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Study of Some Parameters of Modified Aminoaldehyde Oligomers Produced on the Basis of Urea and Formaldehyde

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Annotation: The article discusses the preparation of aminoaldehyde oligomers based on carbamide, urotropine and methacrylic acid, the conditions for the synthesis of oligomers, the dependence of the composition, molecular weight, mass fractions of the dry residue of oligomers on the synthesis conditions, on the duration of the process, on the ratios of the components.

Keywords: oligomer, carbamide, formaldehyde, urotropine, modification

Today, all over the world, in various sectors of the national economy, the importance of oligomers, which are obtained on the basis of amino compounds and aldehydes, is increasing. The scope of application of aminoaldehyde oligomers includes the production of plastics, furniture, textile industries, leather and other important sectors of the national economy. High physical and mechanical properties such as thermal stability, adhesive properties, as well as the convenience of production technology have led to the expansion of the scope of use of aminoaldehyde oligomers [1].

Increasing requirements for new materials based on aminoaldehyde oligomers require great attention and careful study of the effect of the composition and various functional groups in its composition on their properties. Scientific research is carried out in the world in priority areas in order to obtain new compositions of oligomers that improve the quality of products after their treatment with aminoaldehyde oligomers. The aminoaldehyde oligomers synthesized by us were used as leather fillers and positive results were obtained.

Studies show that the composition of the urea-formaldehyde oligomer contains free formaldehyde, which can be released from the composition of the finished product during operation and this has a harmful effect on the environment by increasing the concentration of toxic substances in it, which is one of the disadvantages of the urea-formaldehyde oligomer. From this point of view, it is very important to obtain new aminoaldehyde oligomers based on local raw materials, with a minimum content of free formaldehyde, which is one of the main issues in this area, since formaldehyde is a carcinogenic substance.

To resolve this issue, we came to the conclusion that it would be advisable to modify the urea-formaldehyde oligomer with compounds containing functionally active groups that contain

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such active groups containing a double bond, a hydroxyl group, a carboxyl group [2,5]. Considering the above, urotropine, urea, methacrylic and sulfuric acids were chosen as initial components. The ratios between the components for obtaining aminoaldehyde oligomers are given in 1-table.

As a control sample, a urea-formaldehyde oligomer was obtained, and in other cases, methacrylic acid and sulfuric acid were used to obtain aminoaldehyde oligomers for acidolysis of urotropin.

Table 1
Experience options for obtaining aminoaldehyde oligomers and component ratios

Components	Variants of experiments and consumption of components					
	I		II		III	
	m.p	n.f.(%)	m.p	n.f.(%)	m.p	n.f.(%)
Urea	60	30	60	30	60	30
Urotropin	20	10	20	5	23	11,5
Methacrylic acid	10	5			17	8,5
Sulfuric acid	5	2,5	5	2,5	5	2,5
Water	105	52,5	115	57,5	98	49
Total	200	100	200	100	200	100

It should be noted that in order to avoid polymerization of formaldehyde in all variants of the synthesis of aminoaldehyde oligomers, formaldehyde is obtained directly in the reaction medium by acid hydrolysis (acidolysis) of urotropin with the participation of sulfuric acid.

$$C_6H_{12}N_4 + 6H_2O \rightarrow 6CH_2O + 4NH_3$$

To avoid the process of polymerization of methacrylic acid, the reaction mixture was kept under constant stirring while controlling the medium (pH) of the reaction mixture.

The synthesis of aminoaldehyde oligomers is carried out without bringing the reaction mixture to the boiling point, since the solubility of urea increases to 55-60°C, and above it its solubility sharply decreases [3,4,9].

As a result of the synthesis, viscous-fluid oligomers were obtained, the density of which is 1.24; 1.29 and 1.35 g/ml according to experimental options. All three oligomers are soluble in water, and with organic solvents such as acetone, benzene, ether and others, they form azeotropic compounds, i.e. insoluble in them.

In our further studies, we studied the dependence of the molecular weights of the synthesized oligomers on the temperature and duration of the synthesis process. On the basis of which we studied the influence of the above factors and the results are given in table-2

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table 2

Dependences of the mass fraction of dry residue and the molecular weight of oligomers on temperature, process duration and the initial ratio of components

Indicators		Dry residue and molecular weight of experimental variants, in %		
		I	II	III
temperature, in oC, reaction time 2.0 hours.	+20	57,1/400	61,5/470	64,6/500
	+30	56,4/392	61,1/466	64,0/490
	+40	56,0/386	60,7/460	63,7/486
	+50	55,3/378	60,3/454	63,2/480
duration, in hours at a reaction temperature of +200C	0,5	55,2/370	59,1/446	62,4/469
	1,0	55,7/377	59,8/451	63,0/472
	1,5	56,1/386	60,4/458	63,6/479
	2,0	56,7/392	61,0/464	64,1/487
	3,0	57,1/400	61,5/470	64,6/500

From the data of the 2-table, with an increase in the duration of the synthesis process at optimal temperatures, the molecular weight and the mass fraction of the dry residue suitable for each of the oligomers increases according to the experimental options (in the table, the dry residue is given in the numerator, and the molecular weight of the oligomer in the denominator).

As can be seen from the table, the decrease in molecular weight and decrease in the mass fraction of dry residue according to each aminoaldehyde oligomer with increasing temperature is explained by the fact that these polycondensation reactions for the synthesis of modified aminoaldehyde oligomers are exothermic and an increase in the temperature of the reaction mixture inhibits the polycondensation reaction, while preventing chain elongation.

As a conclusion, we can say that the introduction of compounds containing functionally active groups as a modifier leads to a decrease in the content of free formaldehyde in the composition of the oligomer, which is explained by the interaction of the active groups of the modifier with free formaldehyde. If urea-formaldehyde resin during storage due to the content of free formaldehyde passed from the resinous to the crystalline state (within 2-3 months), then after modification, the shelf life of the oligomer is noticeably extended, which indicates a decrease in the content of free formaldehyde in the composition of the finished product [6-8].

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