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	JIF = 1.500	SJIF (Morocco) = 7.184	OAJI (USA) = 0.350

SOI: 1.1/TAS DOI: 10.15863/TAS
International Scientific Journal
Theoretical & Applied Science

p-ISSN: 2308-4944 (print) **e-ISSN:** 2409-0085 (online)

Year: 2022 **Issue:** 04 **Volume:** 108

Published: 06.04.2022 http://T-Science.org

Issue Article

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ANALYSIS OF CARBAMATE DERIVATIVES OF CELLULOSE SYNTHESIZED ON THE BASIS OF LOCAL RAW MATERIALS

Abstract*: In this paper, the composition of cellulose fiber was determined using chemical methods. To study the molecular properties of cellulose and the chemical structure of the obtained products, viscometric method and IR-spectroscopy, Mass-spectrometric, differential scanning calorimetry were used. By processing reed cellulose with alkali and urea, a cellulose product containing carbonyl and amide groups was obtained.*

Key words*: degree of polymerization, viscometric method, IR spectroscopy, IR spectroscopy, Mass spectrometric, differential scanning calorimetry.*

Language*: English*

Citation: Babamuratov, B. E., Ibragimova, A. Kh., Jumayev, X. E., & Khushvaqtov, F. A. (2022). Analysis of carbamate derivatives of cellulose synthesized on the basis of local raw materials. *ISJ Theoretical & Applied Science, 04 (108),* 37-40.

Soi: http://s-o-i.org/1.1/TAS-04-108-6 ***Doi***: crossref https://dx.doi.org/10.15863/TAS.2022.04.108.6

Scopus ASCC*: 1605.*

Introduction

Carbamate cellulose (CTs) is a biodegradable and environmentally friendly bio-based cellulose product. One of the most important features of this crop is that it can be used as a filler in the composition of disposable polyethylene films used for the cultivation of seasonal crops in open fields. The obtained polyethylene films do not decompose under the influence of external factors, leaving no waste, and as a result of this decomposition, carbamate cellulose acts as a fertilizer for plants. It is also an alternative polymer product to the viscose process, which is carried out using oil products and cellulose fibers [3].

Additional research is being conducted to determine the optimal ratios of reagents in the interaction of cellulose with urea, the amount of nitrogen in the obtained carbamate cellulose.The dependence of nitrogen concentration on solubility in urea-alkaline composite is also studied [4].

Hydrogel and aerogel are obtained by good dissolution of the modified cellulose product in a urea-alkaline composite. The transparency of carbamate cellulose (CTs) obtained by modification of cellulose and the degree of swelling in urea-alkaline composite are also evaluated [5].

To carry out the experiment, a mixture of stalks and leaves of crushed reed plant up to 2-3 cm was thoroughly washed in distilled water, sand and other impurities were removed and then thoroughly dried.

The experiments were performed in an autoclave equipped with a mixer, thermometer and manometer. The work began by immersing the raw material in a solution of a certain concentration of alkali to separate the cellulose. The heating process takes about 3 hours. Alkaline solutions of different concentrations were used in the study. The cane, soaked in sodium hydroxide solution, was then placed in an autoclave, the autoclave lid was tightly closed, and the heating was turned on. The work was carried out at different temperatures and heating times. According to the results of the analysis, it was concluded that the best cellulose yield was obtained at a temperature of 120 ° C and a heating time of 1.5 hours. The work was then carried out by heating the autoclave to a temperature of 120 ° C and maintaining this temperature for 90 min [6].

The pressure in the autoclave was maintained at 1-1.5 MPa. At the end of the process, the resulting mass was removed from the autoclave and washed thoroughly in distilled water. During washing, the pH of the washed water was determined using indicator paper. washed to pH = 7.5. The washed mass was then placed in an oven to dry at 40–60 ° C. Due to the fact that the resulting product has a light yellow color after drying, the bleaching process was carried out using a freshly prepared 3% sodium hypochlorite solution. This process was carried out in a reactor equipped with a mixer, a thermometer and a return cooler[7].

The dried product was placed in a reactor, sodium hypochlorite solution was poured over it, a stirrer was started and stirred at a speed of 300 rpm. The temperature was maintained at 70 ° C. The process takes about 1.5-2 hours. The resulting mass was then thoroughly washed with distilled water to pH = 7.5. The resulting product was dried in an oven at a temperature of 60-70 ° C. The result is a white product - cellulose fiber. The resulting product was weighed, compared with the feed weight, and the reaction yield was calculated. The yield of the reaction was 46.5-51% [8].

The results obtained and its discussion.

Chemical and physicochemical confirmation of synthesized cellulose carbamate content

Cellulose is the most widely used and most abundant organic substance in the chemical industry and is an integral part of the cell walls of all higher and lower plants (trees, shrubs, grasses, algae, fungi, etc.). According to the literature, cellulose is formed as a result of complex biochemical changes in plant composition (including photosynthesis reaction). The glucose formed in the photosynthesis reaction enters the polymerization reaction to form the cellulose macromolecule:

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2 \quad (1)$$

$$nC_6H_{12}O_6 \rightarrow (C_6H_{10}O_5)\ n + nH_2O \quad (2)$$

Cellulose is the main chemical component of wood and plant residues (stems, leaves, roots), they contain from 40 to 60%. Reeds contain up to 42% cellulose, straw and corn stalks up to about 30%, and cotton up to 93%. Its physical, physicochemical and chemical properties depend on the chemical structure and physical structure of the cellulose (macromolecular shape, intermolecular interactions, etc.). Therefore, it is included in the class of linear homopolysaccharides. The cellulose macromolecule has a long unbranched structure and consists of a chain of monomers of b-D-glucopyranose anhydrides bound to each other by 1-4 glycoside bonds [9].

Chemical method. To confirm the structural formula of cellulose, it was first hydrolyzed:

$$(C_6H_{10}O_5)\ n + nH2O \rightarrow nC_6H_{12}O_6 \ \text{cellulose D-glucose}$$

The formation of D-glucose confirms the presence of this glucose monomer in cellulose.

Given the presence of 3 hydroxyl groups on 2, 3 and 6 carbon atoms in each monomer link, the hydroxyl groups on 2 and 3 carbon atoms are secondary and the hydroxyl group on 6 carbon atoms is primary groups, the presence of b-glycoside bonds between monomers proved that the synthesized cellulose carbamate is not hydrolyzed in the presence of the enzyme maltose (maltose hydrolyzes α-glycoside bonds), but is hydrolyzed by the emulsion enzyme specific to b-glycoside bonds. This means that the synthesized cellulose carbamate contains b-D-glucopyranose.

Determination of molecular mass by cryoscopic method. The molecular mass of the synthesized cellulose carbamate was determined cryoscopically. When 100 g of NaOH / ZnO mixture was added to the cryostat as a solvent, its freezing point was measured to be -3.36 ° C. Then 1.2 g of cellulose carbamate was dissolved in 100 g of this solvent and its freezing point was -5.24 ° C. Based on the results obtained, the molecular mass was found using the following formula:

$$M = K * a * 1000 / b * DT$$

Here, since the K-cryoscopic constant is not in the reference for cellulose carbamate, it was found that the cryoscopic constant of high molecular weight compounds proposed by British scientist James Odonnel for cellulose derivatives is 1149.5 according to the phase rule and quantum theory.

a- solvent mass, 100 g; b- cellulose carbamate mass, 1.2 g. DT = 5.24-3.36 = 1.88.

$$M = 1149.5 * 100 * 1000 / 1.2 * 1.88 = 106594.$$

Hence, it was confirmed that the average molecular mass of the synthesized cellulose carbamate was 106594 when calculated cryoscopically.

Determination of the degree of polymerization. The degree of polymerization is a key factor in determining the composition of cellulose products, which is determined by the following formula:

PD = MM / 223

Here, the molecular mass of the MM-cellulose product is the molecular mass of the 223-monomer cellulose carbamate $C_7N_{11}O_6N$. The value of PD varies depending on the type of plant from which the cellulose is obtained. The PD of cotton cellulose ranges from 15,000 to 20,000, while that of wood pulp ranges from 5,000 to 10,000. When cellulose is extracted from wood fiber, it is destroyed and the PD value decreases. Because cellulose, like other polymers, is a mixture of macromolecules with different degrees of polymerization, its molecular mass also varies. This condition is called polydispersity. For the above reasons, the molecular mass of polymers, particularly cellulose, is obtained as an approximate average value.

PD = 106594/223 = 478.

This means that the average polymerization rate of the synthesized cellulose carbamate is 478.

We used the mass spectrometric method in view of the need to compare these results with modern methods of physical and chemical analysis.

Mass spectrometric analysis. To confirm the structure of cellulose carbamate, a sample of solid cellulose carbamate obtained by Delta-Plus mass spectrometer of the Central Laboratory of the Surkhandarya Regional Sanitary-Epidemiological and Peace Agency was analyzed [10].

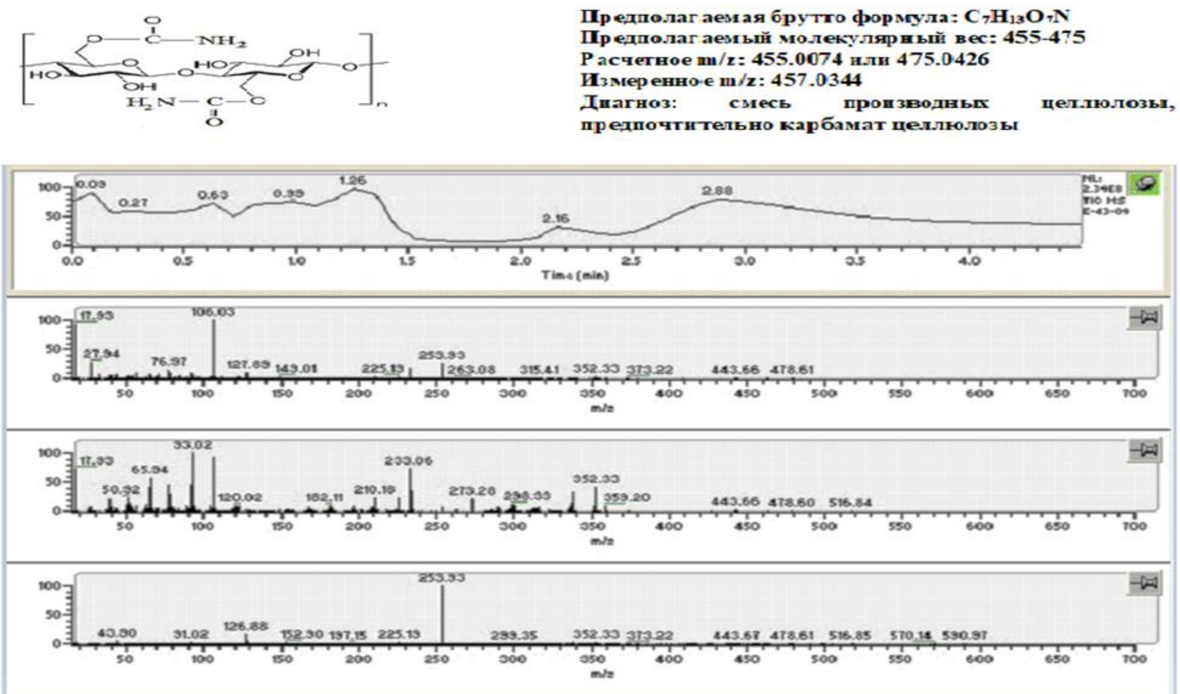

Figure 1. Results of mass spectrometric analysis of cellulose carbamate

As can be seen from Figure 1, the initial molecular mass of the cellulose carbamate sample in the mass spectrum starts from 478.61, the areas of functional groups leaving it, including 2 hydroxyl groups at 443.66, the CH_2OH group at 373.22, 127, The presence of an oxygen atom in 69 areas and finally a carbon atom in 12.33 areas is seen.

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