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Characteristics of selected fireproof properties of particleboard made from particles impregnated with salt agent

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Abstract: *Characteristics of selected fireproof properties of particleboard made from particles impregnated with salt agent.* This paper presents results of selected fireproof properties of three-layer particleboard made from pine particles impregnated with open for general use bio- and salt fireproof agent for wood protection, based on quaternary ammonium compounds and boric acid. It leads to conclusion that impregnation of particleboards increases the fire resistance in relation to unprotected materials.

Keywords: particleboards, fireproof properties, salt agent

INTRODUCTION

Materials designed for furniture and construction are obliged to meet the requirements of fire resistance. Wood is a material particularly susceptible to fire, which is related with its structure and chemical composition.

Particleboard as a wood-based material, is widely used in the furniture industry. Therefore, just as wood, it should be resistant to a variety of degradative factors, including fire (Drysdale 2001, Osipiuk 2001, Grexa et al. 2003, Kozłowski et al. 1999). Salt agents can not fully protect the material against the spreading of fire, but their impact on reduction of its effects is significant. Development of flame retardants production technology leads to new recipes, designed to improve their properties and to make an agent application easier, as well as eliminating the negative effects on human and surrounding environment. Nowadays, due to the ease of application, the most common are salt preparations called antipirenes. Impact of salt fire-retardants addition has not been fully examined yet, especially new generation agents in case of selected fire-retardant's properties of wood-based materials produced with their addition (Babrauskas 2005).

MATERIAL AND METHODS

The research was carried with open for general use salt bio- and flame retardant for wood protection. The product is sold as a water-based paste with 58 - 60% content of solids. Among others it consists of quaternary ammonium compounds (3%) and boric acid (about 3%). Preservative raises fire-retardant properties and bio-protection, which allows to protect wood against fungi and insects. The manufacturer determines the penetration of the product on 2 mm at a moisture content of impregnated material with 12% and 5 mm at 28% (AT-15-7414/2007). The product was used for wood particles impregnation, then three-layered particleboard was made with them (assumed thickness was 12 mm and density was 650 kg/m^3).

From the product, water solution was prepared (3 pbw of agent, 1 pbw of water), which was used for further wood particles impregnation (separately for inner and outer layers). After the initial drying of particles at 21 °C, actual drying was performed, which was conducted at 80 °C for 30 minutes, what allowed the particles to achieve a final moisture content of 6%. Impregnated and dried wood particles were glued in tumble binder with urea-formaldehyde

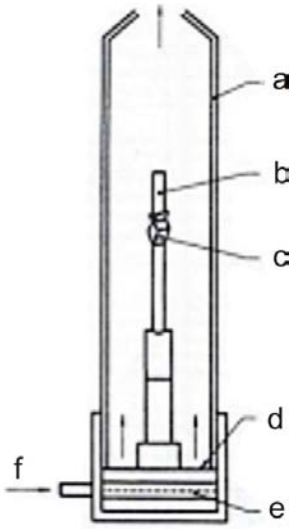
resin, in an amount of 10% based on the completely dry particles weight. Unit recipe of glue contained 50 g of urea-formaldehyde resin at a concentration of 66%, 2 g of ammonium chloride and 15 g of water. From glued particles a mat was formed, which was then compressed in the platen press, at 180 °C and a unit pressure of 2.5 MPa for 5 minutes.

From prepared boards samples were cut for the oxygen index flammability test and the flammability test for a single-flame.

Oxygen index flammability test

This study allows to determine flammability of tested materials. Oxygen index is the smallest percentage of oxygen in the air mixture, which sustains constant burning of the material in laboratory conditions.

Examination was performed in accordance to ISO 4589-2:1999: “Plastics - Determination of burning behaviour by oxygen index”. Test samples were cut from previously prepared boards. The dimensions of mouldings were 10 cm long and 1 cm wide. Examination was held in equipment prepared specially for this purpose. The sample was positioned vertically and covered from the top with a shade, according to the scheme shown in Figure 1.



a - Chimney (height: 450 mm, diameter: 95 mm)
b - Moulder for research
c - Moulder grip
d - Screen made of wire mesh
e - Diffuser ring
f - Mixture of oxygen and nitrogen

Fig. 1. Scheme of the equipment for the oxygen index test

Gas-jet was a source of fire, which was applied for 30 seconds to the top of the sample. Every 5 seconds the burner was moved away from the sample in order to check the uniformity of sample’s top burning. Amount of nitrogen and oxygen flow was regulated with the valve and the process of sample burning was observed, as well as time after which burning of 50 mm of the sample’s top took place.

Oxygen index measurement method is used for comparison of various materials flammability in assessing the impact of additional filler materials including various kinds of flame retardants. However, it should be noted, that oxygen index can not be used for materials classification in terms of fire hazard.

Single-flame source test

Examination is a modification of the method described in standard PN-EN ISO 11925-2:2004 “Reaction to fire tests - Ignitability of products subjected to direct impingement of flame - Part 2: Single-flame source test”. The modification consists on time measurement

after which flame reaches 15 cm of sample's height, which allows to specify not only the flammability of the material, but also to observe how fast the flame spreads.

Test samples were cut from previously prepared boards. Dimensions of mouldings were 25 cm long and 9 cm wide. Research was conducted on a specially prepared test stand (Fig. 2).

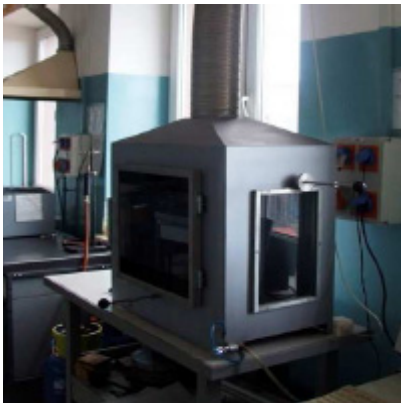


Fig. 2. Stand for flammability test of materials treated with direct flame influence, according to PN-EN ISO 11925-2:2004 in laboratory of Department of Combustion and Fire Theory, The Main School of Fire Service – SGSP

Research was performed with the use of a gas-jet, put for 120 seconds to the sample surface. The burner was fitted on a horizontal panel wich allowed it to uniformly move in a horizontal plane, along the central axis of the test chamber. It was combined with a precise valve, allowing adjustment of the flame. Sample holder constituted double, U-shaped frame from stainless steel, with a width of 15 mm and thickness of 5 mm (Fig. 3). The frame was balted with screws, which prevented from deformation and sliding of the sample during the test. Use of the holder allowed to subject samples for direct flame exposure. Test was carried out by continuous flame exposure on the surface.

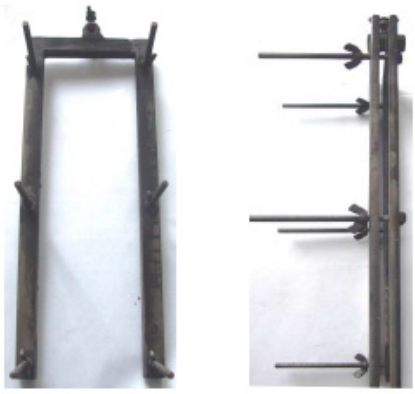


Fig. 3. Sample holder

RESULTS AND DISCUSSION

Obtained work results are set together in tables 1 and 2. Oxygen index of particleboard samples made of particles, which were not protected with fireproof agent was 29.2%, while for boards made of particles protected with flame retardant, this ratio was 33.9% (Table 1).

Table 1. Results of oxygen index flammability test (bolded text indicates the lowest value of oxygen index for particular samples)

Samples without fire-retardant		
Sample No	Concentration of oxygen in the mixture (%)	Observations
1	25	Sample do not burn
2	27	Flame visible for 1 min 30 sec.
3	29	Flame visible for 1 min 40 sec.
4	31	Fire was sustained for 3 minutes, 4.5 cm of sample have been burned
5	30	Fire was sustained for 3 minutes, 2.5 cm of sample have been burned
6	29.5	Fire was sustained for 3 minutes, 4.5 cm of sample have been burned
7	**29.2**	**Fire was sustained for 3 minutes, 15 cm of sample have been burned**
8	29	Fire was sustained for 1 min 50 sec
9	29.1	Fire was sustained for 2 min 20 sec, 0.5 cm of sample have been burned
Samples with fire-retardant		
Sample No	Concentration of oxygen in the mixture (%)	Observations
1	60	5 cm of sample have been burned in 31 sec
2	40	5 cm of sample have been burned in 2 min 46 sec
3	35	5 cm of sample have been burned in 1 min 2 sec
4	32	Fire was sustained for 2 minutes, 8 mm of sample have been burned
5	33	Fire was sustained for 1 min 40 sec, 7 mm of sample have been burned
6	34	Fire was sustained for 1 min 8 sec, 5 mm of sample have been burned
7	33.5	Fire was sustained for 1 min 40 sec, 5 mm of sample have been burned
8	33.8	Fire was sustained for 1 min 24 sec, 5 mm of sample have been burned
9	**33.9**	**Fire was sustained for 3 minutes**

In Table 2, results of reaction to fire test based on the single-flame source test are presented. For particleboard made of particles, which were not protected which fireproof agent, the average height of flame after 120 seconds was 80mm, while for samples made from particleboards previously protected with fireproof agent, the height of flame was reduced by an average of 10 mm.

Table 2. Results of reaction to fire test

Presence of fire-retardant	Time [s]	Average height of flame [mm]
Without fire-retardant	120	80
With fire-retardant	120	70

CONCLUSIONS

On the basis of conducted research it can be stated, that impregnation of particles for particleboards production, with the agent based on quaternary ammonium compounds and boric acid, is beneficial for improving fireproof properties defined in the work.

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Streszczenie: *Charakterystyka wybranych właściwości ogniochronnych płyty wiórowej z wiórów impregnowanych preparatem solnym.* W pracy przedstawiono wyniki badań wybranych właściwości ogniochronnych płyt wiórowych trójwarstwowych wytworzonych z sosnowych wiórów drzewnych impregnowanych ogólnodostępnym bio- i ogniochronnym środkiem solnym do zabezpieczania drewna, na bazie czwartorzędowych związków amoniowych i kwasu borowego. W podsumowaniu stwierdzono, że przeprowadzona impregnacja zwiększa ognioodporność płyt wiórowych względem tworzyw niezabezpieczonych.

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