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Development of amino resin with flexible performance

A. Antunes¹, J. Pereira², N. T. Paiva¹, J. M. Ferra¹, J. Martins³,⁵, L. Carvalho³,⁵, A. Barros-Timmons⁴, F. D. Magalhães⁵

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Amino-formaldehyde resins are thermosetting polymers. They are divided into three main types: urea formaldehyde (UF), melamine formaldehyde (MF) and melamine urea formaldehyde (MUF). These resins are characterized, after cure, by high crosslink density, high stiffness and high tensile strength [1]. However, this stiffness may be undesirable when a final product with some flexibility is desired.

Cork agglomerates are cork-based products that can be used for surfacing, flooring and insulation purposes. They are composed of cork granules with variable dimensions, bound together by rubber, polyurethane adhesive or MUF resin [2]. Cork agglomerates can be sold as flat panels or as a rolled panels (so called “cork roll”). MUF resins cannot be used for the latter form, since its stiffness causes the material to crack when flexed.

The aim of this work is to develop an amino resin with high flexibility, enough to allow its use in cork roll production. Good adhesive properties, hydrolysis resistance and low formaldehyde emissions are also key features. The strategy adopted to address this challenge consists in the modification of the MUF resin with the incorporation of long linear chain compounds that act as flexible segments in the MUF structure. Glycols with different molecular weights were used for this purpose.

The results show different performance for glycols with different molecular weights. Namely, the adhesive properties decrease with increasing molecular weight. The glycol with molecular weight of 200 g/mol yielded a promising formaldehyde-based flexible adhesive polymer.

Acknowledgements

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References

Preparation of amino resins and their impact on the production of wood-based panels

C. Gonçalves¹, J. Pereira¹, N. T. Paiva³, J. M. Ferra³, J. Martins¹, F. Magalhães¹, A. Barros-Timmons⁵, L. Carvalho¹,⁴
¹LEPABE - Faculdade de Engenharia, Universidade do Porto, Rua Dr. Roberto Frias s/n, 4200-465 Porto, Portugal
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In the last decades, the industry of wood products is going through a great evolution thanks to companies like Sonae Arauco, which focus has been on developing more and better wood-based products. In 2015 Portugal produced 1 million and three hundred thousand m³ and exported 278 million euros of wood-based panels [1]. Among these products, the best known are the commercially available particleboard (PB), medium density fibreboard (MDF), oriented strand board (OSB) and plywood (PW). For all these types of panels the use of a synthetic adhesive is required. Among the wide range of adhesives/resins employed in the wood industry, the most important are the amino resins which include urea-formaldehyde (UF) resins, melamine-formaldehyde (MF) resins and melamine-urea-formaldehyde (MUF) resins.

The aim of this work is to optimize the amino resins (UF and MUF) synthesis process by assessing the impact on the final characteristics of wood-based panels (PB and MDF). To understand how the operating conditions influence the final product properties, different tests will be performed. Tools for design of experiments (DoE) will be used for planning experiments and data processing. The purpose is to correlate the conditions of the laboratorial reactor and the main properties of resins (molecular weight distribution, degree of branching, condensing structures and reactivity) and thereafter with some of the final product properties (physical-mechanical performance and formaldehyde emissions). In a second step, using the most promising formulations, other factors related to the sizing process (wood moisture content, resin content) and pressing (temperature, pressing cycle) will also be considered.

At an early stage, different variables related to resins synthesis were studied, trying to better understand their impact on wood-based panels properties, in particular particleboards. In an initial approach, an industrial UF resin was synthesized at different values of pH, temperature, and final viscosity. The resins were characterized using empirical quality control methods and advanced physicochemical characterization techniques. The panels produced were characterized using standard tests. The results are being analysed using the JMP Statistical Software.

Acknowledgements
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References
Greener urea-formaldehyde resins for the production of particleboards

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Urea-formaldehyde resins (UF) are the most used adhesives for the production of wood based panels [1]. Their high reactivity, good binding strength and low cost are the main reasons for their heavy use [2]. However, this type of resin presents some problems due to the emissions of formaldehyde, as it is a chemical compound classified as a human carcinogen [3] and also, because it is obtained from fossil fuels.

There are increasing concerns about the environment, and the populations health, which creates a strong demand for eco-friendly products, such as natural wood adhesives.

The goals of the research project, is to develop a greener urea-formaldehyde resin for the production of particleboards, with the incorporation of at least 30% of a natural compound. In a first approach to accomplish this goal, the incorporation of lignin in the UF resin was envisaged. Lignin is the principal byproduct of the pulp industry. In order to increase lignin reactivity, it was first hydroxymethylated. It is expected that the added reactive hydroxyl groups allow its incorporation in the urea-formaldehyde polymer.

So far, it was possible to incorporate 20% of hydroxymethylated lignin, percentage by mass, in the urea-formaldehyde adhesive.

Three-layer particleboards, 16 mm thick, were manufactured with this adhesive (amount of solid resin 6.5, in the face, and 6.1, in the core layers, based on the weight of the oven-dried particles). Boards were pressed in a laboratory hot-press controlled by computer at 190 °C and at several pressing times, from 3 to 6 min, and then tested for several physical-mechanical properties. They presented an internal bond strength in the range of 0.44-0.50 N.mm⁻² which are above the requirements of the standard EN 312 for standard particleboards type P2 (0.35 N.mm⁻²).

Finally, the future work will focus on a stepwise increase of the lignin content in the UF resin; optimization of the hydroxymethylation process; and reconsider lignin, on its own, as an adhesive for particleboards.

References