ONLINE ISSN 2069-7430
ISSN-L 1841-4737
PRO LIGNO
www.proligno.ro
Vol. 13 N° 4 2017
pp. 199-204

DECORATIVE VENEER PROPERTIES OF BUTTERNUT (*Juglans cinerea* L.)

Roman RÉH
Assoc. Prof. Dr. Eng. – TECHNICAL UNIVERSITY in Zvolen – Faculty of Wood Science and Technology
Address: T. G. Masaryka nr. 24, 960 53 Zvolen, Slovak Republic
E-mail: roman.reh@tuzvo.sk

Abstract:
Butternut is an introduced species in Central Europe with potential for decorative veneers production and veneering. Decorative veneers with the thicknesses of 0.5, 0.6, and 0.7mm were produced from the raw material with Slovak origin. 10 veneer logs with a length of 140 cm and with a diameter of 25–35cm were placed into the water after their transport and consequently the logs were debarked and processed. Veneers were manufactured by off-centre cutting. By means of interrupted off-centre cutting, new and interesting grains and textures of butternut veneer were obtained. Veneers were dried up to a moisture content of 6–8% by drying at a temperature of 100°C. Butternut veneers were subjected to a number of technological test procedures. Butternut as an interesting species for veneer industry is fully recommended. The quality of veneers made from butternut does not differ from the quality of commonly used decorative veneers. Veneer thickness 0.5–0.6mm can be recommended for furniture industry. Glue spread rate of 130–140g·m^{-2} was proposed for particleboard.

Key words: *decorative veneers; biobased composites; veneer properties; butternut; veneering.*

INTRODUCTION

The permanent growth of veneer industries is connected with the reduction of timber supplies of the well-known veneer species (Barbu *et al.* 2014). Therefore the search continues for alternate species, either local or introduced. In screening for new veneer species, it is helpful to know which factors are important for veneer use (Lutz 1971).

This paper includes the recommendation to use the species butternut (*Juglans cinerea* L.) for the production of decorative veneer and veneering. Butternut is an introduced species for Central European wood-processing industry. It is found in the East of North America from southeastern New Brunswick throughout the New England States except for northwest Maine and Cape Cod. The range extends south to include northern New Jersey, western Maryland, Virginia, North Carolina, northwestern South Carolina, northern Georgia, northern Alabama, northern Mississippi, and Arkansas. Westward it is found to central Iowa and central Minnesota. It grows in Wisconsin, Michigan, and northeast into Ontario and Quebec. Through most of its range butternut is not a common tree, and its frequency in North America is declining. The ranges of butternut and black walnut *(Juglans nigra* L.*)* overlap, but butternut occurs farther north and not as far south as black walnut. More detailed information on butternut distribution in Europe is not known. Butternut occurs in parks and in special purpose areas, where its ability can to be included in the assortment of species for the establishment of intensive stands is tested (Soják and Réh 1998).

Common Names: Butternut, white walnut, oilnut
Scientific Name: *Juglans cinerea* L.
Average Dried Weight: 435 kg·m^{-3}
Janka Hardness: 2,180 N
Modulus of Rupture: 55.9 MPa
Elastic Modulus: 8.14 GPa
Crushing Strength: 35.2 MPa
Shrinkage: Radial: 3.4 %, Tangential: 6.4 %, Volumetric: 10.6 % (http://www.wood-database.com/butternut 2017)

Description. Butternut is a hardwood (deciduous) tree growing to 20m tall, rarely 40m. It is a slow-growing species, and rarely lives longer than 75 years. It has a 40–80cm stem diameter, with light gray bark. The leaves are pinnate, 40–70cm long, with 11–17 leaflets, each leaflet 5–10cm long and 3–5cm broad. The whole leaf is downy-pubescent, and a somewhat brighter, yellower green than many other tree leaves.

Heartwood is usually a light to medium tan, sometimes with a reddish tint. Growth rings are darker and form fairly distinct grain patterns. Sapwood is a pale yellowish white. Grain is typically straight, with a medium to coarse texture. Silky natural luster. Semi-ring-porous; medium-large earlywood pores gradually decreasing to small latewood pores; solitary and radial multiples of 2–3; tyloses occasionally to abundantly present; growth rings distinct; rays barely visible without lens; parenchyma banded (marginal), apotracheal

parenchyma diffuse-in-aggregates (sometimes very faint and barely visible even with lens). (Ostry *et al.* 2003) Decay resistance is rated as moderately durable to non-durable; also susceptible to insect attack.

Wood properties. Butternut is easily worked with both hand and machine tools. However, being so soft, butternut has a tendency to leave some fuzzy surfaces after planning or sanding, and sharp cutters and fine-grit sandpaper is recommended. Butternut glues, stains, and finishes well. Butternut has virtually no scent or odor when being worked. Besides the standard health risks associated with any type of wood dust, no further health reactions have been associated with butternut.

Usage. It is available as lumber and carving blanks. Butternut wood is light in weight and takes polish well, and is highly rot resistant, but is much softer than black walnut wood. Oiled, the grain of the wood usually shows much light. It is often used to make furniture, mantelpieces, and interior trims, and is a favorite of woodcarvers along with interior paneling and turnery. It is also suitable for boxes, molding, and crates. It was widely used in churches for detailed woodwork such as intricately carved doors and alters (Nielsen *et al.* 2003). There are not many references to using butternut as plane sliced veneers. The trunks of butternut trees are fluted, which is sometimes still evident in processed lumber - the growth rings in the endgrain may appear more polygonal and faceted rather than perfectly circular. This is not a wood of significant commercial value, but rather a specialty wood.

It normally doesn't leave burn marks and has little dulling effect. The material also works easily with screws, nails, and glue. However, there are some factors to keep in mind. Routing across the grain, for example, can cause the wood to tear out. Although butternut responds well to planning, it's necessary to keep your tools sharp in order to avoid tearing the soft wood. Finally, butternut polishes and finishes beautifully. Because the wood is soft, it's important not to dent it during finishing. Overall, butternut has much to offer.

MATERIALS AND METHODS

Logs (raw material) for this research has Slovak origin and it was taken from Slovak State Forests, the location Levice, Sikenica (Čereš). 10 veneer logs with a length of 140cm and with a diameter of 25–35cm were placed into the water after their transport for soaking and consequently the logs were debarked and processed. Veneers were manufactured by the method of off-center cutting in the Development workshops and laboratories of the Technical University in Zvolen (Slovakia). By means of interrupted off-center cutting, new and interesting grains and textures of butternut veneer were obtained. Veneers with the thicknesses of 0.5, 0.6, and 0.7mm were dried up to a moisture content of 6–8% by drying at a temperature of 100°C in the belt (mesh) dryer.

Butternut veneers were subjected to a number of technological test procedures.

Specific Glue Penetration to the Veneered Area

The glue penetration to the veneered area is usually tested on veneer specimen with the dimension of 250×300mm. Common raw particleboard is used for this test and the proper glue amount is investigated (it was tested the glue spread rate from 100 to 220g·m^{-2}).

The evaluation of the amount of glue penetrated to the veneer surface was done with the help of a transparent net with mesh size of 5×5mm. For each value of the glue spread rate 6 specimen had been pressed and the glue penetrating was evaluated in percentage of the total specimen area.

Veneer Adhesion to the Particleboard Substrate (Surface Soundness)

The adhesion between the veneers and the construction material was monitored. The heart of the test lies in the determination of the strength necessary for severing the veneer from the construction material by means of a cylinder made of light metal. For testing, samples of 50×50mm in size were used.

Technological Properties of Veneer from the Aspect of Surface Finish

The technological properties of veneers had been tested for surface finish by transparent paints and systems commonly used for finishing in furniture industry.

As a substrate, for all the tests, three-layer particleboard reversibly veneered 300×600mm; 150×300mm and 100×100mm in size was used.

Transparent coatings were used only. There exist two reasons for the use of final coating material; aesthetics and protection from the end use environment. The esthetics of the final product varies in many ways, depending upon the selection of the various topcoats available and upon how the final topcoat is handled. The ultimate protection for any wood product finish is dependent upon proper selection of the topcoat for a specific end use.

Three types of clean topcoats were used:

a) Nitrocellulose Lacquers C 1008 and C 1038
b) Synthetic Acid Hardening Lacquer S 1715
c) Nitrocellulose Lacquer Basic C 1026

During surface finishing the panel with veneer was sanded to “knock down” any fibers that have been raised by the application of the finishing material and for further the uniformity of the panel surface.

Specimen were regularly subjected to laboratory tests related to the manufacturing's quality.

Determination the Local Thickness of the Paint. The determination of the local thickness of the paint was done by standards constituting a basis for the evaluation of the paint thickness uniformity on the specimen.

Determination of the Paint Adhesion by Means of the Screen Method (Cross Hatch). The determination of the paint adhesion by means of the screen method was carried out by standards. Adhesion is usually graded in five grades.

Determination of the Resistance to Hot Steam. The intensity of the paint resistance is classified in four grades.

Determination of the Resistance to a Burning Cigarette (Burn Resistance). A burning cigarette was put with about a 10 mm layer of burning ash. The test duration is approximately 60 seconds.

Determination of the Resistance to Chemicals and Selected Consume Liquids (Spot Resistance). The determination of the resistance to chemicals and selected consume liquids was carried out with the drop method.

RESULTS AND DISCUSSION

A survey of the specimen used and their denomination is given in Table 1.

Table 1

Survey and denomination of the specimen for evaluation of the surface finishes

Denomination of Specimen	Substrate	Surface Finish
A	particleboard	C 1008 + C 1038
B	particleboard	S 1715
C	particleboard	C 1026

Specific Glue Penetration to the Veneered Area

Results for specific glue penetration to the veneered area in dependence on the spread rate are given in Table 2.

Table 2

Results of the specific glue penetration to the veneered area in dependence on the spread rate

Veneer Thickness (mm)	Glue Spread Rate (g·m^{-2})												
	100	110	120	130	140	150	160	170	180	190	200	210	220
0.5	-	-	0.033	0.033	0.076	0.090	0.100	0.356	0.436	0.590	0.787	0.990	1.126
0.6	-	-	-	0.014	0.026	0.038	0.188	0.232	0.396	0.580	0.796	0.910	1.222
0.7	-	-	-	-	0.030	0.066	0.117	0.223	0.336	0.397	0.464	0.633	0.728

The test results on glue penetration to the veneered area revealed no substantial glue penetration within the spread rate of 130–140 g·m^{-2}, inclusive of followed thicknesses. Butternut from the point of view of glue penetration to the veneered area proved good properties. In actually used spread rates there is no danger of devaluation of the veneered elements. Glue spread rate of 130–140 g·m^{-2} was proposed for particleboard.

Veneer Adhesion to the Particleboard Substrate (Surface Soundness)

These test results are given in Table 3.

Table 3

Evaluation of veneer adhesion to particleboard substrate [MPa]

Glue Spread Rate ($g \cdot m^{-2}$)	t = 0.5 mm			t = 0.6 mm			t = 0.7 mm		
	Ø	min.	max.	Ø	min.	max.	Ø	min.	max.
100	1.024	0.830	1.202	1.221	1.111	1.321	1.404	0.986	1.802
110	1.264	1.126	1.362	1.263	1.162	1.361	1.566	0.321	1.886
120	1.322	1.143	1.621	1.420	1.221	1.521	1.680	1.399	1.961
130	1.362	1.002	1.543	1.526	1.392	1.643	1.667	1.206	1.896
140	1.403	1.382	1.482	1.630	1.433	1.782	1.702	1.341	2.061
150	1.605	1.503	1.822	1.723	1.701	1.758	1.635	1.218	1.980
160	1.974	1.842	2.202	1.962	1.882	2.121	1.782	1.563	1.913
170	1.707	1.523	1.921	1.720	1.642	1.811	1.708	1.322	2.237
180	1.596	1.423	1.732	1.621	1.532	1.721	1.522	0.980	1.904
190	1.592	1.432	1.648	1.600	1.421	1.681	1.411	0.860	1.786
200	1.329	1.232	1.362	1.426	1.321	1.542	1.545	1.211	1.864
210	1.336	1.321	1.351	1.346	1.212	1.421	1.413	1.012	1.806
220	1.419	1.312	1.542	1.340	1.200	1.366	1.320	0.896	1.523

Test was influenced by the fact that the bottom part of particleboard of the most specimen was destroyed as a result of its imperfectness and not in the glue joint between the veneer and particleboard. We may conclude from this that veneer in the majority of cases kept up with a higher intensity than given in Table 3. The results suggest that adhesion of all three veneer thicknesses of butternut to particleboard substrate highly exceeds required value. Even in lower values of the glue spread rate, veneer adhesion to the substrate was gained with confidence.

Technological Properties of Veneer from the Aspect of Surface Finish

Technological properties of butternut veneer from the aspect of surface finish were studied with a help of the veneer 0.5mm thick which is a current thickness for decorative veneer and this thickness showed to be a convenient thickness according to the test of specific glue penetration to the veneered area.

Determination the Local Thickness of the Paint. The results of this test are given in Table 4 and represent mean values from four measurements performed at given and mutually comparable places.

Table 4

Evaluation of paint thickness

Specimen	A	B	C
Paint thickness (mm)	0.12	0.11	0.11

The values given in Table 4 correspond to common values at the application of the paint types tested.

Determination of the Paint Adhesion by Means of the Screen Method (Cross Hatch). The results of this test are given in Table 5.

Table 5

Paint adhesion by means of the screen method

Specimen	Adhesion Degree				Resulting Adhesion Degree
A	2	3	2	2	2
B	3	2	2	2	2
C	1	2	1	1	1

As shown in Table 5, all finished types of paints provide adhesion degree 1–2 independently of the type of paint used pointing to excellent or very good properties of butternut veneers with regard to the paint adhesion.

Determination of the Resistance to Hot Steam. The values of paint resistance to hot steam are given in Table 6.

Table 6

Evaluation of the paint resistance to hot steam

Specimen	Type of Injury	Intensity of Injury
A	Blistering, matt gloss, soft surface	3
B	Change of the color shade to white, which was gradually lost, cracking, a more matt and softer surface	2
C	Change of the color shade to white, which was gradually lost, cracking, a more matt and softer surface	2

Resistance to hot steam is purely the matter of coating compositions applied. Hot steam did not affect the quality of butternut veneer.

Determination of the Resistance to a Burning Cigarette (Burn Resistance). The results of this test are given in Table 7.

Table 7

Evaluation of the paint to a burning cigarette

Specimen	Description of the Change of Lacquer	Degree of Damage
A	The paint was burned to the level of veneer, darkened and cracked	3
B	The coating was darkened, its surface was essentially unchanged	2
C	The coating darkened, burned, blistering, delamination of paint	2

It follows from the test of paint resistance to a burning cigarette that all coating composition are less resistant to a burning cigarette.

Determination of the Resistance to Chemicals and Selected Consume Liquids (Spot Resistance). The results of this test are given in Table 8.

Table 8

Evaluation of the paint resistance to chemicals and selected consume liquids

Specimen	*1	*2	*3	*4	*5	*6	*7	*8	*9	*10	*11
	Change Evaluated in Time										
	h d	h d	h d	h d	h d	h d	h d	h d	h d	h d	h d
A	1 1	0 0	0 0	0 0	1 2	0 0	0 0	0 0	0 0	0 0	0 0
B	1 2	0 0	0 0	0 0	1 2	0 0	0 0	0 0	0 0	0 0	0 0
C	1 2	0 0	0 0	0 0	1 1	0 0	0 0	0 0	0 0	0 0	0 0

h – Change evaluated in time of 1 hour
d – Change evaluated in time of 1 day (24 hours)
*1 – shoe polish
*2 – ink
*3 – 10 % CH_3COOH
*4 – 96 % ethylalcohol
*5 – 40 % ethylalcohol
*6 – 10 % citric acid
*7 – sour wild cherry juice
*8 – water
*9 – coffee
*10 – tea
*11 – oil

The resistance of surface finish to chemicals and selected consume matters is in the system under examination a matter of the coating composition quality. All coating compositions used are suitable for surface finish of butternut veneer; no visible changes occurred at using any of the chemicals or consume liquids.

CONCLUSIONS

The popularity of wood veneers has increased significantly worldwide. From the results of tests performed it can be said that butternut as an interesting species for veneer industry and its decorative veneers are fully recommended. The quality of veneer made from butternut does not differ from the quality of commonly used veneers and the veneer thickness of 0.5–0.6mm can be recommended for furniture industry. Glue spread rate of 130–140g·m^{-2} was proposed for particleboard.

Selected introduced woody species suggest good perspectives in the coming years. Future quality of wood and volume production may be secured by the providing of systematic and intense tending of forest stands. Butternut veneer is suitable for all commonly used paint system and all given transparent paint systems may be judged as equivalent and suitable for furniture-making. Butternut is suitable for application

in the furniture industry either as a replacement for some commonly used woody species or as a woody species widening the assortment of woody species utilized in furniture industry.

The results obtained suggest that it is possible to recommend its cultivation in larger areas upon properly managed stands (Soják and Réh 1998). It is still necessary to reach more accurate data on the nearest zoning in Central Europe and to realize a research of consumer market in the field of utilizing decorative veneer made of butternut.

ACKNOWLEDGEMENTS

The research described in the paper presented was supported by the Slovak Research and Development Agency under the contract No. APVV-14-0506 and APVV-0200-12. The author would like to thank the agency for the support of this research.

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