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INVESTIGATION OF THE COKING PROPERTIES OF COAL FROM NO. 4 SEAM, SMOKY RIVER AREA, ALBERTA

Part III: Results of Microscopic and Dilatometric Determinations

by

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B.N. Nandi* and S.E. Nixon**

SUMMARY

The interpretation of petrographic and dilatometer results is discussed in this report. In one sample, the low swelling index is attributed either to the presence of an inert component (massive micrinoid) or to mild oxidation. Although all the samples had been oxidized considerably due to storage, the coking characteristics have not deteriorated significantly from this oxidation.

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INTRODUCTION

This report is a continuation of the work reported in Appendix 3 of Investigation Report IR 67-84, Part II of this series (1, 2), by J.C. Botham and E.W. Montgomery, in which the results of the "Maceral Analysis" were attached in summary form.

In the present report (Part III), the interpretation of the petrographic analysis and the dilatometer results are discussed, and the dilatometer curves included for comparison.

The samples under study here were not fresh, but had been stored at the Mines Branch approximately six months prior to this examination. The coking properties as measured by some standard tests had undergone a considerable change in this period--no doubt as a result of oxidation.

PETROGRAPHIC STUDIES

Petrographic studies and reflectance measurements were performed on these samples and the results of the maceral analysis and values for the mean reflectance in oil are given in Table I.

TABLE I

Description of Sample	Alberta Foothills Belt Smoky River No. 4		
Laboratory No.	Sample I 3229-67	Sample II 3230-67	Sample III 3231-67
	%	%	%
Vitrinoid	58.0	60.8	58.8
Exinoid	--	--	--
Semifusinoid	9.8	7.6	7.6
Fusinoid	10.2	14.6	12.2
Micrinoid	19.2	13.8	18.0
Mineral Matter	2.8	3.2	3.4
	100.0	100.0	100.0
Reactives	61.3	63.4	61.4
Inerts	38.7	36.6	38.6
Mean Maximum Reflectance in Oil (R_o)	1.53	1.46	1.45

The massive micrinoid content in Sample I exceeds in proportion the granular micrinoid contents of Samples II and III; otherwise the ratio of reactives and inerts remains the same. No significant difference in the average mean reflectance (in oil) has been observed, although the value of Sample I was slightly higher (which may be due to the mild oxidation undergone). The petrographical investigation did not reveal any structural change in vitrinoid on mild oxidation. The Free Swelling Index is lowest in Sample I (reported by Botham and Lloyd[1]) and it seems that this lowest value is attributed either to the presence of massive micrinoid or to mild oxidation. From the microscopic

examination and considering the proportion of reactives to inert macerals, these three samples are regarded as suitable for good coking coal.

DILATOMETER TESTS

Microscopic examination and reflectance measurement do not, except in severe cases, indicate the extent to which the coal has been oxidized. However, the determination of the dilation properties, using in this case the Ruhr Dilatometer together with a microscopic examination of the residue from the dilatometer test, gives a better understanding of the nature of coal and, to some extent, the degree of oxidation that the coal has undergone. Accordingly, all three samples were tested in the Ruhr Dilatometer, using the method recommended by German Industrial Specification No. DIN 51739/March 1956. The results are given in Table II and the dilatation curves as traced directly by the instrument are plotted in Figures 1-3.

TABLE II

Sample	3229-67 I	3230-67 II	3231-67 III
Softening Point (θ_S), °C	434	436	425
Contraction (C), %	35	28	30
Dilatation, %	Negative	0	-5
Temperature of max.dilatation, °C	Nil	518	500
Temperature of max.contraction (θ_C) °C	491	478	481
Plasticity Index, $C/(\theta_C-\theta_S)$	0.58	0.70	0.58

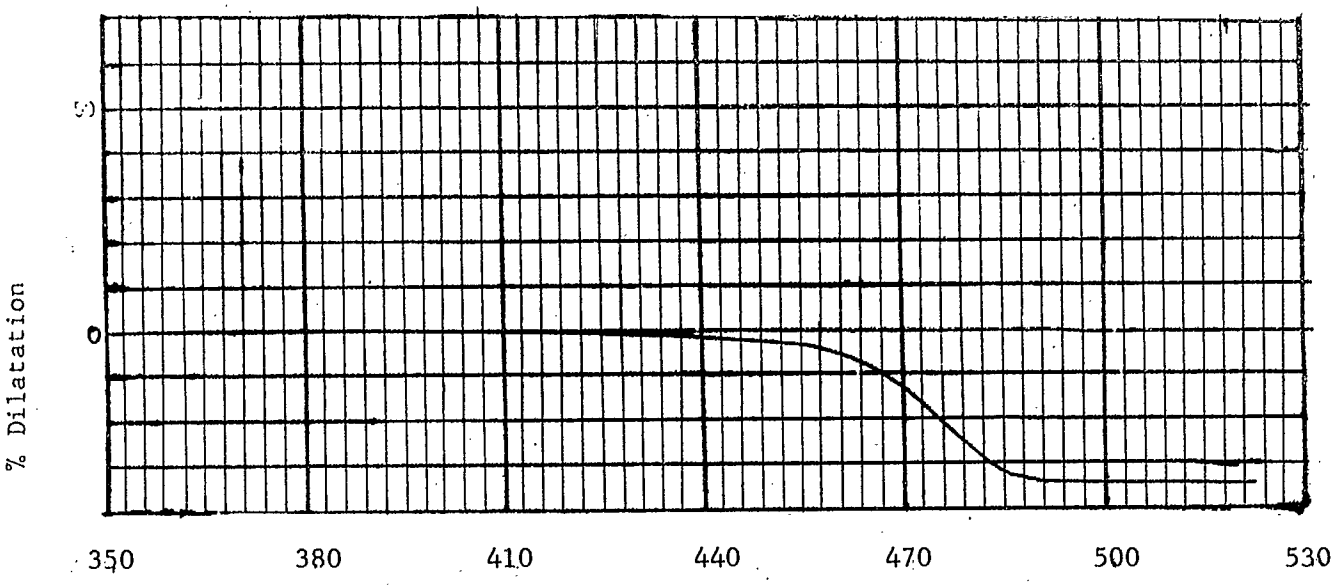

Figure 1 - Temperature Rate of Heating 3°C/min. -- Sample I

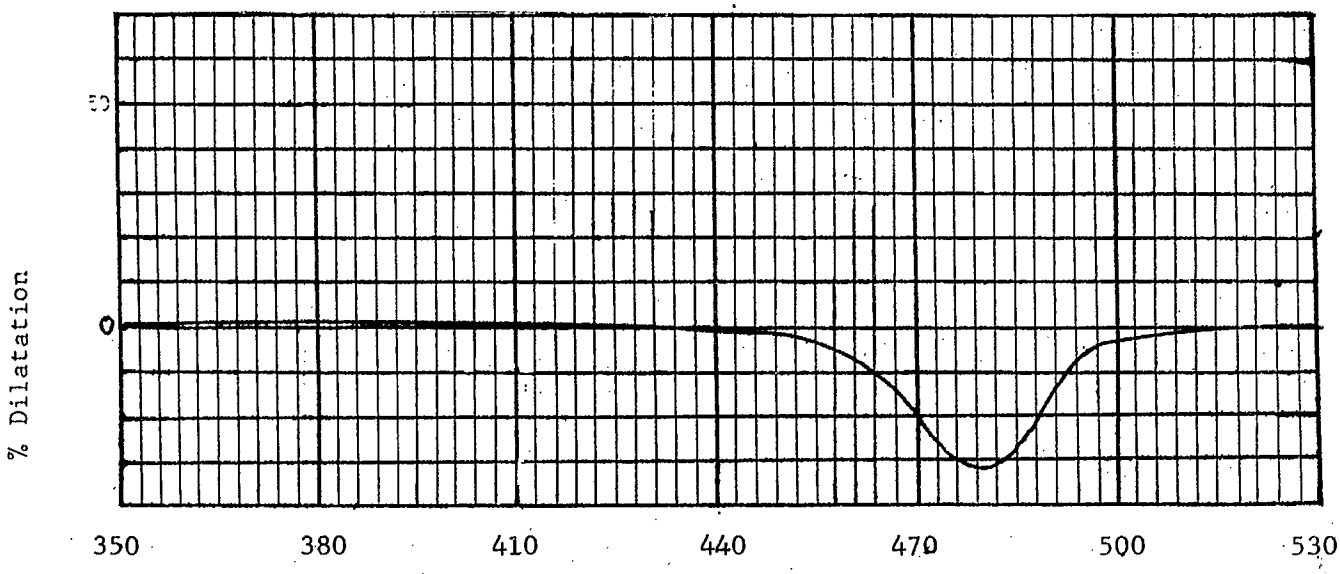

Figure 2 - Temperature Rate of Heating 3°C/min. -- Sample II

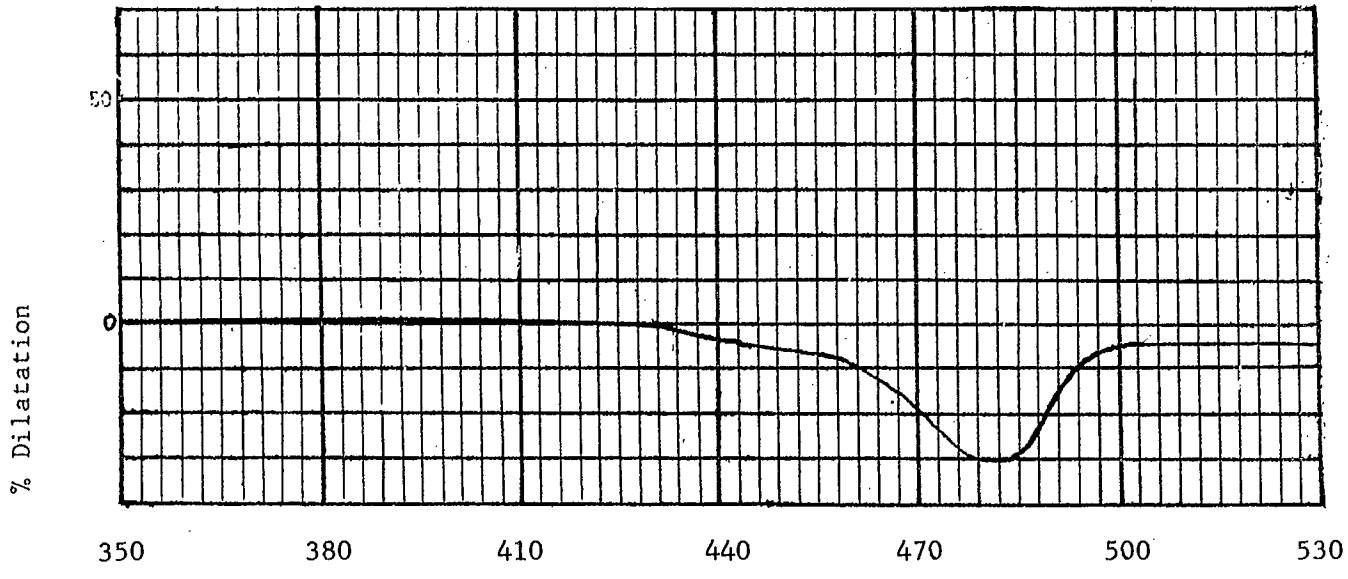

Figure 5 - Temperature Rate of Heating 3°C/min. -- Sample III

DISCUSSION

Contraction is at a maximum in Sample I and practically the same in Samples II and III. The %-contraction value indicates the rheological properties of the coal, while the %-dilatation value has a direct relation to the swelling properties. It has been observed by Boyer[3] that when a coal is oxidized past a certain critical extent, both the dilatation and the plasticity indices decrease; in contrast, on mild oxidation the contraction increases slightly and then falls off suddenly as oxidation is intensified. The %-dilatation in Sample I is negative, while in Samples II and III the values approach 0 and -5 respectively. The dilatation results indicate that all three samples, especially Sample I, were oxidized considerably. Sample II has the highest Plasticity Index,[4]

$$P.I. = C/(\theta_C - \theta_S),$$

where θ_C is the temperature of maximum contraction, °C,
and θ_S is the softening point, °C,

while Samples I and III have the same values.

CONCLUSION

It can be concluded from the results of the petrographical and dilatation tests that, although all the samples (especially Sample I) had been oxidized considerably during

storage, the coking characteristics have not deteriorated significantly from oxidation.

REFERENCES

1. J.C. Botham and T.A. Lloyd, "Investigation of the Coking Properties of Coal from No. 4 Seam, Smoky River Area, Alberta. Part I: Evaluation of Smoky River Coals Alone and Blended with a USA High-Volatile Coking Coal"; Investigation Report IR 67-83, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada, May 1967. Industrial Confidential.

2. J.C. Botham and E.W. Montgomery, "Investigation of the Coking Properties of Coal from No. 4 Seam, Smoky River Area, Alberta. Part II: Evaluation of Smoky River Coals Blended with Japanese Coking Coals"; Investigation Report IR 67-84, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada, November 1967. Industrial Confidential.

3. A.F. Boyer, "Controlled Oxidation of Coal", in Proceedings of International Conference on Chemical Engineering in the Coal Industry, at Stoke Orchard, 1956 (Pergamon Press, London, 1957), pp. 1-24.

4. H.H. Lowry, "Chemistry of Coal Utilization", Supplementary Volume (John Wiley, London, New York, 1965), p. 154.

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