Annals of Warsaw University of Life Sciences - SGGW
Forestry and Wood Technology № 87, 2014: 105-108
(Ann. WULS - SGGW, For. and Wood Technol. 87, 2014)

Effect of storage time of MUF adhesive resins condensed no-waste way on the gluing quality of beech plywood

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Abstract: *Effect of storage time of MUF adhesive resins condensed no-waste way on the gluing quality of beech plywood.* In presented article were discussed properties of beech plywood produced with the use of melamine-urea-formaldehyde resins (MUF) in function of storage time. Properties of produced plywood accordingly to the requirements of standards EN 314-1 after tests p.5.1.1, and p.5.1.3 were tested. On the base of carried out tests it was stated, that independent of storage time of MUF resin, produced 3-layers plywood fulfilling the requirements of EN 314-2 standard for 3 class of gluing quality.

Keywords: resin, waste, plywood,

INTRODUCTION

Adhesive amino resins (UF, MUF and MF) occupy a leading position among the bonding agents used in various fields of the wood industry. Participation of amino resins in the general range of adhesives produced for the wood industry stands at 85%. Amino resins owe their common use to their numerous advantageous properties such as water solubility, high reactivity, colorless glue line and high resistance to biotic factors, and in the case of MUF and MF resins to high hydrolytic resistance of adhesive glue line.
Amino resins are obtained by condensation and then concentrated using evaporators to dry matter content ranging from 60 to 70%. The distilled off part is mainly water containing impurities in the form of formaldehyde and other compounds used as modifiers polycondensates such as alcohols, amides, phenol and others. The process of resin evaporation is carried out mainly in order to improve polycondensates stability, i.e. obtain suitable technological viscosity, as well as to enhance their suitability for transport. In order to eliminate the compaction process some manufacturers of resins use concentrated solutions of formalin or formaldehyde-urea concentrates (Dunky 2004, Pizzi 1994, 2000). However, these technologies are available only at factory level, mainly due to the low stability of concentrated substrates, and the obtained resins are characterized by unsatisfactory stability.
In the Wood Technology Institute research on the synthesis of amino resins, polycondensation (Jóźwiak, Proszyk and Jabłoński 2003, Jóźwiak and Jabłoński, 2007, Jóźwiak 2011) has been conducted for many years. Recently conducted research has shown that in an uncomplicated process of condensation, MUF resins by non-waste method can be obtained, using formalin-stabilized high content of methanol.
The aim of the research were examine of effect of storage time of MUF adhesive resins condensed no-waste way on the gluing quality of beech plywood

MATHERIALS AND METHODS

Resin. We applied MUF resins condensed on the lab scale for the molar ratio formaldehyde : melamine : urea like as 3.8:1.0:1.0. The condensation was a tree-stage process performed at temperature of 82± 2°C and 0.2 mole of urea was additionaly condensated at the third stage.

Condensation was carried out to water tolerance in the range of 100÷150%. Polycondensate was not distilated. Details concerning the syntesis were presented earlier [Jóźwiak 2011]. Resins were stored at a temperature of 20 ± 2°C.
The basic physicochemical properties of the resin was determined using the following methodologies:

- apparent viscosity using Emil rotational viscometer in compliance with PN-92/C-89402
- content of dry mass, according to DIN EN 827 (weighed sample 2.0 ± 0.1 g were dried at a thermal chamber with natural air circulation at 120 ± 1 ° C during 120 ± 1 min)
- pH applying pH-meter with combined electrode according to PN-ISO 1148
- gel time at 100°C according to BN 75/3537-01
- free formaldehyde content by sulphite method according to DIN EN 1243

MUF resin was characterized the following basic properties : apparent viscosity – 41 mPa·s, solid content 52.5%, pH value 9,28, gel time at 100°C – 103 s , and free formaldehyde content 0.53 %.
Glue mixtures. To approximately one third of the MUF resin was added a certain amount of filler, (wheat flour type 650 and kaolin powder KOG-OS, and active silica Aerosil-120 part. by wt.), then the mass was stirred for 10 min with a mechanical stirrer, and then introduced the remainder part of the resin was carried out by stirring for a further 20 min. In the final stage of preparation of the adhesive, the hardener 1,6% NH_4NO_3 was added.
Veneer. In the study beech veneer were used. For the preparation of 3-layer plywood, veneers with dimensions 300x300x1, 8 ± 0.1 mm, and MC = 6 ± 1% were used.
The parameters pressing process. Veneer was applied on one side with the adhesive roller in an amount of 180 g/m^2. Then three layer sets was formed. After 30 min or 24 h assembly time sets pressing at 125° C for 5 min at a pressure of 1.8 MPa.
Testing. Samples were cut to determine shear strength (R_t) of adhesive glue line of plywood in accordance to EN 314-1 standard. Before determining the shear strength of bonds, the samples were subjected to hydrothermal treatments in accordance with point 5.1.1 (24 h soaking in water in temperature 20±3°C) and 5.1.3 (4 h boiling in water as well as 16 h drying in air at the temperature of 60±3°C and 4 h boiling in water and cooling in water to the temperature of 20±3°C) of the EN314-1 standard All the samples were tested in wet state in the Schopper testing machine at loads ranging to 500 daN. Rupture of the samples were occurred within (30 ±10 s). After shear tests, the samples were dried and the percentage share of the bond surface covered with wood fibers – wood failure (WF) was determined comparing the pictures of bond damage with those shown in EN 314-1 standard.

RESULTS

The results of studies on the effect of storage time of MUF adhesive resins condensed no-waste way on the gluing quality of beech plywood presented on Fig 1.
On said graphs with void marks are presented shearing strength from 15 measurements, and for presentations of their variability, standard deviation was put in form of perpendicular sections up and down from said signs. The quality of gluing (% of wood failure) was marked as bars and scale of reference was placed an the right side of the graph.
Plywood were characterized by very high quality waterproof glue lines, independently of the storage time. The glueing effect obtained with resin stored even longer than 12 months represented a fully satisfactory, waterproof plywood. Higher values WF were obtained for 24 h assembly time. Plywood fulfilled the requirements for EN-314-2 standard in terms of strength and water resistance of glue lines.

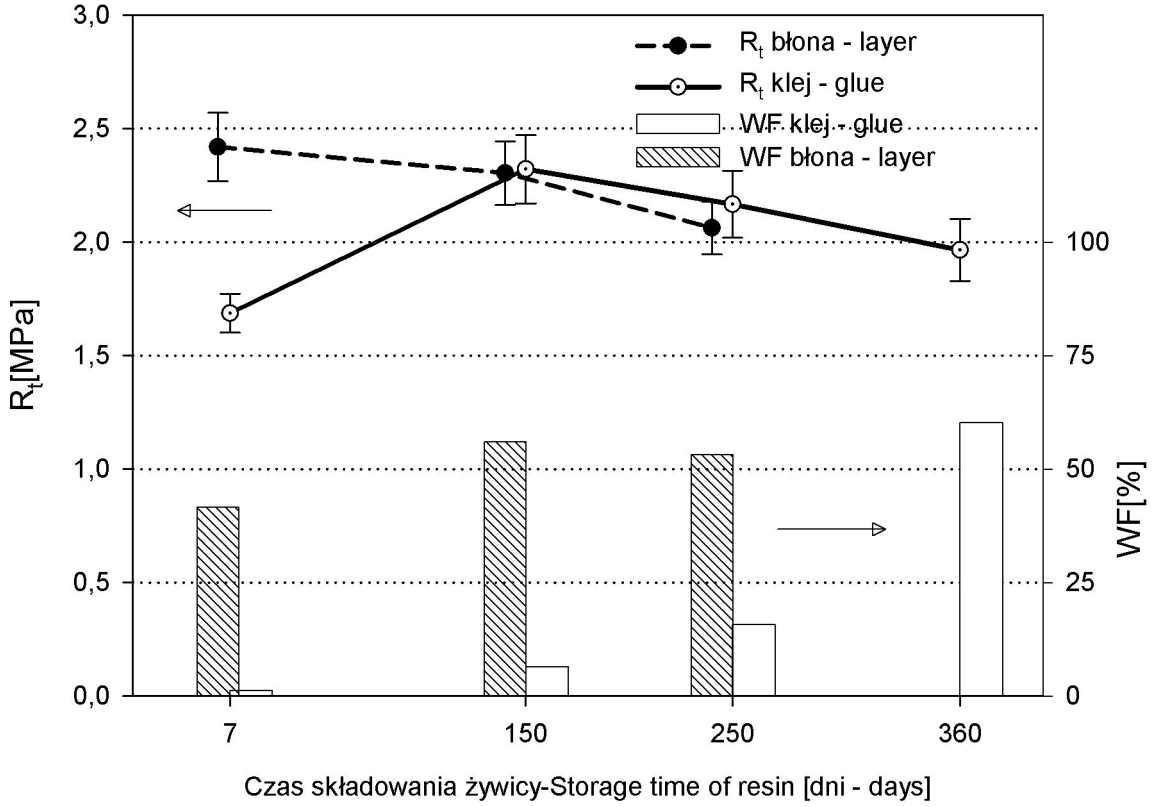

Fig.1 Comparison of shear strength (R_t) and wood failure (WF) of tree-layer beech plywoods after test p.5.1.3. acc. to EN 314-1:2007 obtained from MUF resin depending on storage time of adhesive polycondensate

CONCLUSIONS

Based on the performed study it was found that independently of the storage time of the resin (7-360 days), plywoods obtained were characterized very high water resistance and quality of adhesives bonding. Plywood meet the requirements of EN-314-02 for class 3 of gluing quality.

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Streszczenie: *Wpływ czasu składowania żywic melaminowo-mocznikiwo-formaldehydowych (MUF) na jakość sklejenia sklejki bukowej***.**
W pracy przedstawiono badania nad wpływem czasu składowania żywic melaminowo-mocznikiwo-formaldehydowych (MUF) na jakość sklejenia laboratoryjnej trójwarstwowej sklejki bukowej. W badaniach zastosowano żywicę MUF o stosunku molowym M:U:F jak 3,8:1,0:1,0 kondensowaną sposobem bezodpadowym. Wytworzone w skali laboratoryjnej 3-warstwowe sklejki bukowe przy zastosowaniu żywicy MUF , niezależnie od czasu składowania od 7 do 360 dni i technologii klejenia spełniały wymagania EN 314-2 dla 3-klasy jakości sklejenia wodoodpornego (R_t =1,0 MPa, przy WF=0%)

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