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EVALUATION OF COKING COALS FROM CARMACKS AREA, YUKON TERRITORY

by

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Prob harbour coal
9 not Tantalus.

INTRODUCTION

Four coal samples from the diamond drill Hole #2 in the Carmacks Area, Yukon Territory were sent by Mr. J. E. Hlavay, President, Teslin Exploration, to the Fuels Research Centre for chemical and petrographical evaluation. The property from which the samples were taken is located in Drill Hole #2 in the Carmacks (near Anvil Mines) area as shown on the map (Figure 1).

SAMPLES STUDIED

Sample 1 - 180' - 190' - Powdered coal about minus 48 mesh partial size.
Sample 2 - 192' - Lump coal of various sizes ranging from 1/4" to 3".
Sample 3 - 195.6' - Lump coal of various sizes ranging from 1/4" to 3".
Sample 4 - 211.6' - Core sample of 2" diameter and 4" long.

The four samples weighing about 100 to 250 gms each, were received in plastic bags. Parts of the samples were crushed in accordance with the ASTM Specification for Proximate and Ultimate Analyses, Free Swelling Index, Dilatation Test and Microscopic Examination. These samples are rich in mineral carbonates and part of all 4 samples were leached with 1:1 hydrochloric acid: water for proximate and ultimate analyses and dilatation tests.

EVALUATION PROCEDURE AND RESULTS

(a) Proximate Analysis (Moisture, Ash, Volatile Matter and Fixed Carbon)

(b) Calorific Values

Standard ASTM procedures were followed for these determinations and the results are given in Table 1.

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(c) Free Swelling Index

The ASTM Standard Method of Test for Free Swelling Index of coal, ASTM Designation D720-67 procedures was followed and the results are presented in Table 1.

(d) Ultimate Analysis (Carbon, Hydrogen, Nitrogen and Oxygen)

This analysis was performed in Perkin Elmer Model 240 Micro-elemental Analyser and the results are given in Table 1.

(e) Ruhr Dilatometer Test

Reflectance measurements do not, except in severe cases, indicate the extent to which the coal has been oxidized. However, the determination of the dilation properties using the Ruhr Dilatometer together with the microscopic examination of the residue from the dilatometer test gives a better understanding of the nature of the coal and some indication of the state of oxidation of coal. The test measures quantitatively the contraction and dilation of coal when heated at a constant rate of temperature increase of 3°C per minute. This test was conducted according to the German Specification DIN 51739. Coals which show no dilation and very low contraction, although they may agglomerate, are not considered to have the required qualities that will yield a commercial grade of metallurgical coke. The results of this test are given in Table 1.

(f) Microscopic Examination - Maceral Analysis

The samples were polished in accordance with the procedure described in ASTM Designation D-2797, "Method of Preparing Coal Samples for Microscopic Analysis by Reflected Light".

The maceral analyses were conducted according to ASTM Designation D-2799, "Method for Microscopic Determination of Volume Percent of Physical Components of Coals". The macerals were counted at a magnification of 600. The results are given in Table 1.

(g) Reflectance Measurement of Vitrinoid

The reflectance measurements were performed on the polished samples (prepared for microscopic examination described above) according to ASTM

Designation D-2798, Tentative Method for "Determining Microscopically the Reflectance of the Organic Components in a Polished Specimen of Coal". The results are given in Table 1.

DISCUSSION

The Free Swelling Index values of these coals range from 5-1/2 to 9, which were very unusual for high-ash content coal. In order to ascertain whether these high F.S.I. values were due to the evolution of carbon dioxide, Samples 2 and 4 were leached with hydrochloric acid (1:1). The evolution of a tremendous amount of gas, mostly carbon dioxide, indicates that this coal was rich in carbonate minerals. The F.S.I. of the leached coal decreases considerably. Most of the analyses were performed on the leached coal to obtain a better evaluation of the coal substance freed from the hydrochloric acid soluble minerals.

The volatile matter of Samples 1 and 2 (supposed to represent the upper part of seam 180' to 192') was approximately 20% with high-ash content of approximately 36%; whereas the lower part of seam, Samples 3 and 4 (depth 195.6' to 211.6'), the volatile matter was higher, of the order of 27% with a low-ash content of 1.5 to 11.6%.

Petrographic analysis shows all samples consist of about 95 to 98% vitrinite which is very remarkable for coals of any rank. Many difficulties were encountered in classifying this organic matter (vitrinite). The problem was to determine whether the material was impsonite or coal. Microscopically, impsonite has the same structure as coal but it has a hydrogen content of (4.8 - 5.5%) and an oxygen content (1.9 to 5%). The hydrogen content of these coal samples varies from 4.5 to 5.5% and oxygen content 5 to 7%. From the structure of the semi-coke and the results of the ultimate analysis, it is concluded that these samples are not impsonite but coal.

Dilatometric results show that all original coals have high dilatation and contraction. The dilatation of leached Samples 2 and 4 decreases to nil and 24% from 166 to 245% respectively. This decrease in dilatation is probably caused by the removal of carbonate material from the original coal sample. Contraction and plasticity index was also slightly affected.

CONCLUSION

Coal Samples 1 and 2 (upper seam) have a higher ash content than Samples 3 and 4 (lower seam). In spite of a high-ash content the coals have good plasticity and dilatation. The High Free Swelling Index also indicates that these coals are fluid though carbonates are partly responsible for the high swelling index. The rank of the coal is in the range of medium volatile as determined by Reflectance Measurement and Proximate Analysis.

Petrographic Analysis shows these coals are mainly composed of vitrinite which acts as a reactive component in coke making and about 1 to 2% other macerals which are termed as inerts (fusinite, semi-fusinite and micrinite). We would like to point out that it is very unusual to find a coal seam such as this which consists of almost pure vitrinite. The geologists familiar with this area in the Geological Survey of Canada consider that such an occurrence is so unlikely that they question whether the sample submitted represents the entire seam.

The usual specification for coking coal is that the mineral matter be less than 10 %. It is therefore clear from the proximate analysis of the acid leached samples that extensive washing is necessary to reduce the mineral matter content to acceptable levels.

Samples 1, 2, 3 and 4 were leached with hydrochloric acid to remove the carbonates so that the volatile matter indicated could only be derived from the coal substance. It was essential to do this in order to classify the coal and to differentiate it from the vein hydrocarbon impsonite.

The dilatation of the non-acid washed Sample 2, was 166 while the acid washed material was nil. It was concluded that the dilatation of this coal was considerably influenced by the carbon dioxide released from the mineral matter. The same comment applies to the acid washed and non-acid washed Sample 4. The contraction of the coal samples submitted indicates that this coal if it can be successfully cleaned to remove the mineral matter would make a very good blending coal for combination with other low-volatile coals of low fluidity from western Canada. With these limitations we consider that this coal could find a market in the Japanese coking coal trade.

Table 1

Proximate Analysis*

	Sample 1 180'-190'	Sample 2 192'	Sample 3 195.6'	Sample 4 211.6'
Moisture	0.48	0.51	0.29	0.54
Ash	37.06	35.24	1.51	11.64
Volatile Matter	19.37	20.60	28.71	26.49
Fixed Carbon	43.09	43.65	69.78	61.67
F.S.I. non-acid leached	5-1/2	9	6-1/2	9
F.S.I. acid leached		7-1/2*		5-1/2*

*Ultimate Analysis (on ash-free basis)

Carbon %	83.8	81.0	77.0	82.42
Hydrogen %	5.3	4.7	4.5	4.9
Nitrogen %	1.1	0.99	0.78	1.0
Oxygen %	7.07	7.44	5.15	5.39
H/C	0.76	0.69	0.70	0.71

Dilatation Tests

Softening Point °C θ_S	396	396	400*	387		384	405*	
Contraction % C	22	19	21	28		26	25	
Max. Temp. of Contraction °C θ_C	463	450	489	447		440	470	
Dilatation %	22	166	Nil	168		245	24	
Max. Temp. of Dilatation	498	501	-	507		507	507	
Plasticity Index $\frac{C}{\theta_C - \theta_S}$	0.32	0.35	0.24	0.46		0.46	0.40	

Reflectance Measurement

Max. Reflectance in Oil R_o	0.96	1.1	1.06	0.98

Petrographic Analysis

Vitrinite (Reactive)	> 98 %	> 98 %	> 98 %	> 98 %

*Analysis and tests done on 1:1 hydrochloric acid leached sample.