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FUEL RESEARCH INSTITUTE

OF SOUTH AFRICA

ONDERWERP:
SUBJECT: INVESTIGATION OF SAMPLES OF SELECTED DUFF COALS FOR RAND MINES LTD., AIMED AT PRODUCING LOW ASH PRODUCTS.

AFDELING:
DIVISION: CARBONIZATION.

NAAM VAN AMPTENAAR:
NAME OF OFFICER: C.C. LA GRANGE.

FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

REPORT NO. 5 OF 1965.

INVESTIGATION OF SAMPLES OF SELECTED DUFF COALS FOR RAND MINES LTD., AIMED AT PRODUCING LOW ASH PRODUCTS.

INTRODUCTION:

According to published reports* the problem of dumping duff coal at collieries in the Transvaal is again becoming more and more serious. In fact, it has been estimated** that about 1 million tons of duff per annum is being dumped at those collieries which are members of the Transvaal Coal Owners' Association. This "squandering of a mineral wealth" is undesirable not only from the national point of view but also from that of the collieries concerned, as it means a loss of both valuable reserves and of a substantial source of income. The collieries also argue that this state of affairs is all the more deplorable in view of the establishment of new collieries, and the crushing of large coal, to supply power station fuel for Escom.

On numerous occasions in the past the Fuel Research Institute has drawn attention to the fact that the duff coals are potentially one of the most promising sources of low ash coal in the country. Extensive testing with cyclone washers has proved that this type of washer is capable of effecting efficient separations on duff coals (and also on pea-duff) from which the slurry fraction has been removed, even at specific gravities where the presence of much near gravity material renders such separations very difficult. Technically, therefore, there should be no difficulty with the production of low ash products from duff. Commercial considerations (economics, trade policy, ability to find dependable markets for products, etc.) are probably the only deterrents to action.

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* See for example:- Apex Mines, Annual Report 1963; S.A. Min. & Engng. J., 75, Part 1, 24/4/64, p.881.

** Coal Industry at the Crossroads. Anon. Financial Mail, 12, No. 8, 22/5/64, p.p.442/3.

The fact that optimistic remarks about the prospects of recovering blend coking coal from Witbank duff coal were recently made by the chairman of a prominent colliery company* proves that a suggestion of this nature is by no means far fetched.

SPECIAL INVESTIGATION OF CERTAIN DUFF COALS:

Recently the Institute was asked by Rand Mines, Ltd. to conduct a special investigation on representative samples of duff from collieries belonging to the group. Some details in this connection appear in Table 1.

TABLE 1.

Details of Origin of Duff Samples.

Colliery	Seam(s) Worked	Preparation of Duff at Colliery	Period of sampling - weeks
Douglas	No. 2	Washed	2
Van Dyk's Drift	No. 2	Not washed	1
Wolvekrans	Nos. 1, 2 & 4	Washed	2
Utrecht	Main	Not washed	1

The purpose of the investigation was in the first instance to determine what yields of low ash products could be expected from the duffs, such products to be suitable, inter alia, as blast furnace injection fuel for which there may or may not arise a demand in the future.

It is to be expected that such a project could only be feasible if its economics could be improved by considering it in conjunction with the production of an acceptable quality duff product, suitable for general combustion purposes such as power station fuel, etc.

A third aspect was also considered, namely the possible use of the low ash product as a source of blending coal for metallurgical coke production.

EXPERIMENTAL WORK AND RESULTS:

The samples investigated (each weighing at least 200 lb) were taken under strict supervision at and by the collieries concerned in regular increments of about 10 lb each over a period of 1 or 2 weeks as shown in Table 1. The increments covered all the shifts worked at the collieries concerned over the periods of sampling.

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* Chairman's Statement. Coulter, T. Annual Report, S.A. Coal Estates (Witbank) Ltd., 1963.

On receipt of the samples at the Institute, they were screened over a 30 mesh ($\frac{1}{2}$ mm) screen and the +30 mesh fractions were subjected to float and sink separations by the fractional procedure. The float and sink fractions obtained, as well as the untreated slurry, i.e. -30 mesh size fractions, were analysed, the results appearing in Table 2.

From the data in Table 2 the cumulative results appearing in Table 3 were calculated. These results were also used in preparing Figures 1 - 4 in which the following have been plotted for +30 mesh material:-

Yield against specific gravity;
Yield against ash content;
Specific gravity against swelling number.

In order to convert any yield values read from the curves in these figures to yield percentages based on original material, such values should be multiplied by the following factors (also shown in the figures) in order to correct for slurry excluded before float and sink analysis:-

Douglas, ... F = 0.803
Van Dyk's Drift, F = 0.812
Wolvekrans, ... F = 0.818
Utrecht, ... F = 0.843

The data appearing in Table 4 were calculated in order to obtain information on the material remaining after the extraction of low ash products from the duff coals. Such material would be available for sale as combustion coal, e.g. to power stations. Unless the coal is subjected to an additional washing stage the ash content of cyclone discards may of course be rather high but in view of the absence of slurry the reduction of the moisture content to an acceptable level should not present any difficulty.

Figures 5 - 8 were prepared from data appearing in Table 4. In the figures percentage yields of combustion coal (resulting from single stage washing and based on material as received) have been plotted against the washing specific gravities employed in the production of low ash products, and also against the ash contents of the combustion coal products.

Petrographic analyses of low ash products from the duff coals, representing cumulative floats from +30 mesh material at a specific gravity of 1.35 were carried out. The results appear in Table 5.

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TABLE 2.

RESULTS (AIR-DRY BASIS) OF INVESTIGATION OF DUFF SAMPLES

DOUGLAS WASHED DUFF (Sample No. 65/299).

Size (Mesh)	Sp. Gr. Fraction	Yield %	Moist. %	Ash %	Vol. Mat. %	Fixed Carb. %	Sw. No.	Cumul. Sw. No.
-30	*	19.7	2.1	13.5	28.1	56.3	1	-
+30	Float 1.30	14.3	2.2	3.4	38.8	55.6	6½	6½
	1.30-1.35	25.7	2.1	6.2	32.4	59.3	2	4-4½
	1.35-1.40	29.4	2.0	8.9	26.3	62.8	½-1	1½
	1.40-1.45	13.6	2.1	12.2	24.3	61.4	½	1
	1.45-1.50	7.4	1.9	16.5	23.0	58.6	-	-
	1.50-1.55	3.7	2.0	20.7	22.1	55.2	-	-
	1.55-1.60	2.4	1.9	24.0	21.8	52.3	-	-
	1.60-1.65	1.4	1.7	26.6	22.3	49.4	-	-
	1.65-1.70	1.1	1.7	30.3	22.1	45.9	-	-
	Sink 1.70	1.0	1.7	33.0	22.9	42.4	-	-

VAN DYKS DRIFT DUFF (Sample No. 65/300).

Size (Mesh)	Sp. Gr. Fraction	Yield %	Moist. %	Ash %	Vol. Mat. %	Fixed Carb. %	Sw. No.	Cumul. Sw. No.
-30	*	18.8	2.1	13.7	28.3	55.9	1	-
+30	Float 1.30	12.0	2.4	3.1	37.0	57.5	5	5
	1.30-1.35	21.0	2.2	5.9	31.7	60.2	1-1½	3-3½
	1.35-1.40	19.9	2.2	8.4	26.7	62.7	½	1-1½
	1.40-1.45	19.4	2.2	11.3	23.1	63.4	½	1
	1.45-1.50	11.8	2.1	15.2	22.5	60.2	-	-
	1.50-1.55	4.5	2.2	19.6	21.6	56.6	-	-
	1.55-1.60	2.6	2.0	22.9	22.0	53.1	-	-
	1.60-1.65	2.0	1.9	26.8	22.3	49.0	-	-
	1.65-1.70	1.6	1.7	32.8	23.3	42.2	-	-
	Sink 1.70	5.2	1.0	52.1	27.8	19.1	-	-

WOLVEKRANS WASHED DUFF (Sample No. 65/301).

Size (Mesh)	Sp. Gr. Fraction	Yield %	Moist. %	Ash %	Vol. Mat. %	Fixed Carb. %	Sw. No.	Cumul. Sw. No.
-30	*	18.2	2.1	16.7	24.2	57.0	1	-
+30	Float 1.30	7.9	2.3	3.4	37.2	57.1	5-5½	5-5½
	1.30-1.35	12.8	2.2	6.0	32.4	59.4	2	4
	1.35-1.40	19.8	2.1	8.6	26.5	62.8	½-1	1
	1.40-1.45	23.7	2.2	11.5	22.6	63.7	½	½
	1.45-1.50	16.0	2.1	15.7	21.4	60.8	-	-
	1.50-1.55	8.0	2.1	20.5	20.6	56.8	-	-
	1.55-1.60	4.5	1.9	25.1	20.6	52.4	-	-
	1.60-1.65	2.7	1.9	28.9	20.6	48.6	-	-
	1.65-1.70	2.1	1.7	33.4	20.6	44.3	-	-
	Sink 1.70	2.5	1.4	45.4	21.3	31.9	-	-

UTRECHT DUFF (Sample No. 65/302).

Size (Mesh)	Sp. Gr. Fraction	Yield %	Moist. %	Ash %	Vol. Mat. %	Fixed Carb. %	Sw. No.	Cumul. Sw. No.
-30	*	15.7	1.7	20.5	25.1	52.7	½	-
+30	Float 1.30	8.2	1.5	4.8	33.2	60.5	7	7
	1.30-1.35	31.4	1.6	6.7	31.5	60.2	5	5½
	1.35-1.40	13.1	1.7	9.9	27.9	60.5	1½-2	4-4½
	1.40-1.45	8.9	1.7	13.0	24.7	60.6	½	3
	1.45-1.50	7.6	1.7	16.9	22.7	58.7	-	-
	1.50-1.55	6.6	1.9	21.1	20.5	56.5	-	-
	1.55-1.60	5.1	1.8	25.4	19.6	53.2	-	-
	1.60-1.65	4.4	1.7	29.5	18.6	50.2	-	-
	1.65-1.70	4.4	1.8	34.4	18.5	45.3	-	-
	Sink 1.70	10.3	1.4	51.5	20.1	27.0	-	-

*Not subjected to float and sink analysis.

TABLE 3.

CUMULATIVE RESULTS* - AIR-DRY BASIS.
(+30 MESH SIZE FRACTIONS)

Float at S.G.	Yield, % of + 30 mesh	Yield, % of Orig-inal	Moist. %	Ash %	V.M. %	F.C. %	Sw. No.
Douglas Washed Duff (Sample No. 65/299)							
1.30	14.3	11.5	2.2	3.4	38.8	55.6	6½
1.35	40.0	32.1	2.1	5.2	34.7	58.0	4-4½
1.40	69.4	55.7	2.1	6.8	31.1	60.0	1½
1.45	83.0	66.6	2.1	7.7	30.0	60.2	1
1.50	90.4	72.6	2.1	8.4	29.4	60.1	-
1.55	94.1	75.5	2.1	8.9	29.1	59.9	-
1.60	96.5	77.5	2.1	9.2	29.0	59.7	-
1.65	97.9	78.6	2.1	9.5	28.9	59.6	-
1.70	99.0	79.5	2.1	9.7	28.8	59.4	-
Unwashed	100	80.3	2.0	10.0	28.7	59.3	-
All sizes, as received	-	100	2.0	10.7	28.6	58.7	-
Van Dyk's Drift Duff (Sample No. 65/300)							
1.30	12.0	9.7	2.4	3.1	37.0	57.5	5
1.35	33.0	26.8	2.3	4.9	33.6	59.2	3-3½
1.40	52.9	43.0	2.3	6.2	31.0	60.5	1-1½
1.45	72.3	58.7	2.2	7.6	28.9	61.3	1
1.50	84.1	68.3	2.2	8.6	28.0	61.2	-
1.55	88.6	71.9	2.2	9.2	27.7	60.9	-
1.60	91.2	74.0	2.2	9.6	27.5	60.7	-
1.65	93.2	75.7	2.2	10.0	27.4	60.4	-
1.70	94.8	77.0	2.2	10.3	27.4	60.1	-
Unwashed	100	81.2	2.1	12.5	27.4	58.0	-
All sizes, as received	-	100	2.1	12.7	27.6	57.6	-
Wolvekrans Washed Duff (Sample No. 65/301)							
1.30	7.9	6.5	2.3	3.4	37.2	57.1	5-5½
1.35	20.7	16.9	2.3	5.0	34.2	58.5	4
1.40	40.5	33.1	2.2	6.8	30.4	60.6	1
1.45	64.2	52.5	2.2	8.5	27.5	61.8	½
1.50	80.2	65.6	2.2	9.9	26.3	61.6	-
1.55	88.2	72.2	2.2	10.9	25.8	61.1	-
1.60	92.7	75.8	2.1	11.6	25.6	60.7	-
1.65	95.4	78.0	2.1	12.1	25.4	60.4	-
1.70	97.5	79.8	2.1	12.6	25.3	60.0	-
Unwashed	100	81.8	2.1	13.4	25.2	59.3	-
All sizes, as received	-	100	2.1	14.0	25.0	58.9	-
Utrecht Duff (Sample No. 65/302)							
1.30	8.2	6.9	1.5	4.8	33.2	60.5	7
1.35	39.6	33.4	1.6	6.3	31.8	60.3	5½
1.40	52.7	44.4	1.6	7.2	30.9	60.3	4-4½
1.45	61.6	51.9	1.6	8.0	30.0	60.4	3
1.50	69.2	58.3	1.6	9.0	29.2	60.2	-
1.55	75.8	63.9	1.6	10.1	28.4	59.9	-
1.60	80.9	68.2	1.7	11.0	27.9	59.4	-
1.65	85.3	71.9	1.7	12.0	27.4	58.9	-
1.70	89.7	75.6	1.7	13.1	26.9	58.3	-
Unwashed	100	84.3	1.6	17.0	26.3	55.1	-
All sizes, as received	-	100	1.6	17.6	26.1	54.7	-

*Calculated, except for floats at s.g. 1.30 and swelling numbers

TABLE 4.

CALCULATED RESULTS FOR POSSIBLE PRODUCTS FOR COMBUSTION PURPOSES AVAILABLE AFTER EXTRACTION OF LOW ASH COAL BY WASHING +30 MESH COAL AT VARIOUS SPECIFIC GRAVITIES.

Colliery : Douglas (Sample No. 65/299)

S.G. Range for +30 mesh material	Yield % based on material		Prox. Anal. (Air-dry)			
	+30 mesh	as received	Moist. %	Ash %	Vol. Mat. %	Fixed Carb. %
1.30 - 1.50	76.1	61.1	2.0	9.3	27.7	61.0
1.30 - 1.55	79.8	64.0	2.0	9.9	27.4	60.7
1.30 - 1.60	82.2	66.0	2.0	10.3	27.3	60.4
1.30 - 1.65	83.6	67.1	2.0	10.5	27.2	60.3
1.30 - 1.70	84.7	68.0	2.0	10.8	27.1	60.1
Sink 1.30	85.7	68.8	2.0	11.0	27.1	59.9
Sink 1.30) + Slurry)	-	88.5	2.0	11.6	27.3	59.1
1.35 - 1.50	50.4	40.5	2.0	10.9	25.3	61.8
1.35 - 1.55	54.1	43.4	2.0	11.6	25.1	61.3
1.35 - 1.60	56.5	45.4	2.0	12.1	24.9	61.0
1.35 - 1.65	57.9	46.5	2.0	12.4	24.9	60.7
1.35 - 1.70	59.0	47.4	2.0	12.8	24.8	60.4
Sink 1.35	60.0	48.2	2.0	13.1	24.8	60.1
Sink 1.35) + Slurry)	-	67.9	2.0	13.2	25.8	59.0
1.40 - 1.50	21.0	16.9	2.0	13.7	23.9	60.4
1.40 - 1.55	24.7	19.8	2.0	14.8	23.6	59.6
1.40 - 1.60	27.1	21.8	2.0	15.6	23.4	59.0
1.40 - 1.65	28.5	22.9	2.0	16.1	23.4	58.5
1.40 - 1.70	29.6	23.8	2.0	16.6	23.3	58.1
Sink 1.40	30.6	24.6	2.0	17.2	23.3	57.5
Sink 1.40) + Slurry)	-	44.3	2.0	15.6	25.4	57.0
1.45 - 1.50	7.4	6.0	1.9	16.5	23.0	58.6
1.45 - 1.55	11.1	8.9	1.9	17.9	22.7	57.5
1.45 - 1.60	13.5	10.9	1.9	19.0	22.5	56.6
1.45 - 1.65	14.9	12.0	1.9	19.7	22.5	55.9
1.45 - 1.70	16.0	12.9	1.9	20.4	22.5	55.2
Sink 1.45	17.0	13.7	1.9	21.2	22.5	54.4
Sink 1.45) + Slurry)	-	33.4	2.0	16.7	25.8	55.5

TABLE 4 (Continued).

Colliery : Van Dyk's Drift (Sample No. 65/300)

S.G. Range for +30 mesh material	Yield % based on material		Prox. Anal. (Air-dry)			
	+30 mesh	as received	Moist. %	Ash %	Vol. Mat. %	Fixed Carb. %
1.30 - 1.50	72.1	58.6	2.2	9.6	26.5	61.7
1.30 - 1.55	76.6	62.2	2.2	10.2	26.2	61.4
1.30 - 1.60	79.2	64.3	2.2	10.6	26.1	61.1
1.30 - 1.65	81.2	66.0	2.2	10.9	26.0	60.9
1.30 - 1.70	82.8	67.3	2.2	11.4	25.9	60.5
Sink 1.30	88.0	71.5	2.1	13.8	26.0	58.1
Sink 1.30) + Slurry)	-	90.3	2.1	13.8	26.5	57.6
1.35 - 1.50	51.1	41.5	2.2	11.1	24.3	62.4
1.35 - 1.55	55.6	45.1	2.2	11.8	24.1	61.9
1.35 - 1.60	58.2	47.2	2.2	12.3	24.0	61.5
1.35 - 1.65	60.2	48.9	2.2	12.7	24.0	61.1
1.35 - 1.70	61.8	50.2	2.1	13.3	24.0	60.6
Sink 1.35	67.0	54.4	2.0	16.3	24.3	57.4
Sink 1.35) + Slurry)	-	73.2	2.0	15.7	25.3	57.0
1.40 - 1.50	31.2	25.3	2.1	12.8	22.9	62.2
1.40 - 1.55	35.7	28.9	2.2	13.6	22.7	61.5
1.40 - 1.60	38.3	31.0	2.1	14.3	22.7	60.9
1.40 - 1.65	40.3	32.7	2.1	14.9	22.7	60.3
1.40 - 1.70	41.9	34.0	2.1	15.6	22.7	59.6
Sink 1.40	47.1	38.2	2.0	19.6	23.2	55.2
Sink 1.40) + Slurry)	-	57.0	2.0	17.7	24.9	55.4
1.45 - 1.50	11.8	9.6	2.1	15.2	22.5	60.2
1.45 - 1.55	16.3	13.2	2.1	16.4	22.3	59.2
1.45 - 1.60	18.9	15.3	2.1	17.3	22.2	58.4
1.45 - 1.65	20.9	17.0	2.1	18.2	22.2	57.5
1.45 - 1.70	22.5	18.3	2.1	19.2	22.3	56.4
Sink 1.45	27.7	22.5	1.9	25.4	23.3	49.4
Sink 1.45) + Slurry)	-	41.3	2.0	20.1	25.6	52.3

Colliery : Wolvekrans (Sample No. 65/301)

1.30 - 1.50	72.3	59.1	2.1	10.7	25.1	62.1
1.30 - 1.55	80.3	65.7	2.1	11.7	24.7	61.5
1.30 - 1.60	84.8	69.3	2.1	12.4	24.5	61.0
1.30 - 1.65	87.5	71.5	2.1	12.9	24.3	60.7
1.30 - 1.70	89.6	73.3	2.1	13.3	24.3	60.3
Sink 1.30	92.1	75.3	2.1	14.2	24.2	59.5
Sink 1.30) + Slurry)	-	93.5	2.1	14.7	24.2	59.0
1.35 - 1.50	59.5	48.7	2.1	11.7	23.6	62.6
1.35 - 1.55	67.5	55.3	2.1	12.7	23.2	62.0
1.35 - 1.60	72.0	58.9	2.1	13.5	23.1	61.3
1.35 - 1.65	74.7	61.1	2.1	14.0	23.0	60.9
1.35 - 1.70	76.8	62.9	2.1	14.6	22.9	60.4
Sink 1.35	79.3	64.9	2.1	15.5	22.9	59.5
Sink 1.35) + Slurry)	-	83.1	2.1	15.8	23.2	58.9

TABLE 4 (Continued).

Colliery : Wolvekrans (Sample No. 65/301) (Cont.)

S.G. Range for +30 mesh material	Yield % based on material		Prox. Anal. (Air-dry)			
	+30 mesh	as received	Moist. %	Ash %	Vol. Mat. %	Fixed Carb. %
1.40 - 1.50	39.7	32.5	2.2	13.2	22.1	62.5
1.40 - 1.55	47.7	39.1	2.1	14.4	21.9	61.6
1.40 - 1.60	52.2	42.7	2.1	15.3	21.8	60.8
1.40 - 1.65	54.9	44.9	2.1	16.0	21.7	60.2
1.40 - 1.70	57.0	46.7	2.1	16.6	21.7	59.6
Sink 1.40	59.5	48.7	2.1	17.9	21.6	58.4
Sink 1.40) + Slurry)	-	66.9	2.1	17.6	22.3	58.0
1.45 - 1.50	16.0	13.1	2.1	15.7	21.4	60.8
1.45 - 1.55	24.0	19.7	2.1	17.3	21.1	59.5
1.45 - 1.60	28.5	23.3	2.1	18.5	21.1	58.3
1.45 - 1.65	31.2	25.5	2.1	19.4	21.0	57.5
1.45 - 1.70	33.3	27.3	2.0	20.3	21.0	56.7
Sink 1.45	35.8	29.3	2.0	22.1	21.0	54.9
Sink 1.45) + Slurry)	-	47.5	2.1	20.0	22.2	55.7

Colliery : Utrecht (Sample No. 65/302)

1.30 - 1.50	61.0	51.4	1.7	9.6	28.6	60.1
1.30 - 1.55	67.6	57.0	1.7	10.7	27.8	59.8
1.30 - 1.60	72.7	61.3	1.7	11.7	27.3	59.3
1.30 - 1.65	77.1	65.0	1.7	12.7	26.8	58.8
1.30 - 1.70	81.5	68.7	1.7	13.9	26.3	58.1
Sink 1.30	91.8	77.4	1.7	18.1	25.6	54.6
Sink 1.30) + Slurry)	-	93.1	1.7	18.5	25.5	54.3
1.35 - 1.50	29.6	24.9	1.7	12.6	25.6	60.1
1.35 - 1.55	36.2	30.5	1.7	14.2	24.7	59.4
1.35 - 1.60	41.3	34.8	1.7	15.6	24.0	58.7
1.35 - 1.65	45.7	38.5	1.7	16.9	23.5	57.9
1.35 - 1.70	50.1	42.2	1.7	18.5	23.1	56.7
Sink 1.35	60.4	50.9	1.7	24.1	22.6	51.6
Sink 1.35) + Slurry)	-	66.6	1.7	23.2	23.2	51.9
1.40 - 1.50	16.5	13.9	1.7	14.8	23.8	59.7
1.40 - 1.55	23.1	19.5	1.8	16.6	22.8	58.8
1.40 - 1.60	28.2	23.8	1.8	18.2	22.2	57.8
1.40 - 1.65	32.6	27.5	1.7	19.7	21.8	56.8
1.40 - 1.70	37.0	31.2	1.7	21.5	21.4	55.4
Sink 1.40	47.3	39.9	1.7	28.0	21.1	49.2
Sink 1.40) + Slurry)	-	55.6	1.7	25.9	22.2	50.2
1.45 - 1.50	7.6	6.4	1.7	16.9	22.7	58.7
1.45 - 1.55	14.2	12.0	1.8	18.8	21.7	57.7
1.45 - 1.60	19.3	16.3	1.8	20.6	21.1	56.5
1.45 - 1.65	23.7	20.0	1.8	22.2	20.7	55.3
1.45 - 1.70	28.1	23.7	1.8	24.2	20.3	53.7
Sink 1.45	38.4	32.4	1.7	31.5	20.2	46.6
Sink 1.45) + Slurry)	-	48.1	1.7	27.9	21.8	48.6

TABLE 5.

PETROGRAPHIC ANALYSES AND SWELLING NUMBERS OF CUMULATIVE FLOAT PRODUCTS PREPARED FROM DUFF COALS AT S.G. 1.35.

Colliery		Douglas	Van Dyk's Drift	Wolve-krans	Utrecht
Sample No. 65/-		299BC	300BC	301BC	302BC
Micro-litho-type Analy-sis, %	(Vitrite	47.7	41.4	51.5	51.5
	(Clarite	2.3	1.0	1.9	2.8
	(Vitrinertite	38.2	46.7	34.0	31.3
	(Intermed. Mat.	7.2	7.9	8.2	12.4
	(Fusite	3.6	2.3	3.7	1.6
	(Carb. Shale	1.0	0.7	0.7	0.4
Mace-ral Analy-sis, %	(Vitrinite*	73.9	65.8	75.2	81.0
	(Exinite*	1.8	2.0	3.1	3.2
	(Inertinite**	23.2	31.9	21.0	14.7
	(Visible)** (Minerals)	1.1	0.3	0.7	1.1
Ratio:- Active/Inert		3.1/1	2.1/1	3.6/1	5.3/1
Swelling Number		4-4½	3-3½	4	5½

* Active constituents
** Inert constituents

The upgrading of -30 mesh material, e.g. by means of froth flotation, was not included in this preliminary investigation. Froth flotation is a relatively expensive process. The cost could be of the order of 45 c/ton input, as compared with about 20c for cyclone washing. Furthermore, there is some doubt as to whether a consistent low ash product (maximum ash content, say, 8 per cent) could readily be produced by froth flotation from the available slurries. Nevertheless, it is an avenue which certainly merits further study.

DISCUSSION:

In the preparation of Figures 5 - 8 only single stage washing of the samples as received has been considered. It is, of course, conceivable that a further separation at a relatively high specific gravity may have to be carried out in practice in order to obtain a middlings product of improved quality. However, in view of the relatively small percentages of material having ash contents in excess of, say, 30 per cent, this would hardly be justified, except perhaps in the case of Utrecht duff. If a separation at high specific gravity is required a relatively cheap process such as treatment in the autogenous cyclone (hydrocyclone) may suffice. This should neither add much to the cost nor cause much reduction in the yield of combustion coal.

Until such time as it has been proved that -30 mesh material (raw slurry) can be satisfactorily upgraded for augmenting the low ash product extracted from +30 mesh material the opposite will be assumed. The slurry may then be either dumped, thus assuming a negative value, or it may be added to the +30 mesh material ear-marked for combustion. In such a case it will probably be necessary first to dry the wet slurry thermally (the moisture content may possibly be about 20 per cent) at appreciable cost, to an acceptable level.

Both the yield and the analysis of the combustion coal will be appreciably affected by such an inclusion of slurry, as can be seen from both Table 4 and Figures 5 - 8.

SOME ECONOMIC CONSIDERATIONS:

At the moment the only concerns that may be interested in low ash material from the duff coals are presumably the primary iron and steel producers and possibly the colliery

coke ...../

coke producers in Natal.* These industries must decide for themselves what the value of such low ash (and sulphur**) products might be to them. The relative proximity of the Witbank coalfield to Pretoria and Vanderbijlpark (and of Utrecht Colliery to Newcastle) are important factors in determining costs involved.

An effort has been made to determine the order of the relative costs of producing low ash products from the duff coals. Numerous simplifications were introduced and the following three possibilities have been considered:-

Case A: Low ash coal only is extracted, the rest being dumped.

Case B: Low ash coal is extracted and +30 mesh coal (discard from the cyclone washer) is sold as combustion coal, the slurry being dumped.

Case C: Low ash coal is extracted and both cyclone discard and dried slurry are sold as combustion coal.

The following equations were applied in calculating relative production costs.

To break even:

$$\left.\begin{array}{l}\text{Value of original duff}\\ \text{coal plus costs incurred}\end{array}\right) = \left(\begin{array}{l}\text{Sum of values}\\ \text{of new products}\end{array}\right.$$

<u>Case A</u>:

$$(1 x V_D) + (1 x W) + [(1-L)\ Du] = (L x V_L)$$

$$\text{or: } V_L = \frac{V_D + W + (1-L)\ Du}{L} \text{ Rand}$$

<u>Case B</u>:

$$(1 x V_D) + (1 x W) + (S x Du) = (L x V_L) + (C_c x V_C)$$

$$\text{or: } V_L = \frac{V_D + W + (S x Du) - C_c x V_C}{L} \text{ Rand}$$

<u>Case C</u> ...../

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* The material could conceivably serve to augment the limited coking coal supplies of Natal from which all coke for the general trade has to be produced at present. Such a practice would not be new. For many years Blesbok coal was railed to Vryheid Coronation Colliery for coking in admixture with this colliery's coal.

** Sulphur contents were not determined but from past experience it is known that sulphur contents will be low.

Case C:

$$(1xV_D) + (1xW) + (SxDr) = (LxV_L) + (C_{cs}xV_C)$$

$$\text{or: } V_L = \frac{V_D + W + (SxDr) - C_{cs}xV_C}{L} \text{ Rand}$$

Where V_D = Value of original duff, R/ton
W = Cost of washing in cyclone, R/ton of original material.
L = Yield of low ash coal, tons/original ton.
V_L = Production cost of low ash coal, R/ton.
Du = Cost of dumping, R/ton.
S = Yield of -30 mesh slurry, tons/original ton.
V_C = Value of combustion coal, R/ton.
C_c = Yield of combustion coal from cyclone washer (i.e. +30 mesh discard), tons/original ton.
= (1-S-L)
C_{cs} = Yield of combined combustion coal, i.e. cyclone discard plus slurry, tons/original ton.
= (1-L) = (C_c+S)
Dr = Cost of drying slurry to an acceptable moisture content, R/ton.

The following arbitrary assumptions have been made:-

(i) Value of raw duff : R1/ton.
(ii) Cost of single stage washing in the cyclone washer : 20c/ton of original material.
(iii) Cost of dumping coal : 5c/ton.
(iv) Cost of drying slurry to an acceptable level : 25c/ton.
(v) Value of combustion coal (provided the ash content does not exceed about 23%*) : R1.00/ton.
(vi) Value of combustion coal where its ash content exceeds about 23% and/or its slurry content is excessive : R0.50/ton.

On the basis of the available information and the above assumptions and equations, Table 6 was compiled, depicting the position when producing low ash products, i.e. having ash contents of 5, 6, 7 and 8 per cent, respectively, from the four duff coals considered.

The following brief remarks can be made.

Douglas ...../

* The ash content of 23 per cent was arbitrarily selected in order not to exclude some of the combustion coals considered below. Products with ash contents less than about 20 per cent should probably be aimed at in practice. This will ensure that their calorific values will normally not fall below 11 lb/lb. Numerous Escom power stations burn coal with ash contents well over 20 per cent.

Douglas duff* is the best starting material for the production of low ash products, i.e. yields are the highest and costs the lowest. Second comes Van Dyk's Drift, third Utrecht and fourth Wolvekrans.* However, at the lowest ash level considered (5 per cent) Utrecht and Wolvekrans interchange places due to the very low content of such low ash components in Utrecht duff.

Under favourable circumstances the production of products of, say, 6 per cent ash offers interesting possibilities, estimated production costs ranging from R1.56 to R1.96/ton. Not only should such a premium quality low ash product command a premium price but the associated combustion coal should also be of reasonably good quality. The latter should, however, preferably be consumed by a pulverized fuel power station situated somewhere in the vicinity.

TABLE 6.

SUMMARY OF DATA REFELCTING THE POSITION WHEN PRODUCING LOW ASH COAL OF SPECIFIED PURITY FROM DUFF COALS.

(All yields expressed as percentage of Original)

Colliery		Douglas	Van Dyk's Drift	Wolvekrans	Utrecht
Ash Content of Low Ash Product : 5%					
A. Low Ash Product:					
Washing S.G.		1.35	1.35	1.35	1.30
Yield, %		31	28	17	11
Sw. No.		4	3½	4	7
Relative Production Cost, R/ton	Case A	3.97	4.43	7.29	11.3
	Case B	2.32	2.43	3.30	4.36
	Case C	1.81	1.89	2.47	3.18
B. Combustion Coal, +30 mesh only:					
Yield, %		49	53	65	73
Ash, %		13.0	16.5	15.5	19.0
C. Combustion Coal, including slurry:					
Yield, %		69	72	83	89
Ash, %		13.1	16.0	15.8	19.1

Table 6 (Cont.) ...../

* Note that the Douglas and Wolvekrans duff samples both represented products already washed at the collieries.

TABLE 6 (Continued).

Colliery	Douglas	Van Dyk's Drift	Wolvekrans	Utrecht
Ash Content of Low Ash Product : 6%				
A. Low Ash Product:				
Washing S.G.	1.37	1.39	1.38	1.34
Yield, %	45	40	26	29
Sw. No.	3	1½	2	4
Relative Production Cost, R/ton — Case A	2.73	3.08	4.77	4.27
Relative Production Cost, R/ton — Case B	1.91	2.00	2.50	2.28
Relative Production Cost, R/ton — Case C	1.56	1.63	1.96	1.83
B. Combustion Coal, +30 mesh only:				
Yield, %	35	41	56	55
Ash, %	15.1	19.0	16.8	22.9
C. Combustion Coal, including slurry:				
Yield, %	55	60	74	71
Ash, %	14.5	17.3	16.8	22.2
Ash Content of Low Ash Product : 7%				
A. Low Ash Product:				
Washing S.G.	1.41	1.43	1.41	1.39
Yield, %	58	52	36	42
Sw. No.	1½	1	1	4½
Relative Production Cost, R/ton — Case A	2.10	2.35	3.42	2.93
Relative Production Cost, R/ton — Case B*	1.71 (1.90)	1.77 (2.05)	2.08 (2.72)	(2.38)
Relative Production Cost, R/ton — Case C*	1.43 (1.79)	1.48 (1.94)	1.69 (2.58)	(2.26)
B. Combustion Coal, +30 mesh only:				
Yield, %	22	29	46	42
Ash, %	17.9	22.4	18.3	27.0
C. Combustion Coal, including slurry:				
Yield, %	42	48	64	58
Ash, %	15.8	19.0	17.9	25.2
Ash Content of Low Ash Product : 8%				
A. Low Ash Product:				
Washing S.G.	1.47	1.47	1.43	1.45
Yield, %	69	63	47	52
Sw. No.	1	1	½	3
Relative Production Cost, R/ton — Case A	1.77	1.94	2.62	2.35
Relative Production Cost, R/ton — Case B*	(1.67)	(1.78)	1.83 (2.20)	(2.02)
Relative Production Cost, R/ton — Case C*	1.31 (1.59)	1.40 (1.69)	1.53 (2.10)	(1.92)
B. Combustion Coal, +30 mesh only:				
Yield, %	11	18	35	32
Ash, %**	(24)	(29)	20.5	(32)
C. Combustion Coal, including slurry:				
Yield, %	31	37	53	48
Ash, %**	(17)	(21)	19.3	27.9

* Figures in brackets based on a combustion coal price of 50c/ton instead of R1.00/ton.

** Figures in brackets represent rough estimates by extrapolation.

CONCLUSION:

The present investigation was initiated because it was considered that a product suitable for injection at blast furnace tuyerès might be proved. The scope was widened by regarding the product also as possible blend coking coal, and by considering the simultaneous production of combustion coal.

It is for the iron and steel industries to decide whether they would be interested in such a product of, say, 6 per cent ash and if so, whether the price at which it might become available would be acceptable.

The possibility of incorporating such low ash coal in coking blends should certainly not be overlooked. The swelling numbers reported and the petrographic composition of the material make it more than likely that it should be highly compatible with the other coals in coking blends. It may even be possible to reduce the amount of expensive and precious Natal coking coal in blends by incorporating a low ash product from Witbank duff. As such low ash material from duff has probably never before been subjected tc coking trials in South Africa, it seems highly desirable to undertake such experiments.

Judging by swelling numbers (at 6 per cent ash) and petrographic composition, Utrecht coal appears to be the most promising for coking purposes and Van Dyk's Drift the least so. This should, however, not rule out the latter coal from coking trials as it possesses other virtues (relatively good yield at low ash).

The fairly high volatile matter contents of the low ash products detract somewhat from their attractiveness for coke manufacture. In addition to reduced coke yield, their presence in a blend may result in reduced coke size. This is, however, not regarded as a serious drawback in view of the universal trend to reduce the size range of blast furnace coke, if need be, even by crushing the larger lumps.

Coke can be saved if fuel is injected into blast furnaces, but this technique is only possible if the coke used is strong enough to bear the burden which is extra heavy under such circumstances. Although it remains to be demonstrated, there is a good possibility that the inclusion

of ...../

of suitable low ash product made from duff, in certain blends presently coked could improve coke strength.

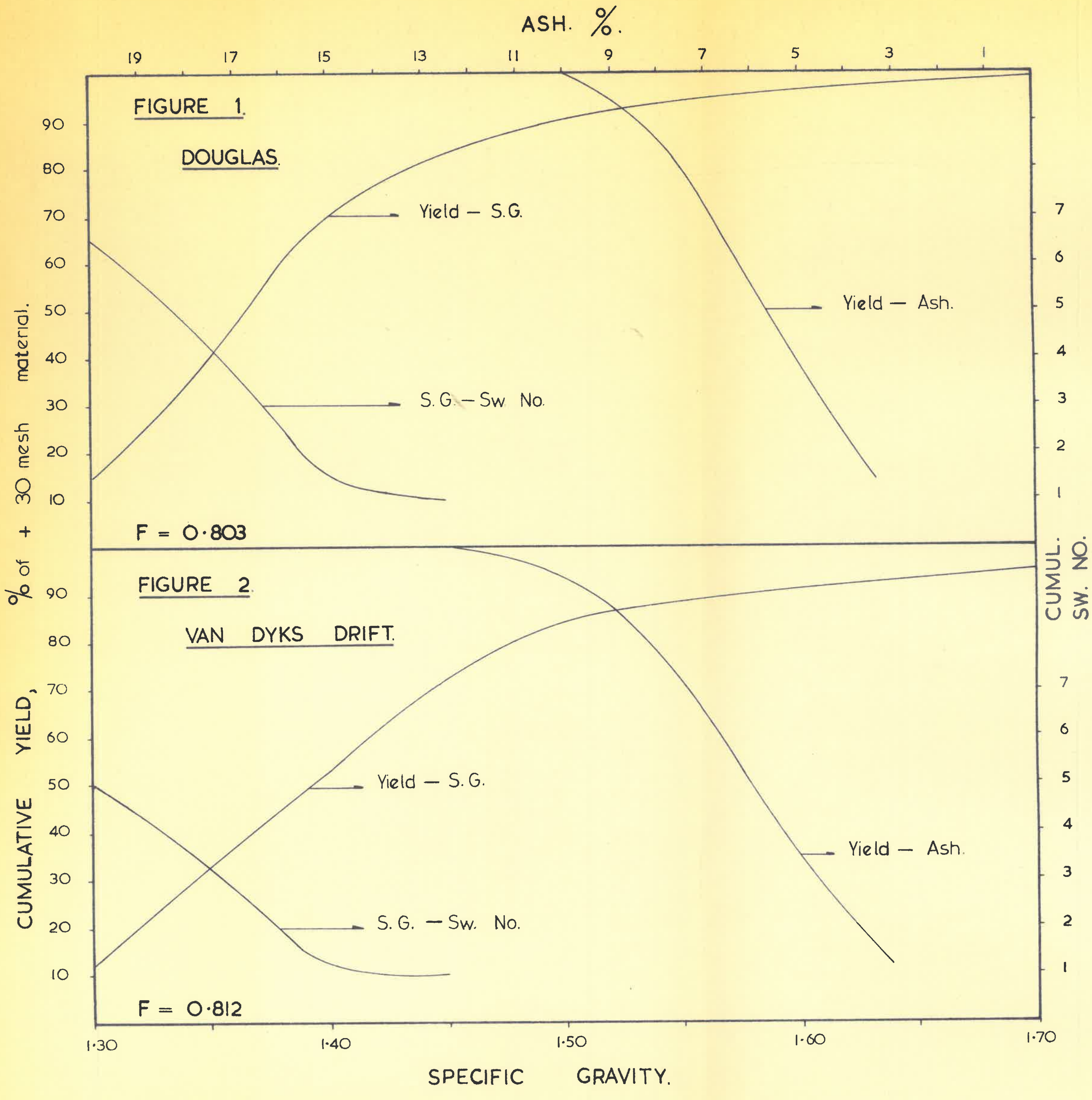
The work carried out and the discussions and arguments put forward above have merely touched upon the real problem which is a regional one in the Witbank coalfield and not peculiar to a particular colliery or colliery group. The large scale dumping of duff, as well as the rationalisation of metallurgical coals are undoubtedly national problems, and should be approached as such.

The continued industrial expansion of the country will not be possible without additional supplies of coke. The possibility of augmenting coking coals with low ash material from duff merits the closest investigation. Ideally the best solution would seem to be the provision of a centralised pulverised fuel power station, adjacent to a washery where duff is taken from surrounding collieries, possibly by pipeline or conveyor belt, whatever method of transport may be the most economical.

These appear to be matters worthy of study at high level.

(Sgd.) C.C. LA GRANGE.
CHIEF OF DIVISION : CARBONIZATION

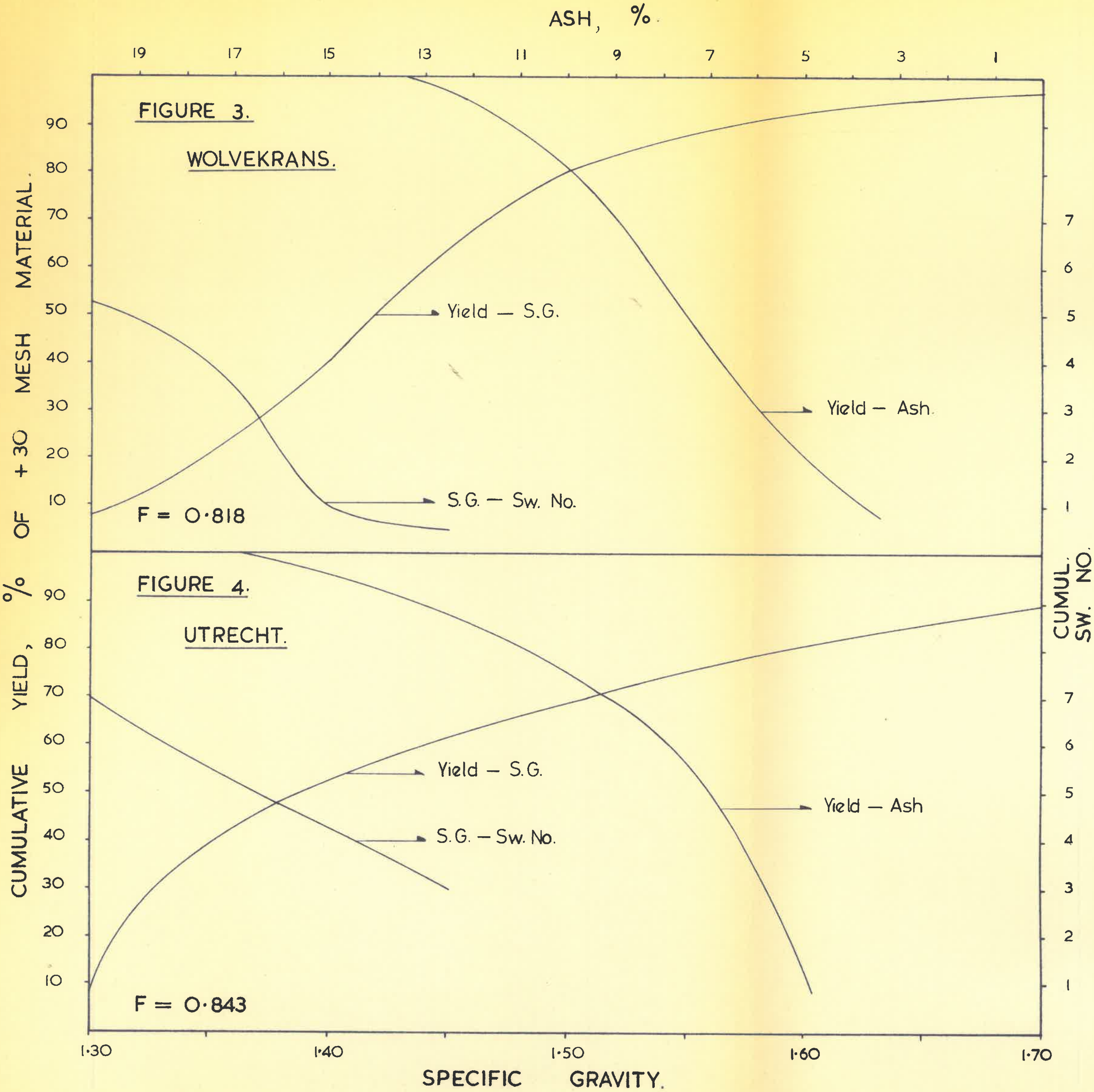
PRETORIA.
18th May, 1965.



Washability Data of Duff Coals.

(+ 30 mesh.)

TO CONVERT YIELDS TO % OF ORIGINAL, MULTIPLY BY F



Washability Data of Duff Coals.

(+ 30 mesh)

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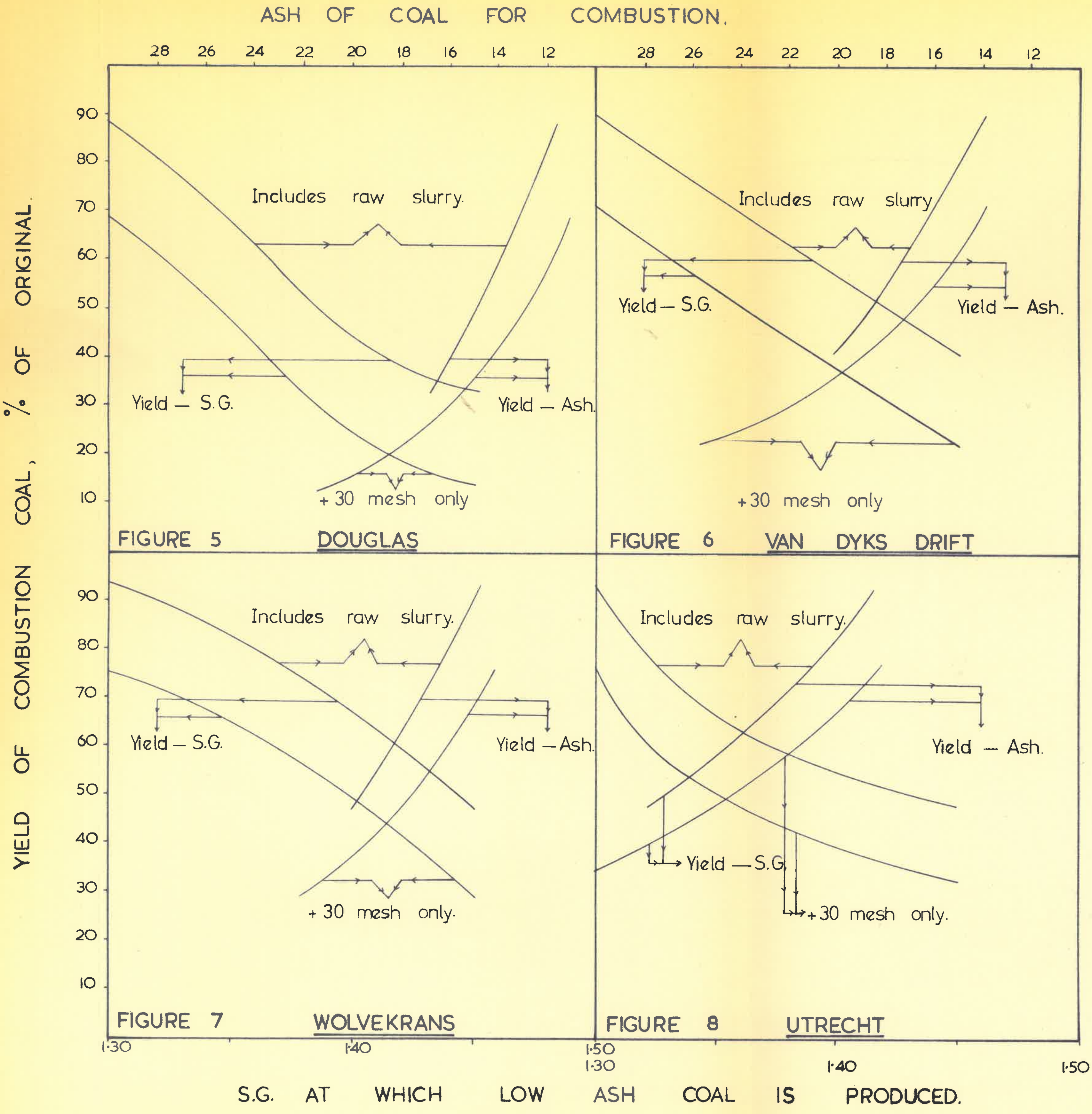

Data for Possible Combustion Coal Products Resulting from Single Stage Washing.