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Reducing the Combustibility of Wood Products by Treating their Surface with Intumescent Paints on a Water-Dispersion Basis

Sergii Guzii*

V Bakul Institute for Superhard materials NASU Ukraine, Avtozavodskaya, Ukraine

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***Corresponding author:** Sergii Guzii, V Bakul Institute for Superhard materials NASU Ukraine, Avtozavodskaya Str 2, Kyiv 04074, Ukraine

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Introduction

In the countries of North America, the construction of low-rise residential log and block houses made of pine wood is common. In addition to the positive properties (environmental friendliness, strength), when external temperature and humidity fields change, wood structures can undergo cracking, torsion and other deformations, and are also prone to burning.

Currently, there are many compositions and means for fire protection of wood on the market. The main protective materials and compositions include fire retardant impregnations and intumescent paints [1, 2]. The latter are especially relevant, since they can process not only internal, but also external surfaces. A variant of fire-retardant paint of intumescent type on a water-dispersion basis "Silic Laquer Panel" (LLC "Silik-Ukraine") is proposed. In the manufacture of paint, ammonium polyphosphate, pentaerythritol and melamine were introduced into the composition of the Silic Laquer Panel in optimal concentrations [3, 4].

The drying time of one layer of paint at a temperature of 20±2°C and relative humidity 50-80% to degree 3 was 3 hours. According to the limitation of VOC emissions, intumescent paint belongs to category A/5, the content of LOS in which is less than 25g/l. For fire and weather resistance tests, the paint was applied in two layers on wooden samples of pine wood with dimensions of 150x 60x 30mm with a moisture content not higher than 12%. The average coating thickness was 125μm.

Before fire tests, samples of painted wood were subjected to thermal stabilization in accordance with the requirements of the standard (DSTU B V.2.7-19-95, Ukraine) until constant weight was reached. Studies to determine the combustibility group of wood treated with the proposed coating were carried out at the OTM installation (Figure 1). The essence of the test procedure is that the sample was centered and placed in the ceramic tube of the OTM installation above the flame of a gas burner. The initial temperature of the gaseous combustion products at the outlet of the ceramic tube was 200±5°C. The test time was 300 sec. During fire tests, the temperature of gaseous products was recorded (Figure 2) using a thermal converter connected to the ADC. After the test was completed and the sample cooled down, a visual inspection was made, and the weight was determined. Based on the test results, the materials are classified as: - slow-burning - $\Delta t < 60$ °C and $\Delta m < 60\%$; - combustible - $\Delta t \geq 60$ °C or $\Delta m \geq 60\%$. The flammability group of paints was determined in accordance with the requirements of DSTU B V.2.7-19-95.

As can be seen from the data in figure 2, during the fire test, the temperature of the flue gases of the control sample and the sample after a year of exposure to atmospheric conditions did not exceed critical values (less than 260°C), the weight loss of both the control sample and the test sample was 4 and 6.5%. This makes it possible to classify the developed material as slow burning.

For weathering tests, painted pine blocks were placed on a stand at a 45° angle, facing south; test site coordinates - latitude: 50°27′16″ N; longitude: 30°31′25″ E; height above sea level 187m. Weather changes for the test period (11.18.2021-11.18.2022) are reflected in the database of the website https://www.gismeteo.ua. The assessment of the external state of the paint coating on pine wood was carried out visually, as well as by changing the values of adhesion of the coating to a wooden substrate using an AN-1 multi-

blade notch adhesive gauge (GOST 15140). The value of adhesion, determined by the method of lattice cuts, in the control specimen was 1 point, which confirms the sufficiently high adhesion of the intumescent lacquer paint to the wooden surface.

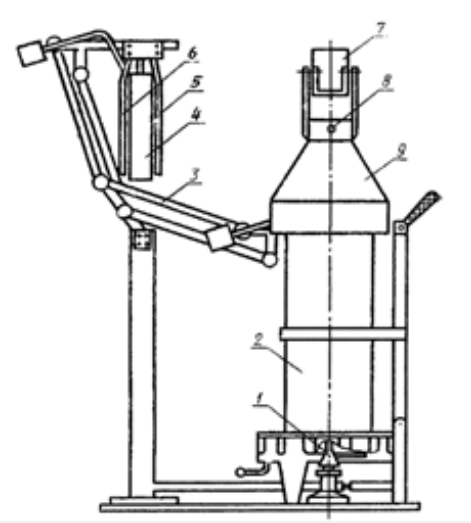

Figure 1: Scheme of the OTM installation for fire tests: 1 - burner; 2 - reaction chamber; 3 - sample introduction mechanism; 4 - sample; 5, 6 - sample holders; 7 - mirror; 8 - thermoelectric converter; 9 - umbrella.

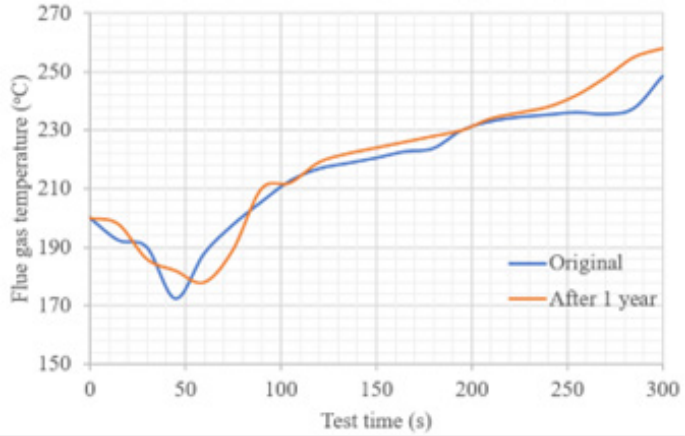

Figure 2: Change in flue gas temperature from the time of fire exposure.

After 3 months of exposure to atmospheric conditions, there were no changes in the appearance of pine samples, opened with intumescent paint, the adhesion value was 1 point. At 6 months of exposure, the paint becomes dull, the adhesion value is 1 point, no cracks or delamination were found. After 9 months from the start of testing, the dullness of the paint increases, slight areas of paint peeling appear, adhesion is 2 points, swelling, peeling is not observed. After a year of exposure of painted wood samples to atmospheric conditions, signs of thermochemical degradation of the polymer appear - slight cracks along the wood fibers, the paint has changed color, burned out, but no swelling or obvious delamination were noted. Adhesion decreased to a value of 3 points. According to [5], exposure of samples to atmospheric conditions for one year corresponds to 10 years of operation. The conducted tests of the intumescent water dispersion-based paint "Silic Laquer Panel" show its promise for use as a fire retardant when painting the external surfaces of wooden structures and products.

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