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FUEL RESEARCH INSTITUTE

OF SOUTH AFRICA

TEGNIESE / TECHNICAL MEMORANDUM NO. 48 OF 1972

THE EXPOSURE OF A WITBANK NO. 5 SEAM BLEND COKING COAL TO THE ATMOSPHERE AT AMBIENT TEMPERATURES AND THE INFLUENCE OF THE SUBSEQUENT OXIDATION ON THE REFLECTANCE OF THE VITRINITES AND ON THE SWELLING PROPERTIES

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THE EXPOSURE OF A WITBANK NO. 5 SEAM BLEND COKING COAL TO THE ATMOSPHERE AT AMBIENT TEMPERATURES AND THE INFLUENCE OF THE SUBSEQUENT OXIDATION ON THE REFLECTANCE OF THE VITRINITES AND ON THE SWELLING PROPERTIES.

INTRODUCTION:

The influence of severe oxidation on bright coal particles (vitrinite) by the application of heat in the presence of oxygen is fairly well known. Vitrinite particles subjected to such treatment are invariably characterised by the so-called oxidation zones. When viewed under the microscope in reflected light the zones appear as high reflectance bands on the perimeters of the grains. However, little is known about the influence of mild oxidation over longer periods on the reflectance of the vitrinites. It is also a well established fact that coking coals, especially those belonging to the lower rank high volatile group, lose their swelling properties fairly rapidly through oxidation when exposed to the atmosphere for some time.

In this study an attempt was made to establish the connection between the deterioration of swelling properties and the increase in reflectance of the vitrinite in the coal.

A series of experiments was devised in which the deterioration of swelling properties and the increase in reflectance could be studied at specific intervals over a fairly long period.

THE CHOICE OF A COAL SAMPLE

Experience has shown that the higher rank coking coals of Natal retain their swelling properties over considerably longer periods than the lower rank blend coking coals of the Transvaal, and since it was desired to obtain results in a relatively

short......2/

short period it was decided to use No. 5 Seam blend coking coal from the Hope Section of Springbok Colliery. The coal sample from this colliery was readily available and also free from the influence of dolerites which may have influenced the reflectance of the vitrinites.

EXPERIMENTAL PROCEDURE

A truck-top sample of ca. 100 kg mass was taken at the Colliery immediately after loading and transported to Pretoria in plastic bags. The sample was then air-dried and crushed to -3/16". After dividing the sample into two equal portions, one portion was stored under water for future reference.

The other portion of the sample was spread out in flat metal trays and exposed to the atmosphere (sunshine) at ambient temperatures for fourteen weeks. A sample of 2 kg mass for study in the laboratory was cut out just prior to exposure in the trays and thereafter from the contents of the trays at 7-day intervals.

Sufficient material was removed from every week's laboratory sample for petrographical analysis and for crucible swelling tests, the rest being immediately immersed in water and stored there for study after completion of the test series. Thus every sample removed had a counterpart which was kept under water.

PRESENTATION OF RESULTS

The results obtained on the samples in the course of the investigation are contained in the tables at the end of the report.

Table 1 gives the mean maceral analysis of the fifteen samples examined.

Table 2 gives the reflectances of the vitrinites and the swelling numbers recorded each week as the work progressed, as well as those of the samples kept under water, which were only analysed after completion of the first phase of the work, i.e. after 14 weeks had elapsed.

Table 3......3/

Table 3 gives the percentage distribution of the vitrinite particles in the different reflectance classes.

Figure 1 is a graphical representation of the deterioration in swelling properties and the increase in reflectance of the vitrinites in the course of time.

DISCUSSION OF RESULTS:

The coal used in the experiment is typical of the presently used Witbank No. 5 Seam blend coking coal. The total reactive constituents amount to 72,4% and the total inerts to 27,6%, giving a ratio of reactives to inerts of roughly 3:1.

A study of the reflectance values recorded in Table 3 shows that all the values fall in only three reflectance classes, namely V6, V7 and V8, with V7 predominating in every sample examined. This very limited number of reflectance classes in which the particles fall is ample proof that the coal is completely free from the influence of dolerites. Thus any change in reflectance recorded must be due to the influence of oxidation on the reflectance and not to other factors. The gradual shift in reflectance to class V8 in the course of time is quite noticeable.

The reflectance of the vitrinite and the swelling number of the fresh coal were 0,74% and 3½ respectively. After the first week of exposure the reflectance of the vitrinites increased to 0,76% and the swelling number of the coal decreased by 1½ units to a value of 2.

Thereafter both the reflectance and the swelling number remained constant for two weeks. The following week, i.e. four weeks after the initiation of the experiments, the reflectance of the vitrinite increased to 0,78% and the swelling number decreased to a value of 1½. Thereafter the swelling number remained constant and the reflectance attained a constant value a week later.
During the following nine weeks the reflectances and swelling

numbers remained constant.

After the conclusion of the first phase of the work the tests were repeated on the samples stored under water. The values reported for the swelling numbers were identical to those of their counterparts examined in phase 1 of the investigation.

The rate of increase in reflectance of the vitrinites was identical to that of the original samples until the fourth week. Thereafter it became constant. Thus a constant value was reached a week before that reached with the original samples. (This deviation can be due to an experimental error such as the divergence in refractive index of the immersion oil resulting from a slight fluctuation in temperature during the standardization of the apparatus.)

CONCLUSIONS:

1. Oxidation of the coal, i.e. the increase in reflectance of the vitrinites, and subsequent deterioration in swelling properties appear to be critical during the first four to five weeks after exposure to the atmosphere. Thereafter it does not seem to have much influence and probably proceeds very slowly.

2. Complete immersion in water appears to be an eminently suitable method for the preservation of the coal's coking properties.

3. There appears to be a close relationship between the swelling properties and the reflectance of the vitrinites, at least for No. 5 Seam coal free from the effect of dolerite.

RECOMMENDATIONS.......5/

RECOMMENDATIONS:

The results obtained indicate that a more comprehensive study of the influence of atmospheric oxidation at ambient temperatures on the coking properties, and on a wider selection of such coals, is justified. Since swelling properties are only an indication of what can be expected from a coal, testing should be extended to dilatometer and Roga tests.

(SIGNED) B. MOODIE
PRINCIPAL RESEARCH OFFICER

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26/10/1972
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TABLE 1

MEAN MACERAL ANALYSIS OF SAMPLES EXAMINED

(Vitrinite (Vol. %)	Reactives	65,2
(Exinite (Vol. %)		7,2
Inertinite (Vol. %)	Inerts	25,1
Visible minerals (Vol. %)		2,5
Total reactives (Vol. %)		72,4
Total inerts (Vol. %)		27,6

TABLE 2

REFLECTANCES OF VITRINITE AND SWELLING NUMBERS OF SAMPLES IN RELATION TO TIME

Time (Weeks)	Original Samples		Counterparts stored under water	
	Reflectance %	Swelling number	Reflectance %	Swelling number
0	0,74	3½	0,74	3½
1	0,76	2	0,76	2
2	0,76	2	0,76	2
3	0,76	2	0,76	2
4	0,78	1½	0,78	1½
5	0,79	1½	0,78	1½
6	0,79	1½	0,78	1½
7	0,79	1½	0,78	1½
8	0,79	1½	0,78	1½
9	0,79	1½	0,78	1½
10	0,79	1½	0,78	1½
11	0,79	1½	0,78	1½
12	0,79	1½	0,78	1½
13	0,79	1½	0,78	1½
14	0,79	1½	0,78	1½

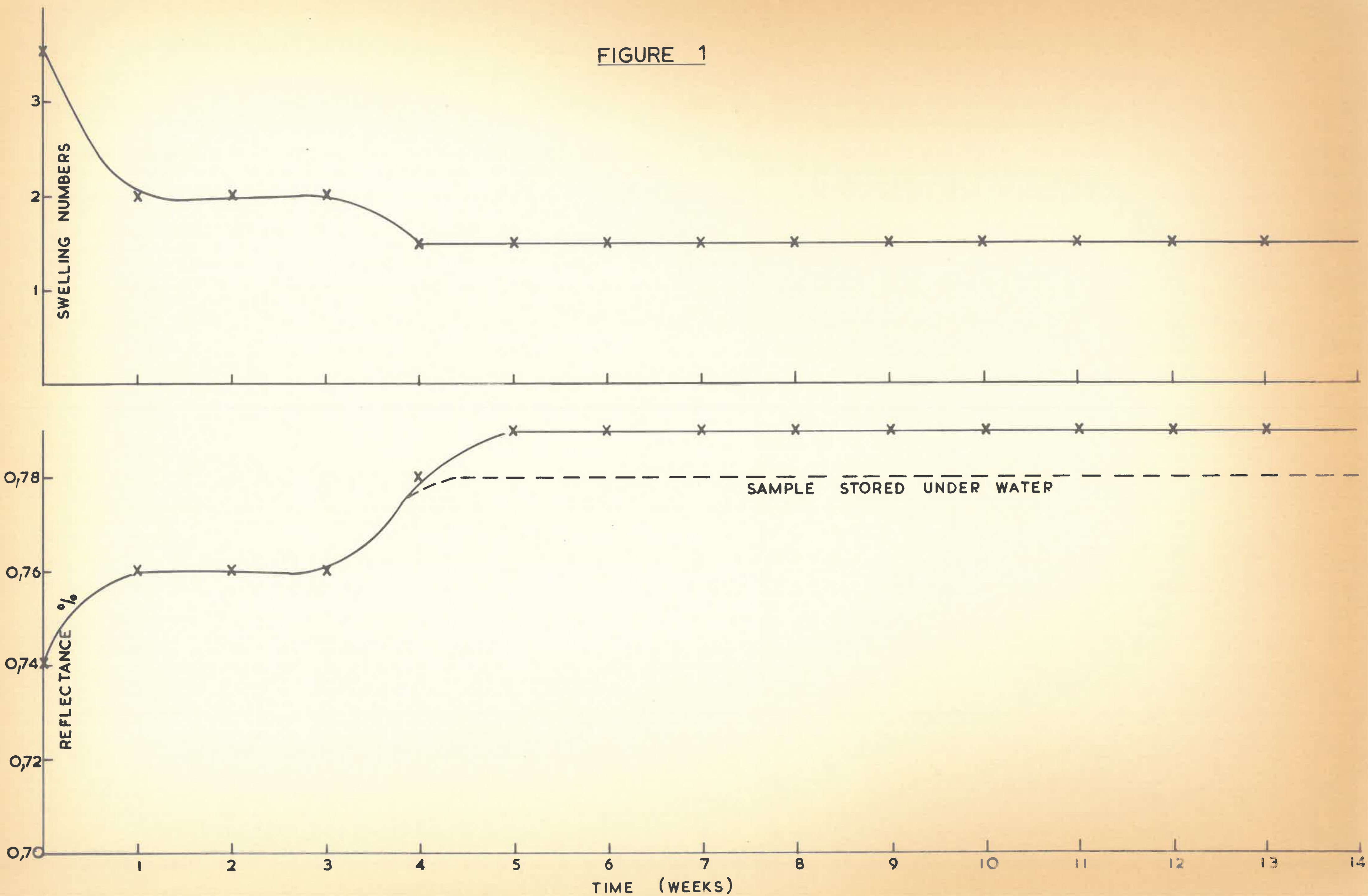
TABLE 3........7/

TABLE 3

PERCENTAGE DISTRIBUTION OF VITRINITE GRAINS IN THE DIFFERENT REFLECTANCE CLASSES

Reflectance Class	V5	V6	V7	V8	V9	V10	V11	V12
Reflectance %	0,50-0,59	0,60-0,69	0,70-0,79	0,80-0,89	0,90-0,99	1,00-1,09	1,10-1,19	1,20-1,29
Week (s)								
0	-	23	73	4	-	-	-	-
1	-	10	77	13	-	-	-	-
2	-	8	82	10	-	-	-	-
3	-	6	85	9	-	-	-	-
4	-	2	71	27	-	-	-	-
5	-	4	69	27	-	-	-	-
6	-	3	69	28	-	-	-	-
7	-	2	73	25	-	-	-	-
8	-	1	74	25	-	-	-	-
9	-	3	68	29	-	-	-	-
10	-	3	67	30	-	-	-	-
11	-	2	69	29	-	-	-	-
12	-	3	71	26	-	-	-	-
13	-	3	70	27	-	-	-	-
14	-	2	73	25	-	-	-	-

FIGURE 1


SWELLING NUMBERS
3
2
1
REFLECTANCE %
0,78
0,76
0,74
0,72
0,70
SAMPLE STORED UNDER WATER
1
2
3
4
5
6
7
8
9
10
11
12
13
14
TIME (WEEKS)