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Study of minimum ignition temperature in layer and cloud of dusts obtained from natural and thermally modified oak *(Quercus robur L.)* and ash *(Fraxinus excelsior L.)* wood

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Abstract*: Study of minimum ignition temperature in layer and cloud of dusts obtained from natural and thermally modified oak (Quercus robur L.) and ash (Fraxinus excelsior L.) wood.* This paper presents the results of the ignition temperature of the layer and cloud of dust: thermally unmodified oak wood, oak wood thermally modified at 195°C, thermally unmodified ash wood, thermally modified ash at 185°C and at 195^{0}C in industrial conditions. The studies were conducted using the measurement methodology described in PN-EN 50281-2-1:2002. Based on the studies can be concluded that used thermal modification didn't affect the ignition temperature of cloud of tested dust and caused a slightly lowering of temperature of layer of dust obtained from thermally modified ash wood (by 10°C).

Keywords: thermal modification, minimum ignition temperature, wood dust, flammable properties

INTRODUCTION

Wood due to its mechanical and physical properties, aesthetic appearance and ease processing has gained incredible popularity. In the modern world wood used in various forms has aroused great interest. However, as any material of plant origin, the wood is exposed to the negative impact of weather conditions, and as an organic material it is attack by insect, fungi and molds. There are different ways of improving wood durability. Wood products are subjected to different treatments aimed to increase their durability, while also improving the appearance and give an appropriate color required by the user. These methods relate their action to the surface of wood, its internal structure or affected to the surface and cross section of elements.. These methods - chemical, thermochemical and thermal - are used to different range, depending on the circumstances in which the wood will be used, what effects the user wants to achieve. Heat treatment is one of the processes used to modify the properties of wood and alternative preservation method to the chemical treatment/impregnation without the using chemical products (Younsi et. al., 2010, Korkus et al., 2008, Manninen et al., 2002, Cerc Korošec et al., 2009, Kocaefe et al., 2010) In the wood industry while woodworking by-products are formed, which could include. They represent a variety of threat to life and health of people in contact with dust. From the standpoint of fire hazard posed by dust refers to their fire and explosive properties. The type and size of effects that result from uncontrolled combustion (smoldering, ignition, explosion) depend primarily on (Jaskółowski, 2008):

a) the origin of matter: organic or inorganic,
b) the degree of fragmentation and the associated surface area,
c) intergranular porosity (bulk density),

d) dust moisture content,
e) the degree of mixing (dispersion) of the mixture,
f) the degree of turbulence,
g) concentrations of dust in dust-air mixture,
h) the initial temperature of dust-air mixtures,
i) the initial pressure of dust-air mixtures,
j) thermal properties.

MATERIALS AND METHODS

Experimental tests were carried out using wood dust, size of grains to 200 μm obtained from samples of ash and oak wood, thermally modified and unmodified. Oak wood was modified at 195°C during 6 hours in industrial conditions. Wood ash was modified at 185°C for 5 hours, one set of samples and also at 195°C during 6 hours, second set of samples. Determination of the ignition temperature of dust was measured using the methodologies described in PN EN 50281-2-1:2002.

The study of layer ignition temperature was carried out using a test stand as shown in fig 1. The test consists of placing the dust with a thickness of 5 mm on a hot plate and heating.

According to the recommended procedure is considered that the ignition of layer of dust, if:

a) the observed glow or smoking, or
b) measured the temperature reached 450° C or,
c) the measured temperature exceeds about 250 K temperature of the hotplate.

The study of ignition temperature of cloud of layer of dust was carried out using the test stand shown in Figure 1

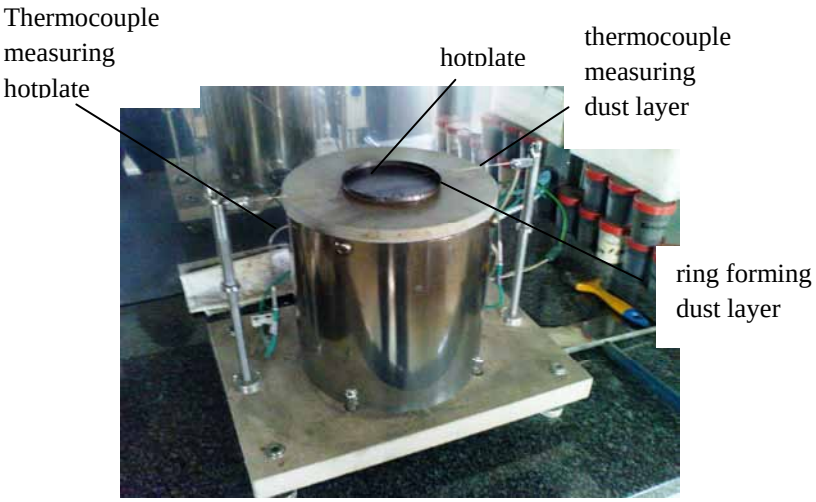

Fig.1. The test stand for determining the ignition temperature of layer of dust

The study of ignition temperature of cloud of dust was carried out using the test stand shown in Figure 2.

Fig.2. The test stand for determining the ignition temperature of cloud of dust

RESULTS AND DISCUSSION

The results are shown in Fig.3 and Table 1-2.

Fig.3. Emission of smoke from wood dust during the measurement: a) initial phase, b) final phase

Table 1. The results of ignition temperature of cloud of dust

No.	Type of dust	Ignition temperature of cloud of dust
1.	Unmodified oak	430°C
2.	Modified oak at 195°C during 6 hours	430°C
3.	Unmodified ash	430°C
4.	Modified ash at 185°C during 5 hours	430°C
5.	Modified ash at 195°C during 6 hours	430°C

Table 2. The results of ignition temperature of layer of dust

No.	Type of dust	Ignition temperature of layer of dust
1.	Unmodified oak	320°C
2.	Modified oak at 195°C during 6 hours	320°C
3.	Unmodified ash	320°C
4.	Modified ash at 185°C during 5 hours	310°C
5.	Modified ash at 195°C during 6 hours	310°C

A sample of dust of thermally unmodified oak was ignited at the temperature of hotplate 340°C and 320°C in a fairly short time of heating, because after the - appropriately - 3 and 4 minutes. Only at 310°C dust has not ignited. Although within 2 minutes there was a rapid increase of temperature observed, however it was not enough to begin the process of incandescence. Tests performed with dust of modified oak did not differ significantly from the behavior of unmodified dust. Although in this case a little more time (6 minutes) elapsed from dug of layer to notice an incandescence. Ignition temperature of layer of dust is also 320°C. Unmodified ash was also ignited at 320°C, which is the same as unmodified and modified oak. The ignition of layer occurred in this case after about 3 minutes. Both types of dust from the thermal modified ash reached ignition temperature at 310°C after about 7 minutes, so over a longer time than the ignition temperature at 320°C.

As a minimum ignition temperature should be the lowest temperature of the furnace, which accepts the ignition, reduced by 20°C at temperature of furnace above 300°C, so on the basis of studies carried out the minimum ignition temperature of cloud of dust at 410°C.

Although the tests of five different samples of wood dust results were the same. All samples of dust blown into the chamber of tested furnace ignited at 430°C. While not every time the ignition followed immediately after blowing a portion of dust. Especially in the case of dust of ash wood has been reported ignition delay at a temperature close to the lowest ignition temperature (dust of modified wood at a temperature of 185°C) or directly at the lowest ignition temperature (dust of unmodified and modified wood at 195°C).

CONCLUSIONS

The results of studies of ignition temperature of cloud of dust are entitled to conclude that thermal modification did not affect the differences from obtained results of study, regardless of the type of wood tested. The study of ignition temperature of layer of dust showed little difference in the case of thermally modified wood ash. The process of thermal modification caused a reduction of ignition temperature of the wood by 10^{o}C compared with other research material.

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7. PN EN 50281-2-1:2002: Urządzenia elektryczne do stosowania w obecności pyłów palnych -- Część 2-1: Metody badania -- Metody oznaczania minimalnej temperatury zapłonu pyłu (in english: Electrical apparatus for use in the presence of combustible dust - Part 2-1: Test methods - Methods for determining the minimum ignition temperatures of dust

Streszczenie: *Badania temperatury zapłonu warstwy i obłoku pyłów otrzymanych z naturalnego i modyfikowanego termicznie drewna dębowego i jesionowego.* W referacie przedstawiono wyniki badań temperatury zapłonu warstwy i obłoku pyłu: drewna dębowego niemodyfikowanego termicznie, drewna dębowego modyfikowanego termicznie w temperaturze 195 ^{0}C, drewna jesionowego niemodyfikowanego termicznie, drewna jesionowego modyfikowanego termicznie w temperaturze 185 ^{0}C i 195 ^{0}C. Badania przeprowadzono z wykorzystaniem metodyki pomiarowej opisanej w normie PN-EN 50281:2002. Na podstawie przeprowadzonych badań można stwierdzić, że zastosowana modyfikacja termiczna nie wpłynęła na temperaturę zapłonu obłoku badanych pyłów oraz spowodowała nieznacznie obniżenie temperatury warstwy pyłu otrzymanego z drewna jesionowego modyfikowanego termicznie (o 10 ^{0}C).

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