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An attempt to use postconsumer MDF as a raw material for the manufacture of particleboards

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Abstract: *An attempt to use postconsumer MDF as a raw material for the manufacture of particleboards*. The aim of the study was to determine the influence of addition of mechanically grinded postconsumer MDF to the inner layer of particleboards on its properties. Three-layer particleboards with a predetermined density of 650 kg/m^3 and a thickness of 16 mm and a weight fraction of MDF particles of 10, 20, 30 and 50 % to the inner layer were prepared. Manufactured boards were tested for the density and density distribution, MOR, MOE, IB, swelling and water absorption after 2 and 24 hours soaking in water. It was observed, that the addition of grinded postconsumer MDF to the inner layer of particleboards (in amount of 10 – 50 %) generally does not have negative effect on their mechanical properties and has a positive influence on the reduction of swelling and water absorption, especially when exposed to water for 24 h.

Key words: postconsumer MDF, particleboards, properties of boards

INTRODUCTION

The steady increase in the production of particleboards and at the same time the deficit of wood makes it necessary to look for new sources of raw materials. Currently in Poland, production of particleboards uses 45 % of industrial waste and 55 % of wood from the forest, where the trends show an increase in the consumption of wood waste including sawdust (Nirdosha and Setunge 2006, Gamagea *et al.* 2009, Setunge *et al.* 2009, Borysiuk *et al.* 2010). Potential source of raw material can also be postconsumer wood, whereby the best in this field in terms of "purity" (no chemical contaminants) is a recycled wood from pallets and packaging (Ratajczak *et al.* 2003, Niecewicz and Danecki 2009). A large group of postconsumer wood are also postconsumer wood-based materials, including MDF. Their re-use is problematic due to the presence of glueing agents and other chemical additives or finishing layers. In case of MDF a number of studies were conducted which aim was to develop the possibilities of its re-defibration and use in the production of fibreboards (Mantanis *et al.* 2004, Rivela *et al.* 2007, Roffael *et al.* 2010). It seems that possibility of mechanical grinding of MDF to particles similar to wood chips and re-using them for particleboards production is much simpler.

As a part of this study an attempt to determine the suitability of particles created from mechanical grinding of MDF for particleboards production was made.

MATERIAL AND METHODS

During the study, three-layer particleboards with a thickness of 16 mm and a density of 650 kg/m³ were manufactured. Share of the outer and the inner layer was 40 % and 60 %. For manufacture of boards used industrial particles, for inner and outer layer with moisture content 5 % and 7 %. For the board's inner layer, grinded postconsumer MDF (Fig. 1) in the amount of 0 % (control variant), 10 %, 20 %, 30 % and 50 % of weight fraction was introduced. Particles originated from the grinding of laminated MDF with an average density of 750 kg/m^3, glued with urea-formaldehyde resin (UF). Moisture content of MDF particles was 5 %. For the preparation of particleboards urea-formaldehyde resin was used (Table 1); ingredients of resin are shown in Table 2. Amount of glue was: 12 % for outer layer, 8 % for

Fig. 1. Grinded postconsumer MDF *photo. M. Byczek*

inner layer. Parameters of boards pressing were: maximal specific pressure 2,5 MPa, temperature 180°C, time of pressing 288 s.

Table 1. Properties of UF resin

Characteristic	**Value**
pH	8
viscosity, mPa·s	900
gel time, s	90
dry mass, %	73

Table 2. Ingredients of the adhesive mass

Ingredient	**Parts by weight**
urea-formaldehyde resin (UF)	50
hardener (10 % NH_4Cl solution)	2
water	20

After manufacturing, boards were conditioned under laboratory conditions for 7 days and then their properties were tested: density, according to EN 323, density distribution through GreCon device, MOR and MOE according to EN 310, IB in accordance to EN 319, swelling and water absorption after 2 and 24 according to EN 317. For each characteristic, ten samples were tested. The statistical significance of differences was determined with the use of Student's t-test for a confidence level of 95%.

RESEARCH RESULTS

The research results of boards manufactured with the addition of grinded MDF to middle layer are shown in Tables 3 and 4 and in Fig. 2.

Table 3. Compilation of the mechanical properties of tested boards

Content of MDF particles	**Density**	**MOR**	**MOE**	**IB**
	kg/m³	**N/mm²**	**N/mm²**	**N/mm²**
0 %	666 (10)	12.1 (1.3)	2807 (201)	0.44 (0.06)
10 %	686 (30)	14.2 (1.2)	3092 (258)	0.35 (0.06)
20 %	652 (2)	13.7 (1.2)	3362 (261)	0.22 (0.04)
30 %	686 (66)	13.2 (2.2)	2977 (424)	0.40 (0.09)
50 %	663 (20)	11.0 (1.9)	2503 (328)	0.39 (0.09)

* values in parentheses - standard deviations

Table 4. Compilation of the physical properties of tested boards

Content of MDF particles	Thickness swelling		Absorbability	
	2 h	24 h	2 h	24 h
	%	%	%	%
0 %	23.2 (1.5)	30.6 (2.1)	77.2 (3.7)	86.5 (2.1)
10 %	18.2 (1.4)	27.4 (1.8)	65.1 (4.6)	81.7 (4.0)
20 %	30.2 (2.5)	33.1 (4.1)	78.7 (10.7)	76.7 (12.9)
30 %	10.4 (2.1)	17.4 (1.3)	48.9 (8.2)	70.6 (7.4)
50 %	13.0 (2.0)	20.9 (2.0)	55.2 (5.7)	78.6 (6.6)

* values in parentheses - standard deviations

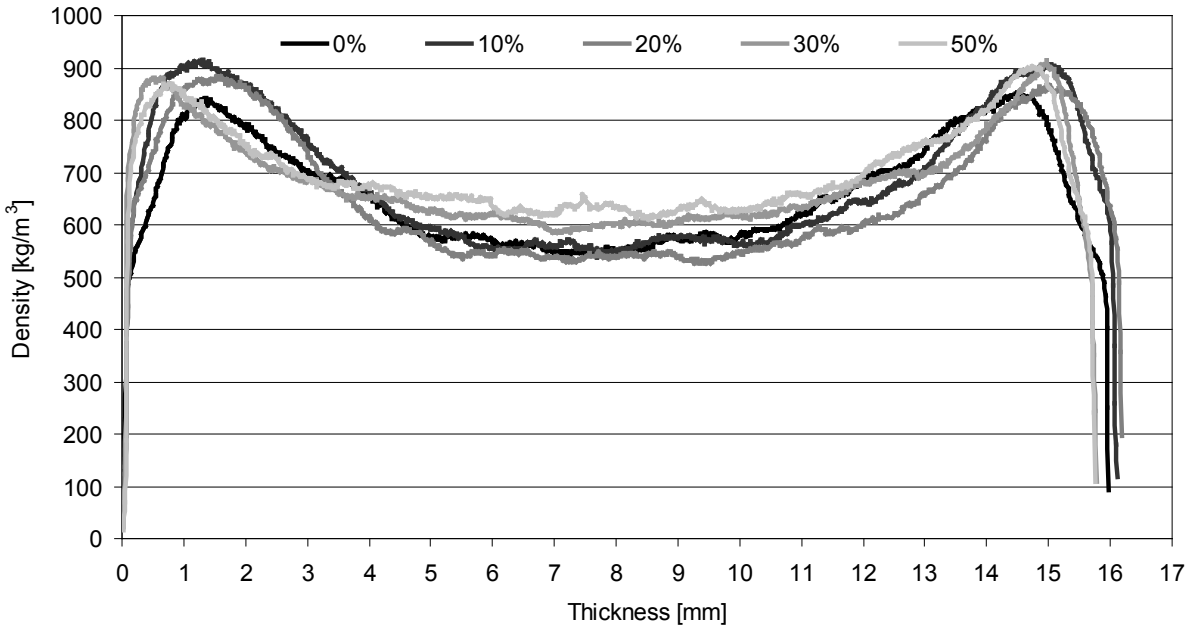

Fig. 2. Density distribution of tested boards with the addition of grinded postconsumer MDF

Overall it can be stated, that the addition of grinded postconsumer MDF to the inner layer of particleboards (at amount of 10 – 50 %) does not negatively affect their chosen strength parameters (Table 3). Both MOR and MOE show comparable or even higher values with respect to the control boards. A statistically significant increase in MOR and MOE, noticed for the boards with the addition of postconsumer MDF (variants of 10 %, 20 % and 30 %) when compared to control boards, is associated with a higher density of the outer layers of the boards, as seen in the density distribution of particular variants of boards (Fig. 2). The increase in density of the outer layers is associated with the introduction of MDF particles to middle layer of cake (with higher density, about 750 kg/m^3, at a density of wood particles approx. 450 kg/m^3), whereby the middle layer had higher resistance during the pressing and hence the outer layers were more concentrated. This effect is not noticeable with the variant of boards with 50 % content of MDF particles, as in this case the share of wood particles in the middle layer was strongly decreased, and thus has also reduced height of the cake so that the effect of material compression encoding was reduced. Addition of the postconsumer MDF particles in an amount of 10 % and 20 % to the middle layer of particleboard influenced (with respect to the control boards) on a statistically significant decrease in the value of IB (Table 3). However, it should be noted, that for the variants of boards with the addition of MDF particles in the amount of 30 % and 50 %, the difference in the values of IB in relation to the

control boards was not statistically significant. The decrease in the IB value for the first two variants (MDF particles addition of 10 % and 20 %) may be associated with unequal distribution of MDF particles in the cake in relation to the wood particles and the disorder of internal cohesiveness of the boards by irregular concentration.

It is worth noting, that tested particleboards with 10 and with 30 % addition of postconsumer grinded MDF particles to the middle layer, met the strength requirements for boards of type P2 (according to EN 312).

Generally, addition of grinded postconsumer MDF to the inner layer of particleboards influenced advantageously on their physical properties: the swelling and water absorption, especially when exposed to water for 24 h. Together with the increase in content of MDF particles (in the range 10% - 50%) specific variants of boards showed a statistically significant decrease of the tested characteristics (swelling and water absorption), when compared to the control variant. This is due to the introduction to the structure of MDF boards particles that has already been originally hydrophobically protected. However, this effect was disrupted either by unequal distribution of particles in the middle layer of MDF (variant 20 %) and the easier access of moisture to the interior of the board (growth of board porosity) associated with a larger proportion of particles with a higher density (variant 50 %).

CONCLUSIONS

On the basis of the study of three-layer particleboard with the addition of grinded postconsumer MDF to the inner layer of boards (in an amount of 0 – 50 %) it is possible to draw the following conclusions:

1. Mechanically grinded postconsumer MDF can be used as an additive for the inner layer of particleboard.
2. Addition of postconsumer MDF to the particleboard's middle layer in an amount up to 50 % does not substantially affect the density of boards and density distribution.
3. Addition of grinded postconsumer MDF particles to the middle layer of particleboards in the range of 10 – 30 % results in the increase in the value of MOR and MOE.
4. Addition of particles from grinded postconsumer MDF to the middle layer of particleboard influences on IB ambiguously. Addition of the postconsumer MDF to the middle layer in the range of 10 – 20 % reduces the strength properties and in the range of 30 – 50 % allows to manufacture boards with strength properties comparable to the control boards.
5. Addition of grinded postconsumer MDF particles to the middle layer in the range of 50 % results in the decrease of water absorption and swelling after 24 hours soaking in water.

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Streszczenie: *Próba wykorzystania poużytkowego MDF jako surowca do produkcji płyt wiórowych.* W ramach badań określono wpływ dodatku rozdrobnionego mechanicznie poużytkowego MDF do warstwy wewnętrznej płyt wiórowych na wybrane ich właściwości. Wytworzono 3-warstwowe płyty wiórowe o założonej gęstości 650 kg/m^3 i grubości 16 mm z dodatkiem wagowym 10, 20, 30 i 50 % cząstek MDF do warstwy wewnętrznej. Dla wytworzonych płyt zbadano gęstość i profil gęstości, MOR, MOE, IB, spęcznienie i nasiąkliwość po 2 i 24 h moczenia w wodzie. Stwierdzono, że dodatek rozdrobnionego poużytkowego MDF do warstwy wewnętrznej płyty wiórowej (w ilości 10 – 50 %) nie wpływa na ogół negatywnie na ich parametry wytrzymałościowe, oraz wpływa korzystnie na zmniejszenie ich spęcznienia i nasiąkliwości, szczególnie przy oddziaływaniu wody przez 24 h.

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