

# **SOME STUDIES ON THE MODIFICATION OF STARCH FOR SIZING**

By

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DEDICATED TO  
MY  
FATHER-IN-LAW  
MOTHER-IN-LAW  
AND  
MUMMY, PAPA

CERTIFICATE

This is to certify that the thesis entitled "SOME STUDIES ON THE MODIFICATION OF STARCH FOR SIZING" submitted by Sarita Garg 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 her. Sarita Garg has worked under my guidance and supervision and has fulfilled the requirements for the submission of the thesis, which to my knowledge has reached the requisite standard.

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



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## ABSTRACT

Unmodified corn starch was chemically modified by substitution with the hydroxyethyl group to three levels (0.05, 0.1 and 0.15 molar substitution). The qualitative presence of the substituted hydroxyethyl group into the starch molecular chains is determined by carbon and proton nuclear magnetic resonance (NMR) spectroscopy and the quantitative estimation of the molar substitution is obtained by 'Modified Zeisel Alkoxy Method'.

The morphological and internal structure of starch and modified starch granules and films is studied. The molecular packing of the granules is determined by the X-ray diffraction and density measurements and of their films by the sonic modulus studies. The surface morphology of the granules is observed on the Scanning Electron Microscope.

The accessibility of moisture to the hydrophilic sites in starch and hydroxyethyl starch is determined by exposing the starch to different ambient environment (relative humidity). Gravimetric method is employed for the moisture regain of the films and the nature and distribution of moisture into the granule is estimated by the pulsed NMR technique. The above technique enables to determine the total moisture and its bound/mobile fractions, the force of binding of different fractions to the accessible groups.

Gelatinization temperature of starch and hydroxyethyl starch is determined using different techniques such as Differential scanning Calorimetry (DSC), Hot stage microscopy and viscography. An attempt is made to discover

the potential of the above techniques for the determination of gelatinization. DSC gives the heat of gelatinization which is helpful in estimating the heat requirement during cooking and reflects ease of cooking. The extent of swelling of the granules at different temperatures is studied by the 'Hot Stage Microscopy' and Image Analyser.

The rheological behaviour of starch and hydroxyethyl starch in terms of gelatinization, viscosity, retrogradation, storage stability and thermal reversibility is studied on the 'Brabender viscograph' as a function of concentration, time and temperature. The effect of addition of mutton tallow in starch is also investigated on the rheological behaviour.

The basic studies from the performance point of view on the films and size fibre matrix is made. The brittleness of the starch and hydroxyethyl starch film is investigated by studying the load-extension behaviour and breaking extension of the films at different relative humidity. In addition, the bending behaviour and cyclic flexing at 65% RH provide useful parameters for evaluating the role of hydroxyethyl group as internal plasticizer. The desizing is studied by investigating the solution rate of different size films by the standard desizing materials such as dilute hydrochloric acid, enzyme solution and under much mild conditions that is water at room temperature.

The adhesion of starch and hydroxyethyl starch to cotton, polyester/cotton (P/C) and polyester/viscose (P/V)

rovings at different relative humidity is compared in terms of 'specific adhesion'. Cotton, P/C and P/V yarns are sized on a laboratory Zell sizing machine. The mechanical properties of the sized yarns at different RH are evaluated on the 'Instron Tensile Tester'. The flexibility of the sized cotton yarns at 65% RH is compared by the flexural rigidity and the sonic modulus.

The effectiveness of different sizing agents at low RH is investigated by studying the relative performance of the sized yarn at different RH on the laboratory weaving simulator, web tester.

The work helped a lot in understanding the relative contribution of the nature and structure of the chemical group substituted into starch in providing accessibility to moisture. The mechanism of plasticization and the role of the internal and external plasticizers in increasing the flexibility, and the weavability is understood. The optimization of conditions of cooking, processing, weaving and desizing is achieved.

Three way statistical analysis of variance of the weavability cycles showed the significant effect of the variables fibre type, size and relative humidity; the contribution of fibre type, size and fibre/size interactions is the highest.

Weavability cycles gave good correlation with adhesion and yarn extension on abrasion.

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