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# FUEL RESEARCH INSTITUTE

OF SOUTH AFRICA

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TECHNICAL MEMORANDUM

NO. 31 OF 1974

REPORT ON THE BENEFICIATION OF MINUS 0,5 mm FINES FROM  
KOORNFONTEIN COLLIERY

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1. INTRODUCTION

The Fuel Research Institute of South Africa was requested to investigate the beneficiation of minus 0,5 mm fines from Koorfontein Colliery as part of the full-scale investigation of the beneficiation of 0,5 mm fines from the Witbank Area.

The General Mining Group Laboratories reported that the Koorfontein fines were amenable to flotation, using 10% MIBC in kerosene. The Institute had to substantiate these findings and also investigate the use of other reagents. In addition, the Institute had to investigate other means of beneficiation such as the Deister Table and the Compound Water Cyclone.

2. THE COAL

The samples of 0,5 mm coal were prepared at the Koorfontein Laboratory. Initially about 100 kg of coal was provided for froth flotation tests only, and then at a later stage about 2,5 tons for the Deister Table, Compound Water Cyclone and froth flotation investigations.

3. TREATMENT OF THE COAL

Screen analyses were done on both consignments of coal and the results are tabulated in Table 1.

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The plus 0,075 mm fraction of the second consignment was also subjected to detailed float-and-sink analyses in the relative density range 1,35 - 1,65, with 0,05 intervals. The ash content of each relative density fraction was determined. The relevant washability data are reported in Table 2.

The second consignment was also analysed petrographically, and the results are shown in Table 3.

### 3.1. Treatment by Deister Table

The mechanical settings were as follows:

Speed of motion	305 r.p.m.
Length of stroke	13 mm
End elevation	6 mm
Side tilt	1,5 - 2°

Tests at feed rates of 0,38, 0,56 and 1,1 t/h were conducted, with pulp densities varying from 16,3 to 42,8 per cent solids. The results obtained are reported in Table 4.

In all tests a clean coal with an ash content of 7,0 per cent could not be produced from the material as received. Only when the minus 75 micrometre fraction was removed from the product by wet screening, was the ash content reduced to the required 7,0 per cent.

At high pulp densities in the feed, however, the minus 75 micrometre fraction hampered stratification on the table deck, and the ash content in the plus 75 micrometre fraction could be reduced to 8,2 per cent only.

/3.2. ....

### 3.2. Treatment by Compound Water Cyclone

Taking into account the washability and size consist of the raw coal, the following cyclone settings were chosen:

Tests	1 + 2	3 + 4	5 + 6
Vortex finder diameter, mm	67	67	67
Vortex finder clearance, mm	90	90	90
Apex valve diameter, mm	30	30	50
Inlet pressure, kg/cm <sup>2</sup>	0,7	0,56	0,7
% Solids in feed	10	10	10

Six tests, using the settings as above, were performed. The results are reported in Table 5.

As with the Deister Table, the large percentage of minus 0,075 mm material prevented the effective cleaning of the coal as received.

### 3.3. Treatment by Froth Flotation

Using the coal of the first consignment, twelve tests in all were conducted. Tests Nos. 10, 11 and 12 were done on coal from which the minus 0,075 mm material had been extracted, but did not show any improvement in the ash content. The results are reported in Table 6.

Eucalyptus oil appeared to be one of the best reagents to use for this coal.

On the second consignment six tests were conducted with similar results. These results are tabulated in Table 7.

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For all the above-mentioned tests a pulp density of 15% was used in a Denver batch cell. No conditioning time was allowed for.

Two tests were then conducted on a continuous basis, using a bank of five Denver cells. A pulp of 15% solids was pumped to the cells at a rate of 20 litres per minute. A reagent mixture of 90 ml paraffin and 45 ml MIBC was administered at the rate of 1,38 ml per minute for the first test. For the second test a mixture of 90 ml turpentine and 45 ml eucalyptus oil was used at the rate of 0,82 ml per minute. The results are shown in Table 8.

The conclusion can be made that this coal is amenable to froth flotation and a low-ash product can be produced by using a variation of reagents.

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TABLE 1SCREEN ANALYSES

(a) Screen analysis of first consignment

Size, mesh	Fract. %	Cum. %
Plus 30	0,5	0,5
30 x 60	19,1	19,6
60 x 100	21,1	40,7
100 x 200	24,1	64,8
Minus 200	35,2	-
Total	100,0	100,0

(b) Screen analysis of second consignment

Size mm	Fractional		Cumulative	
	mass %	ash %	mass %	ash %
+ 1,0	-	-	-	-
1,0 x 0,5	0,4	12,5	0,4	12,5
0,5 x 0,25	25,7	13,7	26,1	13,7
0,25 x 0,125	23,2	14,2	49,3	13,9
0,125 x 0,075	13,6	14,6	62,7	14,1
0,075 x 0,043	9,6	14,5	72,3	14,2
- 0,043	27,7	15,5	-	-
Total	100,0	-	100,0	14,5

/Table 2 .....

TABLE 2

## WASHABILITY DATA OF PLUS 0,075 mm FRACTION

R.D.	Fractional		Cumulative Floats		Cumulative Sinks	
	Yield %	Ash %	Yield %	Ash %	Yield %	Ash %
Fl,35	34,4	3,7	34,4	3,7	65,6	19,2
1,35 - 1,40	6,7	5,2	41,1	3,9	58,9	20,8
1,40 - 1,45	14,3	6,4	55,4	4,6	44,6	25,5
1,45 - 1,50	15,7	9,0	71,1	5,6	28,9	34,4
1,50 - 1,55	7,3	12,6	78,4	6,2	21,6	41,8
1,55 - 1,60	3,7	17,0	82,1	6,7	17,9	46,9
1,60 - 1,65	2,6	20,1	84,7	7,1	15,3	51,5
S1,65	15,3	51,5	-	-	-	-
WHOLE COAL	100,0	-	100,0	13,9	-	-

TABLE 3

## PETROGRAPHIC ANALYSIS

Size mm	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio <u>Reactives</u> Inerts
0,5 x 0	46,2	3,7	45,3	4,8	1,0 : 1
0,5 x 0,075	45,2	4,4	44,2	6,2	1,0 : 1
0,075 x 0	46,0	3,2	42,8	8,0	1,0 : 1

/Table 4 .....

TABLE 4

DEISTER TABLE PERFORMANCE TESTS

Test No.		1	2	3	4
Solids feed rate	t/h	0,38	0,55	0,64	1,1
	kg/min	6,4	9,1	10,7	18,5
Pulp density	mass %	16,3	22,6	26,3	42,8
	g/l	178	245	288	500
Feed water	l/min	32,7	30,9	29,1	24,7
Dress water	l/min	13,0	16,0	30,0	30,0
Total water	l/min	45,7	46,9	59,1	54,7
Total water/solids	mass ratio	7,1:1	5,2:1	5,1:1	3,4:1
<u>Yields</u>		per cent			
Clean coal	Total	73,2	80,5	81,0	80,7
	+75 micrometre fraction	34,4	41,1	48,9	45,1
Discard	Total	26,8	19,5	19,0	19,3
<u>Ash contents</u>		per cent			
Feed		14,4	13,9	13,5	14,3
Clean coal	Total	9,8	10,0	9,4	10,3
	+75 micrometre fraction	6,6	7,1	7,1	8,1
Discard	Total	27,0	30,0	30,9	31,0
Remarks and swelling number on +75 micrometre fraction		1½	N.D.	1½	1½

/Table 5 .....



TABLE 5

## PERFORMANCE DATA OF COMPOUND WATER CYCLONE

Test No.	Raw Coal Ash %	Clean Coal						Discard	
		Total Yield %	Total Ash %	+75 micro-metre %	Ash %	-75 micro-metre %	Ash %	Yield %	Ash %
1	13,1	84,0	11,1	37,8	7,9	46,2	13,7	16,0	23,3
2	12,4	88,7	11,2	34,2	7,2	54,5	13,7	11,3	21,6
3	13,5	80,0	10,8	40,3	8,3	39,7	13,3	20,0	24,2
4	14,3	81,3	10,7	43,6	7,3	37,7	14,6	18,7	29,7
5	14,8	55,3	11,5	20,7	7,8	34,6	13,7	44,7	18,8
6	14,5	55,5	11,3	17,2	7,4	38,3	13,1	44,5	18,6

TABLE 6

## FROTH FLOTATION RESULTS ON FIRST CONSIGNMENT OF COAL

Test No.	Reagent Dosage kg/T					Product		
	Kerosene	Eucalyptus	Turpentine	M.I.B.C.	Paraffin	Yield %	Ash %	Sw. No.
1	0,530	-	-	-	-	24,8	6,5	1 - 1½F
2	0,265	0,306	-	-	-	87,8	9,4	1F
3	-	-	0,580	-	-	31,5	6,4	1 - 1½F
4	-	0,612	-	-	-	87,2	9,0	1F
5	-	0,306	-	-	-	84,9	8,4	1F
6	-	-	1,160	-	-	56,0	7,4	1
7	1,060	-	-	-	-	51,3	7,6	1 - 1½F
8	-	-	1,740	-	-	64,1	8,0	1F
9	1,590	-	-	-	-	64,8	8,2	1F
10	-	0,306	-	-	-	82,7	8,2	1
11	-	-	-	0,268	-	57,3	7,5	1 - 1½
12	-	-	-	0,268	0,260	87,5	9,0	1

Raw coal ash = 14,1%

Swelling number = 1F.

TABLE 7

## FROTH FLOTATION RESULTS ON SECOND CONSIGNMENT OF COAL

Test No.	Reagent Dosage kg/T					Product			Tailing	
	Kero-sene	Euca-lyptus	Turpen-tine	MIBC	Paraf-fin	Yield %	Ash %	Sw. No.	Yield %	Ash %
1	-	0,306	-	-	-	65,9	8,4	1F	34,1	28,5
2	0,265	0,153	-	-	-	67,6	8,2	1½F	32,4	27,0
3	-	0,153	0,290	-	-	59,9	7,9	1½F	40,1	22,8
4	-	-	1,160	-	-	41,9	7,3	1½F	58,1	19,0
5	1,060	-	-	-	-	39,2	7,3	1½-2F	60,8	18,4
6	-	-	-	0,134	0,260	81,0	9,1	1½F	19,0	34,9

Raw coal ash = 13,9%

Swelling number = 1F.

TABLE 8

## RESULTS OF CONTINUOUS FROTH FLOTATION TESTS

Cell Sample	Paraffin & M.I.B.C.				Turpentine & Eucalyptus			
	Fractional		Cumulative		Fractional		Cumulative	
	Yield %	Ash %	Yield %	Ash %	Yield %	Ash %	Yield %	Ash %
1	68,4	9,2	68,4	9,2	36,1	7,3	36,1	7,3
2	9,1	9,0	77,5	9,2	6,3	6,9	42,4	7,2
3	7,6	14,7	85,1	9,7	4,2	10,0	46,6	7,5
4	1,3	12,2	86,4	9,7	1,6	10,4	48,2	7,6
5	0,4	18,6	86,8	9,7	13,6	17,2	61,8	9,7
Tailing	13,2	39,1	-	-	38,2	19,1	-	-
Total	100,0	-	100,0	13,6	100,0	-	100,0	13,3

Raw coal ash = 13,5%

Swelling numbers were poor and are not reported.