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Multi-recovery of specific waste biomass for production environmetally friendly products. Part 1. Preparation of new type wood materials

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Abstract: *Multi-recovery of specific waste biomass for production environmetally friendly products. Part 1. Preparation of new type wood materials*. The article deals with effective utilization of biomass waste (from cellulose pulp and paper industry) for production of new type of wood products. Multipurpose utilization of waste sulphate liquors is possible as environmentally acceptable adhesive mixtures for preparation special wood composite materials. Next declining biomass waste is as compostable materials available for the treatment of forest roads and for the purpose of fire protection.

Keywords: recycling, waste, biomass, wood products

INTRODUCTION

This is currently the preferred multi-use waste as a valuable secondary raw materials. Increasing the efficiency of biomass waste must be conducted in real ecological situation in terms of reducing the quality of biomass waste, improving the quality characteristics of recycled products and meeting the current requirements for hygiene, in particular the ecological quality of the proposed application of waste products, e. g. wood composite materials (Mašura, 1998; Jolly, 1992).

In the preparation of kraft pulp, which is the main intermediate product in the pulp and paper industry, is due to the ongoing process to create delignification reactions quantities of waste products, f. e. kraft black kraft liquor. New kraft recovery of waste liquor is aimed only for the use of certain components to produce liquors of high prices, e. g. derivatives such as kraft lignins or modification reactions modified kraft black liquor that can be applied in the preparation of composite wood materials (plywood panels, agglomerated material) (RUŽINSKÁ, 2003) as adhesive hygienically acceptable and economically than currently used polycondensation - fenolformaldehyde (PF) resin (OLIVARES ET AL., 1995). Recovery of toxic constituents (as phenol) in polycondensation adhesives just natural polyphenols (of kraft waste liquor) obtained from chemical processing of biomass is more efficient to use in the preparation of materials with high added value (SHIMATANI, 1995; VASQUEZ ET AL. 1997).

The reactivity of lignins to formaldehyde is one of the indicators of their suitability for use in the PF adhesive. The chemical structure of sulphate lignins (in kraft liquor), especially aromatic character fenylpropane units allows a number of modification reactions and to an increase in their reactivity and better crosslinking into polycondensate matrix of adhesive mixtures (ALLAN, 1989; OLIVARES ET A., 1995, RUŽINSKÁ, ET AL. 2008, 2010).

The first part of paper deals with the efficient use of waste products prepared from the processing of biomass (production of chemical pulp – sulphate black liquors) for the preparation of composite wood materials the environmental attributes of acceptability while preserving the quality characteristics designed and laboratory prepared materials.

MATERIALS AND METHODS

In the experimental part of the attention modifier treatment kraft liquor, which were subsequently applied to the reciprocal laboratory prepared glue mixtures. The comparison was

designed and prepared various variant adhesive mixtures which are used unmodified kraft black liquor. Prepared mixtures of glue (with reciprocal compensation commercial PF resin 10 – 60 % wt.) was used in the laboratory preparation of composite wood materials – three layers particle board (PB). They were subsequently evaluated selected physical and mechanical properties of laboratory particle board which were compared with a standard manufactured wood composite (PB).

Modified treatment of waste liquor

Methylolation treatment of kraft black liquor has been carried out experimentally The basis of methylolated treatment was the reaction of formaldehyde with waste sulphate liquor at room temperature for 72 hours. The way was prepared methylolated kraft liquor, which was further applied to the adhesive mixture with fenolformaldehyde adhesive (PF) with a gradual proportional refund PF adhesives from 10 to 60 % wt. (DOLENKO, 1978).

Acidification kraft black liquor is the second variant of the modification adjustment was in the previous post-treatment procedure prepared methylolated kraft liquor acidification followed by a strong mineral acid with intensive stirring to value pH = 5 (SHIMATANI, 1995).

Preparation of adhesive mixtures

Adhesive mixture to be applied in the preparation of composite wood materials (PB) were prepared with the gradual replacement of the original proportional fenolformaldehyde adhesive (PF) native and modified liquors gradually from 10 to 60 % by weight. Similarly the reference test were used units - only with PF adhesive glue mixture consisting only of origin kraft black liquor (100 % wt.) (RUŽINSKÁ ET AL. 2008; 2010).

Laboratory preparation and evaluation properties of particle board

Experimental prepared three variants of three-ply particle board (PB) mixed with the application of mixtures adhesives:

- **A** variant: PB with the application of the original, untreated kraft liquor,
- **B** variant: application of modified PB - methylolated liquor,
- **C** variant: application of the modified PB - acidified liquor,

Conditions for the preparation of particle boards:

- moisture content of particles: surface 5,01 %, middle 3,64 %,
- a mixture of glue deposits at the surface 10 %, in the midlle 7 %,
- prepared PB dimensions: 280 x 360 x 16 mm (three-layers beech PB),
- pressing conditions: 195 °C, specific pressure of 4,8 MPa, total pressing time 480 s.

Evaluation of selected physical and mechanical properties of laboratory prepared particle boards:

- tensile strength perpendicular to the plane of the plate according to STN EN 319,
- the swelling diameter in water (20 ± 2 °C) for 2 hours and 24 hours according to STN EN 317.

RESULTS AND DISCUSSION

Laboratory particle board were prepared to gradually replace (from 10 to 60 % wt.) the original reciprocal fenolformaldehyde adhesive by waste sulphate liquor – origin and modified liquors as variants A, B, C. The mechanical properties were assessed as representative of the characteristics - tensile strength perpendicular to the plane of the plate (three layers particle boards). Evaluation of mechanical properties was carried out in the program Statistics.

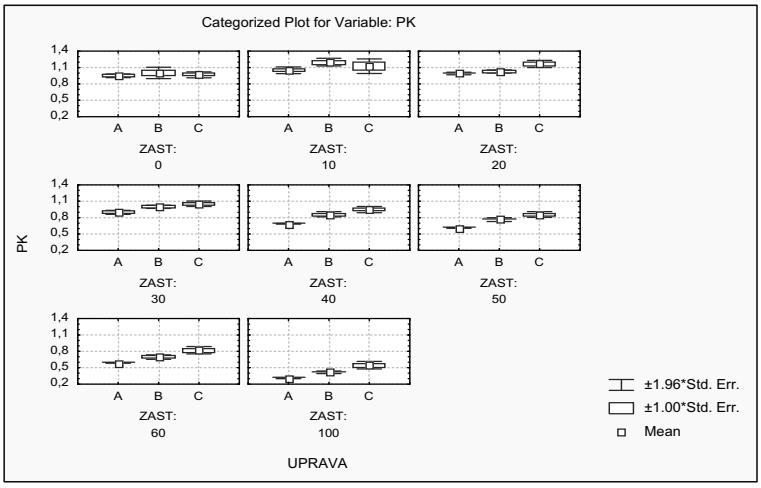

Fig. 1 Mutual comparison of confidence intervals for mean values of tensile strength perpendicular the plain laboratory prepared particle board to changing for three various particle boards

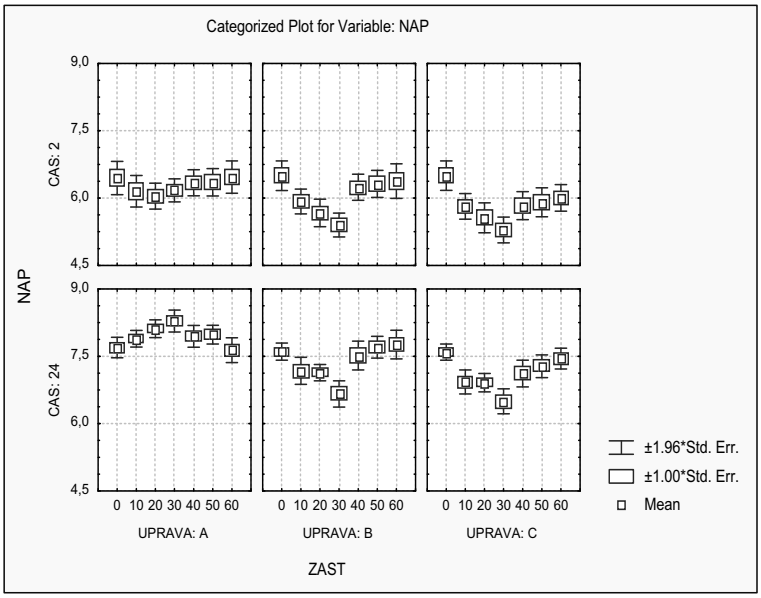

Fig. 2 Confidence intervals the average swelling of laboratory prepared particle boards for exposure 2 and 24 hours (A - origin black liquors, B – methylolated liquors, C – acidified liquors)

In the Fig. 1 are evaluated confidence intervals for tensile strength perpendicular to the plane of the plate (prepared PB) for different variants of the test pieces. Results in Fig. 1 are showed that laboratory prepared particle boards with a gradually increasing share

of reciprocal kraft waste liquor (to replace the original PF resins) comparable strength characteristics: A variant in 20 % wt., variant B to 30 % wt., variant C to 40 % wt. compared to the reference sample (designated as 0 % wt. - PF resin bonding only). Even the experimental particle boards prepared with 100 % wt. replacement PF resin (variant C) has such mechanical properties that meet the quality particle board general use (type N) for thickness 22 mm or more: 0,25 MPa.

The physical characteristics as representative of swelling was evaluated after 2 and 24 hours of exposure in water (20 ± 2 °C). The assessment is clear that the particle boards prepared with the application of modified kraft effluents (variant B, C) demonstrated reduction of swelling after 2 and after 24 hours compared with variant A (the presence of untreated sulphate liquor). Variant A in the evaluation of swelling showed similar swelling values than the reference sample (0 % by weight). There was a significant reduction in swelling after 2 hours was just a variant B and variant C up to 30 % by weight reciprocal compensation PF resin modified extracts. Even reciprocal compensation in the range 40 - 60% wt. the observed physical property decreased only slightly. The assessment of the diameter of the swelling after 24 hours has been shown to reduce the swelling experimentally prepared PB significantly to 30 % by weight, moderate in 40 – 60 % wt. comparable in both models, but better results once again demonstrate variant C.

CONCLUSION

Waste kraft black liquor containing natural polyphenolic substances which are showed very good adhesion characteristics and confirmed the suitability of their application for reciprocal compensation phenolformaldehyde resins by waste sulphate liquor using experimentally prepared composite wood materials - particle board with improved quality up to 30 % by weight. reciprocal compensation (in comparison PF resin) a variant of C - using acidified sulphate liquor.

From evaluation of selected physical characteristics of prepared particle board followed that the application of modified kraft liquor specifically reduced swelling laboratory prepared particle board after 2 and after 24 hours compared with commercially produced particle boards assembling only with the use of PF resin. Even compared to the reference sample (0 % wt.) was recorded experimental reduction of swelling diameter for prepared PB in all three variants for two after 24 hours with the most favorable results for variant C.

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Streszczenie: *Wielokierunkowe wykorzystanie biomasy odpadowej do produkcji produktów ekologicznych. Część 1. Przygotowanie nowych rodzajów materiałów drzewnych.* W artykule omówiono efektywne wykorzystanie biomasy odpadowej (powstającej w przemyśle celulozowo-papierniczym) do wytwarzania nowych rodzajów wyrobów drzewnych. Wykorzystując wielokierunkowo odpadowe ługi siarczanowe można otrzymywać przyjazne dla środowiska masy klejowe, które następnie mogą być stosowane w produkcji specjalnych drzewnych materiałów kompozytowych. Dalszym zastosowaniem odpadów biomasy z odzysku, może być np. ich wykorzystanie jako materiału kompostowalnego do naprawy dróg leśnych oraz jako środków w ochronie przeciwpożarowej.

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