

Note

THERMAL ANALYSIS OF PEAT AND PEAT SOILS

O. ATANASOV and D. RUSTSCHEV

Higher Institute of Chemical Technology, Sofia 1156 (Bulgaria)

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Thermal analysis is a widely spread method for investigating different types of peat and the products of its treatment with solvents and chemical substances. Gluschenko [1] has given DTA curves of six peat samples with different degrees of decomposition (16–60%). Rustschev et al. [2] found out that valley peat differed from mountain peat in its greater exothermal effect. The interaction between the peat organic mass and ammonia [3], the composition of the hydrolyzed products [4] and the influence of the mineral components on peat combustion [5] were studied by thermal analysis. Drojanska et al. [6–8] investigated the thermal degradation of peat combined with different compounds. They studied its pyrolysis in the presence of 20% phenol, hydroquinone and phenanthrene and found out that the activation energy was greater in the last case [9].

In a previous work [10] we attempted to combine the results of peat-group chemical analysis with thermal analysis data. It was found that the primary peat was characterized by two exothermal effects at 290 and 375°C. After bitumen and humic acid separation, the second effect decreases or disappears, respectively. The DTA curves of isolated bitumens, humic acids and hemicellulose have typical endo- and exothermal effects that differ significantly from those of the primary peat.

METHODS AND RESULTS

Seven peat and peat soil samples were used to investigate the influence of the combustible peat mass (CPM) quantity on the thermal degradation of the peat, taken from a different depth of the peat field. The samples were taken from the southwest side of the field by a Riller type prospecting drill with a chamber 20 × 200 mm in size. Radiocarbon dating of some samples was made [11] according to a complex palaeoecological research [12]. The botanical composition of the samples was determined by the Troels-Smith system.

The seven samples investigated can be characterized as follows: (1) from the surface (sedge peat); (2) from 70 cm depth (sedge peat), age 1360 ± 50

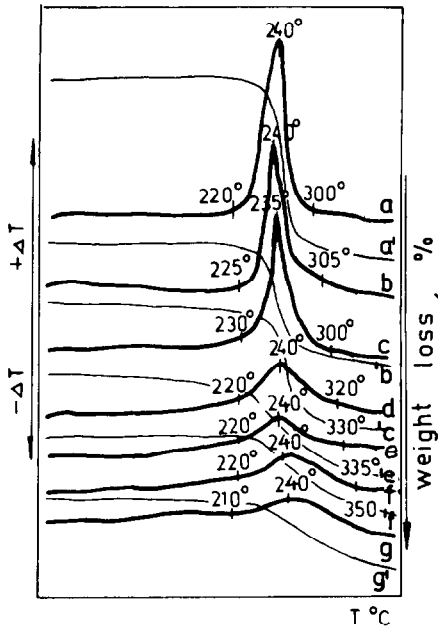


Fig. 1. DTA and TG curves of peat samples taken from different depths of the field: (a, a') surface; (b, b') 70 cm depth; (c, c') 140 cm depth; (d, d') 210 cm depth; (e, e') 280 cm depth; (f, f') 350 cm depth; (g, g') 420 cm depth. The thermal and thermogravimetric analyses were carried out in an oxygen atmosphere.

BP; (3) from 140 cm depth (sedge peat), age 2380 ± 50 BP; (4) from 210 cm depth (sedge peat); (5) from 280 cm depth (sedge peat), age 3130 ± 55 BP; (6) from 350 cm depth (peat mixed with rotten slime); (7) from 420 cm depth (lake rotten slime), age 6500–7000 BP.

A Paulik–Paulik–Erdey type OD-102 apparatus (Hungarian Optical Works, Budapest) was used for the thermal analyses which were carried out under fixed experimental conditions: heating rate, 5° min^{-1} ; temperature range, 20–500°C; sample mass, ~ 100 mg; inert material, Al_2O_3 ; medium, oxygen or air.

The samples were heated first in oxygen to determine the ash amount (A). The quantity of the combustible peat mass was then calculated ($100 - A = \text{CPM}$).

The differential thermal and thermogravimetric curves are shown in Fig. 1. It is seen from the DTA curves that the area of the exothermic peak with maximum at 230–240°C decreases with increasing depth from which the sample is taken and it completely disappears from the last curve (Fig. 1, curves a–g). The change in the exothermic effect is due to the combustion of the peat organic mass and it also corresponds to changes in the thermogravimetric curves. The slope of the TG curves decreases in the temperature range 210–350°C as the depth of origin of the peat samples increases (Fig. 1,

TABLE 1

Temperature of ignition and combustion of peat samples, taken from different depths of the field

No.	Samples taken from (cm):	T_{ign}^0 (°C)	T_{comb}^0 (°C)	Residue weight (%)
1	0	220	300	15.4
2	70	220	305	25.8
3	140	230	300	30.4
4	210	220	320	52.7
5	280	200	330	58.2
6	350	220	335	64.4
7	420	210	330	84.6

curves a–d, f and g). The temperatures of ignition (T_{ign}^0) and combustion (T_{comb}^0) for every sample can be determined from the corresponding DTA curves as the onset and end temperatures of the exothermic peak (Table 1). The ash amount (and the respective amount of peat combustible mass) can be determined from the thermogravimetric curves as the residue weight after heating to 500°C. These results are also given in Table 1.

The data show that the samples have similar temperatures of ignition (210–230°C) and combustion (300–350°C), in spite of the great difference in the amount of combustible mass (83.6–15.4%).

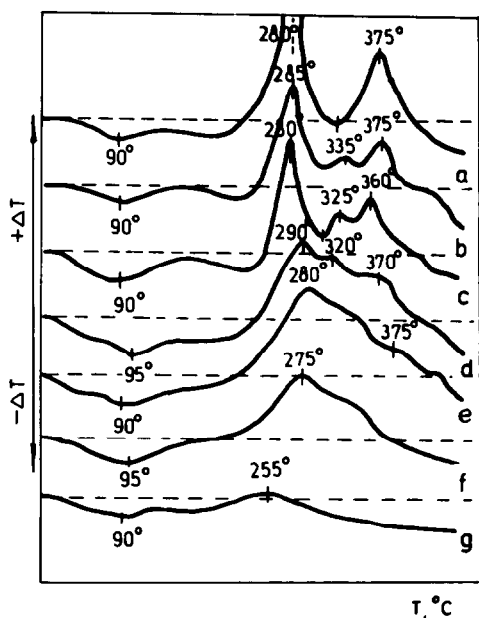


Fig. 2. DTA curves of peat samples taken from different depths of the field: (a) surface; (b) 70 cm depth; (c) 140 cm depth; (d) 210 cm depth; (e) 280 cm depth; (f) 350 cm depth; (g) 420 cm depth. The differential thermal analyses were carried out in air.

The primary peat samples were also investigated in air (uncontrolled air atmosphere). The DTA curves thus obtained are shown in Fig. 2. The exothermal effects in the temperature range 280–375°C are characteristic of samples with higher combustible mass contents (Fig. 2 curves a–g). Gluschenko [1] also considered that the thermal degradation of peat takes place with two exothermal effects at 270 and 460°C which are a result of the significant liberation of volatile compounds and the positive heat effects of both the reaction of decomposition of oxygen-containing compounds (that leads to their isomerization) and the reactions of decarboxylation and dehydroxylation.

With increasing the depth from which the samples are taken and decreasing the combustible mass content, the exothermal peak in the DTA curves (Fig. 2, curves d–f) and its maximum shifts to lower temperatures (290–280°C). According to these results we can use the DTA curves for distinguishing peat samples from peat soil samples. The DTA curve of the last sample (Fig. 2, curve g) which is a typical peat soil sample (with combustible mass content, 15.4%) has no characteristic exothermal peaks. Only one unclear exothermal maximum can be seen at 255°C.

CONCLUSIONS

(1) Differential thermal and thermogravimetric analyses were carried out for seven peat and peat soil samples. The samples were taken from different depths (0–420 cm) of the peat field, whose age varies from 1800 to 7000 BP. Thermal analysis in oxygen allows us to determine the ash amount, $A = 15.4\text{--}84.6\%$ and the respective combustible peat mass content, $CPM = 84.6\text{--}15.4\%$.

(2) The thermal degradation of the peat organic mass takes place with definite exothermal effects: one at 230–240°C, and two more in the temperature ranges 280–290 and 360–375°C dependent on the medium (oxygen or air). The DTA curves are a convenient method for differentiating peat samples from peat soil samples.

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REFERENCES

- 1 I.M. Gluschenko, *Thermal Analysis of Coals*, Metallurgy, Moscow, 1968, p. 118.
- 2 D. Rustshev, E. Alexiev and V. Batschvarov, *Bull. Higher Inst. Chem. Technol.*, Vol. VIII, Book 1 (1961) 9.

- 3 S. Mal and S. Paverkova, *Chemistry of Coals*, No. 5, 1982.
- 4 S. Tolpelnikova, A. Kounina et al., *Chem. Coals*, 3 (1981).
- 5 I. Lishtvan et al., *Chem. Coals*, 2 (1982).
- 6 N. Drojanska et al., *Chem Coals*, 2 (1974) 61.
- 7 N. Drojanska, V. Rakovskii et al., *Chem. Coals*, 2 (1974) 16.
- 8 N. Drojanska, V. Rakovskii et al., *Chem. Coals*, 5 (1980) 7.
- 9 N. Drojanska et al., *Chem. Coals*, 1 (1984) 42.
- 10 D. Rustshev and O. Atanasov, *J. Therm. Anal.*, 27 (1983) 339.
- 11 S. Hakansson, *Radiocarbon*, 25 (1983) 875.
- 12 B. Rerghund, *Presentation of the IGCP Project 158 B*, *Acta Univ. Ouluensis*, A 82, *Geol.* 3, (1979) 39.