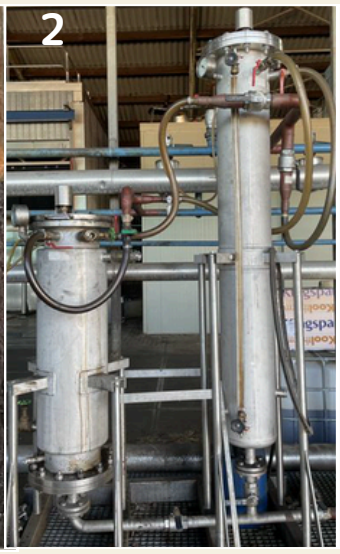
New insights into wood modification

Project goal: The NewWave Project, funded by the European Union's Horizon Europe Programme, is actively working to build a sustainable and circular economy by introducing innovative and bio-based raw materials into production lines. The goal is to replace toxic chemicals and reduce the environmental footprint of products.



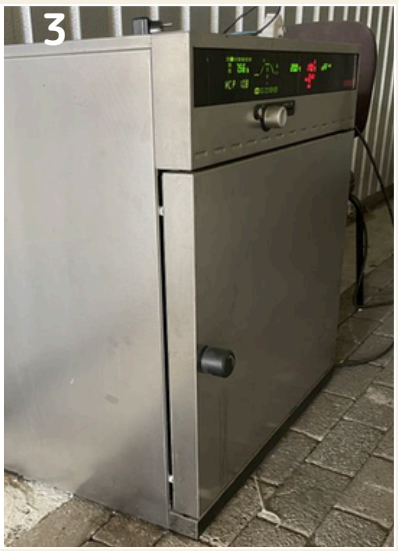


Figure 1: Samples after impregnation
Figure 2-3.Bench-scale Impregnation reactor and curing oven

To validate the properties of the NewWave products and replace fossil-based and toxic preservatives—such as copper salts, organic biocides, and creosote—with an entirely bio-based alternative, further tests have been performed by the partner **FORECO**. Operating at bench scale, the primary objective was to conduct a systematic evaluation to identify the optimal chemical formulations among **10 different options**. This phase provided fundamental insights into the interaction between the formulas and the wood under controlled conditions, while minimizing material consumption.

High-quality **Pinus radiata sapwood** was selected due to its high permeability and uniform behavior during impregnation. Samples were chosen with a controlled moisture content between 12% and 16% to ensure comparable baseline conditions.

Testing methodology

1. "**Full-cell" Impregnation**: a vacuum-pressure process designed to maximize deep absorption into the wood cells.
   - Pre-vacuum: 30 minutes at 20 kPa to remove air from the pores.
   - Pressure phase: 120 minutes at 1000 kPa to force the solution into the wood.

2. **Curing (Thermal Treatment)**:
   - Linear heating up to 130 °C over 8 hours.
   - Temperature maintained for 24 hours to stabilize the modified structure and minimize leaching (oil loss).

Impregnation Efficiency (WPG)

The success of the impregnation was measured via Weight Percent Gain (WPG).

- **Uniform Absorption**: all tested sample formats (small, medium, and large) showed an average WPG of approximately 100% or higher.
- **Penetration Capacity**: data indicate a high absorption capacity of the solutions within the cellular structure of the Pinus radiata wood, regardless of the sample size.

Optimization of Stability and Leaching

A key objective was to minimize the loss of oil from the wood when exposed to weathering (leaching).

- **Temperature Effect**: tests compared thermal treatments ranging from 80 °C to 130 °C with curing times of 12 and 24 hours.
- **Optimal Condition**: results clearly demonstrated that the lowest leaching is achieved with curing at 130 °C for 24 hours. This combination ensures maximum retention and stability of the FPBO formulations within the wood.
- **Physical Properties**: Analyses also monitored product stability, recording variations in pH, density, and viscosity for each of the 10 formulations tested.

Performance Characterization and Final Selection

Partner **InnoRenew** subjected the samples to a wide range of tests to evaluate technical and aesthetic properties.

- **Evaluated Parameters**: Factors analyzed included color, dimensional stability, hygroscopic properties, impact resistance, durability against fungi (such as Rhodonia and Trametes) and mold, as well as Volatile Organic Compound (VOC) emissions and thermal conductivity.
- **The Winner** (Treatment H): Formulation labeled IS15 (Treatment H) was identified as the best performer, achieving the highest scores in most test categories.

The bench-scale phase confirmed that wood modification with FPBO is a valid strategy for obtaining an entirely bio-based, durable product with technical characteristics comparable or superior to traditional toxic treatments.

Learn more on newwave-horizon.eu

Project partners

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