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Study of the Determination of Brands of the Cooking Process of Cellulose Samples Based on Fiber Waste of Cotton Cleaning Enterprises (PTKTCh) Under the Influence of Specified Parameters

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ABSTRACT

During these studies, the results of the analysis of the determination of brands of cellulose samples based on PTKTCh (fiber pulp of textile enterprises) under the influence of the specified parameters of the baking process were performed. The influence of the parameters of the alkaline cooking process on the quality indicators of cellulose (PM-lint, PU- ulyuk, short cotton fluff - PKM-pux composite in 1:1 ratio 20g/l NaOH at the same time, 120 minutes) The released cellulose had a negative effect on the degree of polymerization and, on the contrary, a positive effect on its α-cellulose and swelling.

Cellulose is a stereoregular linear natural polymer, which is insoluble in heat and insoluble in most common solvents due to advanced bonds (primarily hydrogen bonds). Therefore, the products made of cellulose cannot be made by the methods commonly used in the processing of polymers - by molding from a molten substance, by solidification from a solution, or by plastic deformation methods. The main part of the materials containing cellulose is processed by mechanical and chemical methods of dispersing them into fibers, and then making the products (paper or cardboard) by wet molding. In this case, when the fibers are built, the inter-fiber bonds are strongly connected with each other, first of all, by hydrogen bonds.

Cellulose is the most abundant and easily obtained natural polymer and undergoes extensive chemical processing. Cellulose processing allows not only to convert cellulose to a soluble state, but also to obtain from its substances with completely new properties. In a number of cases, cellulose is converted into derivative products that are soluble in solvents that are easy to obtain, and the solution is molded into fibers or coatings. Cellulose is recovered from the derived products, and fibers or coatings of the recovered cellulose are removed. For example, viscose fibers and cellophane. In the chemical processing of cellulose, substances with new properties can be obtained: smokeless gunpowder, etrols, hydrophobic, i.e. non-wetting substances; water-soluble products with adhesive, thickening and apprizing properties; materials with new surface characteristics; products with ion exchange properties; materials resistant to the action of microorganisms; non-flammable, light- and heat-resistant derivative materials, etc.

The chemical properties of cellulose are explained by the structure of its molecule. One end of the molecule is completed with a reducing group, which gives the cellulose its regenerating properties.

Like all polysaccharides, cellulose can be subjected to hydrolysis (hydrolytic decomposition). In complete hydrolysis, cellulose is converted to glucose according to the following reaction:

$$(C_6H_{10}O_5)_n + nH_2O \rightarrow nC_2H_{12}O_6$$

This reaction is at the heart of the wood hydrolysis industry.

Most of the chemical processing processes of cellulose are based on the reactions of the hydroxide groups of cellulose macromolecules. The resulting derivative products of cellulose can be divided into three main classes: molecular compounds, substitution products, and oxidation products. Molecular compounds are unstable products, formed due to hydrogen bonds between hydroxides of cellulose and some extremely polar reagents.

Substitution products are formed as a result of a chemical reaction between cellulose hydroxides and reagents that bind by covalent bonding with the oxygen of these hydroxide groups. They include complex and simple esters of cellulose. These products will be of the greatest technical importance. Oxidized products of cellulose are usually decomposed. For a long time, they were not widely used in practice. Currently, cellulose oxidized with nitrogen dioxide is produced on an industrial scale. This product is primarily used in medicine as a good hemostatic agent. In addition, it is used in the textile industry and other industries. It is possible to introduce new reactive functional groups into cellulose macromolecules, use them for chemical transformations described in classical organic chemistry, and create cellulose graft copolymers and sandwich polymers of cellulose with other polymeric substances. This makes it possible to widely use cellulose preparations in various sectors of the economy.

Chemical processing of cellulose will consist in obtaining its simple and complex esters. In both cases, replacement of hydrogen in hydroxide groups of cellulose macromolecules with complex or simple ether groups occurs. Each elementary unit of the cellulose macromolecule (anhydroglucose unit) has three hydroxyl groups that can undergo etherification (ether addition) and alkylation (alcohol addiction) reactions. The average number of inserted groups corresponding to one glucose residue is called the degree of substitution - **AD**. The degree of substitution in cellulose ethers can vary from 0 to 3. Along with the degree of substitution, the quantity γ is often used, indicating the average number of incorporated groups corresponding to 100 glucose residues, i.e., γ =100x**AD**.

The properties of cellulose ethers change depending on the degree of substitution. Depending on the purpose of the chemical processing of cellulose, it is possible to obtain substances with different degrees of displacement, that is, with different properties.

Cellulose reactions can be homogeneous and heterogeneous reactions, that is, they can take place in homogeneous and heterogeneous media. Dissolved cellulose reacts in homogeneous reactions. An example of a homogeneous reaction is the hydrolysis of cellulose in 72% sulfuric acid. Cellulose is first dissolved in this acid and then hydrolyzed. The reaction of acetylation of cellulose with acetic anhydride in glacial acetic acid or acetylation with a catalyst in methylene chloride begins in a heterogeneous environment and is completed in a homogeneous environment. As a result of homogeneous reactions, products that are more homogeneous in terms of their properties and chemical composition are formed than heterogeneous reactions. Most of the processes of cellulose etherification and other reactions are heterogeneous reactions.

The nature of heterogeneous reactions depends to a large extent on the structure of cellulose larger than the molecular structure, that is, on the presence of directed and undirected sections in the cellulose fiber. In various reactions of cellulose, the process can proceed either only in the non-directed sections (or on the surface of the oriented sections) or throughout the entire mass of the macromolecules with the orientation being disturbed, as can be seen from X-ray images.

In heterogeneous cellulose etherification reactions, the progress of the process depends on the ratio between the reaction rate **R** and the rate of penetration of the reagent or mixture of reagents **D** into the fiber by diffusion. Often, in the etherification of cellulose, the reaction rate is higher than the rate of diffusion of reagents, that is, **R>D.**

In order to increase the homogeneity of the obtained cellulose derivative products (esters), it is necessary to reduce the difference between the chemical reaction rate **R** and the reagent diffusion rate **D**. This can be achieved either by reducing the reaction rate without changing the diffusion rate (which is very difficult to achieve in practice) or by increasing the diffusion rate without increasing the reaction rate. The rate of diffusion can be increased by cooking cellulose fiber in strong alkali solutions, acids. For example, in order to obtain xanthogenate of cellulose and its simple esters, pre-etching in a sodium solution is used. Cellulose can also be included, where the cellulose is soaked in water and then the water is extracted with an organic solvent such as alcohol, which in turn is extracted with pyridine. Due to the structure of the cellulose obtained in such processing, it is less dense and more reactive.

During these studies, the results of the analysis of the determination of brands of cellulose samples based on PTKTCh (fiber pulp of textile enterprises) under the influence of the specified parameters of the cooking process were carried out.

The following table shows the influence of the parameters of the alkali cooking process on the quality parameters of cellulose.

1-Table. The effect of parameters in the alkali cooking process on the quality parameters of cellulose

(*PM-lint, PU- ulyuk, short cotton fluff - PKM-pux composite in 1:1 ratio 20g/l NaOH at the same time, 120 minutes*)

№	Cooking temperature, ^{0}C	The degree of pollution, %	Cellulose product, %	α- cellulose	*PD	Swelling
1	70	32	78,2	61	-	65
2	80		80,9	77	-	80
3	90		88,2	85	1600	130
4	**100**		**96,8**	**96**	**1950**	**145**
5	120		89,1	97	1850	150
6	130		74,3	97	1300	160
7	140		51,3	97	900	160

*** PD - degree of polymerization**

It can be observed from the table that the influence of the parameters in the alkaline cooking process on the quality indicators of cellulose (*PM-lint, PU- ulyuk, short cotton fluff - PKM-pux composite in 1:1 ratio 20g/l NaOH at the same time, 120 minutes*), i.e. increasing the temperature of alkaline cooking The cellulose separated from the composition of the fibrous composite mixture had a negative effect on the degree of polymerization and, on the contrary, a positive effect on its α-cellulose and swelling. In this case, the oven cooking temperature of 100^{0}C was taken as the optimal cooking temperature. Based on this parameter, the yield of cellulose is 96.8%, α-cellulose is 96%, and the degree of polymerization is 1950.

2-Table. Physico-chemical parameters of cellulose based on PM-lint, PU-ulyuk, short lint of cotton -PKM-pux composite

Index of samples	Cellulose samples on the basis of PM-lint, PU-ulyuk, short fluff of cotton - PKM-pux composite (for polyanionic cellulose)			
	1	2	3	4
Cellulose is a product	96	95,1	95,2	89
Fiber length, mm	5/8-6/9	6/9-7/11	5/8-6/9	5/8-6/9
α-cellulose, %	96,4	97,4	96,4	98,4
Degree of polymerization	1900	1450	1600	900
Ash, %	1,8	1,2	1,6	1,3
Humidity, %	4,1	4,9	4,0	4,7

This table shows the physicochemical properties of cotton stalk cellulose. It can be observed from the results that in the future, all quality indicators allow to obtain simple ethers of cellulose - technical KMTs (carboxymethylcellulose) and PATs (polyanionic cellulose) from composite cellulose by chemical processing.

In the chemical processing of cellulose, depending on the chemical composition of cellulose, the related preparations often undergo different reactions, are esterified at different rates, and give products of different quality. In this regard, the question of the susceptibility of cellulose to the reaction arises.

Reactivity is often understood as the speed of the etherification process and the quality of the resulting products - their complete solubility, the ability to give homogeneous, transparent and filterable solutions of high concentration. The term susceptibility to reaction is not clear enough and unambiguous - there are different interpretations of it in the literature. It is not correct to talk about the reactivity of any preparation of cellulose in general, without indicating the specific method by which it is applied to this preparation. Cellulose with high reactivity in xanthogenation may be low in reactivity in acetylation, and so on. High viscose reactivity is understood in the synthetic fiber industry as the ability of cellulose to yield well-filtered viscose fibers suitable for further processing. Thus, not the rate of chemical interaction of cellulose macromolecules, but the xanthogenates obtained as a result of the chemical reaction, their solubility in alkali, and the filtration of viscose solutions associated with this are evaluated. But these indicators are usually not called reaction permeability. The reactivity of cellulose in acetylation is often understood as the speed of the acetylation process.

Thus, the concept of the susceptibility of cellulose to reaction is ambiguous. Therefore, instead of one term, it would be appropriate to use two terms: reactivity (or reactivity to chemical and responsiveness.

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