The tests were conducted on South Witbank coal screened at -3" + ¼".

The testing procedure adopted was generally similar to that described for the Barvoys (Technical Memo No. 16/58). The shale medium used was also similar.

The magnetite medium consisted of Rooiberg Magnetite milled to approximately 90% minus 200 mesh.

Operation of the Drewboy.

In the original design, medium was to be supplied at the feed end of the bath, the bulk of it overflowing at the clean coal lip, while a small proportion was to be

drawn off/..........

drawn off at the bottom of the wheel through an orifice of suitable aperture. When the unit was first tried this procedure was adopted. It was found, however, that there was a tendency for the orifice to block and the efficiency of separation was poor. This was attributed to the formation of a high S.G. zone within the bath and to the fact that medium flowed towards the clean coal and refuse ends, with the possible effect explained in the Barvoys report.

The medium feeding arrangements were then altered and medium was fed in at the bottom as well as at the feed end of the bath. This overcame the difficulty due to blocking. At first a large proportion of the medium was supplied at the bottom of the bath and rather a small amount at the top. The efficiency of separation was still poor under these conditions. This was attributed to the fact that the floats were not being conveyed towards the discharge lip rapidly enough and that rafting was occurring. The quantity of medium fed to the top of the bath was consequently increased and the performance improved substantially.

Best results appeared to be obtained when supplying about 210 gallons per minute at the feed end and 80 gallons per minute underneath the wheel. Unless otherwise stated, all tests were carried out under these conditions.

<u>THE INFLUENCE OF LOAD ON THE PERFORMANCE OF THE DREWBOY WASHER</u>.

A series of three tests was carried out in which load was the principal variable. Shale medium was

used/......

used. Results of these tests are summarised in Table 1.

TABLE 1.

Test No.	2	4	5
Load, tons of -3"+$\frac{1}{4}$" coal/hr.	20.0(approx)	27.9	37.2
Properties of Suspension.			
Yield Value, grams	5.7	4.3	5.9
Diff. Viscosity, poise	0.068	0.043	0.032
-3" + 1$\frac{1}{2}$"			
S.G. of Separation	1.49	1.49	1.50
Probable Error	0.004	0.005	0.006
Error Area	2.85	3.16	3.61
-1$\frac{1}{2}$" + $\frac{3}{4}$"			
S.G. of Separation	1.50	1.50	1.50
Probable Error	0.010	0.011	0.011
Error Area	5.07	5.85	5.9+
-$\frac{3}{4}$" + $\frac{1}{4}$"			
S.G. of Separation	1.52	1.53	1.52
Probable Error	0.018	0.023	0.020
Error Area	9.6+	10.26	10.43

Generally speaking, Table 1 indicates that variation of load within the limits investigated had a negligible influence on the performance. Differences are too small to be significant.

In test 5, the shale wheel was more or less fully loaded and the quantity of refuse discharged was of the order of 17 tons per hour. Clearly if the quantity of refuse should exceed this figure substantially, loss of efficiency can be expected purely due to the mechanical limitation. The refuse capacity can probably be

increased/.......

increased somewhat by speeding up the wheel. If this is carried to extremes, the resultant turbulence may upset the performance.

In Test 5, the quantity of floats was approximately 20 tons per hour which corresponds to a loading of nearly 1.5 tons of floats per square foot per hour. Clearly another factor which can be expected to influence the maximum permissible load is the maximum quantity of floats which can be handled efficiently. In an attempt to obtain some idea of the maximum floats load, a further test was carried out in which the yield of clean coal was increased by adding float 1.45 material (-3"+¼" in size) to the raw coal. In this way, the quantity of refuse was kept within the allowable 17 tons per hour and only the quantity of floats was increased. For comparative purposes, it was not desirable to increase the separating S.G., a step which would have had a similar effect. The results of this test appear in Table 2.

TABLE 2.

Test No.	18
Load, tons of -3"+¼" coal/hr.	35.5
Properties of Suspension.	
Yield Value, grams	3.5
Diff. Viscosity, poise	0.03
-3" + 1½"	
S.G. of Separation	1.49
Probable Error	0.015
Error Area	8.30
-1½" + ¾"	
S.G. of Separation	1.50
Probable error	0.021
Error Area	10.53
-¾" + ¼"	
S.G. of Separation	1.52
Probable Error	0.022
Error Area	12.6+

If/.......

If the results of Test 18 are compared with those shown in Table 1, it will be observed that a decided deterioration of efficiency occurred. A study of the relevant partition curves suggests that this deterioration is probably largely due to rafting at the surface of the vessel (i.e. the one side of the curve is mainly affected). In other words, the loss of efficiency can be mainly attributed to the quantity of floats handled.

In Test 18, the distribution of load was

Floats	26.3 tons/hour.
Sinks	9.2 tons/hour.

In other words, the maximum floats load under the operating conditions mentioned lies somewhere between 20 and 26.3 tons/hour. This is liable to vary with size of coal treated and rate of medium flow along the length of the vessel.

THE INFLUENCE OF SPECIFIC GRAVITY OF SEPARATION AND VISCOSITY ON THE PERFORMANCE OF THE DREWBOY.

Two series of tests were carried out in which the specific gravity of separation was a variable. In the first series, the natural shale medium was used. In the second series the medium was contaminated with a varying proportion of fine coal in an attempt to raise the viscosity to a level which would affect the performance. The load was kept at about 20 tons per hour for each test. This is well within the capacity of the Drewboy and load should therefore have no influence on the efficiency.

The results of these tests are summarised in Table 3.

TABLE 3/........

T A B L E 3.

Test No.	6	2	3	8	17	24	27	28	26	25
Load, tons -3" + $\frac{1}{4}$" coal/hr.	19.2	20.0	22.5	17.8	17.7	17.6	19.7	17.4	19.6	18.6
Properties of Suspension.										
Yield Value, grams.	3.7	5.7	6.5	7.1	5.2	5.5	6.6	6.3	6.65	7.5
Diff. Viscosity, poise	0.020	0.068	0.089	0.102	0.089	0.086	0.185	0.167	0.099	0.135
-3" + 1$\frac{1}{2}$"										
S.G. of Separation	1.44	1.49	1.53	1.56	1.59	1.49	1.51	1.52	1.56	1.59
Probable Error	0.008	0.004	0.005	0.010	0.006	0.008	0.006	0.007	0.008	0.007
Error Area	3.93	2.85	3.61	4.6	3.34	3.84	3.81	3.67	3.84	3.46
-1$\frac{1}{2}$" + $\frac{3}{4}$"										
S.G. of Separation	1.44	1.50	1.53	1.58	1.59	1.50	1.52	1.52	1.56	1.60
Probable Error	0.010	0.010	0.008	0.017	0.012	0.011	0.010	0.012	0.010	0.015
Error Area	5.41	5.07	5.10	7.8+	6.76	5.85	5.30	6.51	5.16	6.88
-$\frac{3}{4}$" + $\frac{1}{4}$"										
S.G. of Separation	1.45	1.52	1.56	1.59	1.61	1.51	1.54	1.54	1.57	1.63
Probable Error	0.016	0.018	0.020	0.025	0.019	0.023	0.020	0.022	0.016	0.021
Error Area	8.8	9.6+	11.7+	12.8+	11.0+	13.3+	10.8+	12.2+	9.0+	12.4+
	Natural Medium.					Contaminated with Fine Coal.				

As explained in the Barvoys report, specific gravity in itself should not affect the separation. It is mainly changes in viscosity resulting from changes in solids concentration which may be expected to affect the efficiency.

Values for the probable error in Table 3 were plotted against the corresponding values of the differential viscosity as shown in Fig. 1.

It will be observed that the points scatter considerably, but that there does appear to be a slight tendency for the probable error to increase with increasing differential viscosity in the case of the smaller sizes. In Fig. 2, Error Area has been plotted against differential viscosity and a similar trend will be observed. For all practical purposes, it is probably true to say however, that differential viscosities up to 0.185 poise have a negligible influence on the separating efficiency. Further tests will have to be carried out to establish limiting viscosity values above which the various sizes begin to be seriously affected.

It will be noted in Table 3, that in all cases the peas were separated at a somewhat higher S.G. than the larger sizes. Under the operating conditions described there is a slight upward current of medium in the vessel. It may be this current itself which causes the increase in S.G. (i.e. a classification effect) but the yield value may also be a contributary factor as explained in the Barvoys report.

The increase/...........

The increase in S.G. of the peas separation over that of the cobbles was plotted against yield value as shown in Fig. 3. It will be noted that a relationship appears to exist. This fact supports the theory that yield value affects the S.G. of separation if the medium flows in one direction in the separating vessel.

THE PERFORMANCE OF THE DREWBOY WITH MAGNETITE MEDIUM.

The Drewboy is intended by its designers for use with magnetite medium. Since all the previous work had been done on shale medium, it was desirable to demonstrate that the Drewboy could function equally well with magnetite. Except in so far as the medium influences the properties of the resultant suspension, there is no reason why the medium in itself should affect the separation.

Two tests were accordingly carried out using magnetite medium. The medium specific gravity was of the order of 1.40 in the first Test. (Test 29). The vessel was definitely unstable with magnetite alone and it was necessary to draw coal slime from the rake thickener to stabilise the system. The quantity of slime was adjusted until the bath was judged to be stable and the test was conducted. It was immediately clear that some condition was abnormal since it was not possible to maintain the S.G. within the normal limits by means of the automatic control equipment. The efficiencies obtained were very poor and this was ascribed to instability of the bath. The stability index of the suspension was 0.09 cm/sec. which appeared to be the critical value when the vessel was checked for stability without coal on a previous occasion. It appears then that a rather lower stability index should be aimed at, say about 0.08 cm/sec. maximum.

The second test was carried out at a somewhat higher S.G. and coal slime was again added. Automatic control was more normal and no other difficulties were experienced.

The results of this test are summarised in Table 4. The viscosity was so low that it could not be determined with any accuracy.

TABLE 4.

Test No.	30
Load, tons of -3" + ¼" coal/hr.	17.9
-3" + 1½"	
S.G. of Separation	1.54
Probable Error	0.008
Error Area	4.09
-1½" + ¾"	
S.G. of Separation	1.54
Probable Error	0.011
Error Area	5.66
-¾" + ¼"	
S.G. of Separation	1.55
Probable Error	0.015
Error Area	9.2

These results compare reasonably well with those normally obtained with shale medium under otherwise comparable operating conditions (compare with Table 3). This suggests that, provided stability can be maintained or alternatively the viscosity is not excessive, the type of medium has little influence on the performance.

P.J. VAN DER WALT.
ASSISTANT DIRECTOR.

PRETORIA.
27/8/1958.

PJvdW/JAZ.

FIGURE 1

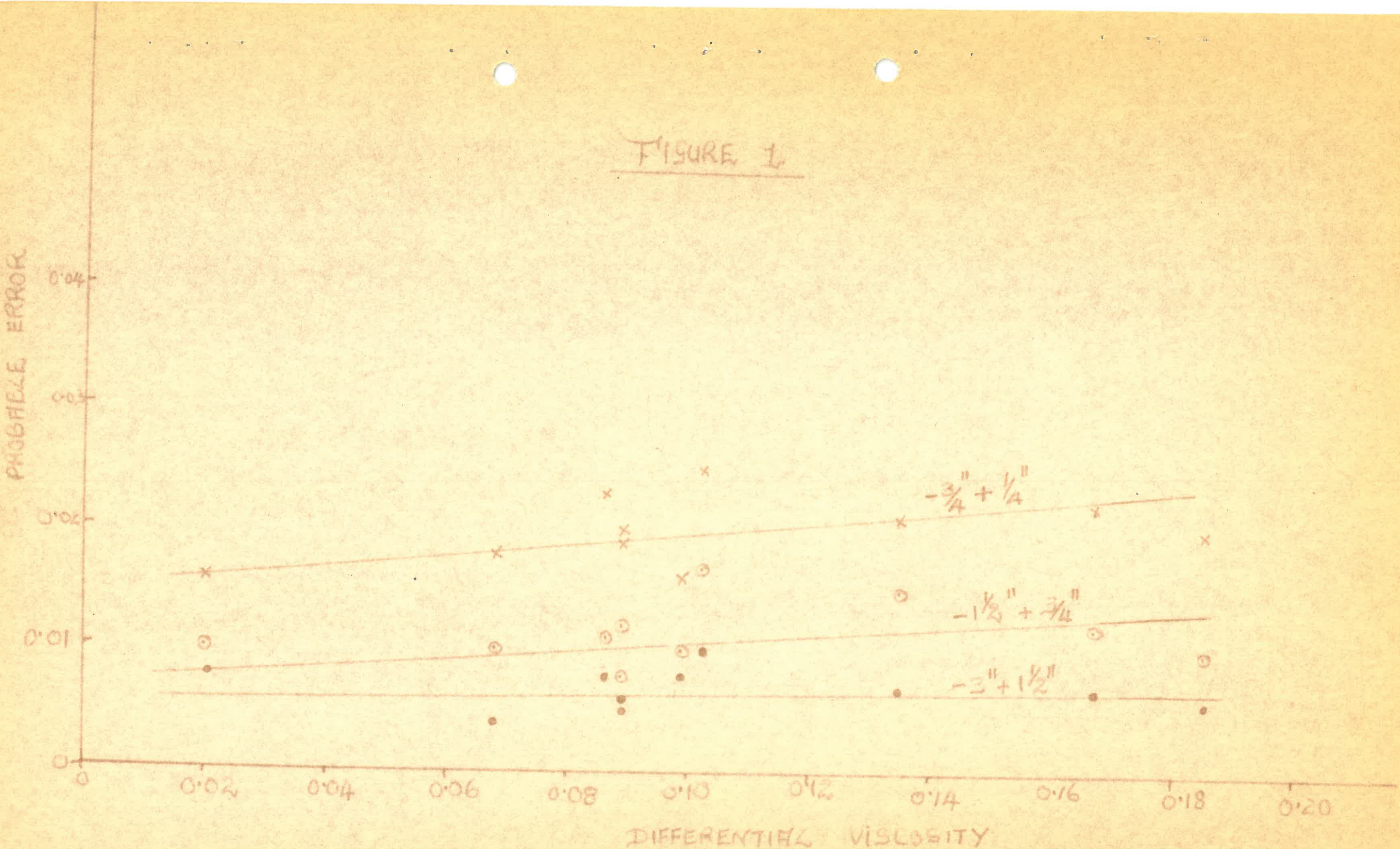
PROBABLE ERROR
0·04
0·03
0·02
0·01
0
0
0·02
0·04
0·06
0·08
0·10
0·12
0·14
0·16
0·18
0·20
DIFFERENTIAL VISCOSITY
$-\frac{3}{4}'' + \frac{1}{4}''$
$-1\frac{1}{2}'' + \frac{3}{4}''$
$-3'' + 1\frac{1}{2}''$

FIGURE 2

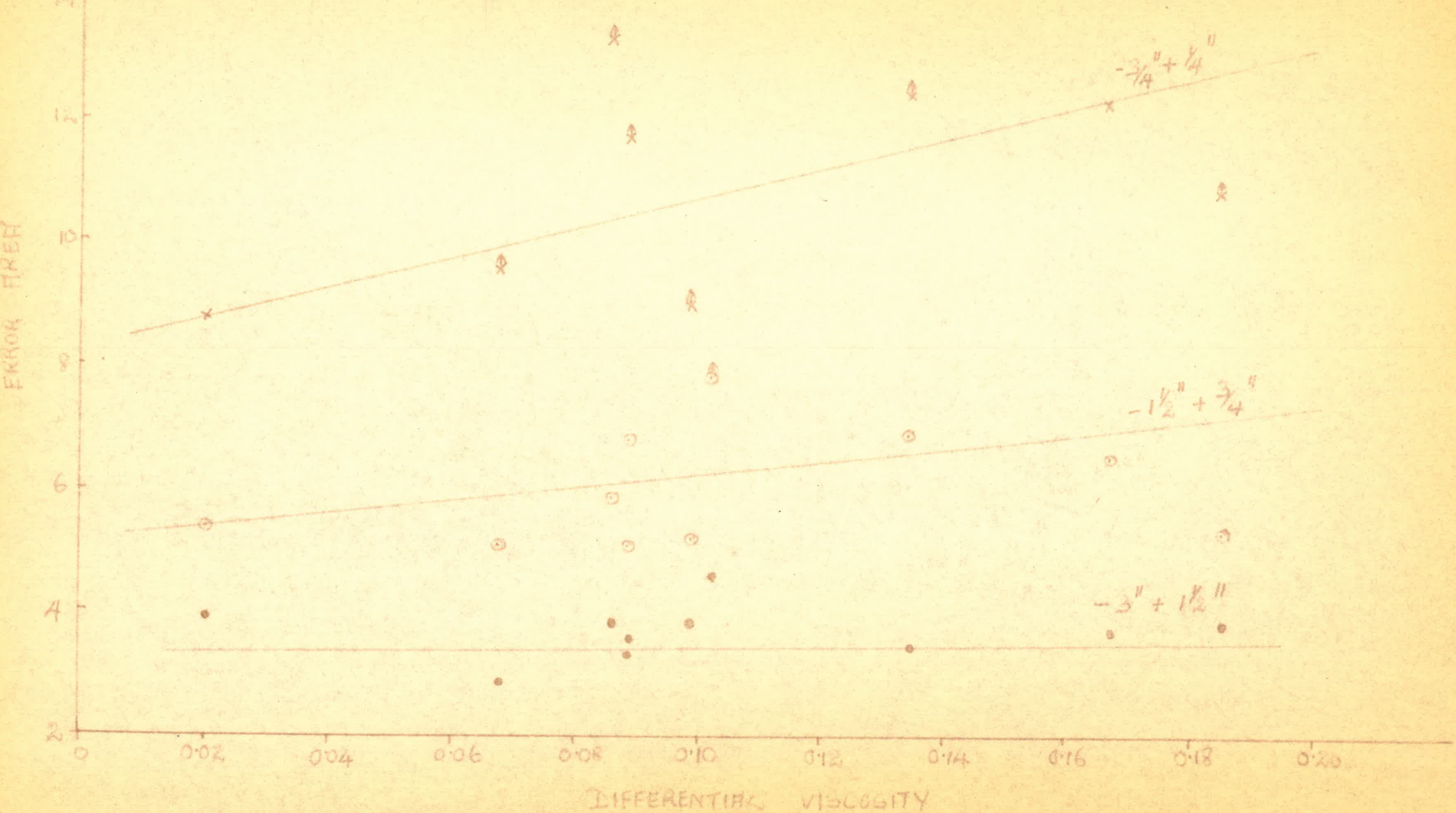
-3/4" + 1/4"
-1 1/2" + 3/4"
-3" + 1 1/2"
ERROR AREA
2
4
6
8
10
12
14
0
0·02
0·04
0·06
0·08
0·10
0·12
0·14
0·16
0·18
0·20
DIFFERENTIAL VISCOSITY

FIGURE 3.