IMPREGNATION AND MODIFICATION OF CELLULOSE-CONTAINING MATERIALS BY INHIBITORS OF BURNING

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The present work is devoted to the study of the impregnation process and modification of wood by reaction-capable fire retardants.

It is known that the most effective inhibitors of burning of wood, cotton textile and other cellulose-containing materials are fire-protection structures containing compounds of phosphorus, nitrogen, boron and other. Fire-retardant properties of processed materials depend on the inhibitor composition, its content in a material and the type of interaction with the material.

Reaction-capable fire retandants on the basis polyphosphorus acids were created in the Institute of General and Inorganic Chemistry. These structures have a number of advantages in comparison with traditionally used ones: carrying out the esterification reaction of cellulose (by heating) we can obtain phosphorus-containing materials which are insensitive to steeping in water. In this case, during the interaction of the esterificating medium with cellulose, not the individual phosphorus atoms are incorporated into its structure, as it occurs in traditional methods of treatment, but a chain of several phosphorus atoms as (P - O - P) n.

In this case the phosphorus content in the quantity of 2.1-10,0 % guarantees receipt of difficult to burn materials, bioprotection of which is 6-12 times greater than of untreated wood The estimation of the fire-protection properties of phosphorus-containing derivatives of cellulose (GOST 12.1.044-89, ISO 6940-84) has shown that the content of phosphorus necessary for significant if not for complete elimination of inflammation in a polymer depends on the structure of ester groups introduced Also in the samples with equal content of phosphorus, a higher degree of condensation of ester groups appearing in the structure of the polymer enhances the fire resistance.

Carbohydrate-lignin complex of wood consists of only about 50 %, cellulose and the anatomy of wood much differs from the structure of cellulose. Because of this, the implementation of the impregnation process which would ensure uniform distribution of the inhibitor over the volume of wood is very important. This exerts a great influence on the fire-protection properties of impregnated materials.

The technology and equipment for deep impregnation of lumbers made from different types of wood are developed in the Heat & Mass Transfer Institute. To perform deep (through) impregnation of wood, one of the two developed methods can be used: a centrifugal method (for wood with the initial moisture content above 60 %) or the method of impregnation under pressure (for wood with the initial moisture content bellow 60 %). This permits distributing the impregnating solution uniformly over the whole volume of wood.

To increase the treatment efficiency for difficult-to-impregnate wood materials, the technology of impregnation at variable pressure has been developed. The pressure can be

changed in a cyclic manner with a wide range of frequency and amplitude. A pulse regime of wood treatment is possible. For example, under cyclic change of pressure the absorption of the liquid increases when the amount of cycles is increased. At the same time, the total duration of wood processing under the elevated pressure does not change. This result was obtained with the use of the developed macroscopic physico-mathematical model of the wood impregnation process taking into account the movement of gas and liquid phases and the peculiarities of wood structure. The experimental data obtained in laboratory conditions and on the pilot-plant equipment at the Borisov Railway Tie Impregnation Plant (Belarus) have lead to similar conclusions Increasing the number of pressure cycles up to 7-8 results in the increase of the absorption of the protective solution by 20-40 %.

The developed equipment and technologies allow us to ensure the saturation of wood with a protective solution in required amount. To produce almost a noncombustible wood, the amount of absorbed solution should be 30 to 50 % of the initial wood mass (depending on the type of a solution). When using the fire-retardant based on polyphosphorus acids (БАН), the absorption should be not less than 50 % (250 kg of the solution per 1 m^3 of wood).

A technology for producing the protective emulsion based on polyphosphorus compounds and small polymeric additives (5-10 %) is developed, which ensures stability of the protective properties of wood against the atmospheric moisture. The technology permits to eliminate the heat treatment operation after the impregnation, which is used for fixing the fire retardant in the wood.