SOME STUDIES ON DEGRADATION AND STABILIZATION OF POLYPROPYLENE TEXTILES

by

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Thesis submitted
in fulfilment of the requirements
for the degree of
DOCTOR OF PHILOSOPHY

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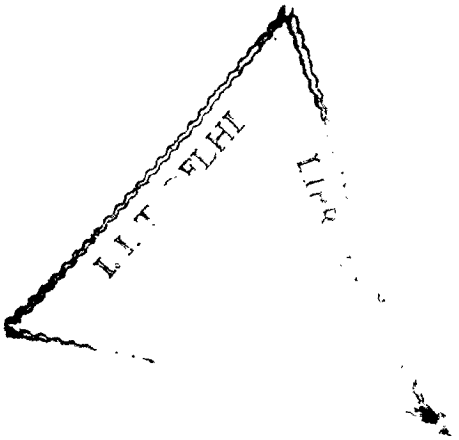
AUGUST, 1995



dedicated to

my parents

CERTIFICATE

This is to certify that the thesis entitled **"SOME STUDIES ON DEGRADATION AND STABILIZATION OF POLYPROPYLENE TEXTILES"**, being submitted by **Mr. Praveen Kumar**, to the Indian Institute of Technology, Delhi, for the award of the degree of **Doctor of Philosophy** in the Department of Textile Technology, is a record of bonafide research work carried out by him. Mr. Praveen Kumar has worked under my guidance and supervision and has fulfilled the requirements for the submission of the thesis.

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

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ACKNOWLEDGEMENTS

I express my deep sense of gratitude to Dr. Kushal Sen, Associate Professor, Department of Textile Technology, Indian Institute of Technology,Delhi, for his immense interest, co-operation and excellent guidance throughout the course of this research work. In these formative years of my research career, I have immensely benefitted from his privilege and pleasure for me to have been associated with him. And, the importance of his role in moulding my career cannot be expressed in words.

I wish to express my deep sense of gratitude to Prof. P. Bajaj and Prof. B.L. Deopura, for their valuable suggestions, keen interest and constant inspiration throughout the work.

I wish to express my gratitude to Prof. V .B. Gupta ,Prof. K.R. Salhotra, Dr. S.M. Ishtiaque, Dr. B.K. Behera and Dr. Sanjay Rastogi, for their help and encouragement.

I am extremely thankful to Mr. V.K. Jhingon, General Manager, Shriram Rayons, for extending my joining period for the completion of the thesis.

I wish to thank Mr. R. Khattar, V.K. Kala, Ashok Kumar, Raj Kumar, Shiv Charan, S.K. Dwivedi, Pati Lal, Om Parkash and Amarjeet of Fibre Production Lab. Mr. D.C. Sharma deserves my special thanks.

I don't have words to express my thanks and feelings for Mr. S.H. Bahrami for his great help, companionship and deep understanding during this research work.

I am extremely thankful to Mr. T.V. Sreekumar, Dr. S.K. Rana, Dr. Sanjay Mehta, Dr. J. Radhakrishnan, Dr. Meeenakshi, Dr. S. Mahajan, Dr. A.K.Roopanwal, Mr. D.K. Paliwal, R. Datta, Sumesh, Pankaj Varma, Ms. Hemlata, Ms. Kirti Sharma, for their

help during the research work.

Dr. Rakesh Koul, Suresh Garg, and Y.C. Bhuvanesh deserve my special gratitude.

My special thanks are due to Mr. Vijay Garg, D.S. Khatri, Dr. Y. Yadav, Mr. Pradeep Yadav, Jagdeep Singh, Dheeraj, Atul, S.P. Singh, Dheeraj, Atul, Narendra Chawla and Manjeet Saini for their help and co-operation.

Words are inadequate to express my feelings for my parents for doing everything for me selflessly. I remain indebted to them. I wish to record my gratitude to my better half, Vandana who is my constant inspiration and reservoirs of limitless love and joys and despairs, and makes my dreams come true. Mention must be made of my brothers Mukesh and Hariom who have always shown their love and co-operation to me.

Praveen Kumar .

(PRAVEEN KUMAR)

ABSTRACT

Polypropylene is commercially one of the most important polymers introduced to the textile and plastic trade and in a relatively short period, it has made its mark in the rapidly growing family of synthetic fibres. It is widely used in the form of fibres, tapes, films, moulded articles, twines, cords as well as in applications such as geotextiles. Its increasing use as a geotextile and industrial fibre is due to its remarkable mechanical properties and excellent resistance to mineral acids, alkalies, sea water, detergents, etc.. Polypropylene is also extremely resistant to fungi and bacteria. Hence, polypropylene based products are not liable to attack by living organism. Both these properties are very important from the point of view of geotechnical applications.

However, polypropylene on its own demonstrates poor resistance to heat and light, specially in the presence of oxygen . The polymer, therefore, is inevitably compounded with generous doses of antioxidants and heat and light stabilizers to inhibit oxidative degradation during processing and in service. Many types of primary and secondary antioxidants, UV absorbers, and free radical quenchers have since been developed. As far as photostability is concerned, hindered amine light stabilizers (HALS) have outperformed the traditional UV absorbers.

However, most of the studies were concentrated on elucidating the mechanisms involved in thermal and

photostability, giving no clues about their role in the development of structure as a result of their inclusion in the polypropylene matrix, and consequently their effect on the performance properties, e.g., mechanical properties of fibres.

Drawing and heat setting do affect the structure and morphology. Whether morphological changes are due to thermomechanical treatments or due to incorporation of foreign compounds, like catalysts, dyes and pigments or even stabilizers, these may lead to different ageing/degradation behaviour in addition to affecting the mechanical properties.

Incidentally, most of the stabilization studies on textile fibres have been conducted keeping short-term applications in mind. On the contrary, geotechnical applications require long-term stability. The fibres that show good performance in short-term may not really be good enough. Is it possible to estimate the useful life of a geotextile? What happens if the degradation process gets initiated before installation of the geotextile? Invariably such materials are stored at the site for long periods before installation and may be subjected to actinic degradation. What will be the effect of this on long-term stability of the geotextile? These and some more such questions were the motivation for the present project.

The work done in the present thesis may be divided broadly into three means :

i) The first one relates to the study involving the

effect of various types of stabilizers on the development of structure and morphology of polypropylene. Irganox 1010, Irgfos 168, Tinuvin 770, and chimasorb 944 were compounded with the polymer, having different concentrations and composition. Detailed investigations have been carried out on the polymer and the fibres therefrom, using WAXD, hot-stage microscopy, DSC, TGA, on-line DSC-FTIR, birefringence, sonic modulus and also tensile properties. Effect of stabilizer loading (%) on mechanical properties and of chemical nature on thermal degradation has also been correlated in this part of the study.

ii) Effect of morphology on the degradation profiles of polypropylene yarn has been investigated and this forms the second area of the present work. Undrawn, drawn and heat-set polypropylene yarns as well as those containing different stabilizers, were subjected to gamma irradiation to study their degradation behaviour with irradiation time. Gamma irradiation has been found to be useful for quick differentiation in degradation behaviour.

iii) The third area covered in this project relates to the study of long-term stability and prediction of functional life of PP geotextiles. To accomplish this polypropylene geotextile fabrics were buried under soil with and without a controlled pre-exposure to gamma radiations, weathering and

combination of these two degrading agencies. The data over a period of 27 months of burial has been collected and correlated. Finally, four different types of accelerated tests were also performed to generate degradation profiles PP yarns. From the long term study and the accelerated tests time factors have been computed to get an estimate, in real time scale, to reach a particular level of degradation.

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