lecno: 5256

FRI 12/1950

F.R.I. 47.

VERSLAG No.

VAN

REPORT No. 12

OF 1950

WU1/A/8/3

BRANDSTOFNAVORSINGSINSTITUUT

VAN SUID-AFRIKA

FUEL RESEARCH INSTITUTE

OF SOUTH AFRICA

ONDERWERP:
SUBJECT: THE EFFECTS OF CLEANING ON THE ANALYSIS, COMPOSITION OF THE ASH AND ASH FUSION POINT OF TWO COALS FROM COLLIERIES IN THE SOUTH-EASTERN PORTION OF WITBANK COALFIELD.

AFDELING:
DIVISION: CHEMISTRY.

NAAM VAN AMPTENAAR:
NAME OF OFFICER: W.H.D. SAVAGE.

W.P—26499—21/6/57

FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

REPORT NO. 12 OF 1950.

THE EFFECTS OF CLEANING ON THE ANALYSIS, COMPOSITION OF THE ASH AND ASH FUSION POINT OF TWO COALS FROM COLLIERIES IN THE SOUTH-EASTERN PORTION OF WITBANK COALFIELD.

The work incorporated in this report was undertaken as a result of the introduction of new Grading Regulations governing the export of coal from the Union, in which minimum analytical requirements for the several grades of coal were laid down. These new regulations stipulate a minimum ash fusion point of 1250°C. for all first and second grade export coals, a figure which is generally easily attainable by the majority of the Witbank exporting collieries except those in the south-eastern portion of the coalfield which are opening up new areas of the No.2 and No.4 seams. Apparently, in this locality, changes take place in the composition of the seams which tend to lower the refractoriness of the ashes, and one or two of the collieries concerned have considered it expedient to make a general survey of their mined seam in all working districts in an attempt to assess the extent of such variation.

The position is further complicated at collieries where it is necessary to instal a washer for the purpose of upgrading the coal. In this case it is a matter of vital importance to determine whether the removal of high ash, often highly refractory constituents during washing will adversely affect the ash fusion point and it is in this connection that the Institute deemed it advisable to make this preliminary investigation.

Two collieries in the area were selected for this purpose, one, A, extracting the No.2 seam and the other, B, the No.4 seam. From each colliery a representative run-of-mine bulk sample of the -4 in. or cobbles size coal was obtained and subjected to washing tests in zinc chloride media of S.G.1.40, 1.50 and 1.58, in the Coalometer apparatus.

Note/.......

(Note: It was not possible to obtain individual cobble size coal at colliery A and, as this was considered the most convenient size for laboratory treatment, a bulk sample of run-of-mine round coal was taken and reduced at the laboratory to -4 in. cobble size, taking precautions not to produce excessive fines.)

The samples, each of not less than 500 lbs. bulk, were progressively washed, taking the "sinks" from the lowest gravity separation and floating them in the medium of next highest gravity, and so on, until four fractions were obtained for analysis, viz., floats at S.G. 1.40, fraction at S.G. 1.40 to 1.50, fraction at S.G. 1.50 to 1.58 and sinks at S.G. 1.58. Cumulative float fractions at each gravity were subsequently made up and also analysed, the analyses including a proximate analysis, the determinations of total sulphur and carbon dioxide, ash fusion point and ash composition. In order to simulate the furnace conditions ash fusion point determinations are invariably carried out in a mildly reducing atmosphere composed of equal volumes of carbon dioxide and hydrogen, the mixture of these gases being circulated continuously throughout the ash fusion point apparatus during each determination.

Descriptions of the washed fractions and tables of analytical data follow:-

COLLIERY A.
(F.R.I. Sample No.S422).

Floats @ S.G. 1.40	Mixed, mainly dull coal containing a small amount of pyrites in the form of small, rounded nodules. A fair amount of fusain associated with filmy pyrites was also present in thin partings. Ankeritic partings up to 1/16 in. in thickness occurred in moderate amounts in the cleats.
Fraction S.G. 1.40 - 1.50.	Mainly dull coal associated with a moderate amount of mixed and bright coal and containing a proportion of calcite which was often associated with filmy pyrites in the cleavage planes. Small, nodular pyrites were also present in the brighter portions. Occasionally, dull coal layers contaminated with what appeared to be finely-disseminated calcite were observed.

Fraction/.......

Fraction S.G.1.50 - 1.58	Generally dull in appearance with varying lustre, often showing fracture surfaces consisting of 'sugary' bright but inferior coal. Contained a fair proportion of bright, highly pyritic coal in which ankerite or calcitic partings were noted. Bands of shaly, high ash dull coal were of fairly frequent occurrence.
Sinks at S.G.1.58	Mainly dull shaly coal and carbonaceous shale, often canneloid in appearance and fracturing conchoidally. Occasional pieces of bright coal contaminated with pyrites were also present. In general this fraction was not so pyritic as floats 1.50 to 1.58.

COLLIERY B.
(F.R.I. Sample No.S421.)

Floats at S.G.1.40	Mainly bright coal, thinly dull banded in parts and containing a fair proportion of ankeritic calcite in the cleats. Globular concretions of calcitic residues were moderately frequent in occurrence in the bedding planes. Pyrites was also present in moderate amount.
Fraction S.G.1.40 - 1.50	Mainly mixed coal containing a small amount of pyrites; calcitic in cleats. Occasional occurrences of calcitic concretions.
Fraction S.G.1.50 - 1.58	Mainly dull coal containing shaly layers and a fair amount of pyrites in nodular lenticles generally associated with the small amount of bright coal present. Again occasional occurrences of calcitic residues were noted.
Sinks at S.G.1.58	Mainly dull shaly coal and carbonaceous shale. A comparatively small amount of visible pyrites but occasional 'gritty' layers and sandstone inclusions noted. A small number of pieces also showed traces of calcitic residues.

The calcitic deposits appeared to be present throughout all the washed fractions but not in great amounts. Pyrites was more concentrated (or appeared to be more concentrated) in the 1.50 to 1.58 fraction with small amounts in the other fractions.

TABLE 1/.......

TABLE 1.

PROXIMATE ANALYSES, CALORIFIC VALUE, TOTAL SULPHUR ETC.

(% on air-dried coal)

Colliery:	Fraction.	Yield %	H_2O %	Ash %	Vol. mat.%	Fix. carb.%	C.V. lbs/lb.	Total S.	CO_2 in carbonates
A	Floats @ S.G.1.40	48.2	2.3	8.4	29.8	59.5	13.4	0.79	1.00
	Fraction @ S.G.1.40 - 1.50	33.5	2.4	13.5	26.0	58.1	12.5	0.83	1.66
	Fraction @ S.G.1.50 - 1.58	7.5	2.4	20.1	22.0	55.5	11.0	1.62	3.16
	Sinks @ S.G.1.58	10.8	-	48.4	-	-	-	-	2.46
	Cumulative Floats @ S.G. 1.50	81.7	2.6	10.5	28.0	58.9	13.0	0.81	1.27
	Cumulative Floats @ S.G. 1.58	89.2	2.5	11.3	27.4	58.8	12.8	0.86	1.43
	Original Sample	100.0	2.4	15.3	27.1	55.2	12.4	0.94	1.49
B	Floats @ S.G. 1.40	13.3	3.4	10.3	34.4	51.9	12.7	1.10	1.38
	Fraction @ S.G.1.40 - 1.50	33.6	3.3	15.3	29.8	51.6	11.9	1.48	2.34
	Fraction @ S.G.1.50 - 1.58	22.0	3.2	22.7	24.6	49.5	10.5	1.19	2.96
	Sinks @ S.G. 1.58	31.1	-	47.5	-	-	-	0.72	1.75
	Cumulative Floats @ S.G. 1.50	46.9	3.6	13.9	31.1	51.4	12.1	1.36	2.07
	Cumulative Floats @ S.G. 1.58	68.9	3.9	16.7	28.5	50.9	11.6	1.35	2.35
	Original Sample	100.0	2.9	26.3	25.9	44.9	10.2	1.06	2.00

TABLE 2/........

TABLE 2.

ASH FUSION POINT (^{o}C.).

Colliery	Fraction	Softening or Melting Temperature.	Fluid Temperature.
A	Floats @ S.G.1.40	1355	1360
	Fraction @ S.G.1.40-1.50	1380	1385
	Fraction @ S.G.1.50-1.58	1355	1360
	Sinks @ S.G.1.58	+1400	+1400
	Cumulative Floats @ S.G.1.50	1355	1360
	" " @ S.G.1.58	1380	1390
	Original Sample	1370	1375
B	Floats @ S.G.1.40	1295	1300
	Fraction @ S.G.1.40-1.50	1275	1290
	Fraction @ S.G.1.50-1.58	1330	1335
	Sinks @ S.G.1.58	+1400	+1400
	Cumulative Floats @ S.G.1.50	1295	1305
	" " @ S.G.1.58	1315	1320
	Original Sample	1305	1315

TABLE 3.

ASH ANALYSES.

S. G. Fraction.	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	CaO %	MgO %	SO_3 %	Alkalies %	Total %
Colliery A.	Analyses of Various Specific Gravity Fractions.							
Float 1.40	30.4	36.0	6.5	14.4	4.4	7.7	0.2	99.6
1.40-1.50	33.4	35.2	5.4	12.2	6.9	7.0	0.4	100.5
1.50-1.58	30.0	35.6	8.5	14.7	5.9	6.3	0.3	101.3
Sink 1.58	41.7	44.9	4.5	5.1	3.5	2.8	0.1	102.6
Whole Coal	34.2	37.7	5.9	11.4	4.2	7.1	0.1	100.6
	Calculated Cumulative Analyses.							
Float 1.50	32.0	35.6	5.9	13.2	5.7	7.3	0.3	100.0
Float 1.58	31.7	35.6	6.3	13.5	5.7	7.2	0.3	100.3
Whole Coal	35.1	38.8	5.7	10.6	5.0	5.7	0.2	101.1
Colliery B.	Analyses of Various Specific Gravity Fractions.							
Float 1.40	30.9	30.0	7.1	19.8	1.6	9.7	2.2	101.3
1.40-1.50	34.6	26.1	8.8	17.1	3.6	8.5	1.2	99.9
1.50-1.58	45.6	22.9	4.9	13.8	5.8	6.0	1.7	100.7
Sink 1.58	60.8	28.6	1.4	5.1	0.7	2.4	0.7	99.7
Whole Coal	49.9	27.4	4.0	9.8	1.9	5.1	0.5	98.6
	Calculated Cumulative Analyses.							
Float 1.50	33.8	26.9	8.4	17.6	3.2	8.8	1.4	100.1
Float 1.58	38.9	25.2	6.9	16.0	4.3	7.6	1.5	100.4
Whole Coal	51.2	27.1	3.8	9.9	2.3	4.7	1.0	100.0

Note: Alumina in the above table is the difference between total mixed oxides and ferric oxide, and thus includes several minor oxides, of which titania is probably the most abundant. The alkalies were weighed as chlorides and calculated to the oxide assuming equimolecular concentrations of potassium and sodium.

Conclusions: The effects of cleaning on the two coals are plainly discernable, but since the investigation was primarily concerned with the refractoriness of the ash, only those aspects which affect this property will be discussed.

With both collieries, particularly Colliery B, there is a large quantity of sink at S.G.1.58, and no colliery would allow this quantity of dirt in their sales products, at least in the larger sizes. Thus the ash fusion temperatures of the original samples and normal sales products will not be comparable. The sales products will in fact be closer in composition to the cumulative float obtained at S.G.1.58.

A study of the ash fusion temperatures of the original coal and the cumulative floats reveals no striking variations in either coal. Both coals show the same tendency. The floats at S.G.1.58 have the highest fusion temperatures with that of the original samples and of the floats at S.G.1.50 and 1.40 being slightly lower. From the ash analyses the low values for the original coals would not be expected, as the high silica and alumina in these ashes should make them more refractory. The ash fusions on the specific gravity fractions also do not show large variations except that the sinks at S.G.1.58 have highly refractory ashes. Here the ash analysis conforms to the ash fusion characteristics, as the fusion temperature generally increases with increasing content of silica plus alumina. The extent to which washing will affect the ash fusion characteristics of the coals is small, and any slight reduction in this property would be more than offset by the improvement in the general quality of the coal.

Several/........

Several interesting variations occur in the ash analysis of the different fractions of the coals. The differences are more striking in the individual fractions than in the cumulative samples. For colliery A there is no striking variation except for the sudden increase in silica and alumina and corresponding decrease in the other constituents, particularly the calcium oxide and sulphate in the sinks at S.G.1.58. In the coal from colliery B the differences are more marked. The silica increases steadily with increasing specific gravity of the fractions. This can be partly ascribed to the siliceous material noted in the descriptions on the sink at S.G.1.58. The alumina decreases except for an increase again in the sink at S.G.1.58. Iron is fairly concentrated in the higher fractions and decreases to a very low value in the sink. Lime shows a steady decrease, the sinks having much less than the other fractions. Magnesia shows the opposite tendency with a sharp reversal to only 0.7% in the sink. Sulphate is very similar to the lime in its trend.

The results are given in a somewhat different form in Table 4. Here it will be noted that as is to be expected the silica and alumina values increase with the specific gravity of the fractions. Relations between iron and total sulphur values, between the lime and sulphate values and the carbon dioxide and lime plus magnesia values are evident from this table.

TABLE 4/......

TABLE 4.

Constituents of Ash as % of Coal or Fractions from which the Ash is Derived.

Colliery.		SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Alk.	Total S.	CO_2
A	F 1.4	2.55	3.02	0.55	1.21	0.37	0.65	0.02	0.79	1.00
	1.4-1.5	4.51	4.75	0.73	1.65	0.93	0.95	0.05	0.83	1.66
	1.5-1.58	6.03	7.16	1.71	2.95	1.19	1.27	0.06	1.62	3.14
	S 1.58	20.18	21.73	2.18	2.47	1.69	1.36	0.05	1.60x	2.46
	Whole Coal	5.23	5.77	0.90	1.74	0.64	1.09	0.02	0.94	1.49
	F 1.5	3.36	3.74	0.62	1.39	0.60	0.77	0.03	0.81	1.27
	F 1.58	3.58	4.02	0.71	1.53	0.64	0.81	0.03	0.86	1.43
B	F 1.4	3.18	3.09	0.73	2.04	0.16	1.00	0.23	1.10	1.38
	1.4-1.5	5.29	3.99	1.35	2.62	0.55	1.30	0.18	1.48	2.34
	1.5-1.58	10.35	5.20	1.11	3.13	1.32	1.36	0.39	1.19	2.96
	S 1.58	28.88	13.59	0.67	2.42	0.33	1.14	0.33	0.72	1.75
	Whole Coal	13.12	7.21	1.05	2.58	0.50	1.34		1.06	2.00
	F 1.5	4.70	3.74	1.17	2.45	0.44	1.22	0.19	1.36	2.07
	F 1.58	6.50	4.21	1.15	2.67	0.72	1.27	0.25	1.35	2.35

x calculated.

(Sgd.) W.H.D. SAVAGE
ASSISTANT DIRECTOR.

PRETORIA.

26th May, 1950.
