INTRODUCTION
I. INTRODUCTION

Cellulose is the most abundantly available naturally occurring organic material in the world. It is a naturally occurring polymer of glucose, and the accepted view is that it is a 1,4-β-D-linked polyanhydro glucopyranose (Figure I.1). It is the principal constituent of the cell walls of higher plants, and provides them with their structural strength. It is estimated that 100 billion tonnes of cellulose in the form of renewable vegetation is produced every year on this planet. This translates into an availability of approximately 20 tonnes of cellulose for every person on earth (1). Indeed, the wide range of derivatisation of cellulose possible has given mankind a magnificent variety of products of academic interest as well as of industrial usage. It is more than a century since cellulose nitrate, cellulose acetate, cellulose xanthate, and many other derivatives were produced as industrial materials, and these continue to be important materials even today. Recent researchers have seen, expectedly, an ever-increasing interest in these materials, and development of new derivatives continues (2). Another major incentive for developing industrial materials based on renewable cellulose is that cellulose derivatives are generally considered to be biocompatible, biodegradable, environment-friendly, and non-toxic. Modern society is increasingly conscious of its responsibility to develop and use environment-friendly
FIG. 1: STRUCTURE AND CONFORMATION OF THE CELLULOSE MOLECULE
materials, and several nations even have strong legislations in this regard.

Oxidation of cellulose to produce modified celluloses known as oxidized celluloses was first investigated in 1882 by Witz (3). This chemical modification of cellulose was seen to impart several desirable properties to cellulose, and therefore continues to be investigated till today (4-10).

A wide range of oxidising reagents such as sodium chlorite, potassium chromate, hypochlorous acid, sodium metaperiodate, nitrogen dioxide, nitrogen tetroxide, etc. are known to oxidise cellulose, and the structure and properties of the oxycellulose produced depends on the reagent used, its concentration, pH of the medium, reaction time, temperature, etc. For example, nitrogen tetroxide is known to oxidise the C-6 hydroxyl of cellulose to produce a carboxyl group, while sodium metaperiodate selectively cleaves the C-2 - C-3 bond to produce 2,3-dialdehyde cellulose. From the large number of possible oxidation products of cellulose, 2-3 dialdehyde cellulose, 2-3 dicarboxycellulose, and polyglucuronic acid have found interesting applications (1, 11-22).

Partial oxidation of cellulose can lead to a variety of polymers having different functional groups, such as aldehyde and carboxyl, in addition to the primary and
secondary hydroxyl groups already present. This can increase the range of applications of cellulose for industrial applications. Oxidized cellulose has increased affinity for various dyes (12), and this has great significance for the textile industries. Fire resistant materials can be made from oxidized cellulose by reacting them with tris(hydroxymethyl) phosphine, alkylene oxide, and tris(aminomethyl) borate (13,14). Oxidized cellulose can have two carboxylate groups, and therefore can have applications in removal of heavy metals from aqueous solution by flocculation (15), and its good sequestering power for ions causing hardness in water results in its useage as a detergent builder (16). Oxidized celluloses show improved initiation characteristics compared to the unoxidised samples of cellulose in graft copolymerisation studies, and give larger yields of graft copolymers (17,18). Use of oxidized cellulose and as reaction-incorporated fillers in epoxy matrix have been shown to improve cure rates, prevent phase separation by chemically linking the filler and the polymer matrix, and eliminate the compounding step for addition of curing agent (19). Oxidized cloth has been shown to be useful for immobilising enzymes like collagenase in bandages for wound healing (20). Microbicides, which are safe and useful for textiles, coatings, and building materials, have shown 100% fungicidal effect when immobilized on oxidized cellulose (21). Oxidized cellulose, when converted to difluoroaminated dialdehyde cellulose, are
useful in explosives and propellants (22).

Thus, it is clear that oxidized cellulosics represent an important class of cellulose derivatives. Oxidation reactions result in a change in the molecular weight and molecular weight distribution, crystallinity and other structural features, solution properties, thermal properties, etc., of the resulting polymer molecule. A search of the literature showed that no detailed systematic study of the structure and properties of oxidized cellulose samples having incremental changes in their degrees of oxidation had ever been reported. In view of these lacunae, as well as their diverse applications and potential for further development as industrial materials, an investigation into the structure and properties of oxidized cellulosics in the solid state as well as in solution seems to be warranted. Therefore, these aspects form the subject matter of this dissertation.
References


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