ОБЕСПЕЧЕНИЕ ПОЖАРНОЙ И ПРОМЫШЛЕННОЙ БЕЗОПАСНОСТИ

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THE EFFECT OF FLAME RETARDANT COMPOSITIONS ON THE PROCESS OF THERMAL DECOMPOSITION OF WOOD

Abstract: The analysis of the results of studies of the process of thermo-oxidative decomposition of wood with various flame retardants, effectively reducing the rate and heat of oxidation of the coal layer. The characteristics of thermal analysis determining the effectiveness of flame retardants for wooden structures are established. The influence of the chemical nature of flame retardants on the features of thermal decomposition of wood composite is shown. The use of flame retardants contributes to an earlier process of carbonation of wood, which leads to a decrease in the mass loss of samples in the temperature range 180 - 450 ° C.

Key words: flame retardants, thermal analysis, dehydration, fire protection, fire hazard

Studies have been conducted with respect to balanced flame retardant systems, different in their chemical nature, including classical phosphorus, nitrogen and boron-containing flame retardants. The concentration of working components in the composition varied from 30-75%, excluding binders. When selecting flame retardants, we proceeded from the fundamental differences in the mechanisms of action and their different effects on the processes of thermal decomposition, carbonation and carbonation of wood materials, which generally determine the fire hazard and fire resistance of wooden structures [1].

Thermal analysis of the studied samples was carried out in air at a speed of 5°C/min. The resulting thermogravimetric (TG) curve and differential thermogravimetric (DTG) curve are shown in Fig. 1.

Thermogravimetric analysis under the conditions showed that the samples of materials have two pronounced destruction intervals:

- at the first interval (50 - 180 °C), moisture is released in the range of 4.0 – 5.0 % by weight;

- in the second interval (180 - 450 °C), pine wood itself actively degrades, while the weight loss was approximately 50-80%, while treatment with formulations based on P-, N-containing flame retardants and organic surfactants, and a complex of P-, N-containing

flame retardants and thermoplastic polymers shifted the maximum of the decomposition reaction to the region of lower temperatures, including in amplitude.

The greatest changes occurred at the stage in the temperature range of 180 - 450 °C. There is a significant shift of the maximum DTG to a temperature of 280 °C, as well as a noticeable decrease in the mass loss of the sample from 80.0 to 50.0%.

If we analyze the curves of TG and DTG, it can be indicated that a high mass loss of a sample of wood with composition 6 is observed at a temperature of about 210 °C, due to the active course of the processes of dehydration and carbonation of wood material [2].

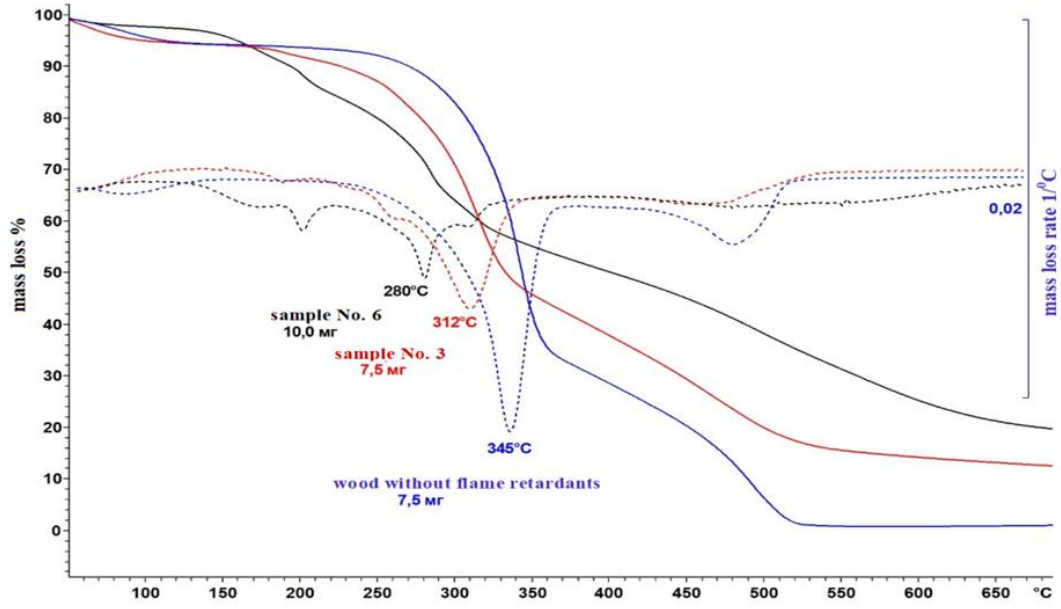

Figure 1 - TG and DTG curves of samples of modern pine wood (without treatment and with treatment with compositions based on P-, N-containing flame retardants and organic surfactants (sample No. 3) and a complex of P-, N-containing flame retardants and thermoplastic polymers (sample No. 6) (5 °C/min., atmosphere – air)

It can be concluded that the composition based on a complex of P, N-containing flame retardants and thermoplastic polymers has a complex mechanism of flame retardant action, including the classic mechanism of "catalytic dehydration". This is confirmed by the results of studies of the effectiveness and mechanism of action of various means of fire protection [3-5].

In order to establish the possibility of reducing the heat release of the oxidative process of the resulting coal, taking into account the use of flame retardants, the curves of the DSC with a heating rate of 20 °C/min were removed (Figure 2).

Analysis of the DSC curves shows that the decrease in the heat of oxidation of coal for pine wood in the presence of a composition based on P-, N-containing flame retardants and organic surfactants, and a complex of P-, N-containing flame retardants and thermoplastic polymers is 1.69 and 2.84 times, respectively. The obtained result indicates that these compositions will eventually contribute not only to reducing the mass loss of the sample when exposed to high temperatures, but also to the formation of a coal layer with a significantly lower oxidative and calorific value compared to the coal of untreated wood.

According to the research results, it was found that the developed flame retardants have high efficiency. The influence of the chemical nature of flame retardants on the features of thermal decomposition of wood composite is shown. The most important indicators of thermal analysis are the loss of mass and the values of characteristic temperatures corresponding to the course of individual stages of thermal decomposition of wood. The use of flame retardants contributes to an earlier process of carbonation of wood, which leads to a decrease in the mass loss of samples in the temperature range 180-450 ° C.

The developed compositions make it possible to effectively reduce these characteristics, especially the flame retardant composition based on a complex of P-, N-containing flame retardants and thermoplastic polymers: the heat of oxidation of the carbon residue for wood with this flame retardant is reduced by 2.84 times, compared with native wood coal.

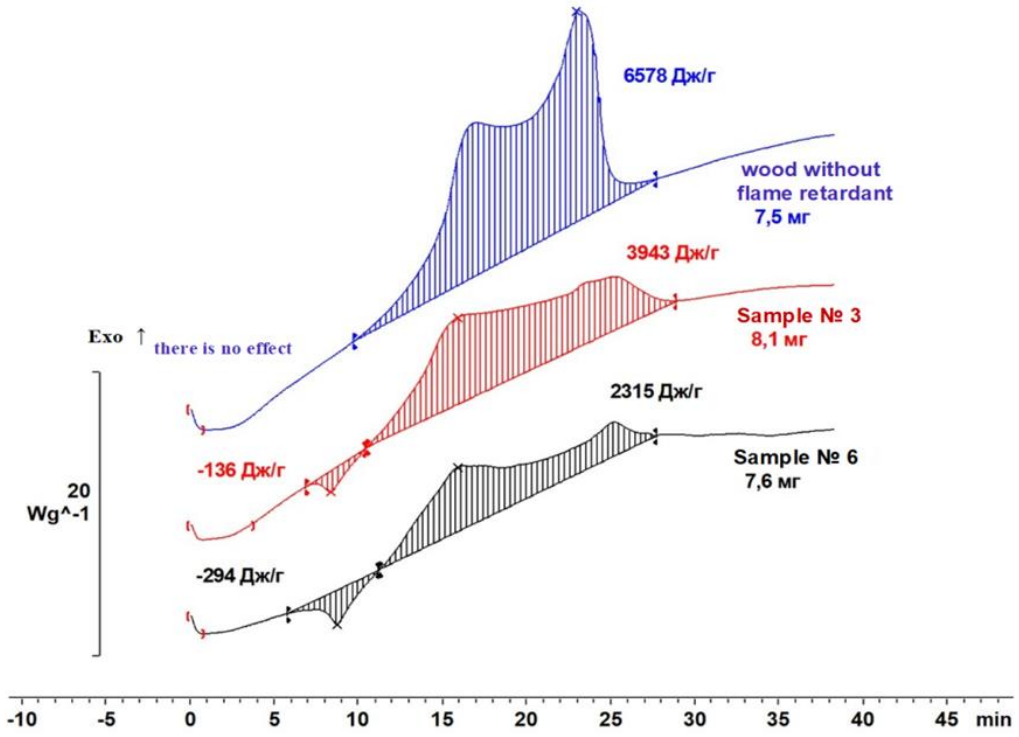

Figure 2 - DSC curves of pine wood samples without treatment and with treatment with compositions based on P-, N-containing flame retardants and organic surfactants, and a complex of P-, N-containing flame retardants and thermoplastic polymers (20 °C/min., atmosphere – air)

These characteristics are closely related to the degree of thermal damage, the rate of charring and the intensity of heat release during gorenje wood, ultimately determining the fire resistance of wooden structures.

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АҒАШТЫҢ ТЕРМИЯЛЫҚ ЫДЫРАУ ПРОЦЕСІНЕ ОТҚА ТӨЗІМДІ КОМПОЗИЦИЯЛАРДЫҢ ӘСЕРІ

Аңдатпа: Көмір қабатының тотығу жылдамдығы мен жылуын тиімді төмендететін, әртүрлі оттан қорғайтын құрамы бар ағаштың термототықтырғыш ыдырау процесін зерттеу нәтижелеріне талдау жасалды. Ағаш конструкциялары үшін оттан қорғайтын құрамның тиімділігін анықтайтын термиялық талдауының сипаттамалары анықталды. Ағаш композитінің жылу таралу ерекшеліктеріне отқа қарсы химиялық табиғаттың әсері көрсетілген. Антипирендерді қолдану ағаш көмірінің ерте процесіне ықпал етеді, бұл 180 - 450 °С температура диапазонында үлгілердің массасын жоғалтудың төмендеуіне әкеледі.

Түйінді сөздер: антипирендер, термиялық талдау, дегидратация, оттан қорғау, өрт қауіпі.

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ВЛИЯНИЕ ОГНЕЗАЩИТНЫХ КОМПОЗИЦИЙ НА ПРОЦЕСС ТЕРМИЧЕСКОГО РАЗЛОЖЕНИЯ ДРЕВЕСИНЫ

Аннотация: Проведен анализ результатов исследований процесса термоокислительного разложения древесины с различными огнезащитными составами, эффективно снижающими скорость и теплоту окисления угольного слоя. Установлены характеристики термического анализа, определяющие эффективность антипиренов для деревянных конструкций. Показано влияние химической природы антипиренов на особенности терморазпада древесного композита. Применение антипиренов способствует более раннему процессу углеобразования древесины, что приводит к снижению потери массы образцов в температурном интервале 180 - 450 °С.

Ключевые слова: антипирены, термический анализ, дегидратация, огнезащита, пожарная опасность.

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