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# FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

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## BRANDSTOF-NAVORSINGS-INSTITUUT VAN SUID-AFRIKA.

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SUBJECT :  
ONDERWERP: WEATHERING TESTS ON COKING COALS.

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DIVISION :  
AFDELING: CHEMISTRY.

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FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

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WEATHERING TESTS ON COKING COALS.

INTRODUCTION:

In August 1939 samples of raw nut coal were obtained from three collieries from the Klip River coalfield and two collieries from the Vryheid coalfield, Natal, and from the No.2 Seam and the No. 5 seam from one colliery in the Witbank coalfield, Transvaal. The object of the investigation was to study the effect of weathering by exposure to the open air on the coking and chemical properties of the coal. The investigation was hampered and finally stopped by the pressure of wartime research. Consequently it was neither sufficiently comprehensive nor carried out for a sufficiently long period to answer all the questions requiring investigation.

TREATMENT OF COAL SAMPLES:

The nut coal samples were crushed to  $\frac{1}{4}$ " in size with the minimum production of fines and the  $\frac{1}{4}$ " +  $\frac{1}{16}$ " fraction screened out and used in the tests. About 35 pounds of each sample was placed in a lead-lined tray 2 ft. x 2 ft. x 3 ins. high, and a sample consisting of 16 increments of 50 gms. each was taken from each tray. The samples in the trays were placed on the roof of the Administration building of the Institute on the 17th of August. In the sketch at the end of the report the lay-out of the samples is given. The east, north, and west walls of the building form a parapet about 2 ft. high, from which the roof slopes down towards the centre of the south wall, the parapet at the points x being 10 ft. high. The pitch of the roof is about 15°.

The samples tested were as follows:-

P1 No. 2 Seam, Navigation Colliery, Witbank.

P2/.....

- P2 No. 5 Seam, Navigation Colliery, Witbank.
- P8 Natal Navigation (Northfield) Colliery, Klip River.
- P9 Merthyr Colliery, Klip River.
- P10 Durban Navigation No.1 Colliery, Klip River.
- P11 New Tendega Colliery, Vryheid.
- P12 Vryheid Coronation Colliery, Vryheid.

The trays were removed from the roof on the 11th December 1939, and samples of 16 increments of 50 gms. each again taken, the trays being replaced on the 19th December. The trays were again removed from the roof on 10.1.41, sampled and subsequently replaced. Up to this time periodical inspections of the coal on the roof were made, but the author subsequently went on military service, the investigation ceasing at this time.

OBSERVATIONS ON THE APPEARANCE  
OF THE COAL SAMPLES:

In general, not many marked changes in the samples were observed, but the following points may be noted:

- 22.8.39 Sample P10 shows marked weathering of inorganic constituents (sulphate formation.)
- 2.9.39 All samples show brown discoloration on sides of lead linings.
- 8.9.39 Sample P10 has two areas of agglomeration of several particles with brown coloration in centre.
- 20.9.39. Sample P10. The sulphate formed in the agglomerations has been leached out. Visible impurities in all samples are more easily distinguishable.
- 25.9.39. Sample P10 shows slight traces of sulphate.
- 6.10.39. Sample P10 shows marked brown staining of pyrites oxidation. Sample P11 has white sandstone particles visible.

11.12.39/....

11.12.39. On removal of samples from roof, samples P1, P2, P9 and P10 show white sulphate deposit at lower end of trays and along the lead sides at the water level.

1.3.40. Sample P2 has a fair quantity of white sulphate deposit. Sample P9 has a very heavy white to yellow sulphate deposit causing slight sintering of the surface. Sample P11 shows incipient disintegration of sandstone. Sample P8 shows slight evidence of pyrites oxidation with a small amount of visible sulphate.

19.10.40. Sample P1 has a dull greyish black appearance. Sample P2 has a dull surface which is bright when scratched. Sample P8 has a finely disseminated sulphate deposit, and some sandstone visible. Sample P9 retains its original bright appearance. Sample P10 has a finely disseminated sulphate deposit and dark brown iron staining. Sample P11 has a brighter appearance than P1 or P12, the sandstone being stained dark brown. Sample P12 has a general greyish black appearance.

ANALYSIS OF SUB-SAMPLES:

The samples of approximately 800 gms. taken at the beginning of the investigation and after 4 and 17 months were subjected to the following analyses:-

- (1) Proximate analysis, calorific value and swelling number.
- (2) Ultimate analysis.
- (3) Forms of sulphur.

(4) Low Temperature Gray King Carbonisation Assays.

(5) Sheffield Coking Tests.

The results of these analyses are given in Tables 1 to 5 at the end of the report. In addition the amounts of undersize at  $\frac{1}{16}$  " were determined. The results were as follows:-

Sample No.:	P1	P2	P8	P9	P10	P11	P12
% minus $\frac{1}{16}$ " (4 months)	3.2	3.9	2.7	2.9	2.6	2.9	2.7
" " " (17 " )	4.3	7.9	9.5	9.4	6.3	5.2	3.2

The 4 months samples show only minor differences, the Transvaal coals having slightly more undersize than the Natal coals. The 17 months samples show considerable differences, samples P12 and P1 increasing only slightly, and samples P8 and P9 by nearly 7.0%, in undersize. Obviously other factors are much more important than rank in determining the extent of disintegration of the samples. There is an approximate correspondence between the original amount of pyritic sulphur and the total disintegration after 17 months, indicating the probable importance of the disruptive effect of the oxidation of pyrites.

#### DISCUSSION ON ANALYTICAL RESULTS:

##### (1) Proximate Analysis etc. (Table 1).

Unfortunately the data on the calorific values of samples P1 and P2 are not available, otherwise the table is complete.

(a) Moisture: There is a general tendency for a slight increase in moisture content with time, as would be expected, although two of the 4 months samples showed a slight decrease and two were unchanged. As the moisture determinations are dependent on the relative humidity of the ambient air at the time of analysis, such anomalies may well be expected.

(b) Ash: The accuracy of the sub-samples affects this value, but the samples taken appear to have been

adequate, /.....

adequate, almost all the changes in ash content observed showing a regular tendency. Sample P11 shows no change in ash content, but all the rest have a steadily decreasing ash content, anomalies in the 4 months samples occurring with samples P1 and P12. These anomalies must be ascribed to sampling errors. The extent of the decrease in ash content varies between the samples, and there is a close correspondence between the loss of ash and the loss of pyritic sulphur (see Table 3). The overall loss in ash for all the samples is slightly more than the theoretical amount of  $\text{Fe}_2\text{O}_3$  associated with the sulphur lost. It is unlikely that all this iron was leached out by rain and it seems that carbonates of the alkaline earths must also have been attacked and leached out of the samples. It is unfortunate from this aspect, and also from others which will appear later, that no determinations of carbon dioxide were done on the samples.

- (c) Volatile Matter: There is a steady decrease in volatile matter with time, the average drop being 1.0% in the first 4 months, and 1.5% in the following 13 months, on the dry ash-free basis. The relatively greater decrease in volatile matter in the first 4 months of sample P10 is possibly due to analytical error. The lack of  $\text{CO}_2$  determinations prevents the correction of the volatile matter for any variations in  $\text{CO}_2$ .
- (d) Fixed Carbon: This figure increases fairly rapidly with time of exposure of the samples, due to the decrease in volatile matter and ash (where the latter occurs) more than counterbalancing the slight increase in moisture content.
- (e) Calorific Value: The calorific value tends to decrease with time. This effect is to a certain extent masked

by/.....

by the simultaneous decrease in ash content in most cases. For this reason the dry ash-free values give a better comparison. No values are available for the Transvaal samples P1 and P2, but the rest show an average drop of slightly more than 0.2 lbs./lb. in each of the periods of exposure. The slightly anomalous effect with sample P11 may be due to faulty analyses. The decrease in the calorific value of individual samples does not vary systematically with rank.

- (f) Swelling Number:<sup>¶</sup> There is a decrease in swelling number with time, except in the case of sample P12 where no variation occurred. Some of the samples had very low swelling numbers originally, and after 17 months all samples excluding P12 gave friable coke residues. Due to the low values no conclusions as to the rate of decrease of swelling number with time can be drawn, as the range of coking powers covered by values of l and F is great and indefinite. It does appear, however, that the decrease is greater in the second period of 13 months than in the initial 4 months.

(2) Ultimate Analysis (Table 2):

Due to the sometimes large differences in ash content, no conclusions can well be drawn on the determined results. The results given in Table 2 are thus expressed on the dry, mineral matter free basis using the following formula for mineral matter:-

Mineral/.....

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¶ The nonswelling coke buttons are designated l, F, and P, corresponding to a well fused coke, a friable coke and a noncoherent residue respectively.

$$\text{Mineral Matter \%} = (A - \frac{1}{4}S) \times 1.08 + 1\frac{7}{8}S.$$

where S = pyritic sulphur %.

A = ash % as determined in the carbon and hydrogen determination.

This value for ash varies slightly from the proximate ash, the average difference being 0.15% and the average bias 0.05%, the ultimate ash being higher.

This value of the mineral matter is not corrected for CO<sub>2</sub>, and the assumed 8% of water of constitution of the bulk of the mineral matter is probably incorrect in some cases at least, due to the presence of varying amounts of arenaceous material. The latter factor will affect the absolute values, but will have only a very small influence on the relative values for each coal. The high ash content of the majority of the samples increases the analytical errors considerably when converting the results to the dry, mineral matter free basis.

(a) Carbon: Although the accuracy of the determination does not warrant expressing the results to the second place of decimals, this has been done because the second place is of significance in the other determined constituents. A notable and peculiar feature of the results is the increase in carbon content in all but one of the coals tested in the first four months, the average increase being 0.25%. The carbon content then decreases by an average of 1.0% in the following thirteen months, sample P12 being exceptional in that the decrease in carbon content is much lower than the average, sample P8 on the other hand having an exceptionally high decrease.

(b) Hydrogen: In general very little variation is exhibited. In the four samples where large variations occur, they are contradictory and can probably be ascribed in part at least to analytical errors. The

average/.....



average of all samples shows an increase in hydrogen content of 0.02% in the first four months, with an equal decrease in the following thirteen months.

- (c) Nitrogen: Although some individual variations occur, generally the original and final determinations are very similar, with the four months sample slightly lower (average difference 0.07%). This may be a consequence of weathering but is more likely to be due to analytical error. (The most likely source of error is in the standardisation of the acid used for the titration of the ammonia formed in the Kjeldahl digestion).
- (d) Sulphur: The organic sulphur is determined by the difference between total sulphur and pyritic plus sulphate sulphur, and is thus liable to greater errors than those forms directly determined. Generally there is no systematic variation in the figures, the average original and final results being the same. The four months samples are 0.06% higher on the average, but this is due to high values in samples P2 and P9, which are probably in error.
- (e) Oxygen: This is a difference figure and, due to the fact that such differences as occur in hydrogen, nitrogen and sulphur tend to cancel one another, is complementary to the carbon content. Thus there is an average initial fall of 0.26% in the first four months with a subsequent average rise of 1.02% in the following thirteen months.

(3) Forms of Sulphur (Table 3).

- (a) Total Sulphur: The total sulphur decreases with time, in some cases the decrease in the two periods being fairly similar, while samples P2, P8 and P9 have considerably larger decreases in the second period. These latter/.....

latter include the two samples with the highest sulphur contents. The explanation of the differences is implicit in the variation shown by the constituent forms of sulphur. Of these the organic sulphur has already been discussed under ultimate analysis. It may be remarked here that none of the samples shows very high or very low organic sulphur.

(b) Sulphate Sulphur: The sulphate sulphur is generally very low initially, but sample P10 is an exception with 0.15% sulphate sulphur. The rate of increase is fairly constant for the two periods, and generally is about 0.1% after 17 months. In the case of sample P9, however, the increase is much larger, and both P9 and P10 have large final sulphate sulphur contents. In the case of sample P8 the sulphate sulphur shows a reversal in the final period. This must be ascribed to leaching of the sulphate formed, and in fact the major part of the sulphate formed in all samples must have been leached out by rain.

(c) Pyritic Sulphur: The decrease in pyritic sulphur is approximately proportional to the amount of pyrites originally present in the samples, about 40% of the total decrease occurring in the first four months. The loss of pyritic sulphur is slightly greater than that of total sulphur, due to the simultaneous increase of sulphate sulphur. The decrease in pyritic sulphur over the full 17 months averaged 41.5%, varying from 33.3% to 50.0%. The samples that were high in pyritic sulphur showed the largest proportional decreases.

(4) Low Temperature Gray King Carbonisation Assays (Table 4).

Results of the assay of the original sample of P9 are not available, except for the residual volatile matter in  
the/.....

the coke. In no cases are the descriptions of the cokes available. On the basis of the available data the following conclusions may be drawn.

The coke yield shows a considerable drop (average 1.3%) in the first four months and a subsequent rise (average 1.0%) to nearly the original figure. The tar figures are not very consistent but show an average decrease of 0.5% and 0.3% in the first and second periods. The liquor figures are fairly consistent with an average increase of 0.55% in the first four months and no subsequent change. The gas yields all show the same tendency, namely an average increase of 0.55% in the first four months, and a subsequent return to the original values. The relative density of the gas tends to decrease slightly in the first four months, and subsequently regain its original value. The volatile matter in the coke was not determined for the final samples, but the four months samples had considerably less volatile matter (average decrease 1.6%) than the original samples, corresponding fairly closely to the decrease in the coke yields. It is possible that the temperature of carbonisation of the four months samples was too high.

(5) Sheffield Coking Tests (Table 5):

It was intended to conduct these tests on the samples as taken, but no expansion of the charge occurred. Floats at a specific gravity of 1.45 on samples P1 and P2 also gave no expansion, so that the experiments in general were carried out on floats at a specific gravity of 1.40. Sample P8, however, gave no expansion of floats at S.G. 1.40 or S.G. 1.35, and the float at S.G. 1.30 was used for this sample. In the Sheffield coking test 6 gm. of coal are heated in a 1.6 cm. tube under 100 gms. load at 1°C per minute and the temperatures of initial contraction, initial expansion and final/.....

final expansion are recorded, together with the amount of contraction and expansion, expressed as a percentage of the original volume.

The results of the tests in general are not susceptible to comparative evaluation due to the fact that only two samples gave any expansion after four months exposure, and of these sample P1 expanded only 1%, and sample P12, which was the only sample tested after seventeen months, also had 1% expansion at this time. The initial contraction temperatures in general varied by 4°C or less, which is probably within the experimental error, only samples P11 and P8 with increases of 7°C and 20°C respectively after four months being outside these limits. Where samples gave an expansion after exposure, the initial expansion temperature increased with time of exposure. Where no expansion occurred the final contraction temperature was either approximately equal to or in excess of the final expansion temperature of the original samples. The final expansion temperature of sample P1 showed a slight increase after four months, while sample P12 showed almost no change in this value even after seventeen months. The percentage contraction increased by 5% for the Transvaal samples after four months, while the Natal samples showed a tendency for the percentage contraction to decrease. The samples had originally expansions of from 8% to 51%, and as mentioned previously only two samples retained any expansion after four months, namely sample P1 which decreased by 24% to a value of 1% and sample P12 which decreased by 8% to a value of 30%. This latter sample decreased by 29% in the subsequent thirteen months.

As a matter of general interest the results of the preliminary Sheffield coking tests on samples showing no expansion are given in the following table:-

Sample/.....

<u>Sample.</u>	<u>P1.</u>	<u>P1</u> <u>F1.1.45.</u>	<u>P2.</u>	<u>P2.</u> <u>F1.1.45.</u>	<u>P8.</u>	<u>P8.</u> <u>F1.1.4.</u>	<u>P8.</u> <u>F1.1.35.</u>	<u>P9.</u>
I.C.T. °C	393	387	381	385	428	413	410	391
F.C.T. °C	441	430	447	430	+481	479	477	+466
Contraction %.	10	10	16	16	4	14	16	19

These results show that there is some correspondence between the loss in coking properties with time and the loss due to the inclusion of heavy non-coking material in the original samples.

Swelling numbers were determined on the samples used in Table 5. A considerable decrease in swelling number with time is evinced by all samples except P12 where the effect was very slight. The decrease in the two periods was not consistent, but in general the decrease was slightly less in the first four months than in the subsequent thirteen months. The results clearly show that there is no close correspondence between swelling number and expansion in the Sheffield coking test for the samples tested.

SUMMARY AND CONCLUSIONS:

Run-of-mine nut coal samples from two Witbank coal seams and five Natal collieries were crushed to  $\frac{1}{4}$ " and the +  $\frac{1}{16}$ " fraction exposed to open-air atmospheric weathering. Samples were taken initially, and after 4 and 17 months exposure, and subjected to various analytical procedures. The effects of exposure in general were as follows:-

The moisture content increased slightly with time of exposure. The ash content of most samples decreased due to loss of iron and possibly alkaline earths as sulphate, the decrease being roughly proportional to the amount of pyritic sulphur originally present in the samples. Volatile matter decreased by about 2 %, and fixed carbon increased rather more on the average due to the decrease in ash content. Calorific values decreased

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by 0.3 to 0.6 lbs./lb. on the dry ash-free basis.

The ultimate analysis(dry, mineral-matter free basis) showed an average increase of 0.25% in carbon in the first four months, and a subsequent fall of 1.0%. The variation in oxygen was complementary, as hydrogen, nitrogen and sulphur (organic) showed no significant changes.

Total sulphur and pyritic sulphur show large decreases, with about a third of the total change in the first four months. The amount of the decrease is roughly proportional to the amount of sulphur present, being about 30% for total sulphur and 42% for mineral sulphur over the seventeen months of the tests. Sulphate sulphur was low initially, and generally increased by about 0.1%. The small increase compared with the loss of pyritic sulphur must be ascribed to the leaching out of sulphates by rain.

The low temperature carbonisation assays showed a preliminary average decrease of 1.3% in coke followed by a subsequent rise of 1.0%. Tar decreased by 0.8% overall, and liquor increased by 0.5% in the first four months subsequently remaining constant. The gas yield showed a preliminary increase of 0.5% with a subsequent return to the original yield, the relative density of the gas showing similar trends. The residual volatile matter in the coke was not determined on the final samples, but decreased by 1.6% in the first four months. The anomalies in the results may be due to the temperature of carbonisation being too high for the four months samples.

The Sheffield coking tests, although done on samples floated at S.G. 1.40, nearly all showed a complete loss of expansion after four months. Where some expansion was retained the initial expansion temperature showed an increase. The initial contraction temperature was reasonably constant except in two cases where a definite increase occurred. The percentage contraction varied from an increase of 5% (on the Transvaal samples)

to/.....

to a decrease of 4%.

Swelling numbers were determined on the whole coal samples and the floats used for the Sheffield coking tests and both showed fairly rapid decreases, the decrease being rather greater in the second period. The actual decrease was greater with the float samples. The highest rank coal showed comparatively very small changes in coking properties and also showed the smallest change in ultimate analysis and size degradation. In general there is possibly a slight tendency for the lower rank coals to be more affected by weathering, but so many anomalies occur that no definite conclusion in this respect can be drawn.

Although much valuable information was obtained from the tests carried out, it is felt that further information on the weathering of coking coals in South Africa could be obtained. It is suggested that, if further tests along similar lines are to be carried in the future, as wide a selection of coals as possible be obtained to ascertain more clearly the interdependence of weathering and rank, and that the samples be floated at a low specific gravity before exposure. This will have the effect of enhancing the coking properties of the coals and facilitating accurate sampling, as well as minimising the errors of converting determined values to the "pure coal" basis.

ACKNOWLEDGEMENT.

The author wishes to acknowledge his indebtedness to Dr. P.E. Hall, whilom Deputy Director of the Institute, under whose direction the investigation was carried out.

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

P R E T O R I A.

29th May, 1951.

TABLE 1.  
PROXIMATE ANALYSIS ETC.

Sample Number.	Exposure Months.	Air Dry Basis.						Dry Ash-Free Basis	
		H <sub>2</sub> O %	Ash %	V.M. %	F.C. %	Cal.Val. lb/lb.	Swelling Number.	V.M. %	Cal.Val. lb/lb.
P1	0	1.5	16.2	29.9	52.4	-	1	36.3	-
	4	1.7	16.3	28.9	53.1	-	1	35.2	-
	17	2.0	15.8	27.7	54.5	-	F	33.7	-
P2	0	2.1	15.8	31.9	50.2	-	1½	38.9	-
	4	1.9	15.2	31.4	51.5	-	1	37.9	-
	17	2.2	14.0	30.1	53.7	-	F	35.9	-
P8	0	1.0	25.7	18.3	55.0	11.48	1	25.0	15.66
	4	1.1	25.2	17.6	56.1	11.29	1 to F	23.9	15.32
	17	1.5	24.8	16.5	57.2	11.1	F	22.4	15.06
P9	0	0.9	18.9	22.5	57.7	12.66	5	28.1	15.79
	4	1.0	18.3	21.5	59.2	12.57	3½	26.6	15.58
	17	1.5	16.2	19.8	62.5	12.6	F	24.1	15.31
P10	0	1.6	15.6	27.9	54.9	12.59	2½	33.7	15.21
	4	1.4	14.9	26.0	57.7	12.62	1½	31.1	15.08
	17	1.8	14.5	25.4	58.3	12.5	F	30.3	14.93
P11	0	1.0	11.8	24.4	62.8	13.71	4	28.0	15.72
	4	1.0	11.7	23.2	64.1	13.70	3	26.6	15.69
	17	1.3	11.8	21.8	65.1	13.4	F	25.1	15.42
P12	0	0.9	19.8	18.8	60.5	12.63	1	23.7	15.93
	4	0.9	20.1	17.7	61.3	12.45	1	22.4	15.76
	17	1.1	19.3	16.7	62.9	12.3	1	21.0	15.45



TABLE 2.

ULTIMATE ANALYSIS. DRY, MINERAL MATTER FREE BASIS.

Sample Number.	Exposure Months.	Carbon %.	Hydrogen %.	Nitrogen %.	Sulphur <sup>‡</sup> %.	Oxygen %.	Moisture %.	Mineral Matter %.
P1	0	83.78	5.21	1.93	0.51	8.57	1.5	18.6
	4	84.46	5.06	1.86	0.39	8.23	2.1	18.5
	17	83.51	5.06	1.86	0.45	9.12	2.0	17.4
P2	0	83.42	5.30	2.04	0.33	8.91	2.1	18.6
	4	83.60	5.35	2.16	0.54	8.35	2.2	17.6
	17	82.60	5.13	2.08	0.39	9.80	2.2	15.9
P8	0	89.18	4.76	2.43	0.64	2.99	1.0	28.6
	4	89.24	4.75	2.36	0.69	2.96	1.5	27.6
	17	87.56	4.90	2.37	0.64	4.53	1.5	26.9
P9	0	87.76	5.07	2.50	0.44	4.23	0.9	22.6
	4	87.60	5.09	2.24	0.75	4.32	1.3	21.3
	17	86.56	5.06	2.51	0.49	5.38	1.5	18.9
P10	0	85.32	4.91	2.13	0.68	6.96	1.6	18.0
	4	85.82	4.98	2.07	0.71	6.42	1.8	16.6
	17	84.60	4.92	2.20	0.77	7.51	1.8	16.3
P11	0	87.60	4.94	2.42	0.54	4.50	1.0	13.1
	4	87.78	5.03	2.34	0.52	4.33	1.1	12.9
	17	86.88	5.01	2.41	0.51	5.19	1.3	12.9
P12	0	90.05	4.44	2.13	0.34	3.04	0.9	21.7
	4	90.35	4.56	2.10	0.30	2.69	1.1	21.9
	17	90.12	4.53	2.15	0.27	2.93	1.1	21.6

<sup>‡</sup> Organic sulphur.

TABLE 3.  
FORMS OF SULPHUR.

Sample Number.	Exposure Months.	Total Sulphur %.	Organic Sulphur %.	Sulphate Sulphur %.	Pyritic Sulphur %.
P1	0	1.63	0.41	0.01	1.21
	4	1.41	0.31	0.05	1.05
	17	1.16	0.36	0.09	0.71
P2	0	3.03	0.26	0.03	2.74
	4	2.70	0.43	0.08	2.19
	17	1.80	0.32	0.11	1.37
P8	0	1.81	0.45	0.01	1.35
	4	1.64	0.49	0.06	1.09
	17	1.33	0.46	0.02	0.85
P9	0	4.41	0.34	0.02	4.05
	4	3.98	0.58	0.13	3.27
	17	2.89	0.39	0.32	2.18
P10	0	2.28	0.55	0.15	1.58
	4	1.98	0.58	0.16	1.24
	17	1.70	0.63	0.27	0.80
P11	0	0.95	0.46	0.01	0.48
	4	0.89	0.45	0.03	0.41
	17	0.81	0.44	0.07	0.30
P12	0	0.81	0.26	0.01	0.54
	4	0.73	0.23	0.03	0.47
	17	0.65	0.21	0.08	0.36

TABLE 4/.....

TABLE 4.

LOW TEMPERATURE GRAY KING CARBONISATION ASSAYS.

Sample Number.	Exposure Months.	Coke %.	Tar %.	Liquor %.	Gas %.	R.D. of Gas (Air = 1)	Vol. Matter in Coke.
P1	0	76.3	10.2	6.8	6.9	0.68	5.8
	4	74.5	10.0	7.5	7.8	0.65	4.0
	17	76.1	9.1	7.6	7.4	0.67	-
P2	0	73.1	11.8	7.2	7.8	0.69	5.1
	4	72.1	10.5	8.4	8.9	0.67	3.3
	17	72.6	11.2	8.0	8.0	0.65	-
P8	0	85.5	5.3	3.7	5.9	0.60	4.3
	4	84.6	4.2	5.1	6.5	0.56	2.7
	17	85.2	4.4	5.0	6.2	0.59	-
P9	0	-	-	-	-	-	4.4
	4	81.0	5.5	5.1	8.2	0.61	3.0
	17	81.5	5.6	5.2	7.7	0.61	-
P10	0	77.9	8.4	5.5	8.0	0.66	5.4
	4	76.2	8.9	7.1	7.9	0.64	4.1
	17	77.0	7.9	7.8	7.6	0.64	-
P11	0	80.7	7.9	4.1	7.9	0.59	5.4
	4	79.3	7.3	5.2	8.5	0.58	3.0
	17	81.0	6.4	5.6	7.5	0.61	-
P12	0	86.0	5.8	2.6	6.1	0.54	3.9
	4	84.8	5.1	4.2	6.3	0.54	2.5
	17	85.9	5.4	3.5	5.8	0.55	-

TABLE 5/.....

TABLE 5.

SHEFFIELD COKING TESTS (ON FLOATS AT S.G.1.40<sup>H</sup>)

Sample Number.	Exposure Months.	I.C.T. °C.	I.E.T. <sup>HK</sup> °C.	F.E.T. °C.	Contraction %.	Expansion %.	Swelling Number.
P1	0	375	411	424	21	25	4 to 4½
	4	371	421	430	26	1	2½
	17	-	-	-	-	-	1
P2	0	373	421	430	25	14	4½
	4	375	450	-	30	0	3
	17	-	-	-	-	-	1
P8	0	390	452	478	18	8	8½ to 9
	4	410	475	-	19	0	5
	17	-	-	-	-	-	3½
P9	0	391	439	470	25	51	over 9
	4	395	482	-	21	0	6½ to 7
	17	-	-	-	-	-	2
P10	0	379	420	438	17	15	6½
	4	376	430	-	15	0	5½
	17	-	-	-	-	-	2½
P11	0	390	444	460	20	3	7½ to 8
	4	397	475	-	17	0	4½ to 5
	17	-	-	-	-	-	1
P12	0	373	428	467	17	38	4½ to 5
	4	372	434	468	18	30	5
	17	373	454	470	15	1	4

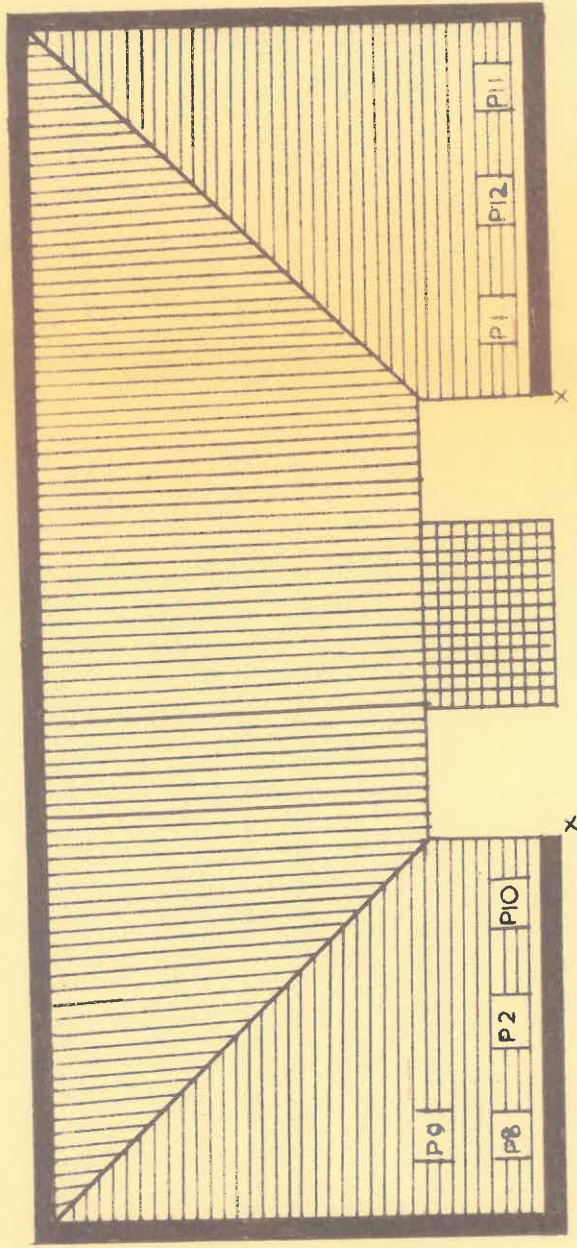
<sup>H</sup> Sample P8 was floated at S.G.1.30.

<sup>HK</sup> This refers to final contraction temperature in cases where no expansion occurred.

I.C.T. is the Initial Contraction Temperature.

I.E.T. is the Initial Expansion Temperature.

F.E.T. is the Final Expansion Temperature.



LOCATION OF SAMPLES ON ROOF OF ADMINISTRATION BUILDING.

