Face Samples.

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RAPPORT No.

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REPORT No. 14

OF 1945

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BRANDSTOF-NAVORSINGS-INSTITUUT

VAN SUID-AFRIKA.

FUEL RESEARCH INSTITUTE

OF SOUTH AFRICA.

SURVEY REPORT NO. 76.

ONDERWERP:
SUBJECT: REPORT ON SAMPLES TAKEN FROM THE NO. 4 SEAM AT THE SCHOONGEZICHT COLLIERY, WITBANK DISTRICT.

AFDELING:
DIVISION: CHEMISTRY

NAAM VAN AMPTENAAR:
NAME OF OFFICER: C. C. v.d. MERWE.

COPY.

SOUTH AFRICAN IRON AND STEEL INDUSTRIAL CORPORATION,

LIMITED.

P. O. Box 450

PRETORIA.

2nd. October, 1958

The Secretary,
Fuel Research Institute,
P. O. Box 217,
PRETORIA.

Dear Sir,

COAL FARMS, PIET RETIEF DISTRICT.

With reference to your letter of the 29th. ultimo, I now supply further particulars regarding the boreholes drilled for the Corporation in the above area.

The boreholes were drilled in the period 1942-1944 when the arrangement was that the coal core was sampled and analysed by the Institute, which then passed the information back to the Corporation. This probably explains why the Institute has no record of boreholes A1 and A2 on Annysspruit, because both boreholes intersected only Lower Ecca strata and no coal was found. On 6/12/44, however, we submitted a plan to the Institute showing the positions of these two boreholes.

Further, it appears that the surveyor who prepared the plans showing the positions of the boreholes on Klipspruit got the borehole numbers mixed up. The numbers of the logs and samples in your possession are correct, as are the positions of the boreholes on the plan, but the numbers of some of the boreholes on the plan are incorrect. The correct numbers are as follows :-

Klipspruit 461 : K1 should be K 0
K5 should be K 1
K6 should be K 2

Klipspruit 462 : K2 should be K 6.
(Rem.)

Furthermore it appears that K8 was drilled in the first phase of activity in the area, while in the later phase the number K8 was at first inadvertently used again. This was later changed to K8a which borehole was lost and K8b was then drilled next to it. Thus K8a and K8b virtually represent one borehole. The position of K8b is shown on the plan submitted to you on 6/12/1944.

We trust this matter will now be clear to you, and you are hereby authorised to disclose to Messrs. African and European the records of all the boreholes on Annysspruit nos. 142 and 143, and Klipspruit nos. 461 and 462.

Yours faithfully,

(SIGNED) E. KLEIN,
DEVELOPMENT MANAGER.

FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

REPORT NO. 14 OF 1945.

SURVEY REPORT NO. 76.

REPORT ON SAMPLES TAKEN FROM THE NO. 4 SEAM AT THE SCHOONGEZICHT COLLIERY, WITBANK DISTRICT.

INTRODUCTION.

The Schoongezicht Colliery works the No. 1, No. 2 and No. 4 Seams of the Witbank Coalfield. Of these seams, the No. 1 and No.2 have been exploited for a number of years and a survey report, (No. 13 of 1935) based on samples taken during 1935, has already been issued. The exploitation of the No. 4 seam has only recently been commenced and in order to complete the examination of this colliery, a further set of samples from the No. 4 seam only was taken during 1944.

The samples were taken by hand at three places in the workings as shown in the accompanying sketch plan. (see back of report). Table 1 (see back of report p. 7) gives the details of the samples taken.

SECTION 1 : ANALYTICAL METHODS.

The analytical methods employed in the coal survey work and the significance to be attached to the determinations are given in the appendix (see end of report).

SECTION 2 : PROXIMATE ANALYSES.

Table 2 (see back of report page 8) gives the proximate analyses on an air dried basis of the samples detailed in Table 1 together with

(a) the percentage float at a specific gravity of 1.45

(b) the percentage ash on the float at 1.45 S.G.

(c) the swelling number on the float at 1.45 S.G.

(d) the percentage float at a S.G. of 1.6

(e) the percentage ash on the float at 1.6 S.G.

(f) the swelling number on the float at 1.6 S.G.

From/.....

From the individual analytical data given in Table 2, the average proximate analysis for the whole seam face at each sampling place has been calculated and these figures are given in Table 3 (see back of report, page 9). A 2" band of stone near the bottom of the seam and 8" of roof coal at place 2 have been excluded from both the width and the average analysis.

SECTION 3 : ULTIMATE ANALYSES.

For the purpose of further and more detailed investigation, samples based on the proximate analyses were made up. These were made by mixing - in proportion to the amount of coal they represent - samples of the same band from different places, provided that the proximate analysis confirmed their general similarity. As a result a series of samples representing the various types of coal found in the seam were obtained and on these the more advanced work was carried out. The composition and description of the composite samples is given in Table 4 (see back of report, page 9).

Table 5 (see back of report, page 9) gives the proximate analyses of the samples listed in Table 4.

In Table 6 (see back of report, page 10) are given the ultimate analyses of the samples listed in Table 4. The analyses have been carried out in all cases on the floats at a S.G. of 1.6 and the results are expressed on a dry, ash-free basis so as to present the composition of the coal substance itself.

Table 7 (see back of report, page 10) shows the sulphur distribution in the composite samples. These analyses have been carried out on the whole coal including adventitious mineral matter. The total sulphur contents of the floats at 1.6 S.G. are also included in this table for comparative purposes. A comparison of the total sulphur content of the whole coal and of the float at 1.6 S.G. gives an indication of whether the sulphur content of the coal would be improved by washing.

SECTION 4 : CARBONISATION ASSAYS.

Low temperature carbonisation assays have been made on the floats at 1.6 S.G. of the samples listed in Table 4. The figures that have been obtained are given in Table 8 (see back of report, page 10).

Table 9 (see back of report, page 10) gives the results of high temperature carbonisation assays carried out on those samples listed in Table 4 which appear to be possible sources of gas or coking coals. The assays have been made on the float at 1.45 S.G.

SECTION 5 : FLOAT AND SINK ANALYSES.

Float and sink analyses, together with their attendant ash and swelling number determinations, have been made on the samples listed in Table 4. The results are given in Table 10 (see back of report, page 11).

SECTION 6 : ASH FUSION TEMPERATURES.

Ash fusion temperatures have been determined on the ash from both the whole coal and the float at 1.6 S.G. of the samples listed in Table 4. The values that have been obtained are given in Table 11 (see back of report, page 11).

SECTION 7 : GENERAL SUMMARY.

The No. 4 seam begins as a continuous formation in the southern part of Schoongezicht 13. To the North this seam is only present in isolated elevated areas.

The workings in the No. 4 seam of the Schoongezicht Colliery is thus confined to the southern corner of the farm Schoongezicht 13. In this portion of the Witbank Coalfield the No.4 seam attains a width of up to 30 feet of which the top section is of low quality and only the bottom 9 feet is extracted.

The/....

The output of individual seams at the Schoongezicht Colliery is not marketed separately but the run-of-mine coal represents all the coal that is extracted from the various seams.

The composite product is washed at the colliery and the washed coal has the following average analyses.

Ash %	13.8
Moisture %	2.0
Volatile Matter %	24.2
Fixed Carbon %	60.0
Calorific Value lbs/lb.	12.7
Sulphur %	0.82
Ash Fusion Temperature °C	+ 1400

The places at which the face samples were taken do not represent a large area and the details given in Tables 1 and 2 show that the sections and the analyses of samples from all the places are fairly similar. The section is as follows:-

	Roof : Coal	Width.	Average.
D.	Top mixed coal	15-21"	18"
C.	Alternating bands of mixed and dull coal.	22-33"	27"
B.	Dull coal with very little bright coal.	39-43"	41"
A.	Mixed mainly dull coal.	17-21"	19"
	Floor : Shale.		

A. The 19" mixed mainly dull band on the floor of the seam is a typical mixed type of coal found in the Witbank area. The hydrogen content (4.8%) is normal and the yields on carbonisation were as could be expected for this type of coal.

The lighter fractions show fairly well developed swelling properties up to a S.G. of 1.4. The heavier fractions are however devoid of swelling properties and this renders the cumulative float material at the higher specific gravities of no value for coke making.

This/....

This band of coal constitutes the cleanest portion of the whole seam that is mined. The ash content is 13.3% and the calorific value 12.6 lbs/lb. The ash fusion temperature is low (1300°C) and the sulphur content of the coal is 1.56%. Both these latter qualities could be improved if the coal were washed.

B. Above the dull mixed coal on the floor a thin band of stone (2" thick) is found which underlies a 41" band of dull coal.

This band of dull coal contains very little bright coal as is shown by its low hydrogen content (4.4%) and the low yields of volatile products that were obtained in the carbonisation test.

The coal is of lower quality, having an ash content of 17.5% and carrying a calorific value of 11.7 lbs/lb.

The coal shows no swelling properties in the fractions that floated at a S.G. of 1.4. Only 2.6% of float was obtained at a S.G. of 1.35.

The sulphur content of the coal is low and the ash fusion temperature is also lower than is usual for this type of coal (1300°C).

C. A 27" band of mixed coal overlies the dull band described under B. It is composed of separate thinner bands of mixed coal and dull coal. The coal is of a relatively good quality with an ash content of 14.1% and a calorific value of 12.5lbs/lb.

The ultimate analyses gave normal results for this type of coal. The hydrogen content is 4.9% and the sulphur content is 1.32%, with an ash fusion temperature of 1300°C. The sulphur content would be decreased to the extent of about 50% and the ash fusion temperature increased to over 1400°C by washing.

The float and sink analyses disclosed swelling properties to be present only in the lightest fractions while the carbonisation assays further proved the absence of coking properties

in the/....

in the float at 1.6 S.G.

D. The top of the section of the No.4 seam which is extracted consists of an 18" band of mixed coal. The quality of this coal is not high. It has an ash content of 16.6% and a calorific value of 11.8 lbs/lb. The volatile matter content is the highest for all the bands that were sampled (27%) and this is also reflected in its higher hydrogen content (5.1%).

The swelling properties of the lighter fractions of this coal are well developed but not sufficiently so to render the whole coal of value as a source of coking coal.

The sulphur content of 1.66% and the low ash fusion temperature (1300°C) would both be improved if the coal were washed.

To summarise, it is evident that the quality of the various bands of coal, which constitute the section that is mined, varies somewhat and raw coal with the following average analytical results is obtained:-

Ash %	16
Volatile Matter %	24
Moisture %	2
Fixed Carbon %	58
Calorific Value	12.0
Ash Fusion Temperature	1300°C

This product, in admixture with coal from the lower seams, is washed and the quality improved considerably.

The washed product of the No. 4 seam would only be suitable as a fuel for general combustion purposes for which its high ash fusion temperature and low sulphur content would be advantageous.

October, 1945. C.C. v.d. MERWE.

TABLE 1.

DESCRIPTION OF SAMPLES.

SAMPLE NUMBER.		LOCATION OF SAMPLE.	WIDTH Ins.	DESCRIPTION OF SAMPLE.
Seam - No. 4.				
N 336		Sampling		ROOF: Dull coal.
	E	Place No. 1	18	Alternating bands of dull and bright coal, mainly dull coal.
	D		27	Alternating bands of mixed and dull coal.
	C		22	Mainly dull coal with very little bright coal.
	B		17	Mixed mainly dull coal.
			2	Stone - Not Sampled.
	A		17	Mixed mainly dull coal, brighter at bottom.
				FLOOR: Shale.
N 337		Sampling		ROOF: Dull Coal.
	F	place No. 2	8	Mixed mainly dull roof coal.
	E		21	Mixed mainly bright coal.
	D		33	Alternating bands of mixed coal and dull coal, mainly dull coal.
	C		24	Dull coal with very little bright coal.
	B		18	Mixed mainly dull soft coal.
			2	Stone - Not Sampled.
	A		18	Mixed mainly dull coal.
				FLOOR: Shale.
N 338		Sampling		ROOF: Dull coal.
	E	place No. 3	15	Bright coal with 3" sandstone excluded.
	D		30	Alternating bands of mixed and dull coal. Mainly dull; 2" of stone 12" from top excluded.
	C		22	Dull coal with very little bright coal.
	B		21	Mixed mainly dull soft coal.
			2	Stone - Not Sampled.
	A		21	Mixed coal, with 5" of bright coal at bottom.
				FLOOR: Shale.

TABLE 2.

PROXIMATE ANALYSES.

Sample Number		Width Ins.	Cal.Val. lbs/lb.	% H_2O	% Ash	% Vol. Matter	% Fixed Carbon	% Fl. 1.45	% Ash Fl 1.45	% Fl 1.6	% Ash Fl 1.6	Sw.No. Fl.45	Sw.No. Fl.6
Seam No. 4.													
N336	E	18	11.7	1.9	17.2	30.0	50.9	50.5	5.7	77.8	9.0	4	3
	D	27	12.6	2.1	12.9	28.6	56.4	59.1	5.6	88.9	9.2	1	1
	C	22	11.4	2.1	19.4	19.6	58.9	16.7	5.7	71.1	11.9	1F	-
	B	17	12.2	2.3	15.6	21.5	60.6	27.8	7.6	88.0	12.5	1F	-
	A	17	12.6	2.3	13.0	22.7	62.0	39.0	6.7	91.0	11.0	1	1f
N337	F	8	10.3	2.0	25.6	22.3	50.1	29.8	5.0	52.8	9.6	1F	-
	E	21	11.6	2.0	17.8	27.9	52.3	46.6	5.9	75.3	8.9	2	1½
	D	33	12.3	2.1	14.8	25.5	57.6	53.6	5.5	79.8	8.2	1	1
	C	24	11.4	2.4	19.1	19.9	56.8	23.0	6.1	70.3	11.9	1F	-
	B	18	12.2	2.3	14.6	21.3	61.7	43.4	6.6	85.7	10.8	1F	-
	A	18	12.6	2.3	13.5	21.8	62.4	44.4	6.4	89.2	10.1	1F	-
N338	E	15	12.1	1.7	15.3	31.7	51.3	67.3	5.5	81.0	7.3	4½	4
	D	28	12.5	2.1	14.2	24.5	59.2	54.6	5.6	83.9	9.0	1½	1
	C	22	11.1	2.0	20.8	19.8	57.4	25.1	6.6	69.7	11.5	1	1
	B	21	12.1	2.3	15.4	21.8	60.5	37.4	6.7	86.8	11.4	1F	-
	A	21	12.6	2.0	13.6	27.6	56.8	58.6	5.8	87.2	8.9	2½	1½

TABLE 3.

AVERAGE PROXIMATE ANALYSES OF SEAM FACES.

Sample Number	Location of seam face	Width. ins.	Cal. Val. lbs/lb.	% Moisture.	% Ash	% Vol. Matter.	% Fixed Carbon	% Fl 1.45	% Ash 1.45	% Fl 1.6	% Ash 1.6
N336 A-E	Place No.1	101	12.1	2.1	15.6	24.7	57.6	39.7	6.0	83.2	10.6
N337 A-E	Place No.2	122	11.9	2.2	16.6	23.4	57.6	42.0	5.9	77.6	9.8
N338 A-E	Place No.3	107	12.1	2.0	15.8	24.6	57.5	47.7	5.9	81.8	9.7

TABLE 4.

COMPOSITION AND DESCRIPTION OF COMPOSITE SAMPLES.

Sample Number.	Composition.	Type of coal represented.
N 415	N336 A - 17 pts. N337 A - 18 " N338 A - 21 "	Mixed mainly dull coal at bottom of seam.
N 416	N336 B - 17 pts C - 22 " N337 B - 18 " C - 24 " N338 B - 21 " C - 22 "	Dull coal with very little bright coal. Separated from bottom mixed coal by a thin stone parting.
N 417	N336 D - 27 pts. N337 D - 33 " N338 D - 28 "	Alternating bands of mixed and dull coal, below top mixed coal.
N 418	N336 E - 18 pts. N337 E - 21 " N338 E - 15 "	Top mixed coal.

TABLE 5.

PROXIMATE ANALYSES OF COMPOSITE SAMPLES.

Sample Number	Whole Coal.			Float at 1.6 S.G.		
	% Ash	% H_2O	% Vol. Mat.	% Ash	% H20	% Vol. Mat.
N 415	13.3	2.3	21.3	9.9	2.3	24.4
N 416	17.5	2.4	17.8	11.3	2.3	20.4
N 417	14.1	2.3	24.8	8.5	2.3	25.3
N 418	16.6	2.1	26.9	9.3	2.2	30.4

TABLE 6.

ULTIMATE ANALYSES.

(on a dry, ash-free basis - Floats at S.G. 1.6)

Sample Number	% Carbon	% Hydrogen	% Nitrogen	% Sulphur	% Oxygen & errors
N 415	84.4	4.8	2.0	0.6	8.2
N 416	84.7	4.4	2.0	0.7	8.2
N 417	84.2	4.9	2.1	0.7	8.1
N 418	83.1	5.1	2.2	0.9	8.7

TABLE 7.

SULPHUR DISTRIBUTION.

Sample Number	On whole coal.			On Floats at 1.6 S.G.
	% Mineral Sulphur	% Organic Sulphur	% Total Sulphur	% Total Sulphur.
N 415	1.12	0.44	1.56	0.58
N 416	0.51	0.32	0.83	0.57
N 417	0.98	0.34	1.32	0.58
N 418	1.15	0.51	1.66	0.77

TABLE 8.

LOW TEMPERATURE CARBONISATION ASSAYS.
(on Floats at 1.6 S.G.)

Sample Number	% Coke	% Tar	% Liquor.	% Gas	Gas Density (air=1)	% V.M. in coke	Nature of Coke.
N 415	79.7	7.0	6.4	7.0	0.62	5.8	Friable.
N 416	83.9	4.7	5.8	6.0	0.64	5.8	Pulverulent.
N 417	79.6	7.4	5.6	7.5	0.62	5.8	Friable.
N 418	75.2	9.9	7.0	8.3	0.64	6.3	Friable.

TABLE 9.

HIGH TEMPERATURE CARBONISATION ASSAYS.
(on Floats at 1.45 S.G.)

Sample Number	% Coke	% Tar	% Liquor.	% Gas	Gas Density (air=1)	% Sulphur in coke	Nature of Coke.
N 418	69.7	6.7	7.5	15.7	0.47	0.54	Friable.

TABLE 10.

FLOAT AND SINK ANALYSES.

		Float 1.3	Float 1.3 - 1.35	Float 1.35 - 1.4	Float 1.4 - 1.45	Float 1.45 - 1.5	Float 1.5 - 1.55	Float 1.55 - 1.6
N415	19"							
Weight %		6.4	10.6	17.3	17.2	25.1	8.4	4.7
Ash %			4.2	6.2	8.2	12.3	19.3	20.8
Cumulative Weight %		6.4	17.0	34.3	51.5	76.6	85.0	89.7
Cumulative Ash %		-	4.2	5.2	6.2	8.2	9.3	9.9
Cumulative Sw. No.		4½	4½	2	1	1	1	1F
N416	41"							
Weight %		0.3	2.3	6.7	26.7	23.2	13.9	5.0
Ash %			5.6		7.8	12.3	18.7	23.5
Cumulative Weight %		0.3	2.6	9.3	36.0	59.2	73.1	78.1
Cumulative Ash %		-	-	5.6	7.2	9.2	11.0	11.6
Cumulative Sw. No.		-	-	1F	-	-	-	-
N417	27"							
Weight %		8.1	16.1	16.5	26.2	9.6	6.2	2.8
Ash %		2.0	3.5	6.7	7.1		19.7	
Swelling Number		3	1½	1F	-	-	-	-
Cumulative Weight %		8.1	24.2	40.7	66.9	76.5	82.7	85.5
Cumulative Ash %		2.0	3.0	4.5	5.5	7.3	8.3	8.6
Cumulative Sw. No.		3	2	1	1	1F	-	-
N418	18" 10½"							
Weight %		11.9	21.9	16.1	15.1	6.4	4.8	2.6
Ash %		2.1	4.4	8.6	8.6	20.5	26.9	35.0
Swelling Number		5½	2½	1½	1F	-	-	-
Cumulative Weight %		11.9	33.8	49.9	65.0	71.4	76.2	78.8
Cumulative Ash %		2.1	3.6	5.2	6.0	7.3	8.4	9.4
Cumulative Sw. No.		5	4	3	2½	1½	1	1

TABLE 11.

ASH FUSION TEMPERATURES.

Sample Number	On Whole Coal °C.	On Floats at 1.6 S.G.
N415	1300	1400
N416	1300	+1400
N417	1300	+1400
N418	1300	+1400

FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

APPENDIX.

ANALYTICAL METHODS AND THEIR SIGNIFICANCE.

1. SAMPLING:

Sampling is carried out according to South African Standard Specification, S.A. No. 13 of 1937, "Standard Methods for the Sampling of Coal in South Africa,"issued by the South African Standards Institution.

11. PREPARATION OF SAMPLES:

The samples are prepared in the manner specified in Standard Methods for the "Sampling of Coal in South Africa", S.A. No. 13 of 1937. The laboratory samples are ground to pass a 60 mesh sieve (square aperture : 0.3 mm) except in the case of specific gravity analysis (float and sink tests) and hydrogenation tests, for which minus 20 mesh (square aperture : 1 mm) material is used.

111. PROXIMATE ANALYSIS:

(1) Moisture Content: This is the loss of weight obtained by heating 1 gram of coal at 101 - 105°C for one hour.

(2) Ash Content: This is the residual ash obtained by combusting 1 gram of coal in a muffle furnace. The coal is slowly heated to 800°C and kept at this temperature for one hour.

(3) Volatile Matter Content: This is the loss of weight obtained by heating 1 gram of coal at 920°C for 7 minutes minus the weight of water present in the coal.

(4) Fixed Carbon percentage: This is obtained by subtracting the sum of moisture, ash and volatile matter contents, expressed as percentages, from 100.

1V. CALORIFIC VALUE:

This value, reported in Evaporative Units (lbs/lb), is calculated from the rise in temperature obtained by combusting 1 gram of coal in oxygen at 30 atmospheres pressure in a Berthelot-Mahler-Kroeker bomb calorimeter.

The determination is carried out according to South African Standard Specification, S.A. No. 5 of 1940, "The Determination of the Comparative Calorific Values of Coals in South Africa".

V. PRELIMINARY FLOAT AND SINK ANALYSES:

Twenty gram portions of the coal are separated into different specific gravity fractions in a centrifuge using petrol and carbon tetrachloride mixtures of varying specific gravity. The apparatus and method used is described in the Journal of the Chemical, Metallurgical and Mining Society of South Africa, Vol. 34, No. 8 : "A Specific Gravity Investigation of Coal Samples" by P.E. Hall.

(a) The/......

(a) The percentage float at a S.G. of 1.45 is the percentage by weight of the coal which has a S.G. less than 1.45. This float contains the majority of the swelling constituents of the coal when these are present in a sample.

(b) The percentage of float at a S.G. of 1.6 is the percentage by weight of the coal which has a S.G. less than 1.6. It represents approximately the amount of coal substance present and also gives a rough figure for the performance of an ordianry washer on the coal. This figure subtracted from 100 gives the amount of adventitious mineral matter in a coal sample.

(c) The percentage ash on the float at 1.45 gives some indication of the minimum ash content likely to be obtained by washing at this specific gravity.

(d) The percentage ash on the float at 1.6 represents the amount of mineral matter intimately associated with the coal substance and as such furnishes an approximate figure for the minimum ash content for a normal washed product from the particular sample.

(e) The Swelling Number is the ratio of the final to the initial volume of 1 gram of coal heated strongly under standard conditions and is a measure of the swelling propensities of the coal.

This test is carried out according to B.S.S. Specification, No. 804 of 1938. "The Crucible Swelling Test for Coal."

1 Denotes a residue of definite coke structure but no swelling. 1 f denotes a residue easily friable and possessed of no coke structure. 1 p denotes a residue in powder form. A value of 3 or more indicates definite coking possibilities.

(f) If the float 1.45 material exhibits swelling propensities, further swelling number determinations are carried out on the S.G. 1.6 fraction. These figures give an indication of the swelling propensity with this S.G. cut.

VI. ULTIMATE ANALYSIS:

The ultimate analysis is generally carried out on the float at a S.G. of 1.6. This procedure is adopted in order to eliminate as far as possible the effects due to the presence of adventitious mineral matter.

Carbon, hydrogen, nitrogen and sulphur contents are all determined by standard methods for coal analysis:- viz:

(a) Carbon and Hydrogen: The method used is described in B.S.S. No. 1016 of 1942, "Analysis and Testing of Coal and Coke", page 31.

(b) Nitrogen: The method followed is that described by Beet (Fuel in Science and Practice, volume XI of 1932, page 196; volume XIII of 1934, page 343) and Hall (Journ. Chem. Met. and Min. Soc. of South Africa, volume XXXVI of 1935, No. 2, page 28.)

(c) Total Sulphur: This is determined by the Eschka method, described in B.S.S. No. 1016 of 1942, "Analysis and Testing of Coal and Coke", page 43.

The oxygen/......

The oxygen content is obtained by subtracting the sum of the carbon, hydrogen, nitrogen and sulphur percentages from 100. The value obtained therefore includes all analytical errors.

The results are expressed on a dry-ash-free basis, so as to present the composition of the organic substance itself, unmixed with mineral matter.

V11. SULPHUR DISTRIBUTION:

The figures showing the distribution of sulphur in a sample are on an "as received" basis, i.e. including adventitious mineral matter.

The total sulphur content of the floats at 1.6 S.G. is usually given in the same table as the sulphur distribution on the whole coal. This is done for comparative purposes since it indicates the change in sulphur content that would be brought about by washing the raw coal at a specific gravity of 1.6.

The total sulphur content is determined by the Exchka method and the mineral sulphur content by extraction with dilute nitric acid, according to the methods described in B.S.S. No. 1016 of 1942, page 45.

V111. CARBONIZATION ASSAYS:

There are two forms of carbonization assays, viz: the low temperature (600°C) and the high temperature (900°C) and both are carried out in the Gray-King Apparatus.

Low Temperature Gray-King Assay:

This is carried out at a temperature of 600°C on the floats at a S.G. of 1.6 and is used, primarily for correlative purposes either as a means of characterising a new coal or for establishing the variation in a given type of coal. The results can also be used, however, for determining the type and quantity of the products which the coal under test would furnish in a large scale low temperature carbonization retort. The apparatus and method used is that described in the "Methods of Analysis of Coal" issued by the Fuel Research Station, Greenwich (Physical and Chemical Survey of the National Coal Resources, No. 7).

No direct relationship between the retort and assay yields obtained from South African coals has been deduced but the following interpretation has been found to be applicable overseas. Depending on the type of plant, the large scale tar yield varies from 70 - 80% of that given by the assay. The gas yield is also slightly higher than can be obtained in practice. The yield of coke will be very close to that given by the assay. "Standard" to "very swollen" coke residues indicate coals which will probably produce satisfactory smokeless fuels, while those which are appreciably more friable than "standard" indicate coals which will not yield suitable large scale coke products.

The assay is carried out on the float at 1.6 S.G. for the same reasons as are outlined in Section 7 (ultimate analysis) and also since that fraction would most nearly represent the ordinary washed product from the seam or section of the seam under consideration.

High temperature/.....

High Temperature Gray-King Assay:

This test is only made on such seams or sections of seams as appear to be possible sources of coking or gas coals. Usually the float at a S.G. of 1.45 is used as representing the optimum quality of coal which could be commercially produced by the best possible washing.

A temperature of 900°C is employed and a cracking unit kept at a constant temperature of 800°C is installed. The method and apparatus used is that described in "The Assay of Coal for Carbonization Purposes (Part III)", issued by the Fuel Research Station, Greenwich, (Technical Paper No. 24). The calorific value of the gas is determined by combustion of a measured volume in excess air in a Löffler Gas Calorimeter.

The High Temperature Gray-King Carbonization Assay has been designed specifically to simulate large scale gas making conditions both in horizontal and continuous vertical retorts. Here again no direct relationship between the retort and assay yields with South African coals has been deduced and it is necessary to rely entirely on overseas results. The assay conditions are such that the factors of comparison with horizontal retort practice approach unity. It is considered that the factors for coke oven practice should not diverge unduly from unity in spite of a number of variables such as type of plant, type of coal and size of coal. The factors retort/assay for gas yield, gas calorific value and coke yield are very close to unity. The assay yield of tar is low and the factor varies from 1.2 to 1.5 as the coal varies from strongly to weakly-swelling. The coke residues "friable" and "pulverulent" obtained from the assays indicate coals unsuitable for large scale coke production. Coke residues from "standard" to "very swollen" indicate that the coals will probably yield cokes under large scale conditions.

The best gas coals so far tested in South Africa give about 18 - 20% gas, and they yield 65 - 70 therms of gas per long ton of coal. The highest calorific values of the gas so far found vary from 5400 to 5700 Calories per cubic metre at N.T.P.

IX. DETAILED FLOAT AND SINK ANALYSIS:

Float and sink analyses together with their attendant ash and swelling number determinations, are made on composite coal samples ground to -20 mesh.

This work is usually carried out from three different aspects, viz:-

(i) the characterization of types of coal and the subsequent use of this data in correlation.

(ii) the investigation, in a more detailed manner, of the possibilities and results of washing.

(iii) the investigation of the effects of washing on the swelling properties of the coal.

Where the two latter aspects - which are, of course, closely related - command the most attention, floats corresponding to possible washery products are preferred, since from them the yields and characteristics of the cleaned products can be readily obtained. This involves making cuts at various specific gravities

and/......

and analysing the resulting floats. Such a method is known as "cumulative" float and sink analysis.

On the other hand, where the characterisation and correlation of coal seams are involved, the separation into a series of fractions of narrow specific gravity range is adopted. In this way, any change in the nature or behaviour of the coal fractions with change in specific gravity is more easily appreciated and more strongly emphasised than would be the case in the cumulative method. This type is known as "fractional" float and sink analysis.

For those properties which are additive, e.g. ash content, the cumulative figures can be built up from the fractional and vice versa. This cannot be done in the case of non-additive properties. Nevertheless, swelling numbers - strictly speaking a non-additive property - can be calculated with fair accuracy from fractional to cumulative figures if the number for any fraction is not greater than 8 or less than 1½.

Where desirable, complete float and sink analyses of both types are determined.

When using float and sink analysis figures as guides to possible commercial results, it must always be remembered that the laboratory separations are made on fine coal and depend entirely on specific gravity differences. The products are, therefore, cleaner and more uniform than could ever be obtained from a commercial washer whether operating on run-of-mine or sized coal. The analytical figures represent optimum conditions and due allowance must be made for this when interpreting them into commercial practice.

Comparative figures obtained from many float and sink analyses carried out on both -20 mesh and commercial coal sizes have demonstrated the value of the laboratory scale tests and have suggested a reliable interpretation which can be given to the figures.

(1) The shape of the graph of percentage yield vs. Specific Gravity obtained from fine coal is similar to that obtained from the commercial sizes of the same coal. This means that the washability of the coal can be satisfactorily determined from the -20 mesh size float and sink analysis.

(2) The large scale percentage of float is always 5 - 10% more than the figure obtained in the laboratory on fine coal at the same Specific Gravity.

(3) The percentage ash on the float obtained at any Specific Gravity from large coal is usually from 2 - 4% higher than the value obtained from a laboratory separation.

(4) It has also been found that the smaller the size of the coal to be washed on a large scale, the more closely does the percentage yield and the percentage of ash in the product approach the fine coal float and sink analyses. That is to say, for example, that the allowance made in estimating the washability of pea coal need not be so great as that for, say round coal.

If the coal is poor (more than 18 - 20% ash) it is advisable to make liberal allowances, since with this material only

washers/......

washers of the best type operated under strict control function at all satisfactorily.

X. ASH FUSION TEMPERATURES:

A knowledge of the composition and behaviour of the ash from any coal is of importance from both a fundamental and technical aspect. The use of coal in many industrial appliances, e.g. producers and forced draught boilers is seriously limited by the behaviour of the ash.

The mineral matter from which the ash is derived occurs in two forms:-

(a) Inherent mineral matter which occurs as an integral part of the coal and is not separable therefrom by ordinary means, e.g. picking or washing.

(b) Adventitious mineral matter which may be again subdivided into:

(i) more or less isolated pockets and more continuous bands included in the coal seams,

(ii) mineral matter derived from accompanying strata.

Run-of-mine coal would contain all the forms of mineral matter described above; effective picking should remove the greater portion of (b) (ii) and washed coals would contain (a), and (b) (i) to a limited extent only. In order to determine the ash fusion temperatures of ordinary picked but unwashed coal, these tests are carried out on the whole coal samples, including adventitious mineral matter. If a figure for washed coal is required, the determination is made on the floats at 1.6 S.G.

A direct correlation between the laboratory determinations of the ash fusion temperature and behaviour of the ash in practice has not so far been possible. Although the determinations are carried out under conditions designed to resemble as closely as possible those actually obtaining in a furnace, the differences between small and large scale conditions are appreciable. The results indicate, however, the probable behaviour of the ash in practice and the following scheme may be used for interpreting the laboratory determination of the ash fusion temperature.

(a) less than 1250°C - likely to cause clinkering trouble under all furnace conditions.

(b) 1250 - 1400°C - unlikely to produce clinker under general conditions, although trouble may be experienced with industrial appliances like producers and forced draught boilers.

(c) greater than 1400°C - highly refractory ash which will probably not clinker under any conditions.

XI. Hydrogenation/.....

XI. HYDROGENATION:

The work done in this sphere constitutes a comparative hydrogenation survey. Consequently, a discontinuous rotary converter, though it affords no quantitive data as to the behaviour of the coal in a large scale continuous plant, can nevertheless be used. Under rigidly standard conditions, results obtained with this apparatus are qualitatively comparable.

The coals are treated in the form of a paste containing 57% of coal, 38% of oil and 5% of molybdenum sulphide as catalyst. After filling the converter with 440 grams of the paste and hydrogen to a pressure of 100 atmospheres, the converter is heated to 450°C and kept at this temperature for one hour, after which it is allowed to cool down and the products of hydrogenation examined.

In evaluating the results obtained from rotary converters, it has been found that the best guide to the probable behaviour of the coal is the percentage of organic benzene - insoluble material remaining after treatment reckoned on a dry-ash-free basis. Where this figure is low, the coal may be expected to give better large scale results than where it is high. The best coals so far tested in South Africa have yielded 8 - 11% of this insoluble residue. The average is about 31% and the maximum 60%.

SCHOONGEZICHT COLLIERY

Plan of Nº 4 Seam Workings as at 20.9.44

Scale - 1:1500