FUEL RESEARCH INSTITUTE OF SOUTH AFRICA

TECHNICAL MEMORANDUM NO. 18 OF 1964

THE INFLUENCE OF NEAR-GRAVITY MATERIAL ON THE PERFORMANCE OF THE DREWBOY WASHER

by

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I. INTRODUCTION

Material of varying density may be separated into two density fractions by placing the material in a fluid of the required separative density. All material having a density greater than the fluid density will sink, and all material having a density less than the fluid density will float.

From Stokes' Law, the falling velocity of a solid particle in a viscous fluid is proportional to the apparent density of the solid particle. As the density of the solids approaches the fluid density, the falling velocity approaches zero, or, in other words, the time required for near-gravity particles to separate becomes longer. Near-gravity material may be defined as material having a density close to that of the separating fluid.

In a continuous process the residence time of the solid particles becomes an important factor. If the separation time is of the order of the residence time, the situation may be obtained where a near-gravity particle may be expelled from the system as misplaced material. It thus follows that a relation between near-gravity and misplaced material exists.

II. OBJECT OF EXPERIMENTS

These experiments were designed to assess the influence of near-gravity material on the performance of the Drewboy washer.

III. PRELIMINARY PREPARATIONS

In essence, the experiments consisted of treating coal containing various percentages of near-gravity material in the Drewboy washer at a separation s.g. of 1.50. It was

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thus necessary to prepare a near-gravity fraction which could be mixed, in various proportions, with a raw coal containing no near-gravity material. Due to the nature of the preliminary preparations, a hard type coal, viz. South Witbank, was selected.

The near-gravity fraction was prepared as follows: Run-of-mine coal was crushed to minus 3", screened at ¼", and the plus ¼" coal washed in the Drewboy washer at a separation s.g. of 1.60. The sink 1.60 was stored in a service bunker and the float 1.60 again washed at a separation s.g. of 1.40 and the products stored in service bunkers.

The float 1.40 and sink 1.60 fractions were mixed and stored in a service bunker. This mixture will henceforth be referred to as residue, whereas the sink 1.40 will be referred to as near-gravity material.

Various mixtures may be obtained by altering the feed rates of the residue and near-gravity material to the washer. A total feed rate of 20 t.p.h. was maintained, ensuring a feed rate well within the design limits. The nominal feed rates employed are indicated in Table 1.

TABLE 1

NOMINAL FEED RATES FOR RESIDUE AND NEAR-GRAVITY MATERIAL

Residue	Near-gravity Material	Total Feed Rate	Near-gravity Material
tons/hr	tons/hr	tons/hr	%
20	0	20	0
15	5	20	25
10	10	20	50
5	15	20	75
0	20	20	100

IV. EXPERIMENTAL PROCEDURE

The residue was fed to the washer at a feed rate of 20 t.p.h. for approximately ten minutes, ensuring the

attainment/...

attainment of stable conditions. During this period, both product streams were diverted to a waste bunker. After the initial 10-minute period the experiment proper was commenced. At commencement the product streams were diverted to hoppers for the subsequent weighing of product streams. Samples of the product streams were obtained at 30-second intervals for a period of at least 30 minutes. At the end of the sampling period the product streams were again diverted to the waste bunker, whilst the feed to the washer was maintained.

The feed rate of the residue was then adjusted to 15 t.p.h. and the near-gravity material feed rate at 5 t.p.h., and the experiment repeated. The various mixtures, tabulated in Table 1, were obtained and treated in the Drewboy washer. Samples of the product streams were stored in 45-gallon drums until the subsequent analysis could be performed.

V. RESULTS

Results obtained from subsequent analyses are indicated below:

TABLE 2
PERCENTAGE NEAR-GRAVITY MATERIAL
AS DETERMINED FROM SAMPLES

Run No.	Percentage Near-Gravity Material		
	$-3'' + 1\frac{1}{2}''$	$-1\frac{1}{2}'' + \frac{3}{4}''$	$-\frac{3}{4}'' + \frac{1}{4}''$
1	9.3	13.5	16.9
2	34.9	40.2	34.5
3	51.0	56.8	49.5
4	74.7	70.2	69.8
5	98.5	92.8	84.7

Table 3/...

TABLE 3

SIZE GRADING OF SAMPLES

Run No.	Product			Discard		
	-3" +1½"	-1½" +¾"	-¾" +¼"	-3" +1½"	-1½" +¾"	-¾" +¼"
1	9.79	35.40	54.21	42.90	30.18	26.37
2	33.86	40.81	24.66	59.86	27.39	12.19
3	36.91	38.82	23.54	56.34	28.74	14.31
4	38.33	36.51	24.29	56.73	27.63	14.82
5	63.72	24.01	11.74	77.40	15.81	6.35

TABLE 4

CUTPOINTS AND PROBABLE ERRORS DETERMINED FROM SAMPLES

Run No.	Cutpoints			Probable Errors		
	-3" +1½"	-1½" +¾"	-¾" +¼"	-3" +1½"	-1½" +¾"	-¾" +¼"
1	1.493	1.499	1.517	0.004	0.014	0.019
2	1.486	1.486	1.497	0.007	0.011	0.017
3	1.481	1.481	1.481	0.005	0.010	0.013
4	1.480	1.479	1.483	0.007	0.009	0.014
5	1.482	1.486	1.492	0.007	0.010	0.013

TABLE 5

FRACTIONAL YIELDS

Run No.	Fractional Yield of Product		
	-3" + 1½"	-1½" + ¾"	-¾" + ¼"
1	0.2132	0.5820	0.7094
2	0.4066	0.6434	0.7102
3	0.4320	0.6106	0.6563
4	0.4510	0.6164	0.6659
5	0.4440	0.5957	0.6438

Table 6/...

TABLE 6

PERCENTAGE MISPLACED MATERIAL

Run No.	Percentage Misplaced Material		
	-3" + 1½"	-1½" + ¾"	-¾" + ¼"
1	>0	0.5	1.0
2	1.5	3.0	3.6
3	2.2	4.7	5.5
4	5.6	7.3	10.7
5	6.0	7.6	11.0

Table 7/...

TABLE 7

DISTRIBUTION FACTORS OBTAINED FROM SAMPLES

	Distribution Factors														
	-3" + 1½"					-1½" + ¾"					-¾" + ¼"				
s.g. Interval	Run 1	Run 2	Run 3	Run 4	Run 5	Run 1	Run 2	Run 3	Run 4	Run 5	Run 1	Run 2	Run 3	Run 4	Run 5
<1.36	100	100	100	94.7	100	99.8	99.9	99.8	94.2	99.1	99.7	99.6	99.4	95.5	98.1
1.36-1.38	100	100	100	95.4	100	99.9	99.9	99.3	95.7	98.5	99.6	99.3	99.2	95.4	97.8
1.38-1.40	100	99.8	99.8	95.0	100	99.6	99.7	99.7	95.5	98.9	99.4	99.0	98.8	95.9	98.2
1.40-1.42	100	100	99.8	94.8	100	99.5	99.5	99.6	96.3	99.5	99.2	98.9	98.1	96.4	98.3
1.42-1.44	100	99.7	100	97.0	100	99.2	98.9	99.4	97.0	99.4	99.1	98.1	97.5	96.3	97.2
1.44-1.46	100	99.4	99.8	95.9	98.9	98.2	98.0	98.1	96.7	98.9	98.6	95.1	93.3	93.4	95.1
1.46-1.48	95.0	97.2	89.7	85.4	89.8	95.6	91.1	80.8	83.4	87.3	96.2	87.5	78.5	83.0	84.1
1.48-1.50	72.0	38.1	15.8	16.8	24.1	65.3	42.7	28.5	25.3	39.4	80.2	60.8	39.2	36.9	56.6
1.50-1.52	0	1.3	1.6	1.0	2.4	32.3	13.5	6.5	11.3	8.4	61.5	34.5	14.0	19.9	21.3
1.52-1.54	0.1	1.5	0.8	0	0.2	10.0	4.9	5.7	3.6	2.9	30.4	13.9	7.9	13.2	10.8
1.54-1.56	0	0	0	0	0	3.4	0	1.3	1.0	1.2	17.0	7.9	4.0	8.8	7.3
1.56-1.58	0	0	0	0	0	0	0	1.4	1.6	0.8	5.7	3.0	3.6	4.3	4.0
1.58-1.60	0	0	0	0	0	0	0	0	0	0.9	5.3	2.1	1.5	3.9	3.5
1.60-1.62	0	0	0	0	0	0	0	0	0	0	3.1	2.4	1.6	4.5	3.1
1.62-1.64	0	0	0	0	0	0	0	0	0	1.8	0.8	0.7	1.8	0.8	3.3
>1.64	0	0	0	0	0	0	0	0	0	1.3	0	0.1	0.2	0.3	1.6

DISCUSSION OF RESULTS

Comparison of the results tabulated in Tables 1 and 2 clearly indicates fractionation of the coal. This is particularly evident from the results obtained from Run 1. In Run 1 the feed to the washer consisted solely of residue and no prepared near-gravity material was added. Due to fractionation, however, approximately 10 percent near-gravity material was produced in each size fraction.

Thus an additional ten percent near-gravity material, produced by the disintegration of the coal, may be assumed to be present throughout the entire experiment. In this case the effect of the additional ten percent near-gravity material will be most marked for Run 1, where no near-gravity material was intentionally added. This effect will be reduced as the percentage near-gravity material added is increased. This is probably one of the reasons why the cutpoints and probable errors for Run 1 differ from the remaining four runs.

Disintegration of the coal will, in general, occur when the coal is transported to and/or from the bunkers. It would thus be expected that the residue, which, in addition, was premixed, would exhibit greater fractionation than the near-gravity material. This is substantiated by the results in Table 3, where the percentage $-\frac{3}{4}$" material in Run 1 greatly exceeds that in Run 5 where the feed consists solely of near-gravity material.

In these experiments the separation specific gravity was 1.50 and the near-gravity material was defined as the material contained within the specific gravity region 1.40 - 1.60. When dealing with a highly efficient washer such as the Drewboy, this definition of near-gravity material is too embracive. A better definition of the near-gravity material would probably be, the material contained within the specific gravity region 1.48 - 1.52. In view of this, the total variation of near-gravity material, during the course of the experiment, is roughly of the order of 8 - 10 percent. No appreciable variation in performance could be expected, which is clearly reflected by the results tabulated in Table 4.

Variation/...

Variation of percentage misplaced material with feed composition is represented in Table 6. As could be expected, the percentage of misplaced material increases. Since the settling velocity of a particle is proportional to the radius of the particle, it would be expected that the misplaced material should increase with decrease in particle size. This effect is clearly illustrated in Table 6.

FINAL CONCLUSIONS

When dealing with a washer such as the Drewboy, the standard definition of near-gravity material, in this case the material within the specific gravity region 1.40 - 1.60, is too embracive. A definition of near-gravity material restricting the material to a smaller specific gravity region is required.

The variation of the true near-gravity material, as was effected in this test, is insignificant and, apart from the misplaced material, has no effect on the performance of the Drewboy washer.

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PRETORIA,
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