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Influence of freeness of pulp on properties of hardboards

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Abstract: *Influence of freeness of pulp on properties of hardboards.* Hardboards were produced from pulps of different freeness (11, 13, 16 and 25DS). Pulps of freeness 11, 13 and 16 DS were obtained as a result of one-stage defibration of wood chips, while the pulp of freeness 25 DS. - as a result of two-stage defibration. From these pulps, there were produced hardboards of thickness 4 mm. It was found that there are possibilities of producing hardboards of thickness 4 mm without a necessity of refining.

Keywords: freeness of pulp, hardboards,

INTRODUCTION

In Poland, fiberboards are produced by the wet method (hardboards and insulation boards) and by the dry method (LDF, MDF and HDF). In each of these technologies, wood is disintegrated to the form of chips and chips – to wood fibers. The fibers differ in morphology and size depending on the type of produced boards (Klimczewski et al. 2009).

In the wet method, pulp is usually obtained in a 2-stage process, i.e. by defibration of chips in defibrators and refining of pulp in refiners. In the dry method, chips are defibrated in one stage in new-generation defibrators. New-generation defibrators are equipped with various types of refiner plates, which enable production of fibers of required morphology, ensure high material efficiency with optimum production costs (www.andritz.com, www.metsopanelboard.com).

In the old-generation defibrators, there are fewer possibilities of technical solutions, but these devices are submitted to modernization which increases productivity and improves quality of produced pulp (Dudziec 2004, Dudziec 2008).

There are also changes conducted in particular operations of the technological processes, both in the wet and dry methods (Borysiuk et al.2006, Groom et al. 2004, Klimczewski et al. 2008, Nicewicz 1999, Nicewicz, Sosińska 2003). In the production of hardboards, such a change can consist in one-stage defibration of chips what allows to eliminate the operation of pulp refining. Of course, in this way there are obtained fibers of different degree of refinement than in a 2-stage defibration.

In the present study, there was examined the effect of the freeness of pulp on properties of obtained hardboards. Pulps obtained in one- and two-stage defibration were used in the researches.

MATERIALS AND METHODS

In the production of boards, there were used four pine-wood pulps produced in industrial conditions. The freeness of pulp amounted to: 25, 16, 13 and 11 DS. The pulp of DS. 25 was produced in a two-stage process (defibration, refining) while three other pulps were obtained as an effect of one-stage defibration. Fibers of all pulps were submitted to a fractional analysis in a device produced by a company „Defibrator" with 4 slotted sieves arranged in steps, of slot width: 1.0; 0.5; 0.3; 0.15 mm and terminal sieve with 100 meshes per cm^2.

The assumed parameters of boards: mass density - 950kg/m^3, thickness – 4.0 mm

Boards were produced in laboratory conditions. From particular pulps, there were prepared water slurries of fibers of concentration 1.5%, into which chemical agents were introduced: PF 51 resin in quantity of 1% relative to completely dry mass of fibers and, in the same quantity, paraffin in a form of water emulsion. From the slurry, there was moulded a mat which, after bringing to a humidity of about 60%, was pressed in a plate press according to a standard pressing curve for hardboards (Oniśko 1972). The temperature of press plates amounted to 220^0 C, time of pressing - 8 minutes.

Properties of obtained boards were tested according to the obligatory standards PN - EN 622 -2. Significance of results was examined by means of the Student's criterion.

RESULTS AND DISCUSSION

Table 1 presents percent share of fractions obtained as a result of sorting of pulps

Table 1. Shares of fractions in pulps of different freeness

Pulp number/DS	Sieve 1mm (%)	Sieve 0.5 mm (%)	Sieve 0.3 mm (%)	Sieve 0.15 mm (%)	Sieve Ø 0.1mm (%)
I/25	0	3	5	14	78
II/16	1	17	11	11	60
III/13	3	27	6	17	47
IV/11	4	22	13	24	37

It results from the data that pulps differed not only in freeness but also in shares of particular fractions. However, in each of them, the smallest (zero or several percent) was the share of the fraction retained by the sieve of slot 1 mm, while the greatest (several tens percent) – by the sieve 0.1 mm. Fraction retained by the sieve 1 mm consists mainly of shives – insufficiently disintegrated pieces of chips – so it is basically useless and its occurrence in small quantities testifies to a properly conducted operation of defibration. It can be noticed that the smaller freeness of pulp the more shives in it. Fibers of fraction 0.5 – 0.3 mm, as relatively long, significantly affected board strength. Their quantities in particular pulps were diversified: in the pulp of DS. 25, there were 8% of them altogether, in the pulp of DS. 16 – 28% while in the other pulps – 33 and 35%. It was completely different with the shares of fibers retained by sieves 0.15 and 0.1 mm. In the pulp of DS. 25, these fibers made 92% altogether while in the pulp of DS. 11 - only 61%. These relatively short fibers were filling spaces between big fibers and in this way they facilitated arising bonds between fibers which brought about a compact structure of boards (Back 1987). Properties of produced boards will be undoubtedly a resultant of fiber properties.
Properties of obtained boards are presented in Table 2.

Table 2. Properties of hardboards produced from pulps of different freeness

Pulp/DS	Density (kg/m3)	Standard deviation (kg/m3)	MOR (N/mm^2)	Standard deviation (N/mm^2)	IB (N/mm^2)	Standard deviation (N/mm^2)	Thickness swelling after 24h (%)	Standard deviation (%)
I/25	938	1.67	44	6	0.26	0,11	28	4,0
II/16	935	1.72	44	6	0.26	0,06	30	3,5
III13	935	1.85	42	10	0.24	0,04	32	3,2
IV/11	938	2.02	28	6	0.17	0,04	33	4,3

It is visible from the data in the table that densities of all boards were similar and amounted to about 940 kg/m^3, while the properties of boards were diversified. Therefore an influence of density on board properties should be excluded and differences in properties should be attributed to the size of fibers. Bending strength of boards was relatively high and for pulps of DS. 16 and 25 amounted to 44 N/mm^2. Much lower was the bending strength of boards made from pulp of DS. 11, the difference was statistically significant. Probably this low value was caused by a relatively low content of fibers from fractions 0.15 and 0.1mm. Similar tendencies were observed in the case of internal bond perpendicular to surface. The lowest was the value obtained for boards made from pulp of DS. 11 and this value differed significantly from the internal bond of other boards. It should be noticed that values of internal bond of all boards were lower than that required by the standard (0.5 N/mm^2). It seems that the obtained values are underrated what often happens in the case of determining this property in thin boards (several mm of thickness) (Young 2008). However, these data entitle to comparisons of values of internal bond between variants of boards.

Swelling of boards increased with decreasing freeness of pulp. Boards made from pulps of freeness 16 and 25 DS. satisfied the requirements of the standard while boards made from pulp of freeness 13 and 11 DS. exceeded the admissible value by 2 and 3 % correspondingly.

CONCLUSIONS

To sum up the obtained results, it can be affirmed that there is a possibility of producing hardboards of thickness 4 mm without a necessity of refining pulp. Boards of this thickness and density about 950kg/m^3 can be produced from pulps of freeness 16 DS. Lowering of freeness degree to 13 DS. seems possible but probably it will require changes in the technological process.

The above conclusions should not be applied to boards of other density and thickness. A continuation of the researches seems necessary.

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Streszczenie: *Wpływ stopnia zmielenia masy włóknistej na właściwości płyt pilśniowych twardych*. Płyty pilśniowe twarde wykonano z mas włóknistych o różnym stopniu zmielenia (11,13, 16 i 25DS). Masy o stopniu zmielenia 11, 13 i 16 DS. otrzymano w wyniku 1-stopniowego rozwłókniania zrębków, a masę o stopniu rozwłóknienia 25 DS. w wyniku 2-stopniowego rozwłókniania. Z tych mas wykonano płyty pilśniowe twarde o grubości 4 mm. Stwierdzono, że istnieje możliwość produkcji płyt twardych o grubości 4 mm bez konieczności domielania mas, ale stopień zmielenia masy nie powinien być niższy od 16DS.

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