Short Communications

DTA STUDY OF THERMAL COMBUSTION OF TEXTILE FIBRES

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(Received February 20, 1973)

A modification of the Speil theory is used to compute the heat of combustion of textile fibres, via a standard curve $\Delta H/S$ (S: thermal peak area of standards) against temperature (T).

In the last years thermal methods have become very highly developed as a result of their widespread use in the characterization of materials and processes of great practical interest. In the field of polymers [1], and fibres in particular, thermal methods have proved to be of great help in the study of polymerization

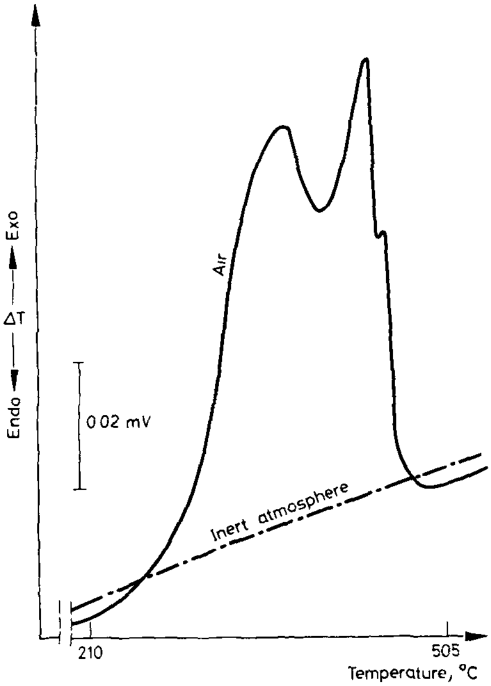

Fig. 1. DTA curves of cotton fibre in air and in an inert atmosphere

mechanisms, reactions between polymers and the measurement of physical constants such as transition temperatures, heats of combustion and degrees of crystallinity.

It has been observed in the present work that the decomposition of the textile fibres studied – the latest on the market – is due to self-combustion.

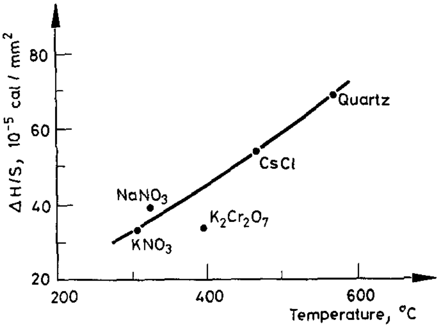

Fig. 2. $\Delta H/S$ curve of standards against temperature (T)

This explains why, in general, the reproducibility of the decomposition peaks is not so good as in the case of fusion maxima, as similarities in the differential thermal curves of the fibres exist in outline only.

Comparison of DTA curves obtained in the atmosphere and those in inert gas (nitrogen) (Fig. 1) suggests that the exothermic peaks do not properly correspond to fusion with decomposition of the fibre, but instead to true combustion.

The computations originating from the integration of the areas below the DTA curve do not correspond to heat changes due to fusion, therefore, but to heat of combustion.

Experimental

DTA measurements were carried out in a "B.D.L." apparatus, model M-1 (Platinel thermocouples) equipped with a "Kipp et Zonen" recorder, type BD1, under the following experimental conditions:

1. Heating rate: 4°/min;
2. Atmosphere: static air or inert (N_2, 20 cm^3/min), according to experiment;
3. Sample weight: 0.5 – 1.5 mg;
4. ΔT scale: 0.1 mV for complete deflection of 250 mm;
5. Reference material: MgO.

The method followed to compute heat of combustion [2] is based on the theory of Speil [3], with some modifications. In the first instance the areas of the peaks corresponding to the combustion of the fibres were computed, and since the combustion peaks do not correspond to Gauss maxima we proceeded to compute the areas of the $\Delta H = f(T)$ curves by planimeter methods (trapezoidal rule). At the same time, since the combustion zone oscillates between 300 and 800°, the heat of fusion was calculated from standards establishing the $\Delta H/S$ curve (Fig. 2) (S = thermal peak area of standards).

Results

The ΔH values obtained are expressed in cal/g instead of cal/mole, as the exact molecular weight of the fibre is not known: the textile fibres used are those obtainable commercially and are not fibres synthesized by us. The heat of combustion computed according to the method explained in the previous part is shown in Table 1.

Table 1

Fibre	Weight, mg	Temperature interval, °C	Heat of combustion, cal/g
Polyester	1.54	320–570	1642
Nylon-6	0.56	380–570	1200
Acrylic	1.37	398–800	885
Polyurethane	1.13	264–580	2854
Rayon	0.84	245–530	3145
Wood	0.96	235–650	4404
Cotton	1.39	212–504	3469

References

1. J. S. Double, Trans. J. Plastics Inst., (1966) 73.
2. W. J. Smothers and Yao Chiang, Handbook Differential Thermal Analysis, Chemical Publ., 1966, p. 97.
3. S. Speil, Technical Paper No. 664, U. S. Bureau of Mines, Washington DC (1965) 1.