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Influence of starch content on selected properties of hardboard

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Abstract: *Influence of starch content on selected properties of hardboard.* The aim of the research was to examine the possibility of producing wet-formed fiberboard using a different content of potato starch. The scope of works included the production of plates in laboratory conditions with 0, 1, 5, 10 and 20% mass content of potato starch and subjecting them to selected physical and mechanical tests. Thanks to the research, it was possible to produce a hard fiberboard hardboard using a mass fraction of starch. The results of the tests confirmed that as the starch content in the panel increases, the value of mechanical properties increases also.

Keywords: potato starch, fiberboard, mechanical properties, physical properties

INTRODUCTION

Starch, due to its adhesive properties, can be a substitute for artificial adhesives. The properties of individual boards, in which starch was used as an adhesive, will depend on the chemical and physical properties of starch. Not only potato starch, but also corn starch, cassava and other starch are used and their great advantages are low price and availability. Until now, starch has already been used as a binder for example in production of particleboard from rubberwood (Amini *et al.* 2013). Radosavljevic *et al.* (2018) presents in his research a new one production line offering an alternative income for agricultural and ecological producers crop diversification. Molded fibreboards can be used as three-dimensional pressed elements in the furniture, automotive and construction industries. Natural binders such as starch, sugar, cellulose, vegetable oils and proteins were used for the production of the boards. Monteiro *et al.* (2016) used cassava starch as an admixture of chitosan, thanks to which 100% natural glue was created, enabling the production of low density particleboards with very good performance properties.

Potato starch is obtained through mechanical separation of starch grains from other components in potatoes followed by rinsing, purification, drying and sifting. Starch is a polysaccharide which plays the role of storage substance in plants. Crystalline structure of starch grain is built of branched starch macromolecule, amylopectin, and linear macromolecule, amylose. Because amylose and amylopectin differ in many important features, the proportion of each in a given type of starch determines the physical chemistry characteristics of the substance (http://pepees.pl).

Potato starch is used in many areas of life; for example, in the food industry for baking cakes, thickening soups and sauces, for the production of yeast, pasta, cakes and puddings. Another area is the textile industry, where it is used to starch and fabric finishes. In the chemical industry, it is used for the production of glues, dextrins and explosives, while in the pharmaceutical industry it is used for the production of antibiotics (http://www.ppz-trzemeszno.com.pl).

The aim of the research was to examine the possibility of producing wet-formed fiberboard using a different share of potato starch

MATERIALS AND METHODS

Hardboard production

A 3.2 mm-thick fiberboard hardboard, with nominal density of 900 kg/m^3 and share starch as a binder of 0%, 1%, 5%, 10%, 20% by weight (hereinafter called variant 0/reference, variant 1, 5, 10 and 20). Wet-formed panels were produced in laboratory conditions from industrially produced fibres from pine and spruce wood. A control (reference) panel variant without starch was also produced. No hydrophobic agent was added during the production of the panels. The pressing parameters were the following: temperature – 200ºC, total pressing time – 7 min, maximum unit pressure – 5.5 MPa.

Mechanical properties testing

The modulus of elasticity (MOE) and the modulus of rupture (MOR) during bending were the mechanical parameters of the produced panels investigated in accordance with appropriate European standard procedure EN 310:1994. 10 samples of every panel type were used in the tests.

Physical properties characterization

The following physical properties of the produced panels were investigated: swelling in thickness and water absorption after immersion in water in accordance with EN 317:1993 standard (10 samples) and density profile with the use the Grecon DA-X unit (sampling step – 0.02 mm and measuring speed – 0.1 mm/s for 3 samples; most representative profile presented then on a plot). The samples were sorted regarding density.

Prior to testing, all the samples were conditioned in 20°C/65% RH to achieve a constant weight.

RESULTS

Mechanical properties

The test results for the modulus of elasticity at static bending are presented in figure 1.

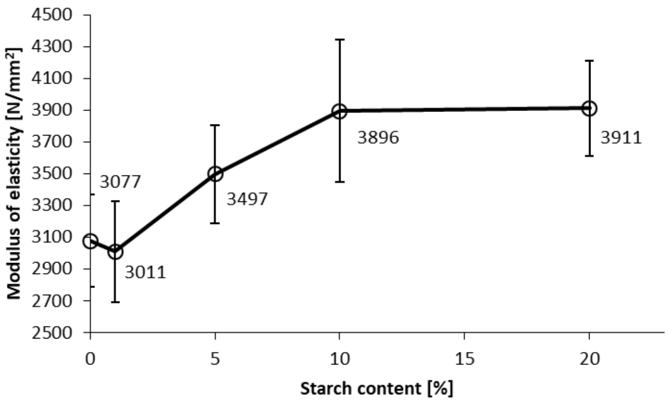

Figure 1. Modulus of elasticity of the investigated panels

The graph clearly shows the relationship between the increase in modulus of elasticity and the increase when the starch content increases. Variant 20 samples had the highest modulus of elasticity value, i.e. 3900 N/mm^2, and it is about 27% higher than the reference sample (3077 N/mm^2).

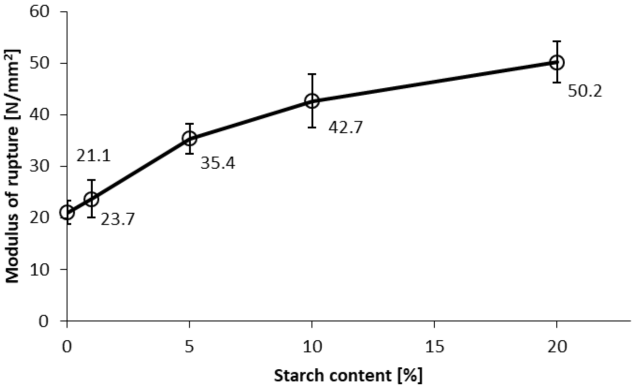

Figure 2. Modulus of rupture of the investigated panels

The modulus of rupture values for the tested panels of different starch content are presented on figure 2. In this case, the modulus of rupture is increasing for samples with any applied starch content. The result for variant 20 with the highest amount of starch added was higher by about 138% in comparison to the reference panel.

Physical properties

The results of measuring thickness swelling of a wet formed fiberboard produced with different starch shares are presented on figure 3a. The result of variant 1 was highest after 2 and 24h of soaking (68 and 87%, respectively). It was interesting to notice that an increase of the amount of starch added to the panel results in the lowering of swelling thickness. The addition of 5% of starch caused the thickness swelling comparable to the reference panel (with no starch addition), since the thickness swelling of the panels with 20% starch share was significantly lower that of the reference panels. Similar remarks about the influence of starch addition to fiberboards can be formulated with reference to water absorption. The results of this feature measurement are presented in figure 3b.

a) b)

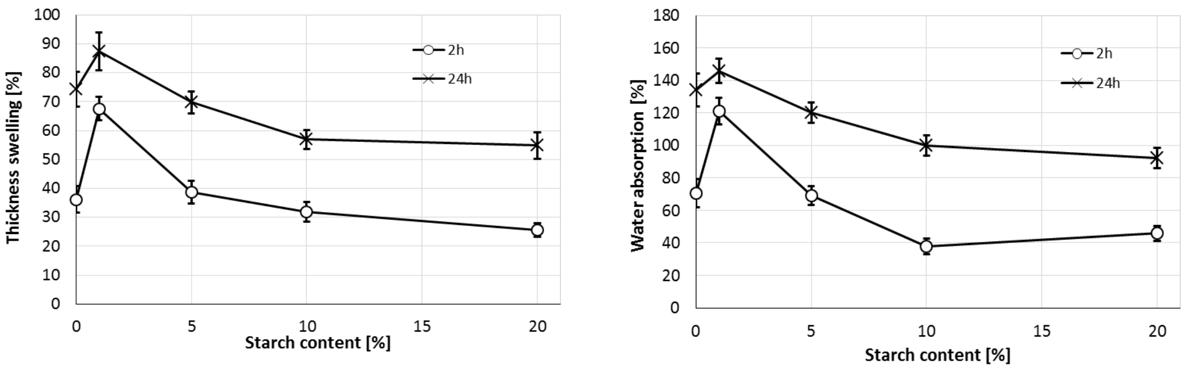

Figure 3. Thickness swelling (a) and water absorption (b) of investigated panels

The plot of density profiles for the tested panels is shown in figure 4. The graph shows the testing of one sample with each variant because the results obtained from a series of samples are similar. The density profile reading was initiated from the top side of the sample (smooth) which in relation to the chart is its left side, and was continued to the bottom side of the sample (with the imprint of the grid) which on the chart is its right side. When analyzing the graph of the control board density profile and the starch-containing boards, the similarity of the starch-free board to variant 1 board should be noted. Comparing subsequent sample variants, i.e. 5, 10 and 20, a significant deviation from the samples of variants 0 and 1 can be found. The graph shows that with a board thickness of 1.0 mm, the density profile for variant 10 increases. However, in the case of panel samples of variants 5 and 20 an analogous phenomenon occurs at a panel thickness of 1.2 mm. The highest value reading for the sample of variant 10 exceeds 1100 kg/m^3.

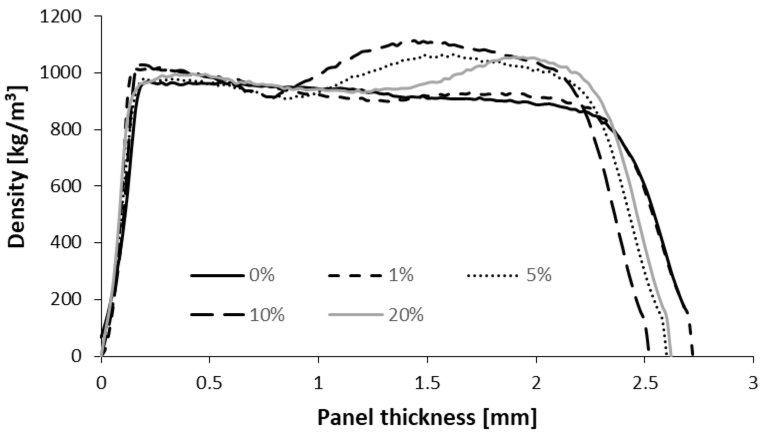

Figure 4. Density profile of investigated panels

CONCLUSIONS

According to the conducted research and the analysis of the achieved results, the following conclusions and remarks can be drawn:

1. Starch can be used as a wood fiber mass-binding substance in the production of wet-formed fiberboard.
2. The bending strength increases with the mass share of starch in wet-formed hardboard within the range of 0% to 20%. The largest increase in the modulus of elasticity was recorded for boards with 10 and 20% of starch, compared to the reference board.
3. The water absorption and thickness swelling of the panels raises for hardboard of 1% of starch content. As the starch content increases, the water absorption and swelling decreases.
4. Shape and density of the density profile of the manufactured fiberboard change and the maximum density increases with an increase in the mass share of starch.

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Streszczenie: *Wpływ udziału skrobi na wybrane właściwości płyt pilśniowych mokroformowanych*. Celem badań było określenie możliwości produkcji płyt pilśniowych twardych (mokroformowanych) z wykorzystaniem różnego udziału skrobi ziemniaczanej, jako środka wzmacniającego. Zakres prac obejmował wytworzenie płyt w warunkach laboratoryjnych przy: 0, 1, 5, 10, 20% udziale masowym skrobi ziemniaczanej oraz poddanie ich wybranym próbom fizycznym i mechanicznym. Potwierdzono możliwość wytwarzania płyt pilśniowych twardych z wykorzystaniem skrobi.

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