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Determination of fire-environmental parameters of selected wooden composites

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Abstract: *Determination of fire-environmental parameters of selected wooden composites.* The contribution is focusing the assessment of selected wooden composite fire danger, where four kinds of wooden composite (plywood, chipboard, OSB board and fibreboard), based on specified point of flammability temperature and flash point temperature as the basic fire parameters. The results of the assessment are important as for the fire prevention needs as for the needs of fire investigation in wood processing industry. Attention is devoted to the proposal and evaluation of important characteristics for the prediction of the behaviour of wood composite materials for their thermal degradation in relation to environmental security.

Key words: wooden composites, point of flammability, flash point, STN ISO 871, environmental characteristics

INTRODUCTION

In assessment of technological processes fire danger is necessary to take into consideration the fire danger related to the materials processed, i.e. the kind and volume of matters which are used in the production process, besides the other factors. The essential raw material in production of wooden compos is a wood. Wood is a natural organic material, which could be found in any form (raw material, semi-finished product, finished product). It is a flammable material, and this fact should be realized by its manipulation, processing or storing. When the fire prevention measures are neglected, there is a high risk of fire formation, which is confirmed by annual statistics. In the last four years, in the wood manufacturing sector, there were recorded 146 fires with the direct losses of 3,781,510 €, in which 9 persons were injured [8-11]. Coming out of the statistical data of the most common fire reasons in wood manufacturing sector (Tab. 1.), we can notice, that the reasons of their initiations are various, because of electrical shock, operational and technical failures, self-ignition and unknown or other reasons. To reduce the fire danger and to realize the preventive measures, it is necessary to know the fire parameters of materials processed.

Tab. 1 The most common reasons of fire in wood manufacturing sector [8-11]

Year	The most common reasons of fire in wood manufacturing sector				
	Unknown reason	Electrical shock	Operational and technical failures	Self-ignition	Other reasons
2010	6	3	3	2	19
2011	11	4	4	3	21
2012	7	3	5	2	20
2013	9	3	4	1	16

Among the basic fire parameters of wood belong: point of flammability and flash point, oxygen number, heat of combustion, optical smoke density and mass burning rate. The fire parameters of wood are described in many publications. They were published, e.g. by Rowell (2005) [12], for the spruce wood they are introduced in Catalogue of materials fire parameters [6]. With the parameters of wood as a part of the construction feature were engaged Delichatsios et al. (2003) [2] too, who states that the critical point for wood in raw form is heat flow of 18 $kW.m^{-2}$. Also Karlsson and Quintere (2000) [5] state, that for formation of the flashover is necessary in a fire section to reach the temperature of 500 - 600 °C, or radiation flow to floor of 15 - 20 $kW.m^{-2}$ respectively.

Based on the point of flammability determined in means of the ISO 871: 2010, we can express an opinion on relative resistance of materials against ignition, which can occur in wood processing.

METHODOLOGY

Determination of point of flammability and flash point

The core of the test is heating of the material in heating chamber by different temperatures in means of the STN ISO 871 [13]. Applying a small incendiary flame routed to the opening of the hot-air furnace shield, there are ignited the released gases and the flash point is set. The point of flammability is set in similar way like the flash point temperature, but without the incendiary flame. The course of the temperature in furnace is measured by the thermocouples (type K) with diameter of 0.5 mm, for recording the temperatures ALMEMO 2290-8 device is used.

SAMPLES

Before the test, the samples were conditioned by the temperature of 23 °C ± 2 °C and relative moisture of 50 ± 5 % for minimum of 40 hours. The samples with the moisture of 9 % had been cut to scantlings with size of 20 x 20 mm yet before the weighting. The third dimension was modified to reach the desiderative weight of 3 ± 0,2 g, in means of the standard STN ISO 871: 2010.

To determine the temperature of the flash point and point of flammability, there were chosen the samples of four wood compos: plywood, chipboard, OSB board and fibreboard (see Fig. 1).

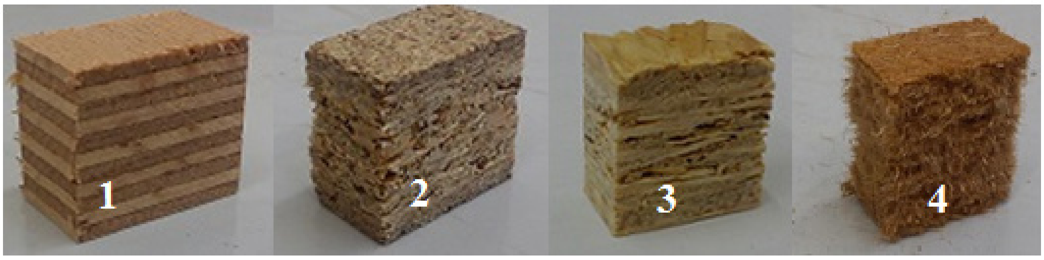

Fig. 1 Test samples
(1 – plywood with diameter of 18 mm, 2 – chipboard with diameter of 18 mm,
3 – OSB board with diameter of 22 mm, 4 – fibreboard with diameter of 20 mm)

RESULTS

Resulting values of flash point temperature and temperature of point of flammability of test samples, as well as the time to reach the flash point and point of flammability are in overall introduced in Tab. 2.

Tab. 2 Resulting values of temperature and time to reach the point of flammability and flash point of the test samples

Sample	Testing temperature (°C)	Flash point (°C)	Time to reach the flash point (s)	Testing temperature (°C)	Flash point (°C)	Time to reach the flammability point (s)
Plywood	320	324.86	484.80	410	408.21	335.80
Chipboard	330	337.10	494.40	420	418.20	308.20
OSB board	340	341.62	444.80	420	415.70	306.20
Fibreboard	280	284.74	481.20	470	468.94	165.40

The lowest temperature of flash point (284.74 °C) was recorded by the samples of fibreboard. Then it is followed by the samples of plywood (324.86 °C), chipboard (337.10 °C) and the highest temperature was measured in case of the samples of OSB board (341.62 °C). In determination of flash point itself, also the time to reach the flash point plays an important role, because not only temperature, but also time reflects the resistance of the material. In our case, the time to reach the flash point was in the range from 444.8 seconds in case of OSB board up to 494.4 seconds by chipboard, what represents 10 % difference in time.

The course of flammability point temperature was in the range of 408.21 °C in case of the samples of plywood, 415.70 °C of OSB board samples, and chipboard samples, where the temperature of 418.20 °C was measured. The highest temperature of flammability point (468.94 °C) we have recorded in case of samples of fibreboard. This temperature is approximately about 50 °C higher like the flammability point temperature of the other samples, however, there was reduced the initiation time to the value of 165.40 s, what represents reduction of the time to reach the flammability point value of 52.22 % in comparison to other samples.

Our results are comparable with measurement results of other authors. In determination of flammability point temperature was engaged also Galla et al. (2013) [3], which work was oriented to the assessment of chipboards and OSB boards, which have been loaded with heat flow value higher than 40 $kW.m^{-2}$. Among the essential materials used in production of wooden compos belong spruce, pine and beech wood. In testing the parameters of those kinds of wood were engaged many authors. In determination of minimal temperature of flammability point of spruce wood samples under different pressures was engaged Zigo et. al. (2014) [15], who came to the temperature values ranging from 470 °C up to 520 °C. Also Hagen et al. (2009) [4] considered the flash point temperatures of spruce wood samples about 487.9 °C. The temperature of the flammability point and flash point introduced in his previous work also Zachar et. al. (2010) [14], where he reached very similar values, the flash point temperature of 360 °C reached in 560 seconds and flammability point temperature of 400 °C reached in 550th second. Also Martinka et. al. (2014) [7], in his work, describes the inductive period of spruce pellets in interval of 460 °C - 560 °C and its whole time course. Also Chrebet et. al. (2011) [1], in his work, introduces the flash point temperature in case of beech wood in interval from 400°C and the time to reach the flash point of 300 seconds up to the temperature of 420 °C and the time of its reaching 235 seconds. The pine wood was investigated by Delichatsios et. al. (2003) [2], who came to the flammability point temperature of c.a. 478 °C.

THE PROPOSAL OF DETERMINATION OF ENVIRONMENTAL CHARACTERISTICS

For the thermal decomposition of wood-based materials, and polymer materials used for the surface treatment of wood products, it is necessary to evaluate the retardants and even the environmental characteristics of these materials and for the prediction of their comprehensive fire-safety and environmental behaviour [16-18]. in their preparation, but also in the context of LCA in terms of their use in practice, the following materials cycle, but also in the simulation of crisis situations, eg. in case of fire and leakage of flammable liquids, gases, solvents, diluents .

The device detects the concentration of gases and combustible-100 MicroCD RIDGID hazardous substances by using internal sensor TCD during the measurement of the heat. Detection of the device indicates the presence of combustible gases (methane, propane, ethylene, hydrogen, CO, hydrogen sulfide) and hazardous chemicals (volatile organic compounds-groups of the benzene, toluene, xylene, benzene, formaldehyde, etc.) using the Visual, audible and vibration mechanism in 5 levels of sensitivity setting thresholds for the presence of deteged substances. For low concentrations of hazardous gases, for example. What is appropriate to complement the measurement device GassAllert device to measure the concentration or CO/CO2 model M7722.

CONCLUSION

Annual statistics of fire development in Slovakia are not kind. The same situation is in wood processing industry. Therefore, there is an unfailing need to tackle this problem. This need reflects also this contribution. Determination of point of flammability and flash point belongs among the basic fire parameters of materials, which is necessary to know as for the needs of technological processing of materials and identification of places with higher fire danger as for the fire investigation needs. Fire parameters represent the basic data in elaboration of fire orders of the workplaces with higher fire danger, and are important for assessment of materials in view of their final use.

For the thermal decomposition of wood-based materials, and polymer materials used for the surface treatment of wood products, it is necessary to evaluate the retardants and even the environmental characteristics of these materials and for the prediction of their comprehensive fire-safety and environmental behaviour (presence of risk chemical substances).

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Streszczenie: Określenie własności ogniowych i środowiskowych wybranych kompozytów drzewnych. Praca dotyczy oceny wybranych tworzyw drzewnych (sklejka, OSB, Płyta wiórowa oraz pilśniowa) pod kątem wartości parametrów temperatury spalania i punktu zapłonu. Własności te są istotne przy działaniach zapobiegania pożarom w zakłądach przemysłu drzewnego. Położono również nacisk na charakterystki opisujące rozkład termiczny wybranych materiałów pod wględem wpływu na środowisko.

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