Annals of Warsaw University of Life Sciences – SGGW
Forestry and Wood Technology No 72, 2010: 57-61
(Ann. WULS-SGGW, For and Wood Technol. 72, 2010)

Recycling of insulation boards by reuse

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Abstract: *Recycling of insulation boards by reuse.* The study presents possibilities of utilization of used insulation boards as secondary raw material in the production of these boards. There is presented a simple method of obtaining pulp from used boards. It was proven that with a growing share of secondary fibers in boards bending strength decreases, but hydrophobic properties of boards get improved.

Keywords: recovered fiberboards, insulation boards

INTRODUCTION

One of the main directions in the utilization of used products from wood and wood-based materials is their reuse in the production of particleboards and fiberboards. It is estimated that over 5 million m^3 (2.8 million tons) of such scrap arise in Poland every year. The easiest to utilize are products which do not contain chemical substances in their structure, i.e. containers and pallets. Possibilities of utilization of these assortments of recovered wood are presented in papers of (Nicewicz et al. 2009, Nicewicz, Danecki 2009).

The second important group of wood-based wastes is constituted by used wood-based panels (particleboards, fiberboards, plywood). The panels should be segregated to different types. Used particleboards should be utilized in the production of new particleboards while boards of fibrous structure – in the production of insulation boards, hardboards and MDF.

Used wood-based panels, except wooden components (particles, fibers, veneers) contain also chemical substances: synthetic adhesives (several to over a dozen percent) and hydrophobic agents (about 1%). Insulation boards make an exception; they are produced without adhesives, only with an addition of hydrophobic agents. Additionally, these boards have a relatively low density ($\geq 230 kg/m^3 < 400 kg/m^3$) in comparison with particleboards and MDF ($\leq 650 \geq 800$ kg/ m^3) or hardboards and HDF ($\geq 900 kg/m^3$). Therefore, for the purposes of recycling, it is proposed to divide used fiberboards into two groups: the first one – insulation boards, the second one – hardboards and MDF. Basing on such a division, it can be assumed that insulation boards will be the easiest to recycle.

There are several possibilities of disintegrating boards to particles (fibers) from which they are made. Kearley and Goroyias (2004), Kearley (2005) proposed disintegration of used boards in autoclaves, Roffael et al. (2009), Roffael et al. (2010) suggest the extruder technique.

Wood fibers can be recovered from insulation boards in a simpler way, by initial disintegration of boards to pieces of several centimeters in length and soaking of these pieces in water with mechanical agitation. Such operation can be conducted in tanks with mixers or in hydropulpers, devices commonly applied in papermaking industry.

MATERIALS AND METHODS

Used insulation boards were disintegrated to the form of pulp (furthermore called secondary pulp) according to the scheme presented in Fig. 1.

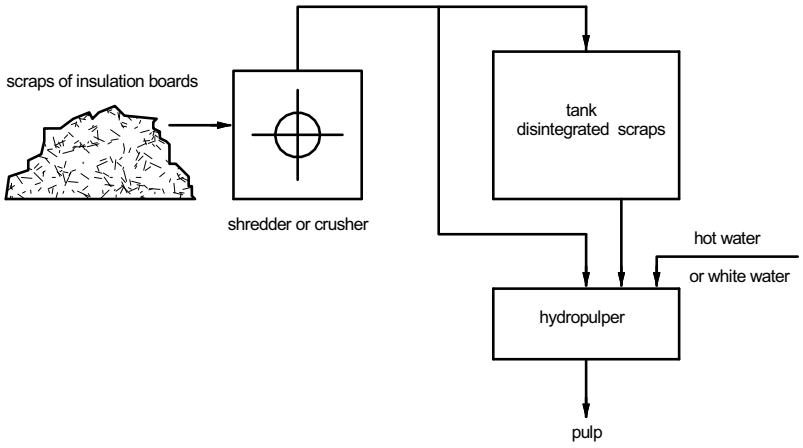

Fig.1. Scheme of the process of obtaining secondary pulp

Boards, after initial disintegration, were flooded with warm water and agitated for several minutes with an electric mixer.

Standard fibers (produced in industrial conditions) and secondary fibers were submitted to a fractional analysis in a device produced by a company "Defibrator", with four 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.

Secondary fibers were added to standard ones in different proportions: 0, 25, 50, 75 and 100%. From the obtained mixtures, there was prepared water slurry of fibers of concentration 1.5 % and insulation boards were produced in laboratory conditions.

Assumed board parameters:

- mass density – 260 kg/m^3,
- thickness – 12 mm

The temperature of drying of mats amounted to 150^0C, time – 3h.

RESULTS AND DISCUSSION

The results of sieve analysis of pulps are summarized below in Table 1.

Table 1. Fractional composition of pulps (%) applied to the production of insulation boards

Sieve slot width (mm)	Pulp from insulation boards (%)	
	standard	from RW boards
1	1.3	0.7
0.5	9.7	2.6
0.3	8.7	17.4
0.5	1.0	7.6
Sieve 100 meshes/cm^2	79.3	71.7

It is apparent from the data presented in the table that the share of fibers retained by sieves 1-0.15 mm in both pulps was different. However, the quantities of fibers retained by the sieves 100 meshes/cm^2 were similar. This fraction was significant because it constituted over 70% of all fibers in both pulps. Therefore it was attempted to produce boards from these pulps. According to the recommendations of the standard PN-EN 622- 4, in insulation boards there are determined two properties: bending strength and thickness swelling after 2h of soaking in water.

Figure 2 presents the bending strength of obtained boards.

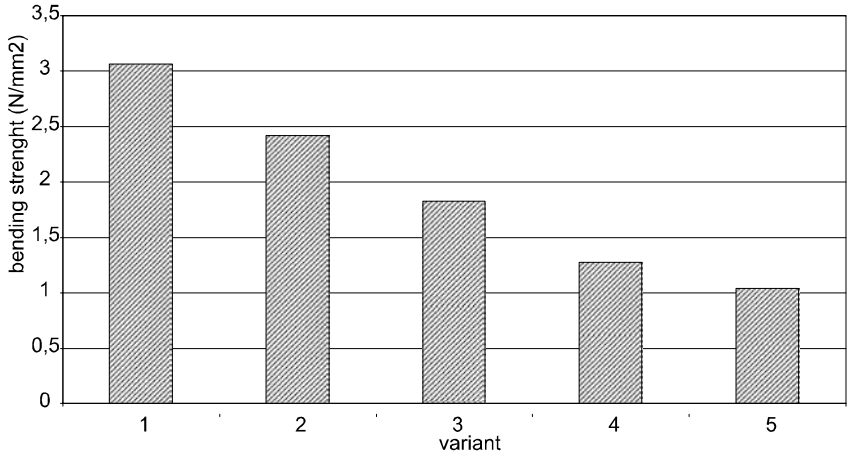

Fig. 2. Bending strength of insulation boards

1 – insulation boards from standard pulp
2 – boards with 25% addition of RW pulp
3 – boards with 50% addition of RW pulp
4 - boards with 75% addition of RW pulp
5 – boards from RW pulp

As visible in Fig.2, with a growing share of secondary pulp, bending strength of boards was decreasing. However, bending strength of all boards, including those made from secondary pulp only, was higher than the value required by the standard (0.8 N/mm^2). It

seems that the drop of bending strength was caused not only by the morphology of fibers, but to a high extent by a lower capacity of functional groups to create bonds between fibers. In the production process, mats from which boards were produced were submitted to drying in the temperature of 150 – 160^{0}C for 3-3.5 h. This thermal treatment was necessary to give boards their final properties, but it caused that secondary fibers were weaker than standard ones.

In Fig.3, there is presented swelling of boards produced with different additions of secondary pulp.

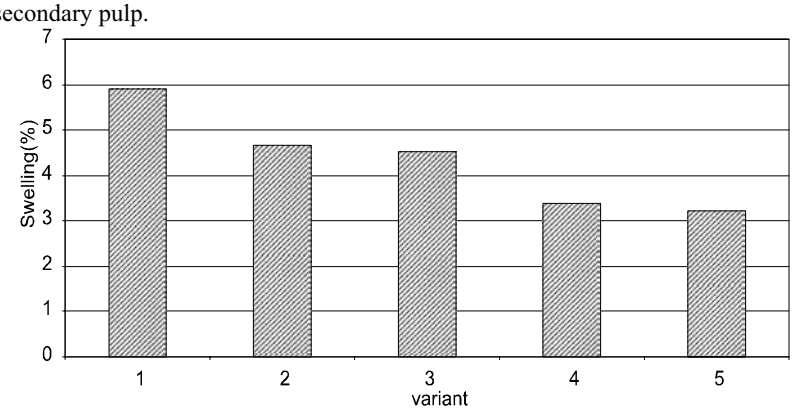

Fig.3. Swelling of insulation boards after 2 h

1 – insulation boards from standard pulp
2 – boards with 25% addition of RW pulp
3 – boards with 50% addition of RW pulp
4 - boards with 75% addition of RW pulp
5 – boards from RW pulp

As visible, swelling of boards declined with a growing proportion of secondary pulp in boards.

The reason for the decrease in swelling was probably the same as that for the drop of bending strength. Secondary fibers had not only lower capacity of bonding with each other, but also they were absorbing water to a lower degree. However, swelling of all boards was below the limits set by the standard (10% for boards of thickness 12 mm).

CONCLUSIONS

There is a possibility of recycling of insulation boards by reuse. Used boards can be disintegrated to the form of wood fibers without a need of defibration. Secondary fibers obtained from boards cause a lowering of bending strength but improve hydrophobic properties of boards.

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Streszczenie: *Recykling technologiczny płyt pilśniowych porowatych.* Praca dotyczy możliwości wykorzystania zużytych płyt porowatych jako surowca wtórnego w produkcji tych płyt. Przedstawiono w niej prosty sposób pozyskiwania mas włóknistych ze zużytych płyt. Wykonano płyty porowate przy różnych udziałach włókien wtórnych i standardowych. Stwierdzono, że włókna wtórne powodują obniżenie wytrzymałości na zginanie statyczne, ale dodatnio wpływają na właściwości hydrofobowe płyt.

This work is financed by the Polish Department of Education and Science; Project no N N309136435

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