IDENTIFICATION OF POLYTHENE (POLYETHYLENE)

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ABSTRACT

This note describes an observation which can be advantageously used for detection or identification of polythene in a laboratory where facilities for ultraviolet or infrared spectroscopy do not exist.

Introduction

The chemistry of this well known thermoplastic material has been studied in detail by various authors but there is very little indication of any attempt to find out a suitable chemical method for its rapid identification when present alone or when admixed with other polymers, or any other apparently similar materials like paraffin wax.

Experimental

Polythene itself does not give any characteristic colouration with Halphen-Hicks reagent [1, 2] nor does it respond to the Liebermann test[3] or Storch-Morawaski test as modified by Kraus[4] and later by Wagner and Schirmer[5] but curiously it was observed that the distillate of the same after pyrolysis at normal pressure in presence of oxygen gives an immediate violet colouration with Halphen-Hicks reagent and a pink colouration with acetic anhydride and conc. sulphuric acid (Sp. gr. 1·62) when subjected to Storch-Morawaski test. This Storch-Morawaski test when tried on the distillates of other thermoplastics and elastomers and materials like paraffin wax etc. either gives negative results or develops different colouration as will be seen from the Table I below. As commercial polythene contains many additives e.g. antioxidant, plasticiser etc. the above colour test was therefore tried on solvent (Acetone benzene, Petroleum ether etc.) extracted sample and positive result was obtained. This was later confirmed by test on Polythene Basic Polymer without any additives (I.C.I. code W.J.G. 11). The details of sample used for confirmation are given in Table II.

TABLE I

Colouration obtained by Storch Morawaski test

Material	On original Material	On Distillate
Polythene	No colouration	Immediate pink colouration.
Polystyrene	No colouration	No colouration.
Polyvinylacetate	No colouration	No colouration.
Polyvinylchloride	No colouration	No colouration.

TABLE I—*contd.*

Colouration obtained by Starch Morawaski test

Material	On original Material	On Distillate
Cellulose acetate	No colouration	Light brown colouration.
Polyamide	No colouration	No colouration.
Polyacrylates	No colouration	No colouration.
Cellulose-Xanthate	No colouration	No colouration.
Cellulose-Nitrate	Green colouration	Colour discharged on addition of sulphuric acid followed by charing.
Rosin	Pink colouration	Pink colouration.
Natural Rubber	Light Green colouration	Faint yellow to violet reddish brown colouration.
Butadiene-rubber	Light yellow colouration	Brownish yellow to light brown colouration.
Polychloroprene	Green colouration	Green colouration.
Acrylonitrile rubber	Faint pink colouration	Slight yellow colouration.
Polysulphides	No colouration	No colouration
Paraffin wax	No colouration	No colouration.

TABLE II

Details of Alkathene Basic Polymer used for confirmatory results

Nomenclature	ICI code No W.J.G. —11.
Melt flow index	2
Density	0·919
Environment stress cracking (*h*)	1·2
Melt viscosity @ 190°C poises	30,000
Melting point	111—115°C.

It has also been observed that the higher fractions of the distillate give more immediate and a deeper colouration than the lower fractions, fractions distilling over 240°C giving the deepest colouration. Moreover, the colour developed is fairly stable and the depth of the colouration appears to be proportional to the amount of the distillate added. This well known colour reaction was tried with mixed distillates and of Polythene, Paraffin wax and various thermoplastics and elastomers and it has been found that even traces of polythene distillate in the mixture develop a pronounced colouration. If the mixed distillate has initially a deep colour, it does not interfere with the identifiation of polythene in a mixture as only a few drops of the distillate is required. Some natural

resins e.g. rosin, and their condensation products will of course interfere with this test but such materials can easily be separated out before proceeding by suitable method e.g. solvent extraction or Saponification.

Conclusion

The detailed chemical structure of polyethylene is most readily studied by infra-red spectroscopy[6]. The main difference between the spectrum of polyethylene and that of a linear paraffin is the presence of bands indicating the presence of methyl groups and of olefinic groups of the types $RCH=CH_2$, $RCH=CHR'$ and $RR'C=CH_2$, the last being the most abundant. Such a structure when thermally degraded random rupture of the C-C links along the chain may occur, preferentially at the points where the molecule branches resulting in the formation of product/s having higher degree of unsaturation [7, 8]. (Iodine value of the distillate was determined as 105-110 as against Iodine value 1 for the original sample). Moreover in presence of oxygen oxidation also is bound to occur and infra-red spectrum has already shown the introduction of Ketonic carboxyl group associated with cross linking of the molecules. However, exact elucidation of the structural characteristics responsible for the colour reaction suggested is under study and a detailed discussion on the subject will be published later.

Attempts are also being made to measure the depth of the colour by suitable physico-chemical means so that a quantitative evaluation is possible.

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