Technology of moisture-resistant chipboard using amino-formaldehyde binder

Vyacheslav Tsvetkov[1*], *Olga* Machneva [1], *Vladimir* Podolny [1], *Vladimir* Semenchenko[1] and *Victoria* Yakobashvili[1]

[1]Bauman Moscow Technical University, 2-ya Baumanskaya ul., d.5, str.1, 105005 Moscow, Russia

Abstract. In this paper we study the possibility of using modified amino-formaldehyde resins in the production of moisture-resistant wood particle boards. As a modifier of amino-formaldehyde resins it is proposed to use a by-product of melamine production - melan, which is a powder of light brown color, insoluble in water. Melan in its chemical composition and properties is largely similar to melamine, but unlike the latter it is an available raw material for the synthesis of polymers. This is the high market value of commercial melamine. Melamine, on the other hand, is often a waste product that is absolutely free. Aminoformaldehyde resins modified with melamine, despite its dark coloring, provide particleboards with a coloring identical to those obtained from conventional aminoformaldehyde resins. However, the properties of the obtained materials allow them to be classified as moisture-resistant.

1 Introduction

Obtaining water-resistant board materials has been and remains one of the priority areas in the production of materials from wood and synthetic polymers.

It is known that amino-formaldehyde resins are the most preferable for the production of wood board materials, which have a reduced content of harmful substances, in particular formaldehyde and methanol, but do not have sufficient water resistance. It is possible to improve this index by chemical modification of aminoformaldehyde resins during or after their synthesis.

One of the most well-known and effective modifiers of amino-formaldehyde resins is melamine. Its effectiveness as a modifier has been repeatedly proven [1-5]. But it has a significant disadvantage - a fairly high market price, which makes this product not very accessible to most manufacturers of synthetic resins.

The optimal solution to this problem is to use instead of pure melamine product - a waste product of its production. This product is called melamine, which in its structure and properties is very similar to melamine, therefore, it also has a modifying effect on aminoformaldehyde resins, and costs significantly cheaper, and often can be absolutely free [6-11]. Consequently, the introduction of melan into the amino-formaldehyde resins at the synthesis stage will reduce the cost of the finished resin by saving such expensive products

* Corresponding author: helga35781@yandex.ru

as urea and melamine, that is, they can be partially replaced by melan [12-16]. And most importantly, melane, like melamine, can significantly increase water resistance of amino-formaldehyde resins and, as a consequence, water resistance of materials made with modified binder.

The aim of the present studies was to develop technology for obtaining water-resistant particleboards obtained on the basis of amino-formaldehyde resins modified with melamine.

To solve the goal the following important tasks have been defined and carried out:

1. evaluation of the properties of amino-formaldehyde resins modified by melanom.
2. development of rational modes of pressing moisture-resistant reinforced wood particle boards.

Evaluation of physical and mechanical characteristics of the obtained reinforced wood particle boards.

Estimation of production cost of reinforced wood particle boards.

2 Methodology and materials of the experiment

The object of the study in this work was reinforced wood particle boards. It was necessary to prove or disprove the effectiveness of amino-formaldehyde resins modified with melanol in terms of moisture resistance of the obtained materials [17-22].

All experiments were carried out in the laboratories of the FT9 Department of Chemistry and Chemical Technologies in Forestry, Mytishchi Branch of the Bauman Moscow State Technical University, which has all the necessary set of laboratory equipment for the synthesis of polymers, analysis of their properties, production of wood composite materials and evaluation of their physical and mechanical properties.

To determine optimal melane quantity we synthesized modified resins with different quantity of melane, eventually it was decided to stop at 8, 14 and 20 % melanes. These resins and participated in further, more detailed studies. They were studied the basic properties, which allowed to judge the high quality of the modified resins.

Synthesized resins were named as follows: KFM-8, KFM-14 and KFM-20.

In the conducted work for the manufacture of particle boards the chips of fraction 7/5 were used, which is usually used to form the middle layer of reinforced wood particle boards. The chips were dried to a moisture content of 4 %. Separation of the chips was carried out on a laboratory sorter that separates the factory chips into several fractions, including the -/10 fraction, which should be further crushed and the dust fraction, which should be removed from the technological process. The size of the manufactured slabs was 300×130×16 mm.

Slabs were made at the average regimes adopted by most modern enterprises for the production of reinforced wood particle boards: the temperature of pressing - 210 ° C, holding time - 0.25 min / mm, the binder consumption - 8.5 and 10.5 %. The density of the boards was 700 and 900 kg/m^3 [8-11].

Ammonium chloride was used as a hardener in an amount of 1% by dry matter taken by weight of the resin. The curing time was determined at 20°C and at 100°C. Determination of curing at ambient temperature allows to judge the viability of the binder (modified resin + hardener), that is, it is important to know how long the resin with the hardener introduced into it will have the fluidity and viscosity that allows to qualitatively conduct the "tarring" of wood particles.

3 The results of experiments and discussion

For the manufacture of reinforced wood particle boards[1 were used three resins KFM. They differ in different amounts of melan added (it is 8, 14, 20%). The main indicators of these resins are presented in Table 1.

Table 1. Properties of the amino formaldehyde resin applied

Index	**Resin brand**		
	KFM -8	**KFM -14**	**KFM -20**
1	2	3	4
Appearance	Homogeneous suspension, brown in color	Homogeneous suspension, brown in color	Homogeneous suspension, brown in color
pH	7,5-8	7,5-8	7,5-8
Viscosity, sec	91	94	89
Speed of curing at 100 ° C, sec	68	64	63
Speed of curing at 20 ° C, h	Not less than 12	Not less than 12	Not less than 12
Free formaldehyde content	0,11	0,08	0,09

The data in Table 1 show that the obtained resins have high physical and chemical characteristics, which will allow these resins to become a good basis for water-resistant aminoformaldehyde binders. And even with the hardener introduced, the modified binders retain a long viscous state for 12 and more hours. The proposed resins are even more environmentally friendly in terms of free formaldehyde content than the well-known low-toxic urea resin KF-MT-15 with formaldehyde content of 0.15%.

Physical and mechanical properties of the obtained reinforced wood particle boards based on KFM-8, KFM-14 and KFM-20 resins are presented in Tables 2-4.

Table 2. Physical and mechanical properties of reinforced wood particle boards based on KFM-8 resin

№	**Modification consumption, %**	**Binder consumption, %**	**Density, kg/m^3**	**Flexural strength, MPa**	**Tensile strength, MPa**	**Swelling by thickness, %**	**VKI, mg/100 g of absolutely dry board**	**Plate brand**
1	2	3	4	5	6	7	8	9
1	8	8,5	700	14,6	0,46	16,2	5,8	P3
2			900	25	0,83	11,4	6,2	P7
3		10,5	700	14,6	0,56	15,8	7,4	P3
4			900	27	0,8	12,0	7,56	P7

Table 3. Physical and mechanical properties of reinforced wood particle borads based on KFM-14 resin

№	Modification consumption, %	Binder consumption, %	Density, kg/m³	Flexural strength, MPa	Tensile strength, MPa	Swelling by thickness, %	VKI, mg/100 g of absolutely dry board	Plate brand
1	2	3	4	5	6	7	8	9
1	14	8,5	700	14,5	0,48	14,6	6,34	P3
2			900	22,4	0,78	9,8	6,87	P7
3		10,5	700	17,8	0,72	11,75	5,99	P5
4			900	25,5	0,83	10,63	8,02	P7

Table 4. Physical and mechanical properties of reinforced wood particle borads based on KFM-20 resi

№	Modification consumption, %	Binder consumption, %	Density, kg/m³	Flexural strength, MPa	Tensile strength, MPa	Swelling by thickness, %	VKI, mg/100 g of absolutely dry board	Plate brand
1	2	3	4	5	6	7	8	9
1	20	8,5	700	15,5	0,42	15,5	6,67	P3
2			900	20,6	0,64	13,2	6,5	P7
3		10,5	700	16,7	0,48	10,7	8,1	P5
4			900	22,3	0,75	10,3	7,9	P7

The data analysis of Tables 2-4 indicates that the boards obtained by using aminoformaldehyde resins with different amounts of melan correspond to the quality indicators of moisture-resistant boards according to GOST 32399-2013 [14, 15]. The table also shows that the type of binder, the amount of modifier, the binder consumption, as well as the density affects the class of the boards. So, for example, the binder consumption of 10.5 % and the density of 900 kg/m3 are required to obtain boards of grade P7 with high characteristics.

From the analysis of tables 2-4, we can also see that some of the boards slightly deviate from the required standards, but these discrepancies will be further eliminated in the finalization of technology for the production of moisture-resistant reinforced wood particle borads [14, 15].

4 Conclusions

1. The proposed technology for obtaining moisture-resistant particleboards has shown its absolute efficiency.
2. Melan, due to its similarity with melamine, is ideally suited as a modifier for the synthesis of amino-formaldehyde resins.

The modified binder allows to obtain moisture-resistant boards, corresponding to GOST 32399-2013 and formaldehyde toxicity class E1.

4. The proposed technology will produce board materials that will be widely used as structural and finishing materials.

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