THERMAL DECOMPOSITION OF ALGAE BLOOM BIOMASS

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(Received January 28, 1995; in revised form June 25, 1995)

Abstract

The algae bloom biomass in the water reservoir 'Rybnik' is an important problem, and not only in Poland [1, 2]. The algae growth in the water affects its odour, colour, taste and quality [3].

Algae bloom biomass removed from water can be treated in the following ways:
- disposal in sanitary landfills,
- storage on special dumping grounds,
- fermentation,
- dewatering and incineration.

In this paper the physicochemical composition and thermal analysis of the biomass of algae bloom dried at 378 K or in the open air are described. Thermal analytical measurements were made in an air atmosphere.

Keywords: algae bloom, thermal analysis, utilization

Introduction

In environmental engineering, thermal analysis is used to determine the thermal stability of various sewage sludges, solid municipal and hazardous wastes [6], biological substances, their characterization and classification, especially in terms of health risk assessment. The thermal analysis of some biological materials has been presented by Pacha [4].

In addition, thermal analysis has been applied to the quality control of soils and agricultural residues to determine the calorific value. The utilization of algae bloom biomass from a polluted water reservoir is known to create certain environmental problems.

0368–4466/96/ $ 5.00

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Experimental

The following samples of the algae bloom biomass were investigated:

– green algae bloom biomass dried at 378 K,

– green algae bloom biomass centrifuged at 4000 r.p.m. for 5 minutes, upper layer, air-dried,

– green algae bloom biomass centrifuged at 4000 r.p.m. for 5 minutes, lower layer, air-dried.

The physicochemical characteristics of the samples of the algae bloom biomass are presented in Table 1.

Table 1 Physicochemical characteristics of samples of the algae bloom biomass

Characteristics	Samples dried	Centrifuged samples	
	at 378 K	upper layer	lower layer
Moisture/%			
gravimetric	96.58	94.84	94.07
azeotropic	97.30	95.60	94.00
Phosphorus in dry matter/%	2.12	2.43	1.89
Nitrogen in dry matter/%	13.26	11.85	13.70
Ammonia in dry matter/%	0.26	1.52	2.60
Sulphur in dry matter/%	0.63	0.71	0.68
Organic carbon in dry matter/%	52.7	65.5	63.2
Loss of dry mass at 823K/%	93.33	94.01	94.01
Heat of combustion/kJ kg^{-1}	21940	23160	23530

Gravimetric and azeotropic methods were used to determine the amount of water while phosphorus, nitrogen and organic carbon were determined by spectrophotometric, Kjeldahl and Turin methods, respectively [5].

Microelements were determined in the samples by atomic absorption spectrometry with an AAS-3 spectrophotometer after mineralization, using concentrated HCl, HNO_3 and $HClO_4$. Thermal analysis was carried out with an OD-102 derivatograph (MOM, Hungary). The samples were heated up to 1273 K in platinum crucibles in an air atmosphere at a heating rate of 10°C min^{-1}, the reference material being aluminium oxide.

Results and discussion

Algae bloom biomass was found to decompose during the drying process at 378 K. The samples changed their consistence, odour and colour into black, whereas the air-dried samples remained green.

After a few days of drying, the mass was firm and hard, so it had to be powdered. Thermal analysis showed that the algae bloom biomass was stable up to 501 K. In a sample dried at 378 K loss of water was indicated by the DTG curve. The real decomposition of the sample, with heat emission, was observed at 501 K. The next exothermic process at 781 K leads to complete decomposition. The mass loss amounts to 95.2% and the residue does not decompose up to 1273 K.

The centrifuged, air-dried upper layer of the algae bloom biomass shows a noticeable mass loss at 373 K. A simultaneous endothermic effect may be observed in the DTA curve due to the departure of moisture. The decomposition of the biomass is indicated by an exothermic effect at 485 K. Further decomposition of organic substances is observed at 781 K, the mineral residue being 4%.

The lower layer of the algae bloom biomass reacts in a similar way at a high temperature. During the centrifuging process, the grey sample also revealed a

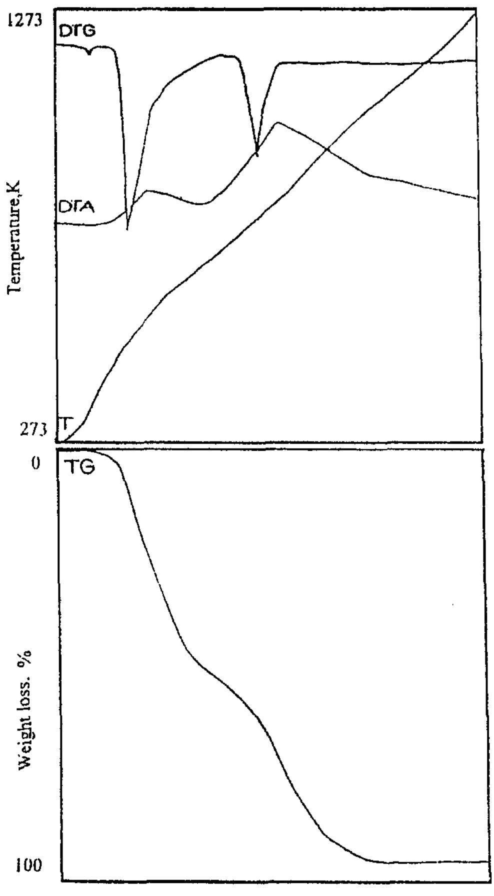

Fig. 1 Thermal decomposition of mixed algal bloom biomass dryed at 373 K

noticeable loss of water with an endothermic effect at 373 K. The decomposition of the algae bloom biomass takes place in an exothermic process at 485 K. A further exothermic process occurs at 797 K. The residue, obtained after heating to 1273 K, amounts to 4.7%.

The reactions of the samples of the algae bloom biomass occurring on uniform heating are presented in Figs 1–3.

Table 2 Contents of heavy metals in the algae bloom biomass/mg kg^{-1}

Sample	Element						
	Cd	Pb	Ni	Mn	Fe	Zn	Cu
Dried at 373 K	2.77	21.07	19.46	19.90	438.1	91.16	30.7
Centrifuged upper layer	3.23	30.27	20.43	33.42	442.5	87.64	30.7
Centrifuged lower layer	3.51	52.42	20.23	32.72	438.1	91.16	30.7

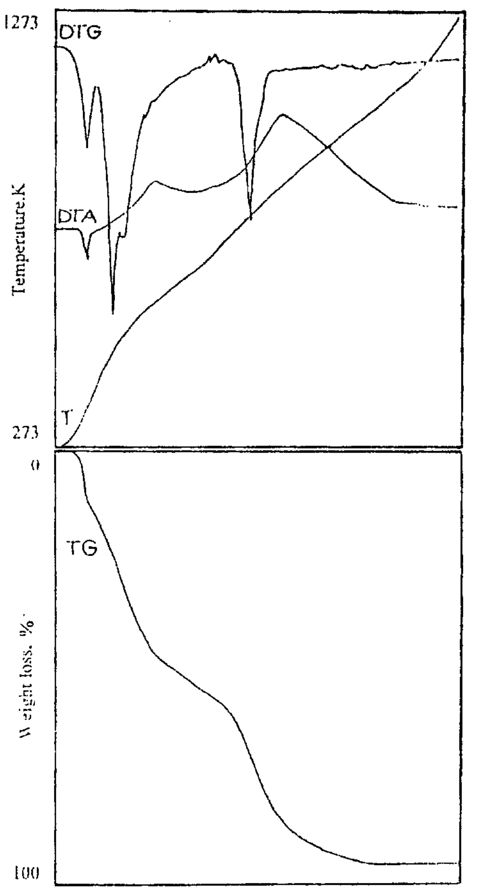

Fig. 2 Thermal decomposition of upper layer of algae bloom biomass centrifuged

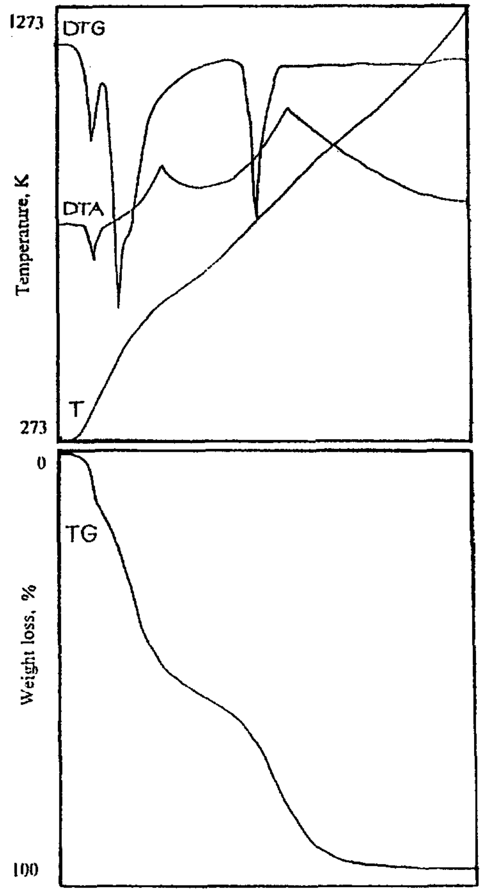

Fig. 3 Thermal decomposition of the lower layer of algae bloom biomass centrifuged

Conclusion

Samples dried at 378 K, and those centrifuged and air-dried clearly differ in colour, odour, appearance and the content of ammonia nitrogen but they show surprisingly small differences in thermal behaviour and fuel value.

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