DIMENSIONAL CHANGES ASPEN WOOD MODIFIED THERMO - MECHANICALLY

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Abstract

The paper presents moisture and shape changes of aspen wood in the shaping process by pressing with the aim of face relieving. We investigated the influence of adjustment wood, degree of pressing and initial moisture content on stability of wood. We evaluated the stability by monitoring of the moisture change – volumetric and linear shrinkage and monitoring of shape changes – permanent deformations. The aspen wood was adjusted with steaming and HF hating. The adjusting is not significant on moisture and shape stability of wood after pressing. The non-adjusted wood shows better stability after pressing.

Key words: *Embossing, pressing, stability, moisture and shape changes, volumetric and linear shrinkage, permanent deformations*

INTRODUCTION

Surface embossing is method, which forms a wood surface by profile plates for better decorative properties and improving of wood surface appearance.

I case of smoothed plated pressing it is increasing of density and hardness of wood surface. For pressing are used press machines with heated profiled plates. Required surface shaping reaches by effect of heat and press on untreated or treated wood, which is stabilized in demanded time. In case of continuous pressing – rolling, phase of stabilization under pressure is not necessary and shape keeping depends on wood stability.

Our research is aimed at industrial utilization of soft deciduous trees. Into this category belongs aspen wood (POPULUS TREMULOIDES), has inexpressive wood structure and by embossing is possible to improve its decorative appearance. Our work is aimed at pressed aspen wood stability, which was evaluated by monitored moisture changes – volumetric and linear shrinkage, by shape changes – monitoring plastic (permanent) deformations. Linear shrinkage was searched in pressing direction, i.e. perpendicular to wood grain in tangential direction. Stability was monitored on untreated wood and on wood treated by steam plasticizing and RF heating at 3 initial moistures and pressed for 5 grades of compression.

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METHODICS OF EXPERIMENTS

For experiments were used samples with dimensions 50x50x50 mm. Dimensional changes of aspen wood was monitored on untreated and treated wood. Treatment was realized by two ways, plasticizing and 5 graded compressing namely 10, 20, 30, 40 and 50% of original sample thickness. Samples were plasticized by steam and RF heating at initial moistures 8, 16, 30 and 100%. Untreated samples had the same initial moistures and it's was comparative group. One group of untreated samples was without treatment and second group was compressed by mentioned compression grades. Compression was perpendicular to wood grain in tangential direction. Treated samples were air-conditioned at 12% moisture after compression and then were did all tests. For unification of comparative basis, the shrinkage results of untreated and treated samples were converted to 12% moisture level by equation, which is introduced by POŽGAJ – CHOVANEC – KURIATKO – BABIAK (1997):

$$\alpha_i\,(\mathrm{w}) = \alpha_i \left(1 - \frac{w}{BNV}\right) \qquad (1)$$

where α_i (w) is appertaining shrinkage to certain moisture,

α_i is total shrinkage (from FSP to 0%),

w moisture to FSP (%).

Shrinkage calculated by equation (1) was subtracted from total shrinkage, where we got result comparable with shrinkage of plasticized samples air-conditioned at 12% moisture (shrinkage from 12% to 0%).

Shape stability was evaluated by plastic deformations, which were determinate immediately after opening of pressing machine and conditioning at 12% moisture.

RESULTS AND DICSUSSION

Side-effect of embossing is wood densification. Wood densification depends on wood species, compression, treatment, moisture and other factors. In our paper we only aimed at influence of moisture, treatment and grade of compression. With increasing of grade of compression and with decreasing of moisture rises density of untreated and treated pressed wood. The highest increment of value was determined at aspen wood treated by RF heating with initial moisture 8% and at 50% grade of compression namely approximately 35%. The same values were determined at untreated and pressed wood, where increment of value achieved 25% GÁBORÍK, J. – DUDAS, J. – GAFF, M., (2003).

From point of view wood treatment influence, the increment of density rises from untreated wood through treated by steam to treated wood by RF heating. Density of untreated aspen wood was in range from ρ_o = 354 kg/m^3 to ρ_o = 502 kg/m^3. Plasticizing and compression increases the density to ρ_o = 420 kg/m^3 up to ρ_o = 543 kg/m^3. In mutual comparison of density changes, used methods of plasticizing hadn't significant influence GÁBORÍK, J. – DUDAS, J. – GAFF, M., (2003).

Stability of aspen wood was evaluated by shape and moisture changes. Wood can be stable, if its volumetric and dimensional changes are less influenced by moisture. Our results confirm that wood compression hasn't significant influence for aspen wood shrinkage. Shrinkage of untreated and treated aspen wood increased about 0,16% (Tab.1,

Fig.1 and 2). The combination of compression and plasticizing proved a influence only after shrinkage process. Plasticizing releases an internal stresses and following pressing can to destruct a wood microstructure, which is reason for increase of wood shrinkage values. In these cases, shrinkage was increased by double in comparison with unplasticized wood. The higher values were only at wood plasticized by RF. Volumetric shrinkage of plasticized wood (from moisture 12% to 0%) was in range α_o = 6,05 ÷ 10,16% and linear shrinkage in tangential direction was α_t = 2,41 ÷ 6,41 %.

The value of total volumetric shrinkage, at untreated aspen wood, was α_o = 12,58 % and total linear shrinkage in tangential direction was α_t = 7,82 %. After re-counting (shrinkage from moisture 12% to 0%) the values are α_o = 4,72 % and α_t = 2,93 % (Tab.1, Fig.1 and 2). The similar shrinkage results were introduced by SERGOVSKIJ (1975).

Initial wood moisture had most influence at plasticized wood, where was obtained highest shrinkage values at 16% moisture.

Tab. 1 Aspen wood shrinkage

Initial moisture [%]	Volumetric shrinkage [%]			
	RF heating and compressed (*	steamed and compressed (*	unplasticized and compressed (*	unplasticized (** and uncompressed
8	7,43	7,27	5,89	4,72
16	10,16	8,36	3,73	
30	6,38	7,29	4,30	
100	6,05	6,80	5,60	
Average	7,51	7,43	4,88	4,72
	Linear shrinkage [%]			
8	5,18	4,87	4,0	2,93
16	6,41	5,28	2,49	
30	4,03	4,32	2,80	
100	3,71	3,70	3,69	
Average	4,83	4,54	3,24	2,93

Note: (Results from measured shrinkage values from moisture 12% to 0%.*
*(** Results from re-counted shrinkage values from 12% moisture to 0% moisture - in compliance with Methodics of experiments*

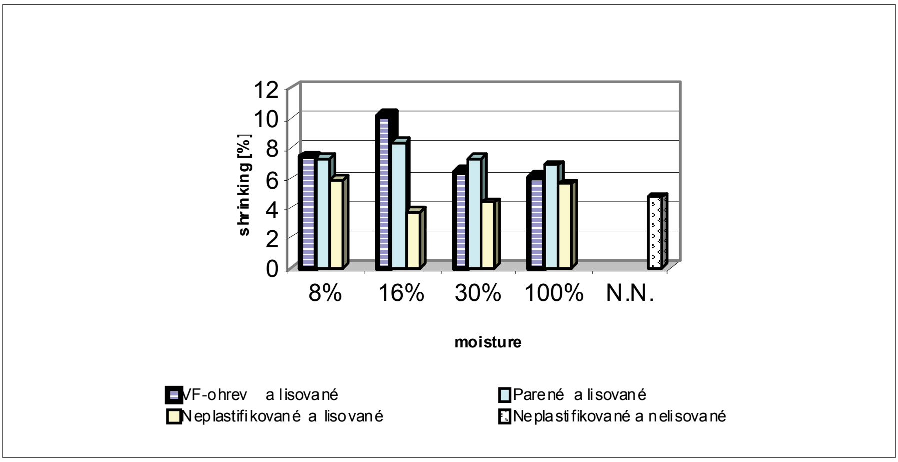


Fig. 1 Volumetric shrinkage of aspen wood from moisture 12% to 0%

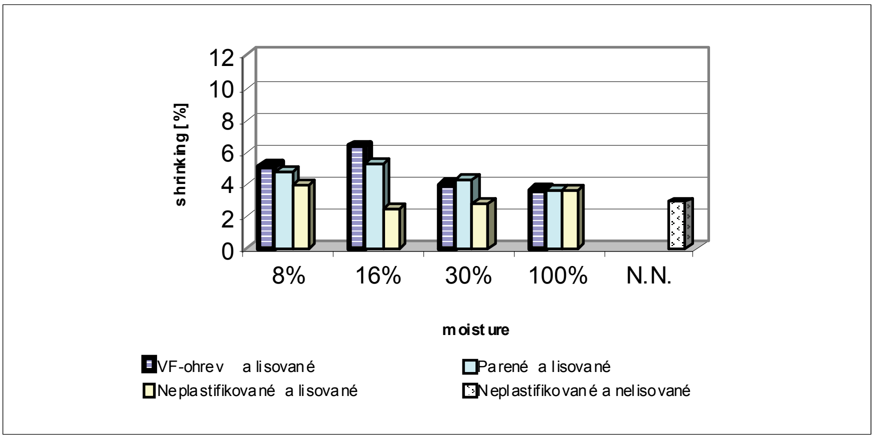
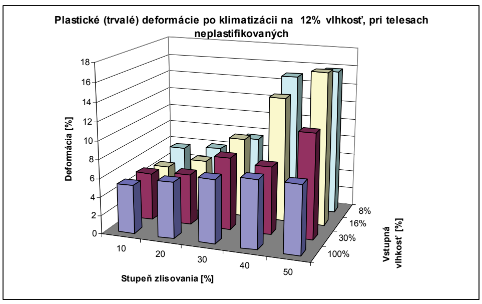


Fig. 2 Linear shrinkage of aspen wood from moisture 12% to 0%
Note: N.N. – comparative benchmark, i.e. shrinkage of untreated wood for stated moisture range

Shape stability was evaluated by monitoring plastic deformations. Plastic deformations are important factor at keeping embossment shape.

After picking material out from pressure machine, elastic deformation appears immediately and afterward elastic deformation in time, which makes shape instability. If we can to eliminate influence of elastic deformations and different moisture, material have to be conditioned at 12% moisture and then was determined plastic deformations.

The plastic deformation (permanent) values of testing samples are shown in Tab.2. We can to assert that plasticizing method haven't significant influence on shape stability. At both methods are permanent deformations almost identical and reaches a value approximately 15% at 50% compression. The change of plastic – permanent deformations is more influenced by initial moisture and grade of compression. Moisture decreasing rises portion of plastic deformations what improve the shape stability of material. At lower initial moistures (8% and 16%) with increasing grade of compression are values of permanent deformation higher (15%) and shape stability too. At higher initial moistures (30% and 100%) the grade of compression hadn't significant effect.



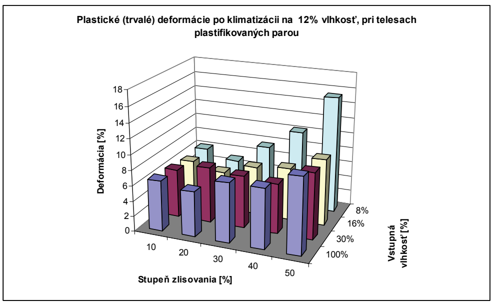


Fig. 3 Plastic deformation of aspen wood by unplasticized after conditioning to 12% moisture

Fig. 4 Plastic deformation of aspen wood wood plasticized steam after conditioning to 12%

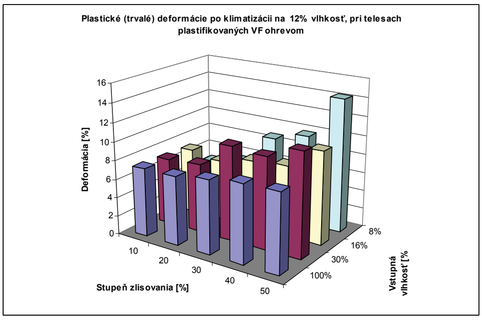


Fig. 5 Plastic deformations of aspen wood plasticized by RF heating after conditioning to 12% moisture

CONCLUSION

In decorating process by continuous way the more important factors are moisture stability and shape stability. In our work, we evaluated moisture changes by volumetric and linear shrinkage. These changes are negligible at unplasticized and compressed wood. Plasticizing and compression of aspen wood increased shrinkage values by double in comparison with unplasticized wood, at 16% moisture. Re-counted volumetric shrinkage (from 12% to 0%) had values α_o = 6,05 ÷ 10,16 % and linear shrinkage was α_o = 2,49 ÷ 6,41%.

At untreated wood were these values α_o = 4,72 % a α_t = 2,93 %. Untreated wood had total volumetric shrinkage α_o = 12,58 % and linear shrinkage in tangential direction α_t = 7,82 %.

At plasticizing methods comparison wasn't significant difference.

Some monitored factors of shape stability, evaluated by plastic deformations, were more expressively than at moisture changes. With decreasing wood moisture and with increasing of compression grade the value of plastic deformation rises - shape stability rises. Maximal value of of plastic deformation εpl = 15 % was reached at 8% initial moisture and at 50% compression.

In case of shape stability, plasticizing methods hadn't significant differences.

Our results indicate that the aspen wood is suitable for continuous embossing without plasticizing what can to offer good results.

We recommend that aspen wood with initial moisture 16% and with maximal compression 50% for practical application of embossing, compression and other similar methods.

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