Development and pilot production of SUStainable bio BINDer systems for wood based panels

Reporting

Project Information

SusBind

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Periodic Reporting for period 3 - SusBind (Development and pilot production of SUStainable bio BINDer systems for wood based panels)

Reporting period: 2021-05-01 to 2022-08-31

Summary of the context and overall objectives of the project

The overall objective of the SUSBIND project was to produce and test, in an industrially relevant environment (TRL5), bio-based binders as alternative to formaldehyde-based binder currently used in the production of wood-based panel board.
Several market factors are driving major changes in the composition and technology of these adhesive systems in the EU. Upcoming regulations foresee reduced formaldehyde emissions from furniture due to its effects on indoor air-quality.
Manufacturers have made several attempts to produce alternative binders from renewable resources, but a bio-based binder able to compete at industrial scale with incumbent chemicals does not yet exist.
In order to cope with increasing global consumption and climate change, innovative products in the wood-based panel mass market are urgently needed to reduce greenhouse gas emissions and dependency on fossils.

Over the past 4.25 years (May 2018 – Aug 2022), the SUSBIND consortium partners have developed the 'SUSBIND adhesive'. This adhesive is partly bio-based (80% biogenic carbon). It consists of biobased fructose and hydroxymethylfurfural (HMF) and fossil bis(hexamethylene)triamine (BHT). The SUSBIND adhesive has shown promising technical performance in boards produced at small scale and in a prototype final product (at Technology Readiness Level, TRL 5). Alongside the technical development of the SUSBIND adhesive, different aspects related to its environmental impact, human health effect, and market feasibility were studied.

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

Specific Objective 1: To select the most sustainable feedstock from starch-based and vegetable oil-based biorefineries was successfully completed in Period 1.

Specific Objective 2: To develop, scale up and validate (TRL5) chemical routes for the synthesis of carbohydrate-based amino-plastic, and other wood adhesive systems, by in-situ polymerisation of urea and other monomers with reactive intermediates derived from high purified carbohydrates and use the chemicals produced accordingly as bio-based binders for wood board production was fulfilled at various stages of the project. A literature study on 5-HMF as monomers for bio-based adhesives was summarised and first adhesives were produced from different carbohydrates and 8 different amine crosslinkers followed by lab-scale testing of the most promising resin and pilot resin production and upscaling production of carbohydrate-based binder (TRL5) for particle board and MDF validation.

Specific Objective 3: To develop, scale up and validate (TRL5) a new enzymatic technology, for the selective epoxidation of unsaturated plant fatty acids and oils with peroxygenases to be used as bio-

based binders for wood board production.
A significant amount of scientific work has been done to create, scale up, and validate an enzymatic epoxidation process, and the results are impressively documented by WP3's results and publications. The last set of fungal strains was analysed in search for better unspecific peroxygenase enzymes (UPOs) producers, and previously unknown UPOs were made available by identifying the corresponding genes in databases and using heterologous expression systems.
MS5 validated new enzymatic process for lipid epoxidation in the manufacture of epoxy lipid at laboratory scale. Successful scale up of the epoxidation technology providing 10 kg of epoxidized lipid was achieved in October 2021 (M42).

Specific Objective 4: To validate the novel bio-based binders, derived both from carbohydrates and oils supply chains, in industrially relevant environments (TRL5) and particularly for Particle Boards (PB) and Medium Density Fibre Boards (MDF) with the scope of obtaining comparable or superior mechanical properties and lower emission profiles than current state of the art boards using common mineral oil-based binder chemicals.Design of the suitable binder composition starting from bio-based binders able to deliver suitable industrial standards was reached in Feb 2022 (M46). The chipboards (PB) from Egger reached the industrial standard and the boards were sent to IKEA in M44 followed by the MDF boards in M46 with final validation D4.3 of PB and MDF at IKEA achieved in August 2022 (M52).

Specific Objective 5: To assess whether the developed bio-based resin has a lower carbon footprint and human health impact when used in a binder system than the current formaldehyde-based binder systems and complies with all relevant market, standardisation and regulatory requirements. The Guideline for carbon footprint reduction at TRL9 combined deliverables to construct an environmental impact of the produced binder system at TRL5. The TRL 9 binder system was compared with the environmental impact of current state-of-the-art resins. Based on these findings the guideline included action points to follow in the further development of the biobased resin. The action points mainly aimed at reducing the risk of increasing the carbon footprint and the human health impact of the new binder system when upscaling from TRL5 to TRL9.

Specific Objective 6: To develop and implement a dissemination, exploitation and communication (DEC) strategy & plan to enhance innovation capacity and integrate new knowledge of both the partners involved in the resins and wood-based board sector as a whole.
The final period was marked by numerous dissemination activities, scientific publications, final research results and materials, expert events and conferences.
Highlights of this period include producing 15 open access scientific publications and the online SUSBIND Final Conference with live panel discussion. An important Period 3 achievement was presenting the IKEA prototype (SUSKET) at 12th International Conference on Wood Adhesives conference in Portland, Oregon. Public scientific and industrial results were shared and communicated in dedicated campaigns to accompany the final events across SUSBIND media channels.

Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)

The SUSBIND consortium partners have developed the ‘SUSBIND adhesive’. It consists of biobased fructose and HMF and fossil BHT. Within the project, environmental and market analyses were conducted in order to verify the potential human health benefits, to compare the carbon footprint of the new adhesive and to provide advice on carbon footprint reduction options, and to assess its potential for large-scale introduction from a techno- economic and market point of view.

Key conclusions:
• The human health impact of the SUSBIND adhesive is lower than that of Urea-formaldehyde (UF) adhesives.
• The Life cycle assessment (LCAs) show that SUSBIND adhesive is expected to have a higher carbon footprint than UF adhesive over its entire life cycle driven primarily by the fossil crosslinker in the adhesive, BHT. BHT contributes between 43% and 65% of the total carbon footprint of SUSBIND adhesive systems. Nevertheless, it is possible that a combination of options would enable the SUSBIND adhesive to achieve its goal of a 5% carbon footprint reduction compared to UF resin.
• The market uptake analysis highlighted that the SUSBIND adhesive is technologically promising, that sufficient biomass resources are available and that more stringent formaldehyde emissions norms could support the SUSBIND adhesive.

SUSBIND collage

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