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## ASSESSMENTS ON USING HEMICELLOSES TO IMPROVE FUNCTIONAL PROPERTIES OF FOAM FORMING FIBER-BASED MATERIALS INTENDED FOR NOISE INSULATION APPLICATIONS

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### **Introduction**

Foam forming is an innovative way to produce highly porous materials within the manufacturing process of cellulose fibres based products, when the fibres and other components are mixed with foam instead of water. This innovative method leads to obtain very porous materials with low density and low environmental impact, which can replace the petroleum-based products in different industrial application fields, e.g. packaging, cushioning, noise and vibration control. This technology provides potential savings in terms of raw materials, energy and water, comparing with conventional water-forming process. A significant advantage is the 3D structure of foam that prevents fibres flocculation and allows production of lightweight products with bulky and porous structure, open pores and unique properties. The structural integrity of this extremely soft and porous fibrous network is usually provided without any other additives. Although, even these materials provide suitable functional properties for regular applications, it can be improved as required by specific practical utilization, e.g. wet-ability for outdoor noise insulation, mechanical strength for large panels etc. Whole of these aspects supply the actual interest of scientific community all over the world for continuously investigation, gaining of new knowledge and enlarge applications area. Unfortunately, the approaches regarding cellulose-based foams for noise protective solutions are weakly presented within the available scientific literature. Into this study the authors present the results obtained by surface treatment with hemicelluloses of foam formed cellulose fiber-based materials intended for acoustic insulation practice.

### **Materials and methods**

Foams were obtained based on cellulose fibres, from virgin pulp and recovered papers, mixed with anionic surfactant (SDS, 4% relative to the fiber weight) at high shear velocity. The bleached softwood cellulose with 43..60°SR and 1.98% consistency has been used as fiber source for this research (typically 400–800 µm average fiber length, and 15–35 µm diameter). The mixture was dewatered on Buchner funnel under low vacuum and air dried in non-restrained conditions.

Xylan derivatives (in terms of acetylated and hydrophobized xylan) were considered for surface treatment of foams, supposing that hemicelluloses represent by-products of pulp and paper industry, and xylan polysaccharides are the most abundant hemicelluloses type. Xylan hemicellulose from beechwood with molecular mass of  $(132)_n$  was used. Acetylated xylan was obtained in laboratory by esterification of native xylan with acetic anhydride in two stages, at 50°C for 1 h and molar ratio of acetic anhydride to functional hydroxyl groups in the structural unit of xylan about 8:1. The degree of substitution was about 0.48. Hydrophobized xylan was obtained by reaction of native xylan with long chain anhydrides as alkyl ketene dimers at 20°C and 24 h of magnetic stirrer at 1500 rpm. Four different commercially available petroleum-based materials, currently used for soundproofing, were also considered, in order to have a suitable reference for analysis. These materials include expanded/extruded polystyrene (EPS/XEPS), polyurethane (PU), and expanded polyethylene (EPE) respectively.

The experimental investigations were performed in terms of sound absorption/reflection coefficients and sound transmission loss, in order to evaluate the level that surface coatings have affected noise insulation properties of basic cellulose foams. The Impedance Tube Kit Type 4206® Brüel&Kjær was used for measurements, according to ISO 10534-2, ASTM E1050-12 and ASTM E2611-17 International Standards.

### ***Results and conclusions***

Firstly, it was observed that xylan treatments penetrate much more the foam based on cellulose fibers with low beating degree (between 40% – for native xylan and 60% – for acetylated xylan, of sample high), comparative with the foams from high beating degree cellulosic fiber (between 60% and 70%).

Combining the acoustic absorption characteristics acquired for the two basic materials and supposing the wet-ability aspects of each treatment type, results that (a) native xylan can be used for low level beating degree cellulose fibers, but does not enable enough hydrophobicity contribution; (b) hydrophobized xylan represents a good choice for high level beating degree cellulose fibers, especially for medium frequencies between 1000...5000 Hz; (c) acetylated xylan provide better treatment alternative at the same time with increasing of beating degree. Comparative with the petroleum-based materials, good acoustic absorption performances of cellulose fiber-based foams are evident. The comparison with still large-scale used petroleum-based materials was justified by the lack of scientific literature generally presenting functional performances of cellulose foams, and especially for using hemicelluloses additional treatments.

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