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WOOD FIRE PROTECTION MECHANISMS

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Wood is one of the oldest building materials which is widely used today. Together with a large number of positive properties of wood as a construction material, it also has negative properties. One of these properties is flammability. According to existing regulatory documents wood intended for use in construction, must be subjected to fire retardant processing.

Even Lavoisier (late 18th century) and Gay-Lussac (early 19th century) believed that substances possess flame retardant properties, which, under the influence of heating, melt and emit non-combustible gases. Scientists before the 40s of the current century held the same views. But with the improvement of research methods, it was found out that some substances that do not have the ability to release when burning, non-combustible gases can have a fire-retardant effect. Some value in reducing the flammability of protected wood began to be given the possibility of reducing temperature of the burning material due to the release of crystallization water or increasing the amount of slowly burning coal when the fire retardant interacts with the components of wood or the initial products of their decomposition.

Naturally, the explanation of the fire-retardant effect of various substances due to any one of their properties is unacceptable. Even when using fire retardants of the same type per combustion process can be influenced by a significant number of factors. In addition, the effect of two or more factors may be more than the sum of their effects due to the phenomenon of synergy.

To prevent wood fires, it is necessary to create conditions excluding excess of the temperature of heating wood above the ignition temperature. This temperature range is in the range of 200–250° C. Funds must show fire retardant effect inhibiting the development of combustion processes to the ignition temperature of wood.

Fire protection mechanisms include:

– thermal insulation of the protected surface from impact ignition source;

– heat absorption due to the heat capacity of the fire-retardant coating and flow endothermic processes in the coating;

– inhibition of the combustion process due to the death of active centers of the flame and inhibition of the chain chemical reaction of combustion;

– acceleration of the processes of decomposition of carbohydrates with the formation of non-combustible gas products of thermal destruction of water and coke oven residue, which in turn has thermal insulation properties;

– dilution with non-combustible wood decomposition products or covering flammable substances in the combustion area.

Due to the above influence of the chemical structure substances on their flammability, it can be concluded that for organic of film-forming substances, the flammability increases in the following order:

1) compounds that contain halogens, acid residues of phosphoric, sulfuric and sulfurous acids (per-chlorovinyl resins, organo-phosphorus bromine polymers, sulfite alkali, etc.);

2) compounds that most completely passed into three-dimensional polymer. Among them, the most resistant are urea resins, resins, etc.;

3) connections that have partially switched to three-dimensional polymer retaining unused functional groups (films of vegetable wood oils that dry out);

4) high molecular weight chain compounds that have fusibility (ethyl cellulose, benzyl cellulose, etc.);

5) low molecular weight compounds such as bitumen;

6) high molecular weight chain compounds, which have kept a large number of unused and combustion-friendly functional groups (rubber, nitrocellulose, etc.). According to the above principle, the most suitable for fire retardant coating are organic film formers of the first and second group.

Studying the behavior of pine wood, treated with inorganic salts, Eikner found that the concentration of salts at which wood is least resistant to heating is 10-20%. Calculated from data statistical thermo-gravimetric analysis of the magnitude of the apparent activation energies of the wood decomposition process (with different additives) are as follows (Table 1.)

Table 1. – Values of the apparent activation energy (E) of the decomposition process wood (with various additives)

Variety salts	Content salt in sample,%	E, kJ / mol
Untreated salt	-	149.8
NH_4Cl	17,7	145,7
NaCl	12,0	138,1
$(NH_4)_2SO_4$	15,7	142,3
$NH_4H_2PO_4$	45,1	138,5
$(NH_4)_2HPO_4$	10,8	133,5
$Na_3PO_4 \cdot 12H_2O$	18,0	122,6
$Na_2B_4O_7 \cdot 10H_2O$	17,4	103,4
K_2CO_3	20,0	106,3

Results and Discussion. It is known that the rate of thermal destruction of wood decreases with the addition of fire retardants and depends on their quality. It has been proven that it is possible to more than double the yield of carbonaceous residue by treating pine with phosphates and borates, and the release of volatile products will change, which means that the heat of combustion of volatile combustible products and the amount of heat delivered to the surface wood. As a result, more powerful heat flux, and the coal layer, as it accumulates, will protect the inner layers of wood.

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