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FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

TECHNICAL MEMORANDUM NO. 19 OF 1962.

EXPERIMENTS CONDUCTED TO DETERMINE THE REPRODUCIBILITY OF RESULTS OF WASHING TESTS AND THE SIGNIFICANCE OF PROBABLE ERROR DETERMINATIONS.

By:

T.C. ERASMUS.

FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

TECHNICAL MEMORANDUM NO. 19 OF 1962.

DREWBOY WASHER.

EXPERIMENTS CONDUCTED TO DETERMINE THE REPRODUCIBILITY OF RESULTS OF WASHING TESTS AND THE SIGNIFICANCE OF PROBABLE ERROR DETERMINATIONS.

PROGRESS REPORT NO. 1 PERIOD: JUNE-AUGUST, 1962.

GENERAL.

The raw coal brought to the plant was reduced to minus three inches. The minus three inch coal was passed over screens to eliminate minus $\frac{1}{4}$ inch fines and the -3 inch +$\frac{1}{4}$ inch coal was stored in service bunkers in the pilot plant building. During storage the coal was water sprayed daily to eliminate oxidation as much as possible.

The rate of withdrawal of coal and maintenance of a constant feed rate was achieved by the use of vibro-feeders and "Adequate" belt weighers, the latter may also serve to determine the total tonnage of coal used in an experiment. It is, however, desirable to weigh the product and refuse in tubs, on the weighbridge since this is the more accurate method. During the course of the experiments the latter method was adopted.

Before entering the washer the coal was wet screened to remove any -$\frac{1}{4}$ inch fines adhering to it.

Products leaving the bath were passed over the conventional drainage, rinsing and dewatering screens and passed to tubs for weighing. Sampling devices were used at the ends of the dewatering screens such that the entire stream of coal leaving the screen could be diverted to sample containers. The frequency and duration of this stream diversion during the course of an experiment, was regulated to obtain an adequate number of increments and a large enough gross sample for subsequent accurate, detailed analysis.

The necessary correction for moisture content of products was made from the data obtained from the above samples. The weight of all samples taken was allowed for in determining the yield of the products.

SEPARATING VESSEL.

The shallow-bath vessel utilized during the course of the experiments, was the Drewboy washer which is so well known that no detailed description is necessary. The

"standard" .../

"standard" supply of heavy medium suspension, viz. 200 gallons per minute top feed and 80 gallons per minute bottom feed, was employed for experiments discussed in this paper.

COAL USED IN THE STUDIES.

The coal selected for these studies at the pilot plant, was 80 tons of cobbles from the Brakfontein Navigation and Steam Collieries. This coal was chosen because of its relatively uniform specific gravity distribution in the s.g. range 1.30 - 1.65. The cobbles were crushed and screened and the -3 inch +¼ inch size fraction utilized for the experiments. From typical cumulative yield versus specific gravity curves it was estimated that at a specific gravity of separation of 1.40 a cumulative yield of approximately 50% would be obtained for Brakfontein coal. To ensure adequate quantities of product and refuse it was decided to employ a separation specific gravity in the washer equal to 1.40.

EXPERIMENTAL PROCEDURE.

The experimental procedure adopted in all the experiments was as follows:

The heavy medium suspension, magnetite, was circulated through the washer and the specific gravity was adjusted to the desired level of 1.40. The automatic control was then brought into operation, but no coal was fed until the automatic control of the specific gravity of the bath was fully established.

The vibro-feeder was then started and adjusted to feed the coal steadily at a feed rate of 20 tons per hour. The plant was then run until stable conditions had been established. This is usually a period of 10 - 15 minutes.

At this stage the experiment proper was started. This was usually of 30 - 40 minutes duration and during this period sample increments, of the order of 12 - 14 lbs. were taken of the product and refuse at 30 second intervals.

At the end of the initial sampling period, a period of 10 - 15 minutes was allowed for removal of samples whilst the raw coal feed to the washer was maintained. At the end of this period a second sampling period, of 30 - 40 minute duration, was introduced during which the sampling procedure was similar to that employed for the initial sampling period. A third sampling period was similarly introduced.

At the end .../

At the end of the compound experiment both the product and refuse were weighed on the weighbridge and from these total masses, corrected for moisture content, the yield of product and refuse evaluated assuming the yield to be constant for the three individual experiments.

The heavy medium suspension in the bath was also sampled at regular intervals so that its properties as well as the degree of contamination of the medium during the course of the compound experiment could be determined.

These results are given in Table I.

TABLE I.

Run No.	% Magnetite	Specific gravity
1	97	1.38
2	96	1.40
3	95	1.39

Since very little contamination occurred during the course of the compound experiment it was not deemed to be necessary to repeat the medium analysis for subsequent experiments.

The product and discard obtained from the compound experiment were remixed and stored in the service bunker. The mixing process was executed by transferring alternate tubs of product and refuse to the service bunkers.

This "reconstituted" raw coal was used for a compound experiment similar in all respects to the one just described.

ANALYSIS OF PRODUCTS.

Having combined all the increments representing a specific product, the resulting bulk samples were wet weighed, sun dried, weighed and then separated into size fractions using perforated screens of apertures $1\frac{1}{2}$ inch diameter, $\frac{3}{4}$ inch diameter and $\frac{1}{4}$ inch diameter.

A detailed float and sink analysis was done on each size fraction over a sufficiently wide band in the range of specific gravities: 1.30 - 1.50, in 0.02 increments, to establish the specific gravity of separation.

RESULTS .../

RESULTS.

(1) Compound experiment 1.

TABLE II.

SIZE DISTRIBUTION.

	Product			Discard		
Run No.	1A	1B	1C	1A	1B	1C
Size fraction	%	%	%	%	%	%
-3" +1½"	25.31	34.02	40.48	31.33	34.06	42.19
-1½" +¾"	41.91	39.14	41.54	41.29	40.15	40.74
-¾" +¼"	32.31	26.34	17.42	26.62	25.26	16.55
-¼"	0.46	0.48	0.56	0.77	0.52	0.52

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TECHNICAL OFFICER.

PRETORIA
29th September, 1962.

TABLE III.

FLOAT AND SINK ANALYSIS OF WASHERY PRODUCTS FOR RUN 1A.

Size Range	-3" +1½"			-1½" +¾"			-¾" +¼"		
S.G. Interval	Fractional Yield		Distribution Factor	Fractional Yield		Distribution Factor	Fractional Yield		Distribution Factor
	Product	Discard		Product	Discard		Product	Discard	
	%	%		%	%		%	%	
<1.30	0	0	100	0.07	0	100	0.38	0	100
1.30 - 1.32	0.41	0	100	1.50	0	100	3.50	0.02	99.40
1.32 - 1.34	3.77	0	100	6.66	0.01	99.9	8.77	0.06	99.30
1.34 - 1.36	15.44	0.01	100	18.57	0.04	99.8	17.30	0.11	99.40
1.36 - 1.38	19.32	0.02	99.90	18.79	0.13	99.3	18.52	0.19	99.0
1.38 - 1.40	16.14	0.46	97.23	14.14	0.65	95.6	13.29	0.63	95.5
1.40 - 1.42	6.08	3.14	65.90	5.46	2.22	71.1	5.21	1.74	75.0
1.42 - 1.44	0.64	4.52	12.20	1.33	3.70	26.4	2.18	2.82	43.6
1.44 - 1.46	0.01	3.06	0.33	0.37	3.22	10.3	0.83	2.80	22.9
1.46 - 1.48	0.01	2.70	0.37	0.12	2.85	4.0	0.49	2.43	16.8
1.48 - 1.50	0.07	2.33	2.90	0.04	2.65	1.5	0.24	2.43	9.0
>1.50	0	21.90	0	0.03	17.43	0	0.21	15.85	1.3
	61.89	38.13		67.08	32.90		70.92	29.08	

TABLE IV.

FLOAT AND SINK ANALYSIS OF WASHERY PRODUCTS FOR RUN 1B.

Size Range	-3" +1½"			-1½" +¾"			-¾" +¼"		
S.G. Interval	Fractional Yield		Distribution Factor	Fractional Yield		Distribution Factor	Fractional Yield		Distribution Factor
	Product	Discard		Product	Discard		Product	Discard	
	%	%		%	%		%	%	
<1.30	0	0	-	0.08	0	100	0.79	0	100
1.30 - 1.32	0.40	0	100	1.50	0	100	3.31	0.01	99.7
1.32 - 1.34	7.28	0	100	7.67	0.01	100	8.93	0.05	99.4
1.34 - 1.36	17.40	0.02	99.8	18.10	0.04	99.7	16.35	0.13	99.2
1.36 - 1.38	20.37	0.05	99.8	19.09	0.11	99.4	17.69	0.28	98.4
1.38 - 1.40	15.09	0.59	96.2	12.89	0.73	94.6	11.62	0.79	93.6
1.40 - 1.42	4.85	2.57	65.4	4.41	2.52	63.6	4.92	1.96	71.5
1.42 - 1.44	0.81	3.97	16.9	1.39	3.93	26.1	1.83	3.33	35.5
1.44 - 1.46	0.15	3.38	4.3	0.38	3.87	8.9	0.82	3.35	19.7
1.46 - 1.48	0.07	3.25	2.1	0.21	3.17	6.2	0.47	2.71	14.8
1.48 - 1.50	0	2.52	0	0.11	2.52	4.2	0.32	2.62	10.9
>1.50	0	17.23	0	0.06	17.22	3.5	0.32	17.40	1.8
	66.42	33.58		65.89	34.11		67.37	32.63	

TABLE V.

FLOAT AND SINK ANALYSIS OF WASHERY PRODUCTS FOR RUN 1C.

Size Range	-3" +1½"			-1½" +¾"			-¾" +¼"		
S.G. Interval	Fractional Yield		Distribution Factor	Fractional Yield		Distribution Factor	Fractional Yield		Distribution Factor
	Product	Discard		Product	Discard		Product	Discard	
	%	%		%	%		%	%	
<1.30	0	0	-	0.02	0	100	0.17	0	100
1.30 - 1.32	0.15	0	100	0.56	0	100	2.14	0	100
1.32 - 1.34	4.04	0	100	5.30	0.01	100	7.31	0.07	99.1
1.34 - 1.36	17.15	0.01	99.9	15.23	0.03	99.8	13.67	0.14	99.0
1.36 - 1.38	21.71	0.03	99.9	21.43	0.13	99.4	21.25	0.26	98.8
1.38 - 1.40	16.50	0.70	95.9	16.34	0.62	96.3	14.78	0.77	95.1
1.40 - 1.42	5.62	3.59	61.0	5.65	3.28	63.3	5.73	2.26	71.7
1.42 - 1.44	0.86	5.08	14.5	1.15	5.51	17.3	1.70	4.25	28.6
1.44 - 1.46	0.09	3.45	2.5	0.37	3.93	8.6	0.67	3.14	17.60
1.46 - 1.48	0.05	3.08	1.6	0.08	3.07	2.5	0.36	2.23	13.9
1.48 - 1.50	0	2.92	0	0.04	2.93	1.4	0.20	3.30	5.7
>1.50	0	14.98	0	0.05	14.29	0	0.21	15.38	1.4
	66.17	33.84		66.22	33.80		68.19	31.80	

(2) Compound experiment 2.

TABLE VI.

SIZE DISTRIBUTION.

	Product			Discard		
Run No.	2A	2B	2C	2A	2B	2C
Size Frac.	%	%	%	%	%	%
-3" +1½"	12.20	18.37	35.00	15.29	24.80	30.63
-1½" +¾"	38.13	38.52	40.86	39.88	41.32	44.90
-¾" +¼"	47.84	41.61	22.84	43.46	32.65	23.29
-¼"	1.44	1.38	0.64	1.02	0.99	0.74

TABLE VII.

FLOAT AND SINK ANALYSIS OF WASHERY PRODUCTS FOR RUN 2A.

Size Range	-3" +1½"			-1½" +¾"			-¾" +¼"		
S.G. Interval	Fractional Yield		Distribution Factor	Fractional Yield		Distribution Factor	Fractional Yield		Distribution Factor
	Product	Discard		Product	Discard		Product	Discard	
	%	%		%	%		%	%	
<1.30	0.32	0	100	0.04	0	100	0.39	0	100
1.30 - 1.32	3.56	0	100	0.83	0	100	2.21	0.01	99.5
1.32 - 1.34	11.81	0	100	5.10	0.01	99.8	6.05	0.05	99.2
1.34 - 1.36	13.51	0	100	14.50	0.03	99.8	13.27	0.11	99.2
1.36 - 1.38	12.92	0	100	14.91	0.07	99.5	14.00	0.20	98.6
1.38 - 1.40	2.93	0.79	78.8	10.04	0.50	95.3	8.69	0.59	93.6
1.40 - 1.42	0.35	4.04	7.8	3.86	3.66	51.3	6.16	2.14	74.2
1.42 - 1.44	0	5.76	0	0.56	7.88	6.6	1.76	5.40	24.6
1.44 - 1.46	0.05	4.26	1.2	0.12	5.16	2.3	0.49	4.71	9.4
1.46 - 1.48	0	5.12	0	0.03	5.61	0.5	0.22	4.79	4.4
1.48 - 1.50	0	3.93	0	0	4.07	0	0.14	3.74	3.6
>1.50	0	30.65	0	0	23.05	0	0.11	24.77	4.4
	45.45	54.55		49.97	50.04		53.49	46.51	

TABLE VIII.

FLOAT AND SINK ANALYSIS OF WASHERY PRODUCTS FOR RUN 2B.

Size Range	-3" +1½"			-1½" +¾"			-¾" +¼"		
S.G. Interval	Fractional Yield		Distribution Factor	Fractional Yield		Distribution Factor	Fractional Yield		Distribution Factor
	Product	Discard		Product	Discard		Product	Discard	
	%	%		%	%		%	%	
<1.30	0	0	100	0.06	0	100	0.47	0	100
1.30 - 1.32	0.64	0	100	0.81	0	100	2.46	0.01	99.6
1.32 - 1.34	4.16	0	100	5.58	0	100	7.04	0.04	99.4
1.34 - 1.36	11.88	0	100	13.62	0.03	99.8	13.83	0.06	99.6
1.36 - 1.38	15.01	0.14	99.1	15.38	0.20	98.7	15.73	0.21	98.7
1.38 - 1.40	8.94	0.50	94.7	9.79	0.86	91.9	10.46	0.90	92.1
1.40 - 1.42	2.70	4.69	36.5	3.32	3.96	45.6	4.93	2.73	64.4
1.42 - 1.44	0.24	7.80	3.0	0.64	6.36	9.1	0.85	4.29	16.5
1.44 - 1.46	0.06	5.49	1.1	0.12	6.08	1.9	0.78	3.88	16.7
1.46 - 1.48	0	6.02	0	0.03	5.04	0.6	0.30	3.95	7.1
1.48 - 1.50	0	3.60	0	0	5.04	0	0.14	3.73	3.6
>1.50	0	28.10	0	0	23.11	0	0.13	23.08	0.5
	43.65	56.35		49.35	50.66		57.11	42.89	

TABLE IX.

FLOAT AND SINK ANALYSIS OF WASHERY PRODUCTS FOR RUN 2C.

Size Range	-3" +1½"			-1½" +¾"			-¾" +¼"		
S.G. Interval	Fractional Yield		Distribution Factor	Fractional Yield		Distribution Factor	Fractional Yield		Distribution Factor
	Product	Discard		Product	Discard		Product	Discard	
	%	%		%	%		%	%	
<1.30	0	0	-	0.05	0	100	0.06	0	100
1.30 - 1.32	0.81	0	100	1.07	0	100	2.18	0.01	99.5
1.32 - 1.34	6.01	0	100	5.19	0.01	99.8	6.26	0.05	99.2
1.34 - 1.36	18.11	0	100	14.69	0.04	99.7	14.16	0.12	99.2
1.36 - 1.38	19.62	0.03	99.9	15.55	0.13	99.2	13.94	0.26	98.2
1.38 - 1.40	8.47	1.12	88.3	8.51	1.27	87.0	8.55	0.90	90.5
1.40 - 1.42	1.28	4.52	22.1	2.84	4.25	40.1	3.76	3.27	53.5
1.42 - 1.44	0.10	5.91	1.6	0.63	6.14	9.3	0.98	4.70	17.3
1.44 - 1.46	0.02	5.50	0.4	0.12	5.76	2.0	0.40	4.83	7.6
1.46 - 1.48	0	3.58	0	0.07	4.78	1.4	0.14	4.11	3.3
1.48 - 1.50	0	4.15	0	0.01	4.45	0.2	0.10	4.81	2.0
>1.50	0	20.77	0	0	24.44	0	0.08	26.31	0.3
	54.42	45.58		48.74	51.26		50.61	49.39	

TABLE X.

COMPARISON OF PROBABLE ERROR AND CUT POINT FOR VARIOUS RUNS.

Size Range	-3" +1½"		-1½" +¾"		-¾" +¼"	
Run No.	Probable Error	Cut Point S.G.	Probable Error	Cut Point S.G.	Probable Error	Cut Point S.G.
1A	0.005	1.412	0.011	1.418	0.019	1.424
1B	0.007	1.415	0.013	1.416	0.016	1.420
1C	0.008	1.414	0.010	1.415	0.013	1.419
2A	0.007	1.415	0.005	1.411	0.008	1.412
2B	0.003	1.410	0.006	1.409	0.010	1.415
2C	0.004	1.399	0.010	1.406	0.010	1.420