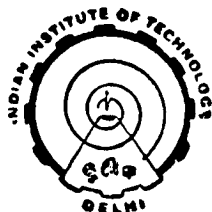


STUDIES ON CHLORINATION OF ATACTIC POLYPROPYLENE

by
MANORANJAN PATRI

A thesis submitted to the
Indian Institute of Technology, Delhi
for the award of the degree of
DOCTOR OF PHILOSOPHY



Department of Textile Technology
INDIAN INSTITUTE OF TECHNOLOGY, DELHI
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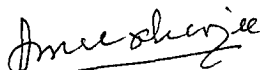
dedicated to

my parents.

CERTIFICATE

This is to certify that the thesis entitled "STUDIES ON CHLORINATION OF ATACTIC POLYPROPYLENE" being submitted by Mr. Manoranjan Patri to the Indian Institute of Technology, Delhi, for the award of the degree of Doctor of Philosophy, is a record of bonafide research work carried out by him. Mr. Manoranjan Patri has worked under my guidance and supervision and has fulfilled the requirements for the submission of this thesis, which to my knowledge, has reached the requisite standard.

The results presented in this thesis have not been submitted in part or in full, to any other University or Institute for the award of any degree or diploma.



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ABSTRACT

The present study deals with chlorination of atactic polypropylene (APP) followed by characterization and evaluation of properties of chlorinated product. Chlorination was carried out by thermal initiation without adding any other catalyst. The effects of various parameters on chlorination such as time, APP concentration, chlorine flow rate and temperature have been studied. The order of reaction with respect to APP concentration, and activation energy involved for the process have been determined. A mechanism for the process has been suggested.

The presence of chlorine in the polymer chain was ascertained from quantitative estimation of chlorine and from infrared spectroscopy. IR results indicate appearance of new absorption bands at $600-800\text{ cm}^{-1}$, which may be assigned to the presence of chlorine in the derivative polymer. ^{13}C -NMR study shows the presence of chlorine atoms in all the three possible positions namely tertiary, secondary and primary carbon atoms. Density of chlorinated APP (CAPP) shows a linear increase with increase in chlorine content due to decrease in free volume. Molecular weight and molecular weight distribution (MWD) studies by gel permeation chromatography and dilute solution viscosity show that molecular weight increases with increase in chlorine content, in general. However, during chlorination, chain scission takes place and hence the reaction conditions influence not only the chlorine content but also the molecular weight of

the chlorinated product. MWD curves are shifted towards the higher molecular weight side and the distribution was narrower in the chlorinated samples as compared to APP. Dilute solution viscosity value shows a continuous decrease with increase in chlorine content and is not dependent on the reaction conditions. The decrease in viscosity can be attributed to increased polar interaction leading to a decrease in hydrodynamic volume.

Thermal behaviour of chlorinated APP has been evaluated by thermogravimetric analysis (TGA), differential thermal analysis (DTA) and flammability studies. TGA study shows that initial decomposition temperature (IDT), integral procedural decomposition temperature (IPDT) and char yield of CAPP samples increase with increase in chlorine content. Similarly, T_g as measured by DTA, continuously increases with the increase in chlorine content and reaches a value of 98 °C at 53.5% Cl.

Flammability characteristics of chlorinated APP, as evaluated in terms of limiting oxygen index (LOI), shows a marked increase with increase in chlorine content of CAPP and reaches a value of 49 at 53.5% Cl.

The electrical properties, such as dielectric constant and volume resistivity of CAPP having different chlorine content have been evaluated. The results show that dielectric constant and volume resistivity of the chlorinated samples increase with increase in degree of chlorination.

Chlorinated APP has been used in PVC compound as a secondary plasticizer in conjunction with DOP as the primary plasticizer.

PVC compounds containing different amount of CAPP showed an improvement in properties, such as tensile strength, hardness, flammability and electrical properties as compared to those of compounds containing no CAPP.

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