Annals of Warsaw University of Life Sciences - SGGW
Forestry and Wood Technology № 83, 2013: 271-274
(Ann. WULS - SGGW, For. and Wood Technol. 83, 2013)

The influence of kind and quantity of hydrophobic agent on the properties of HDF

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Abstract: *The influence of kind and quantity of hydrophobic agent on the properties of HDF*. The effectiveness of the aqueous wax dispersions (used in industry) and low molecular weight dispersion (currently in progress of implementation into industry) on the properties of high density fiberboards (HDF) was examined. The used agents were characterized by a varied content of the wax phase, petroleum derived dispersions – solid content of 16 and 60%, the low molecular weight dispersion - 55%. It was found that most efficient dispersion was the petroleum-derived dispersion at 16% solid content, that it is enough to add 0.5% in relation to the mass of absolutely dry fibers.

Keywords: properties of HDF, hydrophobic agent, F-T synthesis based hydrophobic agent

INTRODUCTION

Hydrophilic properties of wood based panels can be reduced in different ways and at in different stages of production. The wood particles (fibers, particles) can be heat-treated Mohebby et al. [2008] or by some chemicals to reduce the activity of functional groups of wood component [Rowell 2005, Rowell, Tillman, Zhengtian 1986], [Rowell, Keany 1991, Rowell et al. 1991]. In industrial applications, the most common wooden particles are coated with a thin layer of hydrophobic substances. The liquid paraffin or the paraffin as an aqueous dispersion are applied in an amount of 0.5 - 1.5% by weight of completely dry wood. Paraffin particles in the aqueous dispersion are much smaller (0.5 - 5μm) than the particles in liquid form (about 100μm), which results in more uniform distribution of wax on the fibers [Prowotorow 2012].

In the manufacturing processes is the need to offload the environment through the use of substances which are not derived from oil. The such agents belong the modern hydrophobic agents. These agents have a new generation of wax phase, obtained in the Fischer-Tropsch process (F-T). This synthesis takes place in a monitored conditions, the composition of product is controlled, thereby achieving a high reproducibility of the composition of paraffin. The aim of this study was to examined three type of wax dispersion on the properties of HDF.

MATERIALS AND METHODS

Two hydrophobic substances were petroleum derived dispersions and one new obtained in the process of the synthesis F-T. The dispersions had a varied content of the wax phase: petroleum derived dispersions – solid content of 16 and 60%, and dispersal on the basis of syntheses F-T –55%. Paraffin droplet size in petroleum derived dispersions was around 1μm, and in the new generation dispersion - <400nm.

Standard pulp from pine wood, obtained in industrial conditions was applied in the production of HDF. Urea - formaldehyde resin - Silekol® 130 was added as an adhesive in the amount of 12% in relation to absolutely dry fibers. The paraffin agents were added in an amount of 0.5 or 1.0% in relation to absolutely dry wood fibers.

Boards with a target density of 900 $kg \cdot m^{-3}$ and thickness of 3 mm were produced in laboratory conditions. UF resin and hydrophobic agent were sprayed onto fibers in a laboratory blender. The blended fibers were manually formed into mat using a wooden frame. The mats were pre-pressed in the platens press at room temperature, and then in hot- press at 180°C, at a pressure 2,5 MPa for 54 s.

Properties of obtained boards were tested according to the PN-EN 622-5/2010 standard and additionally: surface water absorption and surface toluene absorption PN-EN 382-1:2001 tests were performed. Significance of results was evaluated using the Student's T-test.

RESULTS AND DISCUSION

Tables 1 show the influence of different hydrophobic agents on thickness swelling and surface absorption of boards.

Tab. 1 Thickness swelling and surface absorption of HDF

Variant	TS 24h [%]	SD [%]	Water absorption [g/m^2]	SD [g/m^2]	Toluene absorption [mm]	SD [mm]
16/1*	23%	1%	110	10	300	0
16/0,5	24%	1%	140	20	172	13
60/1	23%	2%	318	20	164	49
60/0,5	27%	1%	295	10	142	55
55/1	25%	2%	175	10	182	45
55/0,5	27%	2%	175	5	193	32

*16/1 is means: solid content in dispersion/ amount of paraffin in relation to absolutely dry wood fibers

As a result of the experiments it was determined, that the lowest swelling value was achieved by boards manufactured using the dispersion at a solid content of 16%. The thickness swelling of boards manufactured with the use of the remaining dispersions was higher by 2-4%. However, all of the examined boards fulfilled the standard's requirements in the scope of allowed maximal thickness swelling. The differences in the values of swelling of boards manufactured in different variants were statistically insignificant.

Boards made using the 16% solid content dispersion were also characterized by the lowest water absorption value [110g/m^2]. Boards made using the low molecular weight dispersion had slightly higher values of this property [170g/m^2], and the highest - 320g/m^2 – were found for boards made using the 60% solid content dispersion.

The results of swelling and surface absorption of boards were statistically independent from the amount of added hydrophobic agent [0.5 or 1.0%].

The value of toluene absorption was the highest (the best result) for boards made using 1% of paraffin added as a 16% solid content dispersion. When the amount of the agent is lowered to 0.5% then the best result goes to the board made using the low molecular weight dispersion [55% solid content].

The strength properties of board are shown in Table 2

Tab. 2 Strength properties of HDF

Variant	MOR [N/mm^2]	SD [%]	MOE [N/mm^2]	SD [g/m^2]	IB [N/mm^2]	SD [N/mm^2]
16/1*	45	5	4540	430	0,8	0,2
16/0,5	40	5	2860	360	0,6	0,1
60/1	45	10	4550	1080	1,0	0,2
60/05	40	5	2820	360	0,6	0,1
55/1	35	5	3650	660	0,7	0,2
55/0,5	30	5	2640	240	0,5	0,1

*16/1 is means: solid content in dispersion/ amount of paraffin in relation to absolutely dry wood fibers

The work also confirmed, that the changes in the mechanical properties of boards (MOR and IB) depending on the used petroleum-derived dispersions had a similar course – the decreasing of board properties occurred to the same degree. A more intensive decrease of these properties took place in boards made with the low molecular weight dispersion. However, only boards from one of the variants had the IB values slightly below the minimal value stated in the standard.

CONCLUSIONS

1. Taking into account all of the tested board properties it was determined, that the best hydrophobic agent was the petroleum-derived dispersion at 16% solid content.
2. Due to the efficiency of board hydrophobization, regardless of the wax dispersion type, it is enough to add the agent in 0.5% in relation to the mass of absolutely dry fibers.
3. The values of swelling and surface absorption (water and toluene) of boards manufactured with the use of the modern dispersion were comparable to the properties of boards manufactured using the petroleum-derived emulsion with 16% solid content.

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Streszczenie: *Wpływ rodzaju i ilości środka hydrofobowego na właściwości HDF*. W pracy zbadano skuteczność działania woskowych dyspersji wodnych (obecnie stosowanych w zakładach przemysłowych) i dyspersji drobnocząsteczkowej (wprowadzanej do praktyki przemysłowej) na efekt hydrofobizacji HDF. Faza woskowa dyspersji nowej generacji została pozyskana w procesie syntezy Fischera- Tropscha (F-T), w odróżnieniu od dyspersji starej generacji, których fazę woskową pozyskano w wyniku rafinacji ropy naftowej. Zastosowane środki hydrofobowe miały różne stężenia fazy woskowej; dyspersje ropopochodne - stężenia 16 i 60%, dyspersja drobnocząsteczkowa -55%. Wielkość cząstek parafiny w dyspersjach ropopochodnych wynosiła ok. 1µm, a w dyspersji drobnocząsteczkowej <400nm. Za najbardziej skuteczną uznano dyspersję o zawartości 16% parafiny. Przy wykorzystaniu tej dyspersji do produkcji HDF, płyty uzyskały najniższe wartości spęcznienia i absorpcji powierzchniowej. Dodatkowo stwierdzono, że w produkcji HDF wystarczy dodawać 0,5% środka hydrofobowego w stosunku do masy zupełnie suchych włókien.

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