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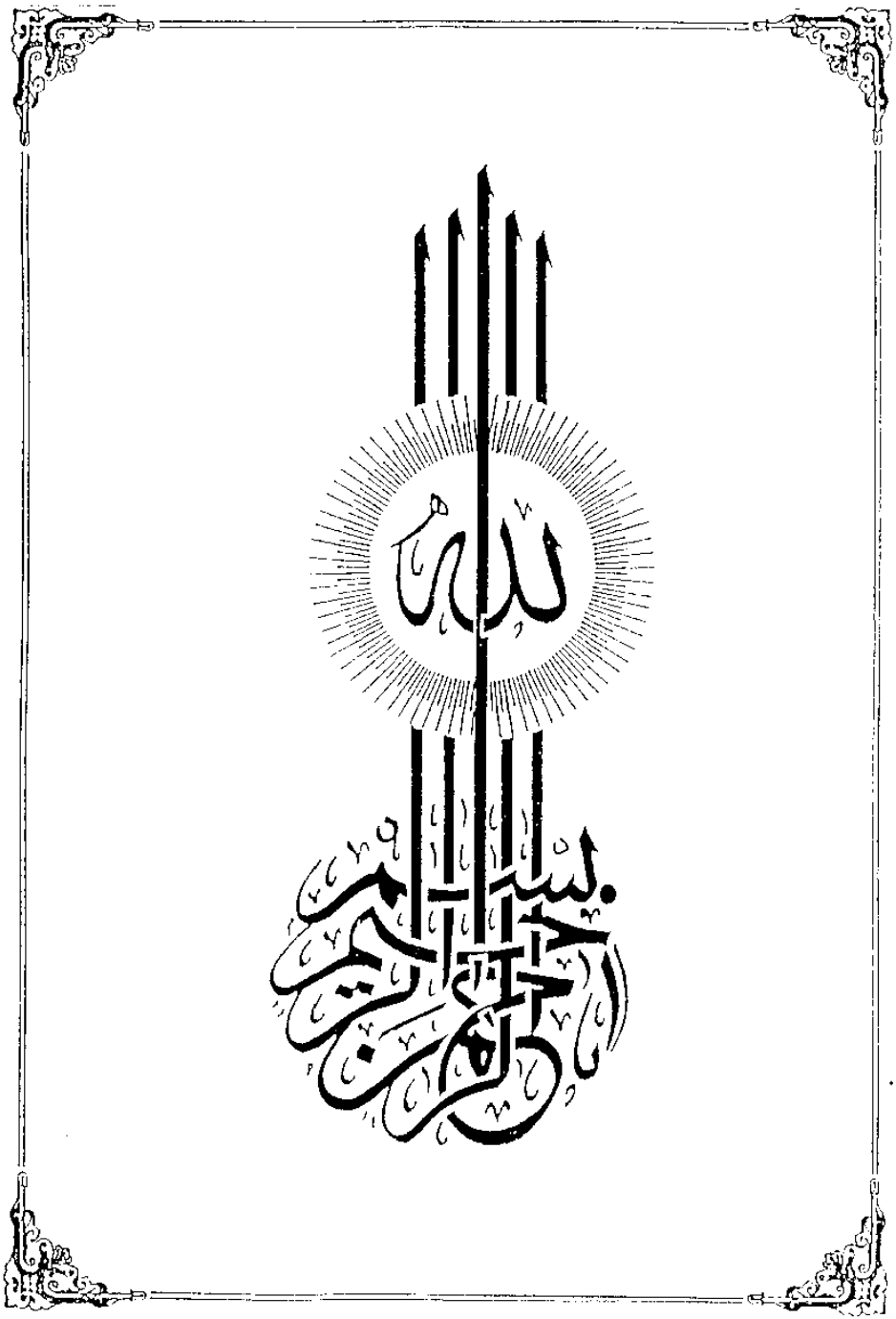
مشرفا وعضوا .



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C O N T E N T S

Page

INTRODUCTION

1. Structure of Cellulose Fibers:

A wood fiber cell consists of primary wall, secondary wall and the lumen or cell cavity. The fibers are cemented together by non-cellulosic material known as middle lamella[1]. In higher plants, the primary wall in the form of a thin membrane is called cuticle. The secondary wall represents the bulk of cellulose substance paper. The fibers of cellulose may be regarded as a two-phase system consisting of the same chemical material which is arranged in two different types of physical aggregation, with a meso-amorphous portion as a region of transition. The cellulose chains in the crystalline region are arranged strictly parallel, less so in the meso-amorphous portion and more less in the amorphous region. The primary wall is though consisted mainly of amorphous non-cellulosic constituents. The major part of the crystalline cellulose exists in the secondary wall which is built up of fibrils. The ratio of crystalline to amorphous materials in cellulose fibers can be determined by:-

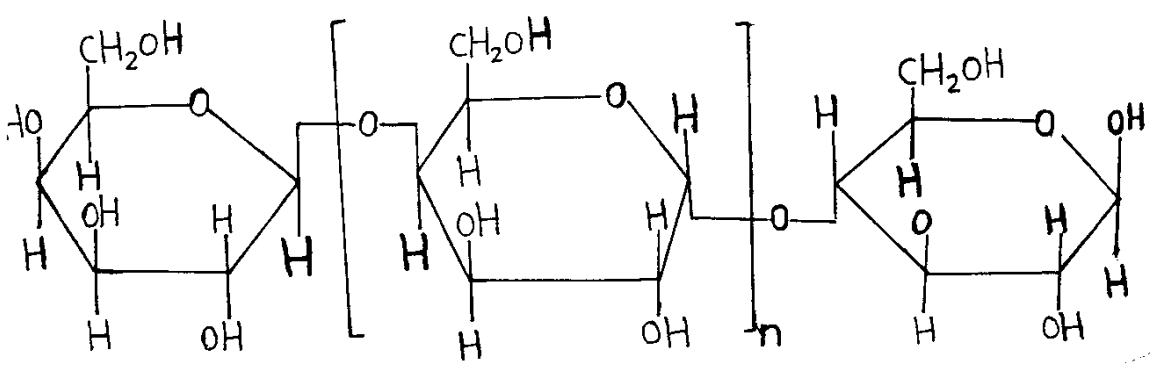
1. Chemical method such as the difference in the rate of acid hydrolysis and oxidation[2].

2. Physical method such as x-ray analysis and density measurement.

In general, the results obtained by chemical method show higher proportion of crystallinity than the physical method due to the crystallization which takes place during the treatment[2].

The amorphous cellulose determined by the chemical method is sometimes refferred to as accessible cellulose. In the crystalline region, the fiber has its maximum resistance to elongation and its maximum strength. In the amorphous region, the fiber has its greatest extensibility and flexibity. The degredation which occurs when cellulose is treated with acids or oxidizing agent, the reaction occur in the amorphous regions where the molecule can easily penetrate between the chains.

The cellulose molecule is composed of a series of glucose units. These glucose units are linked together by oxygen bonds. The cellulose molecule thus consists of long straight chains of glucose anhydride units arranged in cellobiose pairs. The alcoholic group in the cellulose molecule undergoes alcoholic reaction such as esterification, oxidation and alcoholate formation. In addition to alcoholic groups, there are also some carboxyl groups which are few in numbers, so cellulose acts as a monobasic acid. The concentration of carboxyl group is highest in the outer layer of cell wall decreases linearly near the lumen (neart to O). Cellulose used for chemical reaction are obtained from different raw materials such as wood, cotton, staple fibers, sugar cane, bagasse and straw[3].



Structure of Cellulose

II . Paper Manufacture[4]:

Pulp preparation is the beginning phase of paper manufacture, since it is impossible to produce paper without first reducing the raw material to the fibrous state by mechanical or semimechanical means. The second basic step is pulp purification whereby the pulp is subjected to bleaching and purifying agents to render the pulp more suitable for its intended use. The properties of pulp and paper made from it are determined in the pulping process which have three principal types[5]:

- The mechanical process: Involves the reduction of wood or other raw material to the fibrous state by mechanical means, generally by grinding wood to a pulp against a large groundstone[5].

- The chemical process: Involves cooking the wood with chemicals which selectively remove lignin and other impurities, isolate and partially purify the individual fibers[5].

- The semichemical process: Involves an initial treatment for softening the wood, followed by mechanical reduction to the fibrous state[5].

The initial treatment may vary from a simple steaming of wood to a more drastic treatment with chemical. Functional properties cannot be changed without chemical treatment of the fibers or protection of the paper through cooking. The type of wood used, the extent of cooking, bleaching and the degree of bonding between fibers determine to a large degree, the physical and optical properties of the paper. The amount

of the fiber treatment, formation on the wire, amount of wet pressing method of drying and amount of calendering are the principal factors affecting the degree of bonding. The variables must be controlled to obtain a finished paper of desired properties which often means sacrificing one property to another. Paper has two sides, the wire and felt sides. The wire side is always the rougher because of the diamond-shapped pattern caused by wire marks. Paper is generally open or porous on the wire side and a closed or non porous on the felt side. The difference in smoothness and porosity on two sides is refferred to as two sidness.Paper has a definite grain caused by the greater orientation of fibers in the direction of travel of the paper machine and the greater tension exerted on the paper in this direction. This is known as the machine direction. The cross direction is the direction at right angles to the machine direction. So the grain of paper must be taken into account in measuring all physical properties[6].

III. The Role of Beating on Fiber Preparation[7]:

Cellulose fibers must be subjected to mechanical treatment before they can be made into paper. This treatment may be applied in a number of different ways but it ordinarily includes fiberation, rubbing or crushing action on fibers. The term "Beating" are used in the paper industry to describe the operation of mechanically treating pulp fibers. Beating refers to a fiber separation, fiber cutting and a fibrillating effect on the fiber. Beating is an important step in the processing of pulps for nearly all grades of paper. It is probably the most fundamentally important process in papermaking. Paper made from unbeaten stock is low in strength, fluffy, porous and unfit for most uses, whereas paper made from beaten stock is strong, dense and hard in texture. Well-beaten fibers can be readily formed into a uniform sheet of paper quite high density, whereas unbeaten fibers cannot. It is now believed that no major chemical changes in the fiber occur during beating, since the x-ray diffraction pattern is not changed. The principal effects of beating are physical and among the most important are the following: fracture and partial removal of the primary wall of the fiber, decrease in fiber length, increase in fiber flexibility, formation of fibrils (fibrillation) and increase in the external specific surface of the fiber. The effects of beating are of fundamental importance in determining both the degree of interfiber bonding in a sheet of paper and the papermaking qualities of a given pulp. In general, beating improves some properties and has a bad effect on others. Thus, the papermakers must

select the proper beating condition to bring out certain properties without deteracting too much from other properties. However, increased beating within the commerical range increases bursting strength, tensile strength and folding endurane but generally tends to decrease tearing resistance. Increased beating tends to increase smoothness, hardness and amount of surface bonding of the fibers but on the other hand, tends to decrease the opacity and lower the bulk and dimensional stability of the paper. Beating of pulps is primarily mechanical and as a result physical changes in the fibrous structure and colloidal nature of the pulp occur but the chemical changes which may occur is a result of the great increase in surface activity of the fiber.

The effect of beating on the pulp are discussed as shown (5) :

- Effect on primary wall: Many chemists have pointed out that without extensive beating there is enough of the primary wall left on the surface of commerical pulps to prevent the maximum adhesion of the fibers. However, beating tends to break up, rub off whatever part of this wall which is left, thus exposing the layers of the secondary wall which swells very greatly. The considerable rate of increase of sheet strength which normally occur in the early stages of beating can be attributed to the removal of the primary wall (Clark, 1943)(8). When this occurs, the secondary wall is no longer constricted and can swell to two or three times its original diameter.

2. Hydration of pulp: Pulp is fully hydrated in the usual sense of the word before it is beaten but beating increase wetness or tenacity with which the fibers hold water, and in this way affects the rate of drainage on the paper machine wire. The amount of wetness which is developed in the beater is a very important factor in determining the properties of the final paper. It affects the amount of fiber-to-fiber bonding and hence, the bursting and tensile strength of the paper as well as the stifness, porosity, opacity, etc.

3. Fibrillation: An important effect of beating is fibrillation of the fibers. Fibrillation involves a loosening of the coarse fibrils. Beating increases the external surface of the fibers at the expense of internal surface but does not affect the total surface. The fibrillae also contribute to the retention of fibers in the paper by reducing the pores in the wet fibrous mat and entrapping the fine particles. Fibrilliae takes place as a result of the mechanical pounding of the fibers by beater roll. The type of fibrillation can be controlled by the beating process. External fibrilliation, which tends to produce strong, opaque papers is favored by prolonged light beating. Internal fibrillation which tends to produce strong translucent paper is favored by hard beating. Also, the type of refining equipment is important and various pulps differ in the type and amount of fibrillation which they undergo on beating[5].