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THE STUDY OF COAL BY THERMAL ANALYSIS, ADVANTAGES AND DISADVANTAGES

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ABSTRACT

The investigation of different types of coal by thermal analysis was carried out on two different apparatus (Derivatograph OD-102 and Q). The different instruments gave somewhat different curves. As the degree of coalification increases, the range of characteristic temperatures reflecting the decomposition of the structure is shiftsd to higher temperatures.

INTRODUCTION

The permanent progress in thermal analysis and the resulting development of relevant apparatus cause the thermal analysis to be introduced more and more frequently into industrial laboratories. Kaiserberger [1] believes that it can be used in industrial laboratories to analyse both substrates and products. Pioneers in the field of investigation into fuel solids by DTA were Hollings and Cobb (1914, 1915) [2]. By carrying out thermal analysis in the nitrogen atmosphere they were able to determine the particular stages of coal decomposition. Further investigation of coal by thermal analysis made it possible for them to draw a number of conclusions from which the following are worth noting: the DTA curves reflect many complex chemical reactions and on their basis it is possible to distinguish the rank of coal; the nature of peaks and the maximum (or minimum) temperature undergo considerable changes depending on the degree of coal coalification [3–17]. Yoshimura and Mitsui [18] suggest that the DTA has limited utilization in investigating coal pyrolysis since the peak temperatures may change in relatively wide ranges depending on the pressure used and the measuring conditions. The changes in the peak temperatures, the amplitude and the area of peaks may be caused by the grain size of sample, the ash content, the heating rate, the holder geometry and others. These and other problems mentioned above caused a stagnancy in using the thermal analysis to the investigation of coal. It may be wondered what is the reason for this stagnation. This question can be answered as follows: the apparatus used to this kind of research is relatively expensive; the information obtained from thermal analysis may be dependent on many factors, which obliterates the result of analysis; coal is a heterogeneous substance of a very complex structure while interpretation of thermal analysis curves is not always univocal.

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Having the above considerations in view an attempt was made to present a thermal analysis of different types of coal according to the atmosphere and apparatus used.

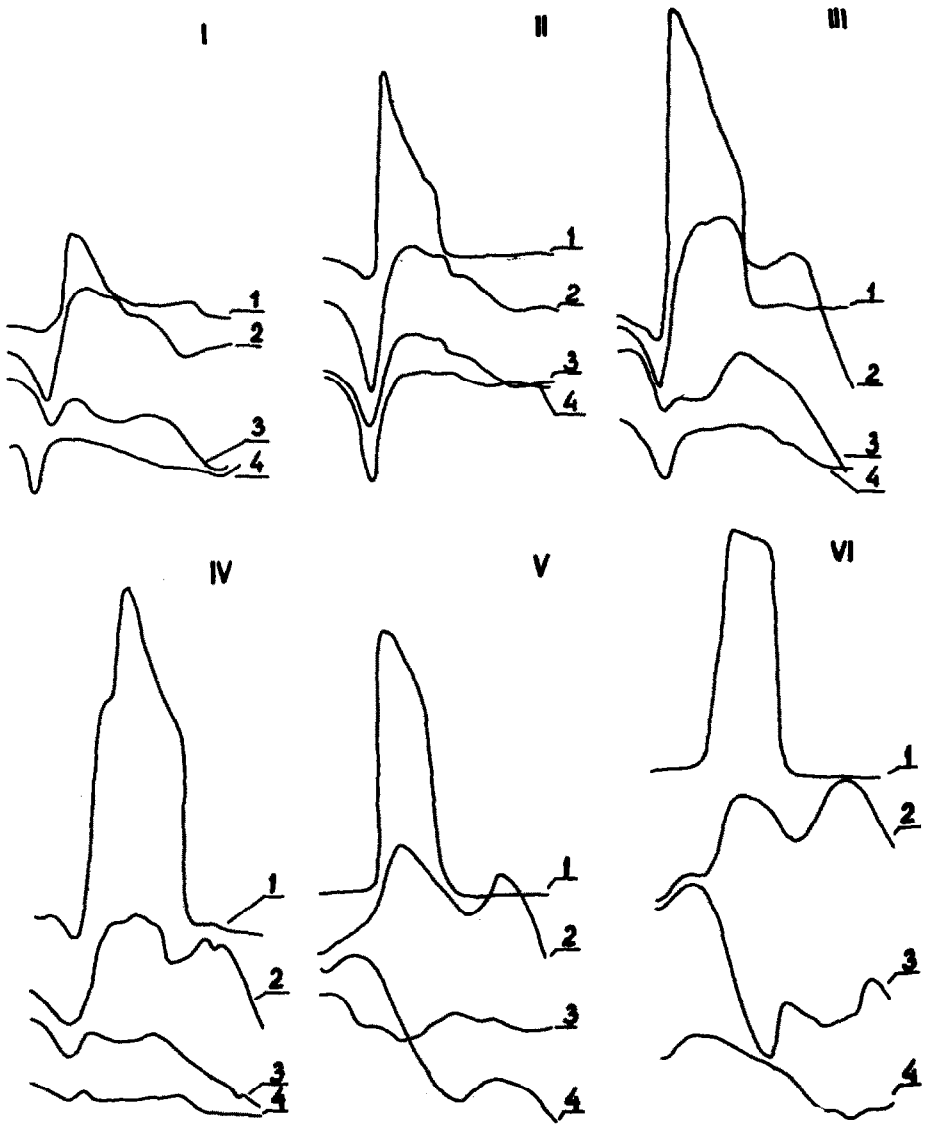

Fig.1. DTA curves of various coals (derivatograph OD-102)
I-II brown coals
III-V bituminous coals
VI antracite
curve 1 - oxygen atmosphere
curve 2 - air atmosphere
curve 3 - carbon dioxide atmosphere
curve 4 - argon atmosphere

EXPERIMENTAL AND RESULTS

The investigation of coal by thermal analysis was carried out on two different apparatus designed by the same company (derivatograph OD-102 and Q). The coals being analyzed were

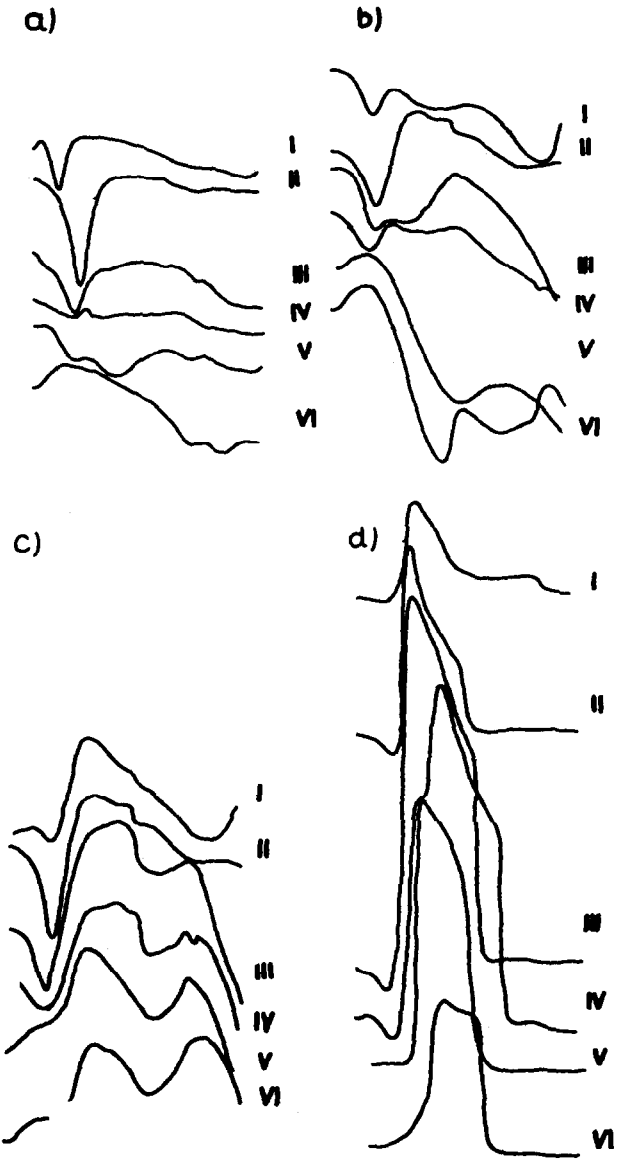

Fig.2. DTA curves of coals investigated in various atmospheres
I-II brown coals
III-V bituminous coals
VI antracite
a) argon atmosphere
b) carbon dioxide atmosphere
c) air atmosphere
d) oxygen atmosphere

Table 1

Characteristic of coal investigated

Number of Coal	Kind of Coal	Moisture W^a %	Ash A^d %	Volatile Matter V^{daf} %
I	Brown Coal (Sieniawa Coal Mine)	22,70	28,90	54,50
II	Brown Coal (Lubstów Coal Mine)	27,95	11,95	52,95
III	Bituminous Coal (Sosnowiec Coal Mine)	10,78	5,41	33,13
IV	Bituminous Coal (Manifest Lipcowy Coal Mine)	1,26	8,36	26,91
V	Bituminous Coal (Victoria Coal Mine)	2,30	4,53	15,17
VI	Antracite	0,71	4,22	13,41

coals of various coalification degree (brown coals, low-, medium-, and high rank bituminous coals and antracite).All the coals analyzed had the same grinding (particle below 0.2 mm i.e. analytical grains). Characteristic of the coals is given in Table 1. Fig. 1 presents the DTA results of coal investigated made in the dynamic atmosphere: oxygen, air, carbon dioxide and

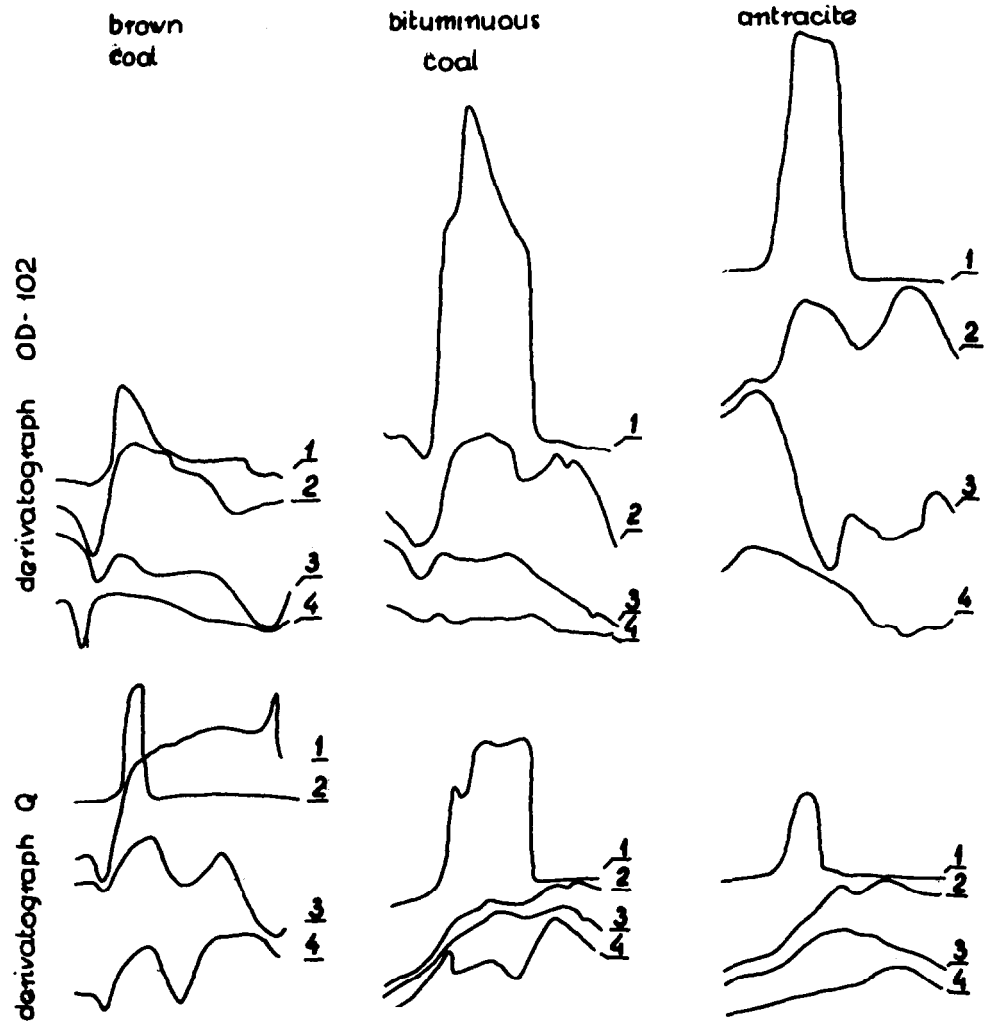

Fig.3. Comparison of the DTA results carried out on the two derivatographs.
curve 1 - oxygen atmosphere
curve 2 - air atmosphere
curve 3 - carbon dioxide atmosphere
curve 4 - argon atmosphere

argon. On the basis of these analyses it is possible to determine the nature of changes for the particular coal depending on the atmosphere as well as to determine at what temperatures the most important changes egzo-, or endothermic take place. The DTA curves made in the same atmosphere (Fig. 2) has similar character depending on the coal coalification degree while the peaks characterizing the decomposition of the structure are shifted at higher temperatures, which is the case in all atmospheres investigated.
When comparing the thermal analyses the same coal in the same atmosphere with those made on two different derivatographs (Fig. 3) it is possible to observe a somewhat different run of the DTA curves. Of different nature is also the range of temperatures which are characteristic of the given changes.

CONCLUSIONS

As the degree of coal coalification increases, the range of characteristic temperatures reflecting the decomposition of the structure or reaction is shifted towards higher temperatures. The repeatability of thermal analyses is comparatively good on each apparatus mentioned above. However when comparing the results of the thermal analysis of coal obtained from the above mentioned derivatographs the relative results are somewhat different from each other. On account of the complex structure of coals and their heterogeneity there is a pressing need for unifying investigations into coal by means of thermal analysis since the evaluation of coal thermal analysis may appear (as shown in introduction) to be non-univocal.

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