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НАУКИ И ИННОВАЦИЙ РЕСПУБЛИКИ УЗБЕКИСТАН**

НАЦИОНАЛЬНЫЙ УНИВЕРСИТЕТ УЗБЕКИСТАНА ИМ. МИРЗО УЛУГБЕКА

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FP-87. CONDUCTING a VIRTUAL LABORATORY LESSON on THE TOPIC "CELLULOSE HYDROLYSIS"

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The article is devoted to the optimization of the educational process in higher educational institutions using IT technologies. Students develop the idea of replacing the direct physical performance of laboratory work with the analysis of its computer counterpart, such as a virtual laboratory. The conditions for the equivalence of such a replacement and application in the educational process 5140500-Chemistry are considered.

Keywords: cellulose, monoses, hydrolysis, destruction, knowledge, virtual laboratory, technique, polymer.

The changes taking place in various industries in independent Uzbekistan pose a challenge to society about the need to find effective ways to enrich the younger generation with knowledge, morality, and scientific worldview. It is also necessary to apply the knowledge gained by young people to the development of our society. At the same time, one of the ways to increase the effectiveness of lessons is to familiarize students with interesting, up-to-date information of science [1-3, 5,6]. For this purpose, a methodology for conducting a laboratory lesson on the topic "Cellulose hydrolysis" was created on a virtual basis and used in the lesson, in which attention was paid to the expediency of using information technology in the lesson [4.10]. Before the beginning of the laboratory lesson, the teacher provides information about the regularity that the process of cellulose hydrolysis obeys [7,8].

If the process of cellulose hydrolysis takes place under heterogeneous conditions, then cellulose hydrolysis is carried out with the participation of concentrated and dilute acids; at the beginning the reaction goes quickly, then slows down, because hydrolyzing reagents easily act on amorphous (disordered parts) cellulose macromolecules and thus the initial reaction process is fast. The second reaction process slows down due to the presence of crystalline parts in the cellulose. So, knowing the degree of cellulose hydrolysis, it is possible to determine the number of amorphous and crystalline fractions. Typically, the degree of polymerization of cellulose samples decreases in the initial reaction process from 250 to 150. Then the degree of polymerization of the samples does not change. This means that during the hydrolysis of cellulose with dilute acids, even when the reaction takes place under pressure and high temperature, its decomposition to glucose is not possible. It was found out that under these conditions, the glucose yield is generally about 10%. With this method, the degree of polymerization of cellulose samples can be slightly reduced.

Cellulose hydrolysis in homogeneous conditions, in comparison with heterogeneous ones, ends faster, because in this process hydrolyzing reagents can affect all parts of cellulose macromolecules.

The mechanism of such hydrolysis can be observed in the decomposition of cellulose by concentrated mineral acids. Concentrated mineral acids are used for the complete decomposition of cellulose, here the sample is first dissolved, then hydrolyzed under homogeneous conditions. Samples of partially hydrolyzed cellulose are called hydrocelluloses. In the composition of hydrocellulose, low-molecular substances formed from undecomposed, partially decomposed and completely decomposed macromolecules can be found. Low molecular weight compounds with a degree of polymerization from 2 to 6 are called oligosaccharides, and with a degree of polymerization from 7 to 60 are called cellodextrins.

Methods of cellulose hydrolysis consist of the following:

1. Hydrolysis of cellulose under the action of concentrated acids.
2. Hydrolysis of cellulose under the action of dilute acids.
3. Hydrolysis of cellulose under the action of anhydrous mineral acids.

The possibility of obtaining various substances by hydrolyzing cellulose under the action of concentrated acids and high speed is noted. However, mineral acids play the role of a catalyst, where mineral acid reacts by mutual polycondensation with small molecules. For this reason, at the end of the reaction, during the hydrolysis of cellulose under the action of concentrated mineral acids, only monoses are not formed. For the decomposition of monoses, they should be diluted by adding water to the hydrolysate. With a decrease in the concentration of acids to 1-2%, side reactions of hydrolysis take place, where only monoses are formed at the end of the reaction. Among the mineral acids, fluoric acid is considered the most active, which acts on cellulose [9].

The following devices and reagents are required for the hydrolysis of cellulose: a 250 ml glass, a 150 ml flask with a slot, a Buchner funnel, a water pump, a drying cabinet, a rubber pear, a stopwatch, a shaking apparatus, pure cotton wool (cellulose) and sulfated cellulose – 5 g, 10% H_2SO_4 - 100 ml, copper–ammonia solution ($CuSO_4*H_2O$, 1000 ml distilled water, 3% sodium hydroxide solution, 50 ml ammonia solution) [9].

Progress of work. 5 g of a suspended cellulose sample is placed in a glass, 100 ml of a 10% sulfuric acid solution is added to it, heated to a boil in a water bath (or in a magnetic mixer) for 1 hour. The hydrolyzed cellulose is transferred to the Buchner funnel using a glass rod, filtered and washed with distilled water until a neutral reaction. Then it is dried in a drying cabinet to a constant weight.

Initially, the laboratory work is demonstrated by the teacher to students, showing it on a computer in a virtual form, and each process is commented on separately.

Seeing the image of the hydrolysis process, students, after familiarizing themselves with its contents, proceed to the implementation of the experiment. The viscosity of 1% of the initial and hydrolyzed cellulose hydrolysis product dissolved in a copper-ammonia reagent is determined.

The copper-ammonia reagent is prepared as follows: 69.3 g of copper sulfate is dissolved in 100 ml of distilled water. Then a 3% solution of caustic soda is prepared and gradually added to the solution of copper sulfate until the copper hydroxide is completely precipitated. The sediment is filtered on a Buchner funnel, washed with distilled water and dried at room temperature. The sample dried to a powdery state is dissolved in 50 ml of ammonia ($\rho(NH_3)=0.91$g/ml).The viscosity of a 1% cellulose solution is determined by a capillary viscometer. Copper-ammonia reagent is accepted as a solvent [9].

In a cone-shaped flask with a volume of 100 ml, a cellulose sample weighed to an accuracy of 0.02 g and a calculated amount of a solution of copper-ammonia reagent are placed. The dissolution is carried out at room temperature, by strong shaking in a shaking apparatus. Complete dissolution is controlled by observation in the light of the bulb.

5 ml of the finished solution is taken with a pipette, placed in a viscometer and transferred to a thermostat. The viscosity of the solution is determined by the following formula: $[\eta]=kt\rho$

k – viscometer constant

t – solution expiration time

ρ – density of the test solution

The density of the cellulose solution in the copper-ammonia reagent is 0.97 g/ml. At the end of the lesson, a task is given to draw up a diagram of the hydrolysis process and, based on the results obtained, draw a conclusion about the process of chemical destruction of cellulose.

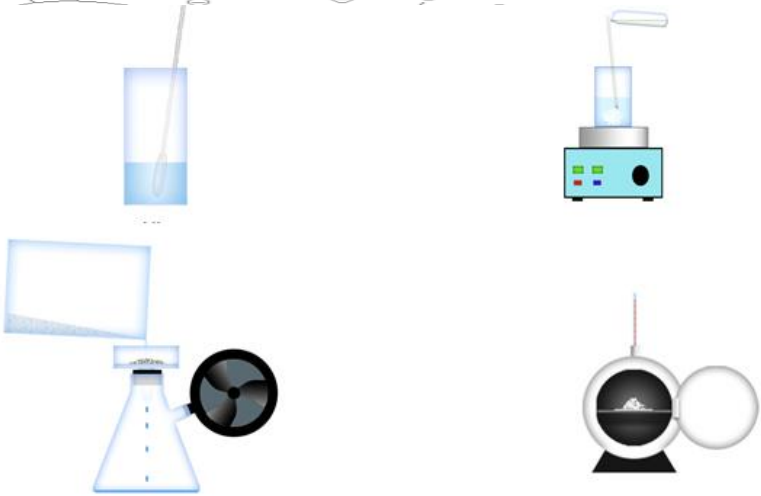

Fig. 1. The process of cellulose hydrolysis is depicted in virtual form

The organization of a laboratory lesson in a virtual form provides students with the opportunity to better understand the lesson, repeatedly see the progress of the process on the computer before the reaction is performed, as well as the meaningful performance of the work within a short time. In some cases, in the absence of some reagents or appliances and utensils, it is possible to achieve the performance of a laboratory lesson on a virtual basis.

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