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FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

TECHNICAL MEMORANDUM NO. 21 OF 1962.

FULL SCALE COKING INVESTIGATION OF NATAL COALS POSSIBLY REQUIRED BY AMCOR FOR COKING.

BY:

DR. C.C.LA GRANGE.

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According to published reports a battery of 57 coke ovens is to be erected soon for African Metals Corporation Ltd. (Amcor) at Newcastle, Natal. Such a battery would require at least about half a million tons of coking coal per annum to keep it going and possible sources of coal supplies have, therefore, had to be considered.

From the point of view of minimizing transportation costs the coal should preferably come from Natal coalfields, but existing production of coking coal at operating Natal collieries is completely absorbed by existing carbonization plants and extra supplies could therefore only be provided by opening up new supply sources, or by increasing the output at the collieries supplying coking coal at present. The investigation undertaken was mainly concerned with the latter possibility.

There are at the moment only five collieries producing straight coking coal in the country and they are all situate in Natal. They are:

Durban Navigation Colliery (D.N.C.),
Vryheid Coronation,
Hlobane,
Enyati and
Northfield.

As a result of preliminary negotiations between Amcor and the Natal Navigation Collieries and Estate Co. Ltd., owners of Hlobane and Northfield Collieries, production of coking coal at these two collieries will probably be stepped up in order to provide the coking coal required*, with the

possibility .../

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*See Report and Accounts of the Company for the year ended 30th June, 1962.

possibility of some coking coal also being obtained from Enyati Colliery.

The question, however, arose firstly, whether it would be possible to blend these coals in relatively widely varying proportions and secondly, whether varying amounts of inert substances such as finely crushed anthracite or coke breeze could be incorporated with advantage.

When the Institute was first approached by the Colliery Company for assistance with an evaluation of the position and the possibilities of increasing coking coal production, the Company was advised that the most positive and reliable results are to be expected from full scale trials. On enquiring from Iscor whether the Corporation would coöperate by making available its coal handling and blending facilities and coke ovens, the answer was in the affirmative.

It was realized that at present Hlobane and Northfield coking coals were produced from relatively small sizes ($-\frac{3}{8}$") naturally arising at these collieries. It is known that the best coking coal is usually relatively friable, and thus concentrated in the smaller size fractions. If coking coal production is to be stepped up at these two collieries without appreciably increasing total production, larger sizes will also have to be included and the characteristics of products may become different from what they are now. For example, in order to counteract weaker coking properties in larger size fractions it may be necessary to wash at lower specific gravities. Thereby the ash contents of products may become lower than they are now.

In order to obtain a more accurate indication of what the position would be after stepping up production of coking coal, it would be necessary to take into consideration not only these factors but also such matters as reserves in the various properties and seams, and rate of production from various localities. This may be done at a later stage.

For ..../

For the present, and to get the investigation going, it was decided to work on products as produced by the various collieries in, say, August 1962.

RESULTS OF INVESTIGATION.

Table 1 contains data on the characteristics of the various cokes made in the full scale trials while details of blends, of carbonising conditions and of components used in blends appear in Tables 2 and 3.

All the coals used in the tests (excluding Indumeni coal) had been washed at the collieries concerned. The Northfield and Navigation (S.A.C.E.) coals were simply drawn from Iscor's regular stocks. The two anthracite products were washed pearls, 5 - 12 mm in size. The coke breeze was taken from Iscor's supplies. These 'inert' components (anthracite and breeze) were specially crushed to a fine state in a rod mill at Iscor before incorporation in blends.

The Indumeni coal had originated from the so-called 'coking area' in Indumeni Colliery. The coal was washed at a specific gravity of 1.44 (and $-\frac{1}{2}$ mm material froth flotated) at the Institute's pilot plant washery before despatching to Iscor for coking trials. This coal had originally been obtained for another investigation which had preceded the Amcor tests. At the conclusion of the other investigation, and when the Amcor tests were due to start, it happened that a small tonnage of Indumeni coal had been left over. In spite of not any of the interested parties having asked for a blending test with Hlobane coal to be done it seemed desirable, even if only in the general interest, to do such a test in view of the co-incidental availability of both coals.

It appeared (Test Is.97) that the two coals blended well, at least in the ratio applied, the resulting coke being of good quality.

Judging ..../

Judging by tests Is.101, Is. 102 and Is 107, Northfield yielded coke having the best physical characteristics, Hlobane is nearly as good, and both these are appreciably better than Enyati, in spite of the much lower ash content of this coal. The ash content of the Hlobane coal was rather high. It is possible, that with more drastic washing, Hlobane coal may yield a product in no way inferior to Northfield. It is likely that a Hlobane product having a lower swelling number than Northfield could have comparable coking qualities. Stated in another way, it seems as if Northfield coal has to have a higher swelling number than Hlobane to be of equivalent coking quality.*

As was to be expected, the three Natal coking coals Hlobane, Northfield and Enyati show good compatibility in blends and could probably be blended successfully in widely varying proportions. Coke quality will, however, probably become lower as the percentage of Enyati in the blend is increased.

Unfortunately the degree of crushing with the Elandsberg Anthracite component was not as satisfactory as with the Alpha Anthracite component (see bottom, right hand section of Table 3), and direct comparison between the relative merits of these two inert components is, therefore, rendered somewhat difficult. It is generally accepted that very fine crushing of inerts - preferably below about 30 mesh, i.e. $\frac{1}{2}$ mm is desirable if the best result is to be obtained,

At both the $7\frac{1}{2}$ and 15 per cent levels of anthracite addition (Tests Is.106 and Is.109 and Tests Is.108 and Is.110) the cokes from Tests Is.109 and Is.110 (Alpha Anthracite added) were appreciably smaller, but otherwise slightly better than the other two cokes where Elandsberg Anthracite was added. These differences may, however, be due to the finer crushing of the Alpha Anthracite. It appears quite feasible to add even up to 15 per cent of anthracite, provided it is adequately crushed. Reduction of coke ash content results from the addition of low ash anthracite.

Comparing ..._

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*The phenomenon that relatively high swelling number is not entirely satisfactory as a guide towards indicating coking behaviour has also been observed with Indumeni coal.

Comparing Tests Is.99, Is.112 and Is.111 (amounts of finely crushed coke breeze being 0, 3 and 6 per cent, respectively), the most striking difference brought about by the addition of these amounts of coke breeze is the increase in coke size and a slight but definite deterioration in resistance to abrasion of the coke. Unless a breeze with lower ash content could be obtained coke ash content would deteriorate through breeze addition.

Coking practice, like most other industrial operations, is to a large extent dictated by economic considerations. Hence, no doubt, Amcor's intention to use Natal coking coals to the extent of 100 per cent (or nearly so) for coke production.

It is, however, well known that the reserves of such coals are not unlimited, and it is even possible that weakly coking coal from the more plentiful Witbank reserves may, in time to come, have to be railed to coke ovens in Natal in order to augment the rather indispensible Natal coking coal and to make it last longer.

It is with this possibility in mind that the final test (Is.113) was undertaken. Rather severe conditions prevailed during the test. The Hlobane component (35 percent in the blend) was already more than a month old. The most weakly coking Witbank component available (Navigation, with a swelling number of only $1\frac{1}{2}$) was deliberately selected, and a high proportion (50 per cent) of this component was incorporated.

Although the coke obtained was inferior to cokes made from Hlobane or Northfield or from combinations of them, it is of usable quality, proving that this type of blending could be feasible, technically, if circumstances should demand it.

(SIGNED) C. C. LA GRANGE.

CHIEF OF DIVISION.

9th.November, 1962.
PRETORIA.

TABLE

FULL SCALE COKING TESTS IN ISC

ANALYTICAL DETAILS OF COM

Test No.	Is. 97		Is. 98		Is. 99		Is. 100	
Sample No. &	62/685		62/821		62/822		62/823	
Identification	C	D	C	D	C	D	C	D
Components*	H	Ind	H	N	H	N	H	N
Proximate Analysis % (Air-dry basis) H_2O	1.1	1.0	1.1	0.9	1.1	0.9	1.0	0.9
Ash	14.6	9.1	14.7	12.9	14.5	12.8	14.5	13.
V.M.	22.2	25.8	22.4	24.1	22.5	24.2	22.4	23.
F.C.	62.1	64.1	61.8	62.1	61.9	62.1	62.1	62.
Swelling No.	3 - 3½	8½ - 9	3	8½	3	8½	3 - 3½	8½

Test No.	Is. 106			Is. 107	Is. 108			
Sample No. &	62/866			62/867	62/898			
Identification	C	D	E	C	C	D	E	C
Components*	H	N	El	Eny	H	N	El	H
Proximate Analysis % (Air-dry basis) H_2O	1.2	1.0	1.8	1.1	1.3	1.1	2.0	1.3
Ash	13.5	12.5	9.6	10.2	13.6	12.8	9.1	13.6
V.M.	22.4	23.8	5.9	23.2	21.9	23.6	6.2	22.2
F.C.	62.9	62.7	82.7	65.5	63.2	62.5	82.7	62.9
Swelling No.	3 - 3½	8½	0	3 - 3½	2½	8½	0	3

Test No.	Is. 112			Is. 113			
Sample No. &	62/902			62/1004			
Identification	C	D	E	C	D	E	
Components*	H	N	C.B.	H	N	NAV	
Proximate Analysis % (Air-dry basis) H_2O	1.1	1.0	1.7	1.2	1.0	2.3	
Ash	14.3	12.3	18.2	13.8	12.2	12.4	
V.M.	22.2	23.8	2.4	22.6	23.7	30.6	
F.C.	62.4	62.9	77.7	62.4	63.1	54.7	
Swelling No.	3	8½	0	3	8½	1½	

Size Analysis of Inert added.

*Abbreviations used:-

See Table 2.

OR'S OVENS, Is.(AMCOR) SERIES.

PONENTS USED IN BLENDS.

	Is. 101	Is. 102	Is. 103		Is. 104		Is. 105		
	62/824	62/849	62/850		62/851		62/852		
	C	C	C	D	C	D	C	D	E
	H	N	N	Eny	H	Eny	H	N	Eny
3	1.1	1.0	1.0	1.4	1.3	1.4	1.3	1.1	1.4
5	14.5	11.9	12.2	10.4	13.6	10.4	13.5	12.6	10.4
5	22.4	24.3	23.9	22.3	22.3	22.4	22 3	2[illegible] 9	22.4
1	62.0	62.8	62.9	65.9	62.8	65.8	62.9	62.4	65.8
	3 - 3½	8½	8½	3½	3	3½	3	8½	3½ - 4

Is. 109		Is. 110			Is. 111		
62/899		62/900			62/901		
D	E	C	D	E	C	D	E
N	Al	H	N	Al	H	N	C.B.
1.1	1.7	1.3	1.1	1.7	1.2	1.1	1.1
13.2	9.9	14.3	13.0	10.2	14.2	13.0	18.3
23.5	10.2	22.2	23.6	9.9	22.3	23.6	3.0
62.2	78.2	62.2	62.3	78.2	62.3	62.3	77.6
8½	0	3 - 3½	8½	0	2½ - 3	8½	-

Test No.	Is. 106	Is. 108	Is. 109	Is. 110	Is. 111	Is. 112
Sample No. &	62/866	62/898	62/899	62/900	62/901	62/902
Identification	E	E	E	E	E	E
Component*	E1	E1	A1	A1	C.B.	C.B.
(%) +⅛"	0.3	0.7	0.0	0.0	0.0	0.0
⅛" x 1/16"	8.2	9.1	0.8	0.4	0.0	0.0
1/16" x 22m	28.3	27.9	13.3	13.7	4.7	4.3
22 x100m	48.2	50.7	57.1	62.8	58.2	53.6
-100m	15.0	11.6	28.8	23.1	37.1	42.1

TABLE 2.

FULL SCALE COKING TESTS IN ISCOR'S OV

DETAILS OF BLENDS CHARGED AND OF C

	Test No.	Is. 97	Is. 98	Is. 99	Is.100	Is.101	Is.102	Is.103	Is
	Sample No.	62/685	62/821	62/822	62/823	62/824	62/849	62/850	62
Coal Charged	Composition of Charge * %	70 H 30 Ind	50 H 50 N	65 H 35 N	80 H 20 N	100 H	100 N	60 N 40 Eny	7(3(
	Prox. Anal. % (A.D. Basis) H_2O	1.1	1.0	1.0	0.9	1.1	1.0	1.2	1
	Prox. Anal. % (A.D. Basis) Ash	12.9	13.8	13.9	14.3	14.4	11.8	11.5	1:
	Prox. Anal. % (A.D. Basis) V.M.	23.2	23.0	22.7	22.8	22.4	24.6	23.2	22
	Prox. Anal. % (A.D. Basis) F.C.	62.8	62.2	62.4	62.0	62.1	62.6	64.1	6:
	Prox. Anal. % (A.D. Basis) S	1.02	-	-	-	0.87	1.31	-	-
	Sw. No.	4½-5	4½-5	4½-5	3½	3-3½	8½	5½	3-
	Size Anal. % +⅛"	9.0	5.1	9.1	6.7	4.7	5.7	6.0	5
	Size Anal. % ⅛" x 1/16"	17.7	17.7	21.3	16.0	17.4	19.3	16.8	17
	Size Anal. % 1/16" x 22m	23.6	23.8	23.9	23.1	26.3	25.0	23.5	29
	Size Anal. % 22 x 100m	36.7	40.5	37.3	42.8	41.8	38.0	42.8	3(
	Size Anal. % -100m	13.0	12.9	8.4	11.4	9.8	12.0	10.9	11
Carbonisation Details.	Moist. as Charged %	7.8	8.0	7.3	7.4	7.6	7.1	6.7	5
	Date Charged	23/8/62	27/8/62	28/8/62	29/8/62	3/9/62	4/9/62	7/9/62	9/
	Oven No.	97	158	123	120	96	138	140	15
	Mean Temp. °C	1315	1318	1326	1319	1325	1315	1298	132
	Nett Coking Time, hrs.	17.3	15.8	16.2	15.8	15.9	14.3	15.3	15.
Estimated. Dry Basis	Total Coke Yield %	79.6	80.2	80.4	80.3	80.6	78.8	79.9	80.
Estimated. Dry Basis	Ash in Coke %	16.4	17.4	17.5	18.0	18.1	15.1	14.6	16.

* For Analytical details of Components used in Blends see Table 3

Abbreviations used:

H	-	Hlobane
Ind	-	Indumeni
N	-	Northfield
Eny	-	Enyati
El	-	Elandsberg Anthracite
Al	-	Alpha Anthracite
C.B.	-	Coke Breeze
NAV	-	Navigation (S.A.C.E.)

ENS - Is. - (AMCOR) SERIES.

ARBONISING CONDITIONS.

.104	Is.105	Is.106	Is.107	Is.108	Is.109	Is.110	Is.111	Is.112	Is.113
/851	62/852	62/866	62/867	62/898	62/899	62/900	62/901	62/902	62/1004
H Eny	50 H 30 N 20 Eny	27½ N 7½ El 65 H	100 Eny	60 H 25 N 15 El	65 H 27½ N 7½ Al	60 H 25 N 15 Al	61 H 33 N 6 C.B.	63 H 34 N 3 C.B.	35 H 50 NAV 15 N
.3	1.2	1.2	1.2	1.5	1.2	1.3	1.2	1.1	1.7
.0	12.8	13.1	10.4	12.8	13.3	13.2	14.0	13.9	12.9
.3	22.6	21.7	22.9	19.3	22.0	21.1	21.4	22.4	26.9
.4	63.4	64.0	65.5	66.4	63.5	64.4	63.4	62.6	58.5
	-	-	0.92	-	-	-	-	-	-
3½	4½-5	3½-4	3-3½	1½-2	3-3½	3½	4-4½	4-4½	3
.4	7.2	6.8	4.6	6.7	8.4	5.0	6.2	3.2	20.5
.3	16.9	18.9	13.7	17.1	17.5	13.7	15.6	14.9	21.8
.3	24.3	26.0	27.2	25.5	22.5	22.9	23.2	24.5	21.3
.5	38.3	38.0	43.0	39.5	41.4	42.2	41.8	40.5	27.9
.5	13.3	10.3	11.5	11.2	10.2	16.2	13.2	16.9	8.5
.3	5.9	6.2	5.5	5.4	4.8	5.4	6.5	5.3	7.4
9/62	10/9/62	11/9/62	13/9/62	17/9/62	18/9/62	19/9/62	21/9/62	24/9/62	1/10/62
7	92	107	99	142	147	132	137	117	143
0	1324	1313	1318	1324	1335	1318	1281	1320	1288
1	15.3	14.5	14.6	15.4	15.5	15.6	15.5	15.2	15.3
7	80.4	81.2	80.2	83.2	81.0	81.7	81.5	30.6	78.5
3	16.1	16.3	12.8	15.6	16.6	16.4	17.4	17.4	16.7

TABLE 1.

PHYSICAL CHARACTERISTICS OF COKES MADE IN FULL S

Test No.	Is.97	Is.98	Is.99	Is.100	Is.101	Is.102	Is.103	Is.104
Composition of Charge (%) *	70 H 30 Ind	50 H 50 N	65 H 35 N	80 H 20 N	100 H	100 N	60 N 40 Eny.	70 H 30 Eny
Size Analysis % Retained on (sq.holes) 4"	19	21	12	22	20	13	15	18
3"	50	49	45	51	48	39	47	50
2"	85	84	82	83	81	77	81	83
1"	97	97	96	95	95	96	96	96
½"	97	97	97	97	96	97	97	97
Mean Size, in.	3.05	3.13	2.88	3.08	2.98	2.80	2.93	3.01
B.S.Shatter Index 2"	71	72	68	72	70	69	69	69
1½"	90	89	88	89	88	89	88	87
½"	97.7	98.1	98.0	97.9	97.7	98.1	98.1	97.8
B.S.Abrasion Index	77	80	78	78	78	80	80	78
S.A.S.S.Value **	39	40	41	39	39	42	37	36

*Abbreviations used:
- Ind - Indumeni coal, washed.
- H - Hlobane
- N - Northfield
- El - Elandsberg Anthracite
- Al - Alpha Anthracite
- C.B. - Coke breeze
- NAV - Navigation (S.A.C.E.)
- Eny - Enyati

**Index of combined resistance to shatter and abrasion.

CALE COKE OVEN TRIALS.

Is.105	Is.106	Is.107	Is.108	Is.109	Is.110	Is.111	Is.112	Is.113
50 H 30 N 20 Eny	65 H 27½ N 7½ El	100 Eny	60 H 25 N 15 El	65 H 27½ N 7½ Al	60 H 25 N 15 Al	61 H 33 N 6 C.B.	63 H 34 N 3 C.B.	35 H 50NAV 15 N
17 47 84 95 96	25 56 81 96 97	22 60 85 96 97	33 60 84 95 96	16 48 83 95 96	18 47 79 95 96	40 70 89 96 97	25 55 83 93 97	36 65 88 97 97
2.98	3.17	3.18	3.33	2.95	2.92	3.56	3.16	3.41
71 89 97.6	70 88 97.7	73 88 97.4	75 87 97.6	67 85 97.7	70 87 97.6	84 93 97.8	78 90 97.7	78 91 97.1
80	79	71	73	80	76	76	77	70
39	36	33	32	37	36	43	40	34