EVALUATION OF COAL SAMPLES FROM KAISER RESOURCES LIMITED WHEELER RIDGE AREA ADIT 26, SEAM Nº 3

CANADA DEPARTMENT OF ENERGY, MINES AND RESOURCES
FUELS RESEARCH CENTRE

MAY 1971

Industrial Confidential

CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

MINES BRANCH

OTTAWA

FUELS RESEARCH CENTRE

DIVISIONAL REPORT FRC 71/31 PREP

EVALUATION OF COAL SAMPLES FROM KAISER RESOURCES LIMITED, BRITISH COLUMBIA, FROM ADIT #26, WHEELER RIDGE AREA

by

B. N. Nandi and D. S. Montgomery

May 1971

CONTENTS

CONTENTS (CONT'D)

Evaluation of Coal Samples from Kaiser Resources Limited, British Columbia, From Adit #26, Wheeler Ridge Area

by

B. N. Nandi* and D. S. Montgomery**

INTRODUCTION

This report is in continuation of the previous reports on the "Evaluation of Coal Samples from the Sparwood Ridge, Crowsnest Coalfield, British Columbia Part I, II and III" (1, 2, 3).

LOCATION OF PROPERTY, COAL SEAMS AND SAMPLING STATION

The property from which the sample was taken is located in Wheeler Ridge area as shown in the map (Figure 1).

This sample of coal was taken by Kaiser Resources Limited and the description of the sample, the seam thickness, Adit number and sampling location were sent along with sample by Mr. J. B. Murphy, Chief Geologist, Kaiser Resources Limited to the Fuels Research Centre. For convenience these data are given below.

Sample No.	FRC No.	Location	Adit No.	Seam Thickness	Sampling Station Location
1	2203-71 - Raw Coal	Wheeler Ridge	26	47 feet	Crosscut at 150 ft. from the portal
2	2016-71 - Clean Coal	Wheeler Ridge	26	47 feet	Crosscut at 150 ft. from the portal

SAMPLES STUDIED

About five pounds of raw coal sample, taken from the bulk sample, was sent separately in a plastic bag on January 13, 1971. The clean sample of five pounds immersed in water in air-tight container to prevent oxidation in transit was forwarded by mail on December 23, 1970 for petrographic evaluation.

---

* Research Scientist

** Head, Fuels Research Centre, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

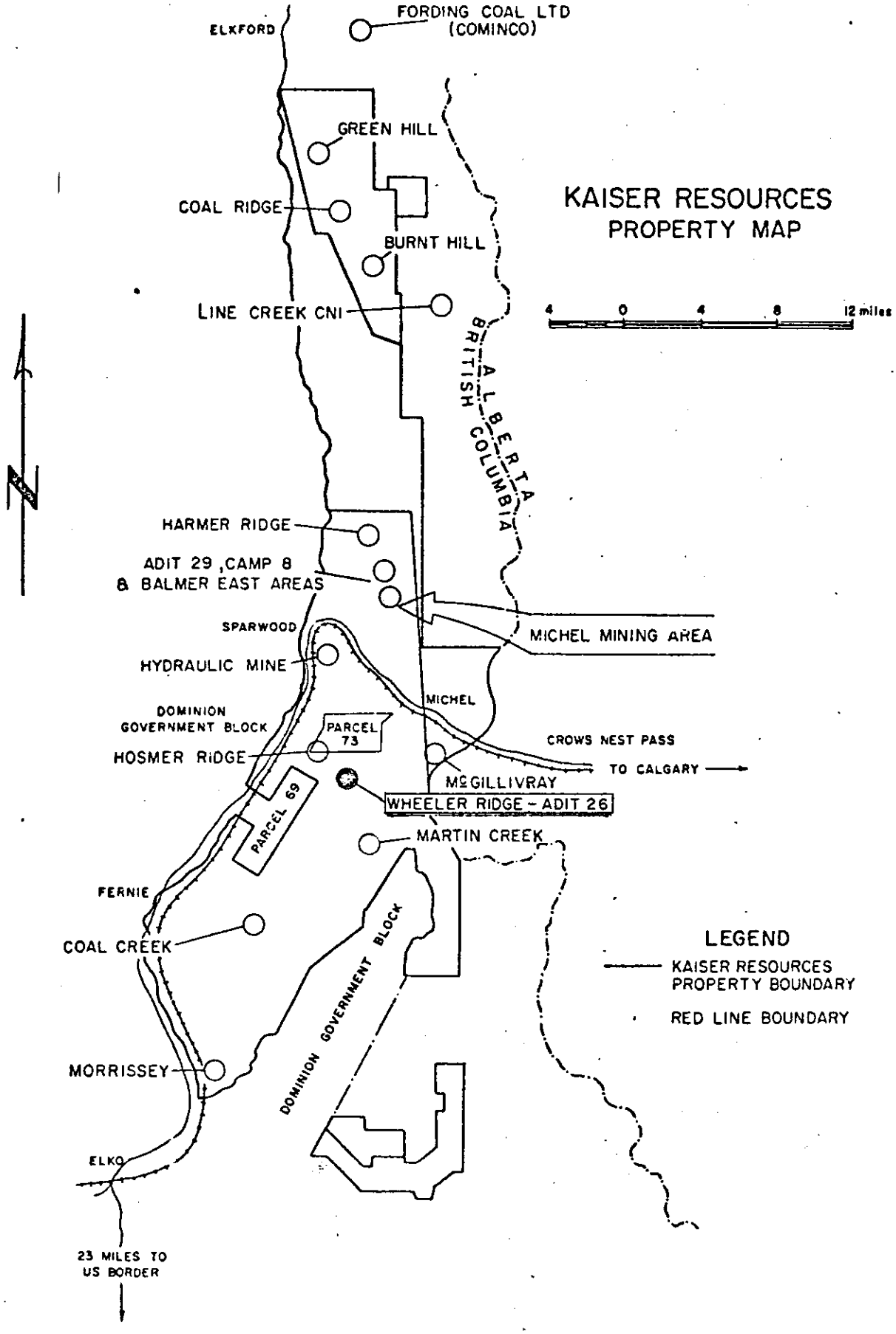


Figure 1. Map showing detailed location of Adit #26, Wheeler Ridge Area.

The coal particle size of both samples as received was 1/4" X 0. The clean sample was floated at 1.50 S.G and the resulting product contained approximately 9 per cent mineral matter.

The clean sample was first centrifuged to separate the majority of the water and then dried under vaccuum at room temperature and the raw sample was dried in air at room temperature. Both samples were crushed in accordance with the ASTM Specification for the preparation of samples for microscopic examination, proximate analysis and dilatation in the Ruhr dilatometer.

EVALUATION PROCEDURE AND RESULTS

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

The Standard ASTM procedure was followed for these determinations and the results are given in Table 1.

(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) 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 dilatation 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 a 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 quality that will yield a commercial grade of metallurgical coke. The results of this test are given in Table 2.

(e) 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 the 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 3.

(f) Reflectance Measurement of Vitrinoid

The reflectance measurements were performed on the polished sample (prepared for microscopic examination described above) according to the 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 3.

DISCUSSION

The proximate analyses of clean and raw samples are similar when calculated on ash free basis and the free swelling of the clean sample is higher than 9 (max. limit is 9) and that of raw sample is 9. The high swelling index of 9 indicates that this coal is a highly fluid coal.

Both samples possess similar dilatation but the contraction and plasticity index are slightly higher in the clean coal as may be seen in Table 2.

Petrographic analysis given in Table 3 shows that this coal is rich in exinoid (Figure 2) which is very unusual in the western Canadian cretaceous coals. Exinoid generally increases the fluidity of coal when heated to the plastic state. Both clean and raw coal possess similar percentages of reactive macerals but the exinoid content is about 5 per cent higher in the clean coal. Some naturally crushed vitrinoid was observed in both coals (Figure 3). In some cases the reflectances of fusinoid and semifusinoid are practically the same in this particular coal (Figure 4) although reflectance of fusinoid is normally higher than semifusinoid in this particular coal and

in coal in general. It is therefore difficult to differentiate the boundaries of the fusinoid from semifusinoid in some cases. Figure 5 shows the inclusion of mineral matter in the semifusinoid which is brownish in colour under the microscope. We mention in our previous paper (4) that finely disseminated iron and calcium appear to be concentrated in the semifusinoid part of the coal as detected by electron proble analysis. The presence of mineral matter can also be observed in the semifusinoid part of the semi-coke obtained at 550°C from the residue of the Ruhr dilatometer (Figure 6 and 7). In Figure 7 the mineral matter was not surrounded by cracks and semifusinoid was fused completely with the vitrinoid part giving a very smooth granular structure in the semi-coke. It is very difficult at this stage to interpret the role of mineral matter in the semifusinoid on coke quality but it appears that there exists good bonding between the mineral matter, coal inerts and reactives macerals without any boundary cracks.

The microscopic examination of the semi-coke obtained from the residue at 550°C from raw coal shows formation of fine grain coke structure with the inclusion of mineral matter and big cavities (Figure 8). Identical semi-coke obtained from clean coal shows good bonding between reactives and inerts (Figure 9). This coke is slightly anisotropic and the grain structure is very fine. Highly fluid coals generally give coke with a fine granular structure.

CONCLUSION

The clean coal at 1.50 S.G from Adit 26, Wheeler Ridge, possesses exinoid which is very unusual for western Canadian cretaceous type coal. Dilatometer tests and swelling index indicate that this coal is extremely fluid when heated to the plastic state. The rather large cavities (Figure 8) tend to confirm the general observation that very fluid coals on carbonization alone tend to give weak cokes due to the rather thin cell walls caused by the large gas bubbles evolved during heating. However, this coal gives every indication of being excellent for blending with other western Canadian medium volatile coals of low fluidity. It is a coal which itself may command

a premium price as it is our understanding that the Japanese require fluid coals for blending.

The crushed vitrinoid may indicate that on washing there will be problems with fines of low specific gravity since as far as it is possible to see there is little associated mineral matter with this type of vitrinoid. This is a marked contrast with some of the other coals of this region where the fine coal consists of semifusinoid and fusinoid laden with mineral matter.

ACKNOWLEDGEMENT

The authors wish to acknowledge the assistance of Mr. S. E. Nixon in the preparation of the coal samples for microscopic examination, the counting and the Ruhr dilatation tests performed, and Mr. W. J. Montgomery and his staff of Solid Fuels Laboratory for the proximate analysis, calorific value and free-swelling index.

REFERENCES

1. B. N. Nandi et al - "Evaluating Coal from Sparwood Ridge Area, Crowsnest Coalfield, British Columbia" Divisional Report FRC 70/39, Prep June 1970.

2. B. N. Nandi et al - "Evaluation of Coal Samples from the Sparwood Ridge Area, Crowsnest Coalfield, British Columbia (Kaiser No. 7 Seam - Adit 75)" Divisional Report FRC 71/9, Prep January 1971.

3. B. N. Nandi and D. S. Montgomery - "Evaluation of Coal Samples for Kaiser Resources Limited from Baldy Mountain Area and Camp 8 East, in Sparwood Ridge Area, Crowsnest Coalfield, British Columbia Divisional Report FRC 71/16 Prep February 1971.

4. B. N. Nandi and D. S. Montgomery - "The Study of Coal by a Scanning Electron Microscope and Electron Probe", Preprints of the American Chemical Society Division of Fuel Chemistry, Vol. 14, No. 1 pp 81-86, Toronto, 1970.

TABLE 1

Proximate Analyses (as received)

FRC Laboratory No.	Sample 1 2203-71 Wheeler Ridge Adit 26, Raw Coal	Sample 2 2016-71 Wheeler Ridge Adit 26, Clean Coal at 1.50 S.G
Moisture	0.84	1.79
Ash	12.92	4.27
Volatile Matter	31.68	33.50
Fixed Carbon	54.56	60.44
	100.00	100.00
Free-Swelling Index	9	more than 9
Calorific Value BTU/per lb/gross	12,773	14,150

TABLE 2

Ruhr Dilatometer Test

	Sample 1	Sample 2
Softening Point Θ_s°C	390	381
Contraction % C	20	25
Dilatation %	69	67
Temp. of Max. Dilatation °C	486	480
Temp. of Max. Contraction Θ_c°C	445	440
Plasticity Index $\frac{C}{\Theta_c - \Theta_s}$	0.36	0.42

TABLE 3

Microscopic Analysis

	Sample 1	Sample 2
Vitrinoid	62.9	60.0
Micrinoid	4.2	4.8
Exinoid	2.0	7.2
Fusinoid	5.2	9.6
Semifusinoid	18.9	16.0
Mineral Matter	6.8	2.4
	100.0	100.0
R_o (Reflectance in oil)	0.72	0.77
Reactives %	71.2	72.5
Inerts %	28.8	27.5

ıre 2. Micrograph of the clean coal from
\dit #26, Wheeler Ridge.
V - Vitrinoid, E - Exinoid, F - Fusinoid,
S.F. - Semifusinoid X 600.

Figure 3. Micrograph of the naturally occurring crushed vitrinoid in Adit #26 coal X 600.

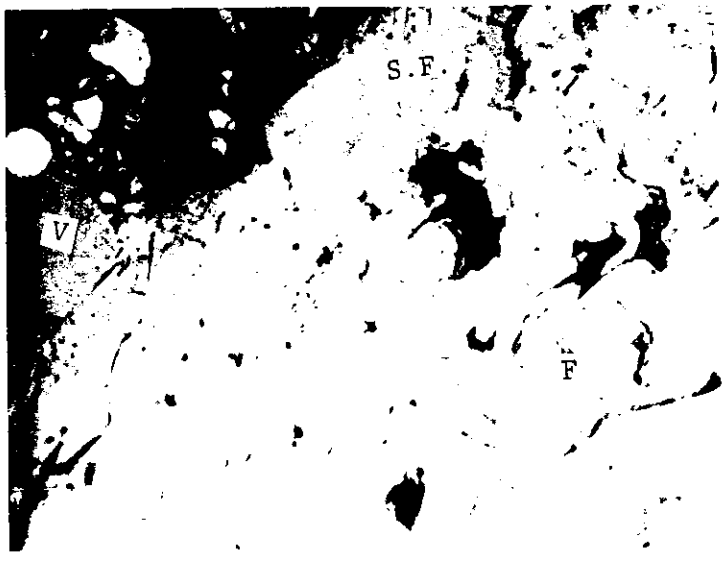


Figure 4. Micrograph of the fusinoid and semifusinoid of the same reflectance.
V - Vitrinoid, F - Fusinoid,
S.F. - Semifusinoid X 600.

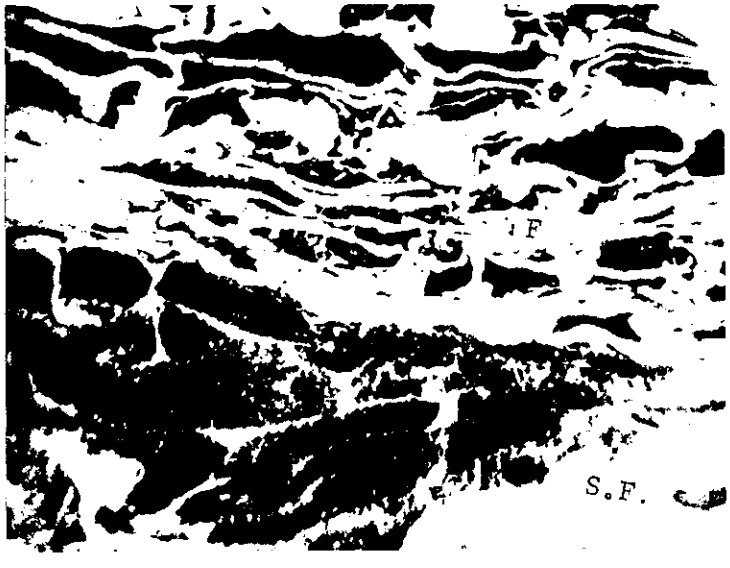
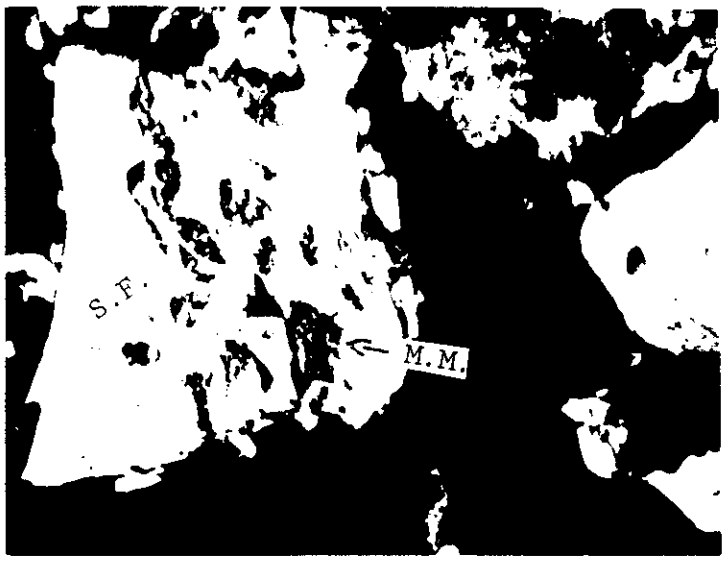


Figure 5. Micrograph of the inclusion of mineral matter in the semifusinoid and fusinoid. F - Fusinoid,
S.F. - Semifusinoid X 600.



.gure 6. Micrograph of the semi-coke (raw coal) .rom the residue of the Ruhr dilatometer test at 550°C. Showing inclusion of fine mineral matter (the semifusinoid. M.M. - Mineral Matter, S.F. - Semifusinoid.

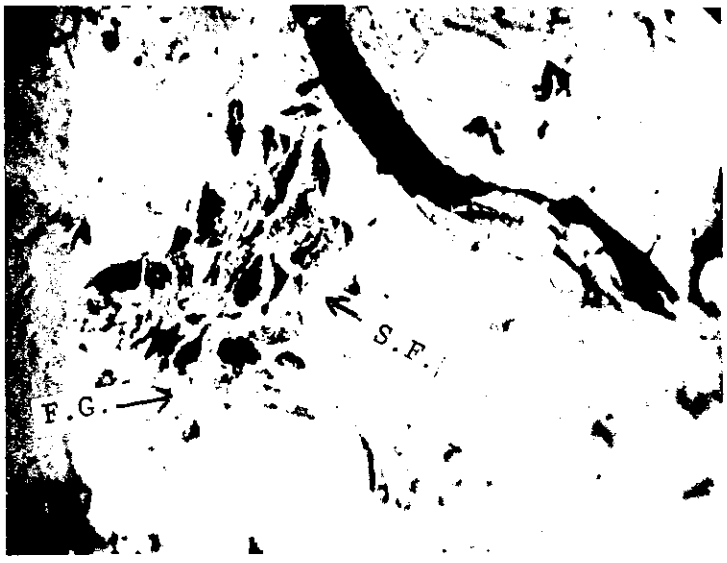


Figure 7. Micrograph of the semi-coke (clean coal) from the residue of the Ruhr dilatometer test at 550°C showing good bonding and fusion between mineral matter of the semifusinoid and vitrinoid. F.G. - Fine Grains, S.F. - Semifusinoid, M.M. - Mineral Matter.

.gure 8. Micrograph of the semi-coke (raw coal) from the residue of the Ruhr dilatometer test at 0°C showing the cavities and the inclusion of neral matter. C - Cavity, M.M. - Mineral Matter.

Figure 9. Micrograph of the semi-coke (clean coal) from the residue of the Ruhr dilatometer showing good bonding and fusion between reactives and inerts. S.F. - Semifusinoid, F.G. - Structure of Fine Grain.

CARBONIZATION TEST IN HINES BRANCH 12 inch, M.W. COKE OVEN.

PROJECT No. 3-2-1 | 16-19.

Test Identification Number	787
Date of Test	28 APRIL 71
Laboratory Number (refer for analysis of charge)	2461-71

COMPONENT COALS IN CHARGE
(% by wt. on db)

ADIT 26 - KAISER	100 %

CARBONIZATION DATA

Net Weight of Charge (wet) lb	526.8
Moisture in Charge %	3.8
ASTM Bulk Density (wet) lb/ft^3	48.5
Oven Bulk Density (db) lb/ft^3	51.0

CARBONIZATION RESULTS

Gross Coking Time hr:min	10:30
Maximum Wall Pressure lb/in^2	0.30
Coke Yield Actual. %	71.7
Mean Coke size in	2.00
Apparent Specific Gravity	0.890

Screen Analysis of Coke
(cumulative percentage retained on)

3 inch sieve	5.4
2 inch sieve	50.9
1 1/2 inch sieve	77.3
1 inch sieve	91.0
3/4 inch sieve	93.6
1/2 inch sieve	94.7
Percentage -1/2 inch (breeze)	5.3

Tumbler Test (ASTM)

Stability Factor	35.9
Hardness Factor	63.5

Japanese Tumbler Test (JIS)
(cumulative percentage retained on)

50 mm sieve	5.3
25 mm sieve	64.7
15 mm sieve	85.3

PRELIMINARY COPY ONLY

TABLE

Analyses of Component Coal
(Project No. 3-2-1/16-19

Identification		
Laboratory Number	2461-71	2487-71
Description	KAISER ADIT 26	COKE FROM M.W. OVEN TEST.
Classification		
Rank (ASTM)		
Specific Volatile Index	164	
Volatile Matter (dmmfb)....%	36.2	
Carbon (dmmfb)....%	86.5	
Proximate Analysis (db)		
Ash....%	8.95	12.7
Volatile Matter....%	33.47	1.3
Fixed Carbon....%	57.58	86.0
Gross Calorific Value (db)		
Btu per pound	13,700	
Ultimate Analysis (db)		
Carbon....%	78.04	
Hydrogen....%	4.97	
Sulphur....%	0.40	0.29
Nitrogen....%	0.05	
Ash....%	8.95	
Oxygen (by difference)....%	7.59	
Ash Analysis (db)		
SiO_2....%	–	
Al_2O_3....%	–	
Fe_2O_3....%	–	
TiO_2....%	–	
P_2O_5....%	–	
CaO....%	–	
MgO....%	–	
SO_3....%	–	
Na_2O....%	–	
K_2O....%	–	
Grindability		
Hardgrove Index	87	
Coal Pulverization		
Total Passing 1/8 in....%	90.4	

PRELIMINARY COPY ONLY

TABLE

Thermal Rheological Properties
(Project No. 3-2-1|16-19

Identification	
Laboratory Number.....	2461-71
Description.....	KAISER ADIT 26
Linear Expansion	
Bd. 52 lb/ft^3 at 2% moisture.....%	-16.8
Gieseler Plasticity	
Start.....°C	406
Fusion Temp.....°C	418
Max. Fluid Temp.....°C	449
Final Fluid Temp.....°C	477
Solidification Temp.....°C	482
Melting Range.....°C	71
Max. Fluidity.....dd/m	520
Total.....dd	3,200
Dilatation	
Ti - Softening Temp.....°C	386
Tii - Max. Contraction Temp.....°C	429
Tiii - Max. Dilatation Temp.....°C	458
Contraction.....%	26
Dilatation.....%	48
Free Swelling Index	8

PRELIMINARY COPY ONLY