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INVESTIGATIONS OF THE THERMAL DECOMPOSITION OF PVC CABLE MATERIAL BY MEANS OF SIMULTANEOUS TG-DTG-DTA-MS ANALYSIS

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ABSTRACT

A simultaneous working TG-DTG-DTA-MS (Thermogravimetry-Derivative Thermogravimetry-Differential Thermal Analysis-Mass Spectrometry) has been used to investigate the degradation process of polyvinyl chloride cable material in a static air atmosphere. The application of a quartz glass gas inlet system has been proved to be successful. The experiments have been carried out regarding the determination of biological hazards as well as the thermal stability of PVC.

INTRODUCTION

Thermal stability of polymer blends has been investigated by several authors. Results from pyrolysis-gaschromatographic and mass spectrometric investigations have been reviewed due to the growth of interest in industrial processing of plastics (ref. 1,2). In addition, a control of the decomposition reaction and determination of the composition of the volatiles released is needed as a function of temperature. These data have to be concerned to the main aspects of the combustion toxicology of fires (ref 3,4).

EXPERIMENTAL

The experimental procedure and description of the instrumental device (Netzsch STA 429, Balzers QMG 511) have been presented earlier (ref. 5). The PVC samples have been cut from phone cable coatings containing di-(2-ethyl-hexyl)phtalate (DOP) as a plasticizer.

RESULTS AND DISCUSSION

Polymer blends undergo transitions and degradation dependent on processing and purity.

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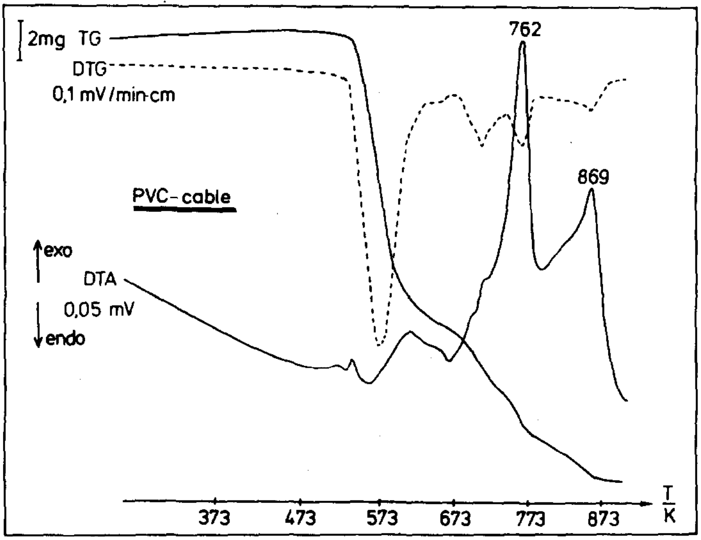

Fig. 1. TG-DTG-DTA curves of PVC cable from 293 K to 900 K

Fig. 1. shows a typical thermoanalytical run of PVC coating in the temperature range of interest. The TG and DTG curves indicate a four-step decomposition starting at 553 K up to a final temperature of about 900 K, when 4.7 % residual char has been formed. For better comparison and evaluation, mention has to be made to the composition of the evolved gas during the various degradation steps.

The simultaneously recorded original mass spectrum is exhibited in Fig. 2.

It shows the temperature dependent cleavage of some hazardous compounds. The sample mass has been 20 mg. The maximum intensity of hydrogen chloride has been estimated at 555 K.

The main mass loss of 58.5 % is due to the release of hydrogen chloride, corresponding to the first stage in the TG and a peak maximum at 555 K in the DTG curve.

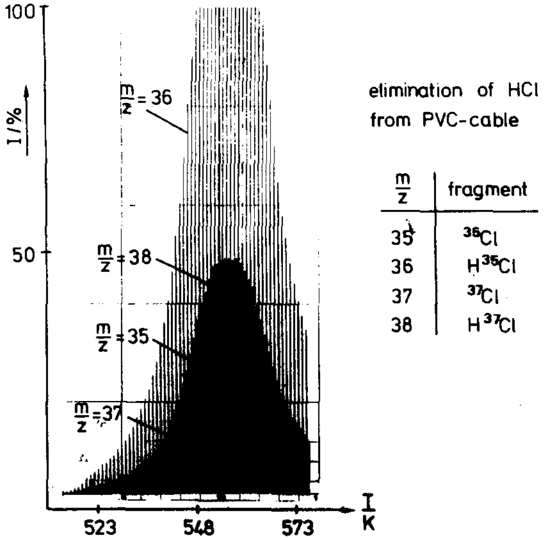

Fig. 2. Elimination of hydrogen chloride from PVC in the temperature range from 523 K to 573 K

The mass scan shown in Fig. 2 ranges from 35 amu to 38 amu confirming the chlorine isotopes in their natural abundance of $^{35}Cl/^{37}Cl$ as 3/1 ratio.

After the dehydrochlorination reaction the overall scanned mass spectra indicate a complicate mixture of chain scission fragments as well as aromatic hydrocarbon products.

The plasticizer DOP is often used in PVC manufacturing, so that our interest has been aimed at the identification of the most typical fragments of DOP as a function of temperature, which is demonstrated by example in Fig. 3. The mass fragment with the mass to charge quotient of 148 can be detected in a high ion yield. It is released from the sample in the same temperature range as the hydrogen chloride evolution occurs.

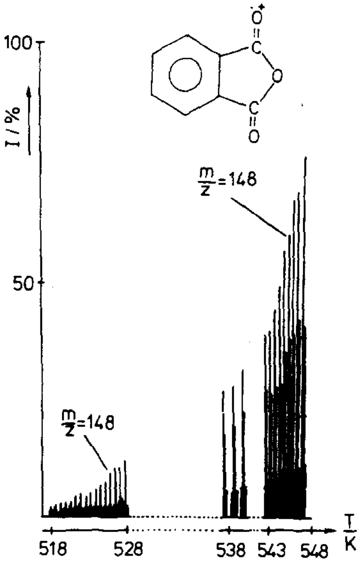

Fig. 3. Mass spectrum of DOP, m/z = 148

From this short communication, it can be concluded that the coupling system may be another suitable approach concerning better handling and investigation of thermal degradation properties of plastic blends and their additives. This method provides not only a measure of physical properties, it gives also an additional insight to the combustion toxicology, which gains more and more interest nowadays.

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