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FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

TECHNICAL MEMORANDUM NO. 3 OF 1963.

EXPERIMENTS CONDUCTED TO DETERMINE THE

REPRODUCIBILITY OF FLOAT AND SINK ANALYSIS AND

THE EFFECT OF COAL PRETREATMENT ON FLOAT

AND SINK ANALYSIS.

By:

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And

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<u>AND SINK ANALYSIS.</u>

<u>GENERAL</u>:

The raw coal brought to the pilot plant was re-
duced to minus three inches. The minus three inch coal
was passed over screens to eliminate minus $\frac{1}{4}$ inch fines.
The $-3"$ $+\frac{1}{4}"$ coal was separated, by hand screening, into
the following size fractions: $-3"$ $+1\frac{1}{2}"$, $-1\frac{1}{2}"$ $+\frac{3}{4}"$ and
$-\frac{3}{4}"$ $+\frac{1}{4}"$.

The compound experiment was conducted in three steps,
viz. experiments were performed on the three size fractions..
The first experiment was conducted on the $-1\frac{1}{2}"$ $+\frac{3}{4}"$ size
fraction, while the remaining two size fractions, $-3"$ $+1\frac{1}{2}"$
and $-\frac{3}{4}"$ $+\frac{1}{4}"$, were stored under water in drums to eliminate
oxidation as much as possible.

Each size fraction was sub-divided into a number
of sub-samples, the number of sub-samples being dependent
upon the total mass of each size fraction. Subdivision of
the size fractions was executed by taking shovel increments.

<u>COAL USED IN THE STUDIES</u>:

The coal selected for these studies, at the
pilot plant, was 5 tons of cobbles from the Brakfontein
Navigation Steam Collieries. This coal was selected be-
cause of its relatively uniform specific gravity distri-
bution in the specific gravity range 1.40 - 1.70. The
cobbels were crushed and screened and the $-3"$ $+\frac{1}{4}"$ size
fraction utilized for the experiments. The $-3"$ $+\frac{1}{4}"$ size
fraction was divided, by hand screening, into $-3"$ $+1\frac{1}{2}"$,
$-1\frac{1}{2}"$ $+\frac{3}{4}"$ and $-\frac{3}{4}"$ $+\frac{1}{4}"$ size fractions.

SUB-DIVISION OF THE COAL:

The method of division used, was as follows:

The $-1\frac{1}{2}$" $+\frac{3}{4}$" size fraction was heaped to form a pile and 24 drums were placed around the pile circumferentially. By taking shovel increments, in a rotary fashion, the pile was evenly distributed amongst the drums. Combining the contents of all even-numbered and all odd-numbered drums the original pile of $-1\frac{1}{2}$" $+\frac{3}{4}$" coal was divided into two sub-samples.

Each sub-sample was divided similarly. By repeating the process the $-1\frac{1}{2}$" $+\frac{3}{4}$" size fraction was divided into 16 equal sub-samples.

The $-\frac{3}{4}$" $+\frac{1}{4}$" size fraction was divided into 8 equal sub-samples utilizing the above method.

The -3" $+1\frac{1}{2}$" size fraction was divided into 4 equal fractions again utilizing the above method. Each of the four sub-samples was then divided into 3 sub-fractions utilizing 24 drums. To achieve this the contents of every _third_ drum was combined to effect the required separation.

NUMBER OF SUB-SAMPLES:

The number of sub-samples obtained from each size fraction was dependent upon the total mass of each size fraction. A further requisite was that the number of sub-samples obtained from each size fraction should be the maximum allowable in order to obtain the maximum number of comparable results to determine their significance.

STORAGE OF SAMPLES:

Sub-samples obtained from each size fraction which could not be subjected to analysis immediately, were stored under water to eliminate weathering.

EXPERIMENTAL PROCEDURE:

(a) $-1\frac{1}{2}$" $+\frac{3}{4}$" size fraction:

The sixteen sub-samples obtained from the $-1\frac{1}{2}$" $+\frac{3}{4}$" size fraction were arbitrarily grouped into

four groups of four sub-samples each. The experiments performed on the four groups were to establish the effect of various pretreatments on the float and sink analysis. The four sub-samples in each group served to ascertain the degree of accuracy that could be expected in performing the various series of tests.

The first group of four sub-samples was subjected to float and sink analysis without pretreatment i.e. the coal was subjected to float and sink analyses in the moist condition it had been received.

The pretreatment of the second group of four sub-samples consisted of soaking the sub-samples in water for a period of 24 hours, sun drying and then subjecting the four sub-samples to float and sink analyses.

The pretreatment of the third group of four sub-samples consisted of soaking the sub-samples in water for a period of 24 hours, sun drying, again soaking in water for 24 hours, sun drying and then subjecting the sub-samples to float and sink analyses.

The fourth group of 4 sub-samples were soaked in water for a period of 24 hours and the water saturated coal was directly subjected to float and sink analysis.

(b) $-3"$ $+1\frac{1}{2}"$ size fraction:

The 12 sub-samples obtained from the $-3"$ $+1\frac{1}{2}"$ size fraction were all soaked in water for a period of 24 hours and the saturated coal was directly subjected to float and sink analysis.

(c) $-\frac{3}{4}"$ $+\frac{1}{4}"$ size fraction:

The 8 sub-samples obtained from the $-\frac{3}{4}"$ $+\frac{1}{4}"$ size fraction were treated similarly to the 12 sub-samples obtained from the $-3"$ $+1\frac{1}{2}"$ size fraction.

ANALYSIS OF SAMPLES:

A detailed float and sink analysis was done on each sub-sample in the specific gravity range 1.40 - 1.70, in 0.02 increments, to establish the specific gravity distribution within the specified specific gravity range.

Solutions of $Zn\ Cl_2$ in water of the required

specific gravities were used as separating medium.

DISCUSSION:

(a) Pretreatment effects:

No definite conclusions, regarding the effect of pretreatment of the coal on the determination of the specific gravity distribution, could be drawn. The variations in the results obtained from analysis performed on the various sub-samples subjected to identical pretreatment is of the same order of magnitude as that obtained from analysis performed on the various groups of sub-samples subjected to diffirent pretreatment. It may thus be concluded that if any variations in the specific gravity distribution of the coal, due to pretreatment, does occur it is well within the limits of experimental accuracy.

From the results obtained for the water saturated coal, subjected to float and sink analysis, a tendency for the specific gravity distribution of the coal to be displaced towards the higher specific gravity region may be observed. The magnitude of the specific gravity shift, however, is comparable to the experimental error.

(b) Identical pretreatment:

The application of identical pretreatments applied to the $-3" + 1\frac{1}{2}"$ and $-\frac{3}{4}" + \frac{1}{4}"$ size fractions affords the estimation of experimental accuracy to be expected in the tests performed to establish the effect of pretreatment on the specific gravity distribution of the coal.

As may be expected the experimental accuracy increased with decrease in particle size. It may be observed that for mass percentages below 5%, in the various specific gravity intervals, maximum variation in mass percentages is of the order of 0.5 units, whereas for mass percentages exceeding 5% the maximum variations are of the order of a unit.

(c) Division:

The division of 5 tons of $-3" + \frac{1}{4}"$ coal into

identical sub-samples is an extremely, if not impossible, task and this may well be the major contribution towards the observed experimental error. In the specific gravity intervals containing less than 2% by mass of coal, especially of the larger particle sizes, the number of particles present in all probability is much less than the number required to obtain representative results. This may be clearly seen from the various combinations compiled.

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RESULTS.   TABLE 1.

Pretreatment: none.

Size fraction $-1\frac{1}{2}$" $+ \frac{3}{4}$".

Subsample No.	1	2	3	4	Mean
S.G. Interval	Mass %	Mass %	Mass %	Mass %	Mass %
<1.40	51.9	52.7	52.6	51.5	52.2
1.40 - 1.42	8.0	7.9	7.8	7.9	7.9
1.42 - 1.44	5.0	5.6	5.3	5.3	5.3
1.44 - 1.46	4.0	2.9	3.8	4.7	3.9
1.46 - 1.48	3.2	3.5	4.2	3.5	3.6
1.48 - 1.50	3.6	3.2	3.2	3.5	3.4
1.50 - 1.52	3.0	2.8	3.1	3.1	3.0
1.52 - 1.54	2.5	2.8	2.4	2.4	2.5
1.54 - 1.56	2.8	2.3	2.2	2.1	2.3
1.56 - 1.58	1.7	2.3	1.6	1.6	1.8
1.58 - 1.60	1.6	1.3	1.5	1.2	1.4
1.60 - 1.62	1.6	1.5	1.5	1.6	1.5
1.62 - 1.64	1.2	1.0	1.0	1.3	1.1
1.64 - 1.66	0.9	1.2	1.5	1.3	1.2
1.66 - 1.68	1.5	1.2	0.9	1.3	1.2
1.68 - 1.70	1.1	1.0	1.2	1.2	1.1
>1.70	6.4	6.8	6.5	6.6	6.6

TABLE 2.

Pretreatment: soaked for 24 hours and sun dried.

Size fraction $-1\frac{1}{2}$" $+\frac{3}{4}$"

Subsample No.	5	6	7	8	Mean
S.G. Interval	Mass %	Mass %	Mass %	Mass %	Mass %
<1.40	51.5	53.3	52.1	52.4	52.3
1.40 - 1.42	7.8	7.1	7.5	7.9	7.6
1.42 - 1.44	5.1	5.6	5.8	5.0	5.4
1.44 - 1.46	4.3	4.4	5.0	5.0	4.7
1.46 - 1.48	4.1	3.6	3.2	3.7	3.6
1.48 - 1.50	3.5	3.4	3.3	3.3	3.3
1.50 - 1.52	2.7	2.1	3.2	3.0	2.8
1.52 - 1.54	2.5	2.7	2.3	2.4	2.5
1.54 - 1.56	2.4	2.3	2.1	2.2	2.2
1.56 - 1.58	1.8	2.0	1.7	1.8	1.8
1.58 - 1.60	1.5	1.6	1.4	1.5	1.5
1.60 - 1.62	1.3	1.4	1.8	1.3	1.4
1.62 - 1.64	1.4	1.4	1.6	1.5	1.5
1.64 - 1.66	1.3	1.2	1.1	1.2	1.2
1.66 - 1.68	1.2	1.1	1.0	1.1	1.1
1.68 - 1.70	1.2	0.9	1.2	1.1	1.1
>1.70	6.5	5.9	5.8	6.1	6.1

TABLE 3.

Pretreatment: soaked for 24 hours, sun dried, soaked for
24 hours and sun dried.

Size fraction: $-1\frac{1}{2}$" $+\frac{3}{4}$".

Subsample No.	9	10	11	12	Mean
S.G. Interval	Mass %	Mass %	Mass %	Mass %	Mass%
< 1.40	51.9	51.7	51.5	52.3	51.9
1.40 - 1.42	7.1	6.8	7.4	8.0	7.3
1.42 - 1.44	6.8	6.0	5.5	5.4	5.9
1.44 - 1.46	5.2	4.3	4.6	4.6	4.7
1.46 - 1.48	2.8	3.8	3.2	3.4	3.3
1.48 - 1.50	3.7	2.9	3.6	3.4	3.4
1.50 - 1.52	2.8	3.1	2.8	2.7	2.9
1.52 - 1.54	2.0	2.3	2.4	2.9	2.4
1.54 - 1.56	1.9	2.9	2.5	2.3	2.4
1.56 - 1.58	1.9	2.0	1.9	1.4	1.8
1.58 - 1.60	1.3	1.4	1.5	1.2	1.4
1.60 - 1.62	1.6	1.3	1.6	1.4	1.5
1.62 - 1.64	1.1	1.3	1.3	1.6	1.3
1.64 - 1.66	1.3	1.4	1.3	1.3	1.3
1.66 - 1.68	0.9	1.0	1.0	1.2	1.0
1.68 - 1.70	0.9	1.2	1.0	0.6	0.9
> 1.70	6.7	6.7	6.9	6.2	6.6

TABLE 4.

Pretreatment: Soaked for 24 hours and directly subjected
to float and sink analysis.

Size fraction: $-1\frac{1}{2}$" $+\frac{3}{4}$"

Subsample No	13	14	15	16	Mean
S.G. Interval	Mass %	Mass %	Mass %	Mass%	Mass%
< 1.40	47.8	47.7	49.4	49.1	49.1
1.40 - 1.42	8.8	9.0	9.3	9.3	9.3
1.42 - 1.44	6.8	6.2	6.6	6.0	6.0
1.44 - 1.46	5.0	5.0	4.4	4.5	4.5
1.46 - 1.48	4.0	4.0	3.8	4.1	4.1
1.48 - 1.50	3.3	4.1	3.4	2.5	2.5
1.50 - 1.52	2.6	2.2	3.1	2.0	2.0
1.52 - 1.54	2.8	2.3	2.3	2.2	2.2
1.54 - 1.56	2.3	1.8	1.7	2.3	2.3
1.56 - 1.58	2.3	2.0	1.9	2.5	2.5
1.58 - 1.60	1.4	1.4	1.4	0.7	0.7
1.60 - 1.62	1.4	2.2	1.4	1.9	1.9
1.62 - 1.64	1.1	1.4	1.3	1.4	1.4
1.64 - 1.66	1.1	1.3	1.3	1.4	1.4
1.66 - 1.68	1.1	0.8	1.0	1.0	1.0
1.68 - 1.70	1.1	1.0	0.9	0.7	0.7
> 1.71	7.2	7.5	7.0	7.5	7.5

TABLE 5.

Means of various combinations.

Size fraction $-1\frac{1}{2}"$ $+\frac{3}{4}"$.

Mean of Sub-samples	1 + 2	3 + 4	5 + 6	7 + 8	9 + 10	11 + 12	13 + 14	15 + 16
S.G. Interval	Mass %	Mass %	Mass %	Mass %	Mass %	Mass %	Mass %	Mass %
$<$1.40	52.3	52.1	52.4	52.3	51.8	51.9	47.8	49.3
1.40 - 1.42	8.0	7.9	7.5	7.7	7.0	7.7	8.9	9.3
1.42 - 1.44	5.3	5.3	5.4	5.4	6.4	5.5	6.5	6.3
1.44 - 1.46	3.5	4.3	4.4	5.0	4.8	4.6	5.0	4.5
1.46 - 1.48	3.4	3.9	3.9	3.5	3.3	3.3	4.0	4.0
1.48 - 1.50	3.4	3.4	3.5	3.3	3.3	3.5	3.7	3.0
1.50 - 1.52	2.9	3.1	2.4	3.1	3.0	2.8	2.4	2.6
1.52 - 1.54	2.7	2.4	2.6	2.4	2.2	2.5	2.6	2.3
1.54 - 1.56	2.6	2.2	2.4	2.2	2.4	2.4	2.1	2.0
1.56 - 1.58	2.0	1.6	1.9	1.8	2.0	1.7	2.2	2.2
1.58 - 1.60	1.5	1.4	1.6	1.5	1.4	1.4	1.4	1.1
1.60 - 1.62	1.6	1.6	1.4	1.6	1.5	1.5	1.8	1.7
1.62 - 1.64	1.1	1.2	1.4	1.6	1.2	1.5	1.3	1.4
1.64 - 1.66	1.1	1.4	1.3	1.2	1.4	1.3	1.2	1.4
1.66 - 1.68	1.4	1.1	1.2	1.1	1.0	1.1	1.0	1.0
1.68 - 1.70	1.0	1.2	1.1	1.2	1.1	0.8	1.1	0.8
$>$1.70	6.6	6.6	6.2	6.0	6.7	6.6	7.4	7.3

TABLE 6.

Pretreatment: soaked for 24 hours and directly subjected to float and sink analysis.

Size fraction: -3" +1½".

Sub-sample No.	1	2	3	4	5	6	7	8	9	10	11	12	Mean
S.G. Range	Mass%	Mass%	Mass%	Mass%	Mass%	Mass%	Mass%	Mass%	Mass%	Mass%	Mass%	Mass%	Mass%
< 1.40	46.9	45.0	44.3	47.6	44.6	42.5	48.3	46.5	48.8	49.6	47.4	45.5	46.4
1.40 – 1.42	10.3	10.8	11.4	9.3	10.4	10.9	9.1	9.4	9.1	9.2	7.8	9.5	9.7
1.42 – 1.44	6.7	6.3	7.4	5.0	7.3	7.2	5.6	6.5	5.7	6.8	7.3	7.0	6.6
1.44 – 1.46	3.8	4.4	3.5	4.6	4.6	4.5	4.8	4.4	4.1	4.2	4.9	5.6	4.4
1.46 – 1.48	3.7	3.9	3.3	3.5	3.5	3.7	4.0	3.9	3.9	4.4	3.3	4.6	3.8
1.48 – 1.50	3.1	3.2	3.8	2.6	3.3	2.7	2.2	2.9	2.6	3.3	3.1	3.2	3.0
1.50 – 1.52	2.3	3.0	1.8	2.3	3.2	3.4	2.1	3.3	2.9	2.2	3.0	3.0	3.0
1.52 – 1.54	2.1	1.3	2.3	2.1	1.8	2.6	2.8	2.5	3.3	2.0	3.0	2.4	2.7
1.54 – 1.56	1.8	2.2	1.7	1.9	1.6	2.0	1.7	1.6	2.8	1.7	2.2	1.8	2.3
1.56 – 1.58	1.7	2.3	1.5	2.4	2.4	1.2	1.6	2.5	2.5	2.4	1.8	1.9	1.8
1.58 – 1.60	1.7	1.8	1.8	1.9	1.7	1.9	1.9	2.1	1.2	1.5	1.6	1.5	2.1
1.60 – 1.62	1.1	2.3	1.4	2.2	3.0	1.7	1.8	1.9	1.7	1.1	1.2	1.3	1.9
1.62 – 1.64	1.4	1.9	1.2	1.8	1.5	1.0	1.4	1.4	1.7	1.2	1.5	1.4	1.5
1.64 – 1.66	1.3	1.0	2.0	0.8	0.9	1.1	0.8	0.8	1.3	1.1	1.3	1.3	1.1
1.66 – 1.68	0.8	0.6	0.4	0.5	1.2	1.1	0.7	0.8	1.0	1.1	1.3	1.0	1.1
1.68 – 1.70				0.7				0.4	0.5	0.7	0.6	0.7	0.7
> 1.70	8.9	8.8	10.7	9.8	7.9	10.9	10.1	8.9	6.7	7.8	8.7	8.3	9.0

TABLE 7.

Means of various combinations.

Size fraction: $-3" + 1\frac{1}{2}"$.

Mean of Sub-samples.	1 + 2	3 + 4	5 + 6	7 + 8	9 + 10	11 + 12
S.G. Interval	Mass %	Mass %	Mass %	Mass %	Mass %	
<1.40	46.0	46.0	43.6	47.4	49.2	46.5
1.40 - 1.42	10.6	10.4	10.7	9.3	9.2	8.7
1.42 - 1.44	6.5	6.2	7.3	6.1	6.3	7.2
1.44 - 1.46	4.1	4.1	4.6	4.6	4.2	5.2
1.46 - 1.48	3.8	3.4	3.6	4.0	4.2	4.0
1.48 - 1.50	3.5	3.2	3.0	2.6	3.0	3.2
1.50 - 1.52	2.2	2.1	3.3	2.7	2.6	3.1
1.52 - 1.54	1.7	2.2	2.2	2.7	2.7	2.7
1.54 - 1.56	2.0	1.8	1.8	1.4	2.3	1.6
1.56 - 1.58	2.0	2.0	2.2	2.1	2.5	2.1
1.58 - 1.60	1.8	1.7	1.5	1.9	1.4	1.7
1.60 - 1.62	2.0	2.0	2.5	1.9	1.4	1.5
1.62 - 1.64	1.5	1.6	1.6	1.6	1.5	1.3
1.64 - 1.66	1.4	1.0	1.0	1.1	1.2	1.3
1.66 - 1.68	1.2	1.8	1.0	0.8	0.9	1.3
1.68 - 1.70	0.7	0.6	1.2	0.6	0.6	0.7
>1.70	8.9	10.3	9.4	9.5	7.3	8.5

TABLE 8.

Pretreatment: soaked for 24 hours and directly subjected to float and sink analysis.

Size fraction: $-\frac{3}{4}" + \frac{1}{4}"$.

Sub-sample No	1	2	3	4	5	6	7	8	Mean
S.G. Interval	Mass%	Mass%	Mass%	Mass%	Mass%	Mass%	Mass%	Mass%	Mass%
<1.40	45.7	45.9	46.9	46.7	45.4	46.7	46.4	46.2	46.2
1.40 - 1.42	9.7	10.0	9.8	9.4	9.7	9.7	9.5	9.1	9.5
1.42 - 1.44	6.8	7.0	6.4	6.8	7.1	6.4	6.4	6.7	6.7
1.44 - 1.46	4.5	5.1	5.1	4.9	4.8	4.7	4.4	4.8	4.8
1.46 - 1.48	4.3	4.0	4.1	4.0	4.3	3.9	4.0	4.3	4.1
1.48 - 1.50	2.9	2.9	2.8	3.0	3.1	3.1	3.1	2.9	3.0
1.50 - 1.52	2.8	2.8	2.7	2.8	2.9	2.8	2.5	2.4	2.7
1.52 - 1.54	2.1	2.1	2.3	2.4	2.1	2.4	2.3	2.3	2.3
1.54 - 1.56	2.1	2.1	2.1	2.0	1.9	2.1	2.1	2.1	2.1
1.56 - 1.58	2.0	1.7	1.7	2.0	1.7	1.9	1.9	2.0	1.9
1.58 - 1.60	1.6	1.3	1.5	1.4	1.5	1.3	1.5	1.3	1.4
1.60 - 1.62	1.7	1.6	1.6	1.7	1.7	1.9	1.7	1.5	1.7
1.62 - 1.64	1.5	1.3	1.5	1.4	1.3	1.5	1.6	1.3	1.4
1.64 - 1.66	1.3	1.3	1.2	1.3	1.3	1.3	1.5	1.3	1.3
1.66 - 1.68	1.3	1.2	1.2	1.3	1.2	1.2	1.3	1.3	1.3
1.68 - 1.70	1.1	1.1	1.1	1.2	1.2	1.1	1.3	1.2	1.2
S 1.70	8.4	8.3	8.0	8.2	9.0	8.0	8.4	8.8	8.4

TABLE 9.

Means of various combinations.

Size fraction $-\frac{3}{4}'' + \frac{1}{4}''$.

Mean of Sub-samples.	1 + 2	3 + 4	5 + 6	7 + 8
S.G. Interval	Mass %	Mass %	Mass %	Mass %
<1.40	45.8	46.8	46.1	46.3
1.40 - 1.42	9.9	9.3	9.6	9.3
1.42 - 1.44	6.9	6.6	6.7	6.6
1.44 - 1.46	4.8	5.0	4.8	4.6
1.46 - 1.48	4.2	4.1	4.1	4.2
1.48 - 1.50	2.9	2.9	3.1	3.0
1.50 - 1.52	2.8	2.8	2.9	2.5
1.52 - 1.54	2.2	2.4	2.3	2.3
1.54 - 1.56	2.1	2.1	2.0	2.1
1.56 - 1.58	1.9	1.9	1.8	2.0
1.58 - 1.60	1.5	1.5	1.4	1.4
1.60 - 1.62	1.7	1.7	1.8	1.6
1.62 - 1.64	1.4	1.5	1.4	1.5
1.64 - 1.66	1.3	1.3	1.3	1.4
1.66 - 1.68	1.3	1.3	1.2	1.3
1.68 - 1.70	1.1	1.2	1.2	1.3
>1.70	8.4	8.1	8.5	8.6