

CHEMICAL ANALYSES OF COAL FROM JARNERS KULMINE

By HOLGER LETH PEDERSEN.

The samples on which the present brief paper is based were collected by Professor H. FREBOLD on the expedition to East Greenland in 1931 led by Dr. LAUGE KOCH. For a detailed description of Jarners Kulmine on Hochstetters Forland the reader is referred to the paper by H. FREBOLD (1). The samples handed over were some pieces of coal, packed in paper and marked with a number referring to the height measurements. In the present paper the samples are designated by these numbers. Since, thus, we are not concerned with average samples, but merely with some isolated mineral fragments, my figures do not pretend to represent a definite characterisation of the East Greenlandic coal, they are merely mineral analyses, which, however, give some collective suggestions.

Calorific value.

The calorific value of the coal was determined by means of a Berthelot-Mahler calorimeter. The samples were coarsely crushed by means of a hammer and subsequently ground finely in a hand-mill and finally ground 6—8 h in a small ball mill. The powder obtained in this way could easily be converted into briquets. These were made in a small briquet press fitted with a matrix, in the cavity of which the eye of a very thin iron wire (weight 10—14 mg) is placed. By means of this iron wire the briquet is suspended in the calorimeter. In all the determinations of the calorific value dealt with here the true rise of the temperature was determined graphically by the method devised by P. E. RAASCHOU (2). It is true that Regnault-Pfaundler's formula allows a direct calculation, but it turned out that the figures calculated agreed well with those found by the graphic method. This is especially the case when the curves for the initial and the final periods are rather flat. We shall give an example of a temperature curve and a comparison of the graphical and the calculated value. As the total rise of the tem-

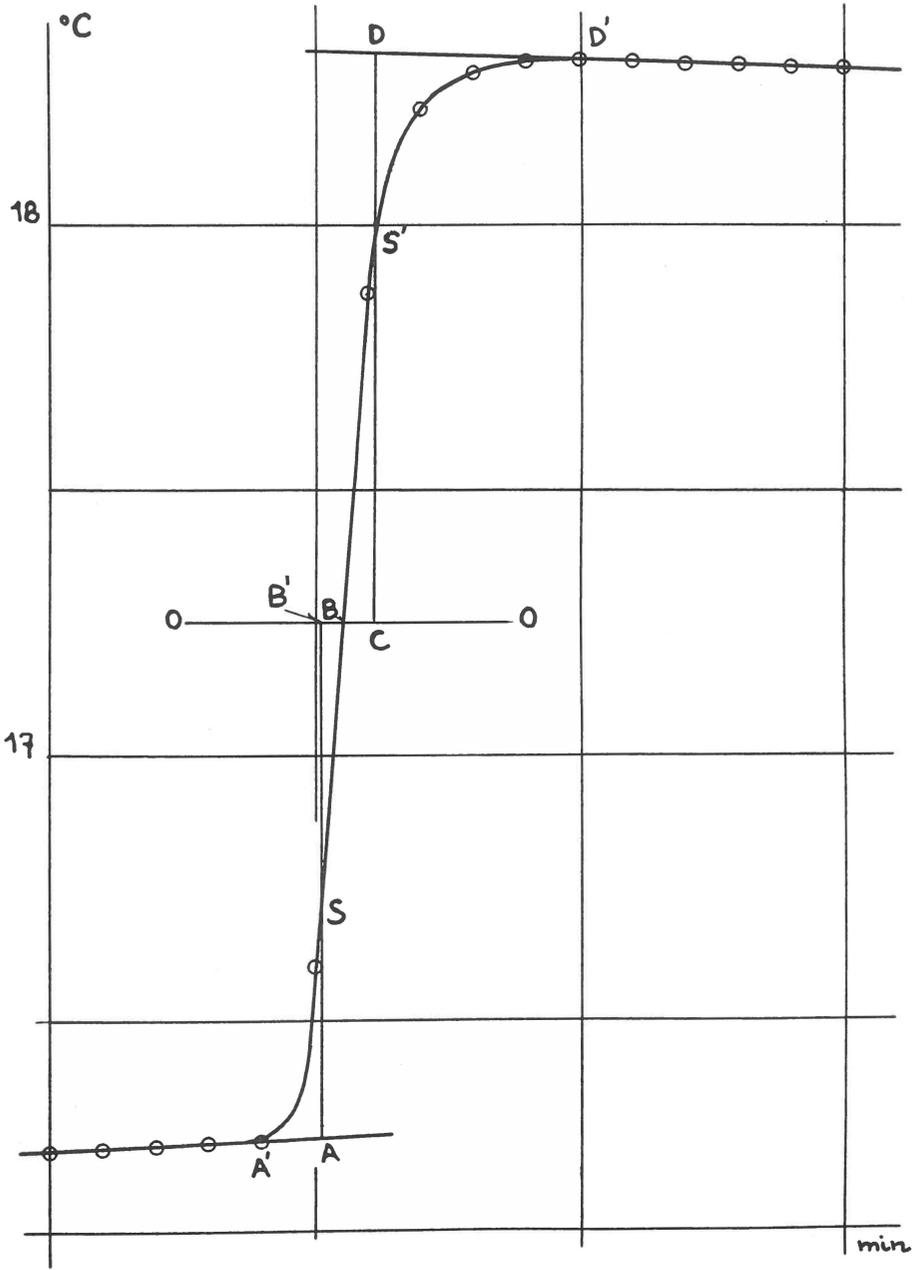


Fig. 251.

perature for 1 g of coal here amounts to 1.8—2.2°C., the initial temperature is fixed at c. 1° below that of the surroundings, that is to say, the water temperature of the calorimeter jacket. The temperature is read every minute with an uncertainty of c. 0.001°C., the thermometer being cautiously tapped 15 seconds before each reading. Similarly, the lamp illuminating the thermometer should be lighted for as short a period as possible. In this way constant temperature differences will be obtained after four or five readings. The coal is now ignited, and the actual temperature rise is noted down (with one assistant the temperature may be read every 10 seconds), and constant differences in the fall of the temperature will then again be obtained.

The curve represents the course of the temperature for coal sample 474, and shows a characteristic and regular variation of the temperature. 0—0 is the jacket temperature, and the lines DC and BA are placed in such a way that the area $BB'S = AA'S$ and the area $BCS' = DD'S'$. The actual rise in the temperature is then: $AB + CD = \Delta t$.

The graphic determination here gives a rise in the temperature of 2.03°C., a more schematic calculation 2.049°C, according to DOLCH (3).

Regnault-Pfaundler's formula is as follows:

$$k = m \times F + \frac{f + e}{E - F} \left(\frac{T_o + T_m}{2} + \sum_1^{m-1} T - m \times F \right)$$

$$\Delta t = T_m + k - T_o.$$

- in which F is the mean temperature in the initial period
- E is the mean temperature in the final period
- f is the mean temperature difference in the initial period
- e is the mean temperature difference in the final period
- T_o is the temperature at the start
- T_m is the maximum temperature.

The temperature variation for C. 474 is given in Table I.

Table I.
Measured temperature for sample C. 474.

	16.252	= T_o	e and f
	.257	> 0.005	
Initial period	.262	> 0.005	+ 0.005
	.267	> 0.005	
	.272	> 0.005	

Ignition	16.600	
	17.870	
	18.214	$\sum_1^{m-1} T$
Final period	.285	
	.301	
	.308	
	> 0.003	
	.305	
	> 0.004	
	.301	
	> 0.002	
	.299	$e = -0.003$
	> 0.002	
	.297	
	> 0.002	
	.295	

The calorific value is now calculated according to the following formula:

$$H = \Delta t (W' + W'') - 1600 p$$

in which Δt is the temperature rise found.

W' is the water content of the calorimeter in g (c. 3000)

W'' is the water value of the calorimeter bomb

p is the weight of the iron wire.

The following table shows the agreement between the two methods:

Table II.

Comparison of measured and calculated values.

Analysis No.	474	489
Δt Calculated value	2.024	2.276
Measured value	2.030	2.270

The lowest calorific value found was 5600 cal/g, the highest 7300 cal/g. A calculation of the uncertainty of the determination has shown that at a calorific value of 7000 cal/g the maximum uncertainty will amount to c. 54 cal/g. This uncertainty of 0.8 per cent is, of course, too high, and more experienced analysts state that they perform the determination with an uncertainty of 0.5 per cent.

The coal samples are characteristic by their high content of ashes and surprisingly high calorific power. This is probably due to the fact that the coal substance proper comes very near to pit-coal in composition if we disregard the content of sulphur.

Determination of sulphur.

The determination of sulphur was made by ESCHKA's method, precisely as indicated in (4). At first a platinum crucible was used and a spirit flame for burning the coal, but after a blank parallel had been made in a porcellain crucible over a gas flame for a sulphate determination in Eschka's mixture it turned out that the gas flame by no means transferred SO_2 to the mixture. This moreover contained no demonstrable trace of SO_4^{--} . However, it is a great advantage to use a platinum crucible, as the incineration of the coal to be analysed is far more convenient in this than in a porcellain crucible.

Determination of water.

The determination of the water was carried out in the usual way by simple drying. The ordinary drying temperature prescribed is $105^\circ C.$, but here the drying was performed at $97^\circ C.$ (temperature of the glycerine-water mixture of the thermostat). After drying for one hour the maximal loss of weight was obtained, after which the weight increases owing to oxidation, c. 0.0005 g per half an hour's further desiccation. However, this method is no exact method, since actually we do not know what is determined. The loss in weight obtained is the sum of evaporated water plus constituents distilled away (destruction of the organic substances) less the increase due to the oxidation.

Determination of the ashes

was performed by a very cautious and gradual heating to intense ignition by means of a Meker burner in an obliquely placed porcellain crucible. The ashes may belong to two types,

- 1) light-yellowish or reddish refractory ashes with a high content of Fe_2O_3 , and
- 2) bluish ashes, no doubt phosphatic (vivianite?).

It is interesting that the determination of the ashes made on the remnants after the elementary analysis showed a very close agreement with the figures obtained by the aforementioned method¹⁾.

¹⁾ In one of the light-coloured ash samples a melting point of more than $1500^\circ C.$ was found.

Table III.
Analytic data for airdry samples.

Sample No.	Calorific power cal/g	Moisture %	Ashes %	S %	C %	H ₂ %
460.....	6750		20.7		58.0	(5.4)
465.....	6400	3.2	17.1		57.5	4.3
467.....	7060	3.1	13.1	4.1	63.1	3.7
469.....	5680	3.6	23.6	2.6	51.5	4.1
470.....	7290	3.8	5.6	3.6		5.7
474.....	6750	4.5	8.6	2.0	65.0	7.5
475.....	7250	2.4	11.8	2.5		
480.....	6010	2.3	22.4	5.2	54.1	2.9
481.....	7060	2.0	14.4		62.1	6.8
489.....	7010	5.3	8.1		65.2	5.6
490.....	6900	2.5	17.2	1.4	60.3	8.2
Mean:.....	6740	3.3	14.8	3.1	59.6	5.4

(The hydrogen values are corrected for H_2O from the moisture of the samples).

The elementary analyses

were likewise made by means of the tube-filling mentioned by P. E. RAASCHOU (5). The external copper net was reduced by heating and immersion into a formalin solution and subsequent drying at not more than 50°C. In addition the tube contained, after filling with CuO , a thin layer of granulated $Pb Cr O_4$ for SO_2 absorption. The absorption was made in a $CaCl_2$ and two soda lime tubes, the last of which as a rule kept a constant weight. The carbon determinations showed good agreement; some uncertainty in the hydrogen determination was, no doubt, due to the high content of ashes (6).

The analytical data are gathered in Table III; on account of the small size of the samples the table is not entirely filled in. For the same reason the data given are somewhat sporadic, but nevertheless a mean value has been computed for orientation. If the calorific value is computed according to Dulong's formula on the basis of this mean composition, and on the assumption of a nitrogen content of c. 1 per cent, the H -mean is found to be equal to 6000 cal/g, which is c. 10 per cent lower than the experimental mean.

For comparison we may add the analysis of a coal sample from Qutdligssat (in northern Disko). The analysis was made by H. NIELSEN, civil engineer (Sensible Heat Distillation Ltd.) and placed at our disposal

by Professor RAASCHOU. In the report on the analysis the coal is characterised as follows: "The coal received had the appearance of being a lignitic coal of an older formation, classification according to Scyler: Ortho-Lignitians."

Although the justification of employing mean values is possibly doubtful, the result of the analysis is given in Table IV converted into dry matter and pure coal substance (100 — (moisture + ashes)) in order to obtain a basis for a comparison. Wieluch's coal index, expressed by the following formula, has likewise been computed:

$$\text{Index} = 1 - \frac{42 \times h + 2.1 \times o + 3 \times n}{7 \times c} \quad (7)$$

in which the small letters denote the percentages of hydrogen, oxygen, nitrogen, and coal in the pure coal substance, the nitrogen content being estimated at 1 per cent.

Table IV.
Comparison of coal from Jarners Kulmine with a sample from Qutdligssat.

Component	Qutdligssat		Jarners Kulmine	
	Dry matter %	Pure coal %	Dry matter %	Pure coal %
<i>C</i>	64.9	72.9	61.6	72.8
<i>H</i> ₂	4.6	5.2	5.6	6.6
<i>O</i> ₂	18.0	20.2	14.3	16.8
<i>N</i> ₂	0.8	0.9		
<i>S</i>	0.7		3.2	
Ashes.....	11.0		15.3	
Wieluch's index.....		0.48		0.39

Typical lignite has an index of 0.35—0.47, while pit-coal has indices over 0.50. Thus according to this classification the coal from Hochstetters Forland should be designated lignite.

In conclusion I wish to thank Professor, Ph. D., I. A. CHRISTIANSEN and Professor P. E. RAASCHOU for the courtesy with which they placed laboratory facilities at my disposal. For valuable assistance during the work I likewise thank B. LETH PEDERSEN. And last but not least my thanks are due to Dr. LAUGE KOCH for his great kindness and financial aid.

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2) I. p. 42.
3) II, p. 43.
4) I, p. 20.
5) I, p. 23.
6) III, pp. 53 and 61.
7) II. p. 138.
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