

WP 1-IR: Bio-butanol as a raw material for the synthesis of bio butylated amino resins, the leader of the content assemblage Miha Kavšek (Melamin d.d. Kočevje),

WP 2-IR, WP 2-ER: Optimization of the pilot line for bio formalin with a higher concentration of HCHO the leader of the content unit Boštjan Hribar (Melamin d. D. Kočevje),

WP 3-IR, WP 3-ER: Optimization of the synthesis conditions of bio-butylated amino resin, the leader of the content unit Tatjana Strnad (Melamin d. D. Kočevje),

WP 4-IR: Recycling of azeotropic mixtures formed in the synthesis of bio-butylated amino resins, doc. dr. Miloš Bogataj (FKKT UM),

WP 5-ER: Applicative testing of the new product of bio-butylated amino resins at end users / purchasers, dr. Simona Lavrič (Melamine d. Kočevje).



Melamin kemična tovarna d.d. Kočevje

(co-ordinator)

Fakulteta za kemijo in kemijsko tehnologijo univerza v Mariboru

(partner)

Other specific project objectives:

- modified and optimized synthesis of bio-butylated amino resins,
- the process of producing bio formalin of higher concentrations to anhydrous bio formaldehyde (bio para formaldehyde),
- technologically / economically rational recycling of by-products (azeotropic mixtures).

The use of renewable bio-raw materials (in the case of the **BAmBi** project, which is wood biomass from which bio-formaldehyde and bio-butanol are obtained) will help to **better utilize indigenous, available raw materials** (wood biomass) that **replace fossil raw materials in many products with high added value**. This will make a substantial contribution to **reducing greenhouse gas emissions**, a prerequisite for the transition to a **low carbon society** and **bio-economy** as a strategic objective of the EU.

The BAmBi project contributes to the achievement of the horizontal objectives of the OP, which address the common strategic goals of the EU for smart, sustainable growth and achieving economic, social and territorial cohesion, in particular from the following perspectives:

environmental sustainability, addressing societal challenges, increasing the material and energy efficiency of companies, applying the principles of the circular economy, and balanced regional development.

Project Coordinator - Melamine d.d. Kočevje pays great attention to renewables of raw materials and energy. For the needs of the production process, in 2014-2016 he built a **wood biomass boiler room**, and in 2018 he will upgrade the boiler with a **turbine for electricity production** (co-generation).

S4 Priority Area: **Circular Economy Transition Networks**

Priority area S4: **Biomass and alternative raw materials**

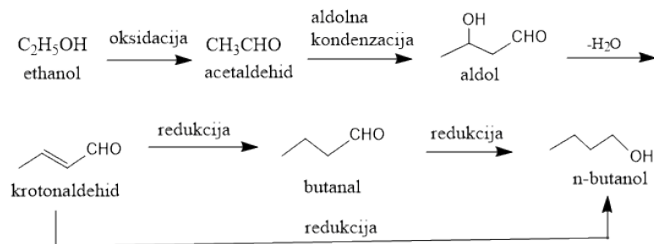
Strategy S4:

- A region with state-of-the-art production and innovation conditions aimed at the development of medium and high-tech solutions in niche fields, in **where the melamine / ammonia chemistry belongs.**

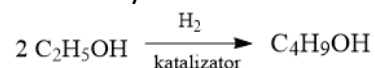
Strategy S4:

- Slovenia as a green, active, healthy and digital region
- Addressing the major future social challenges, such as climate change, energy resource scarcity, health and aging

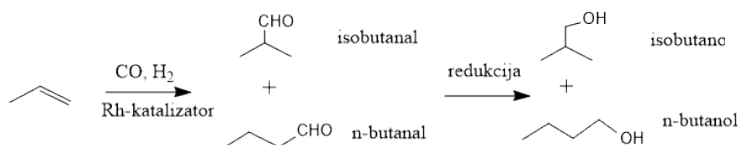
Aldol synthesis of n-butanola:



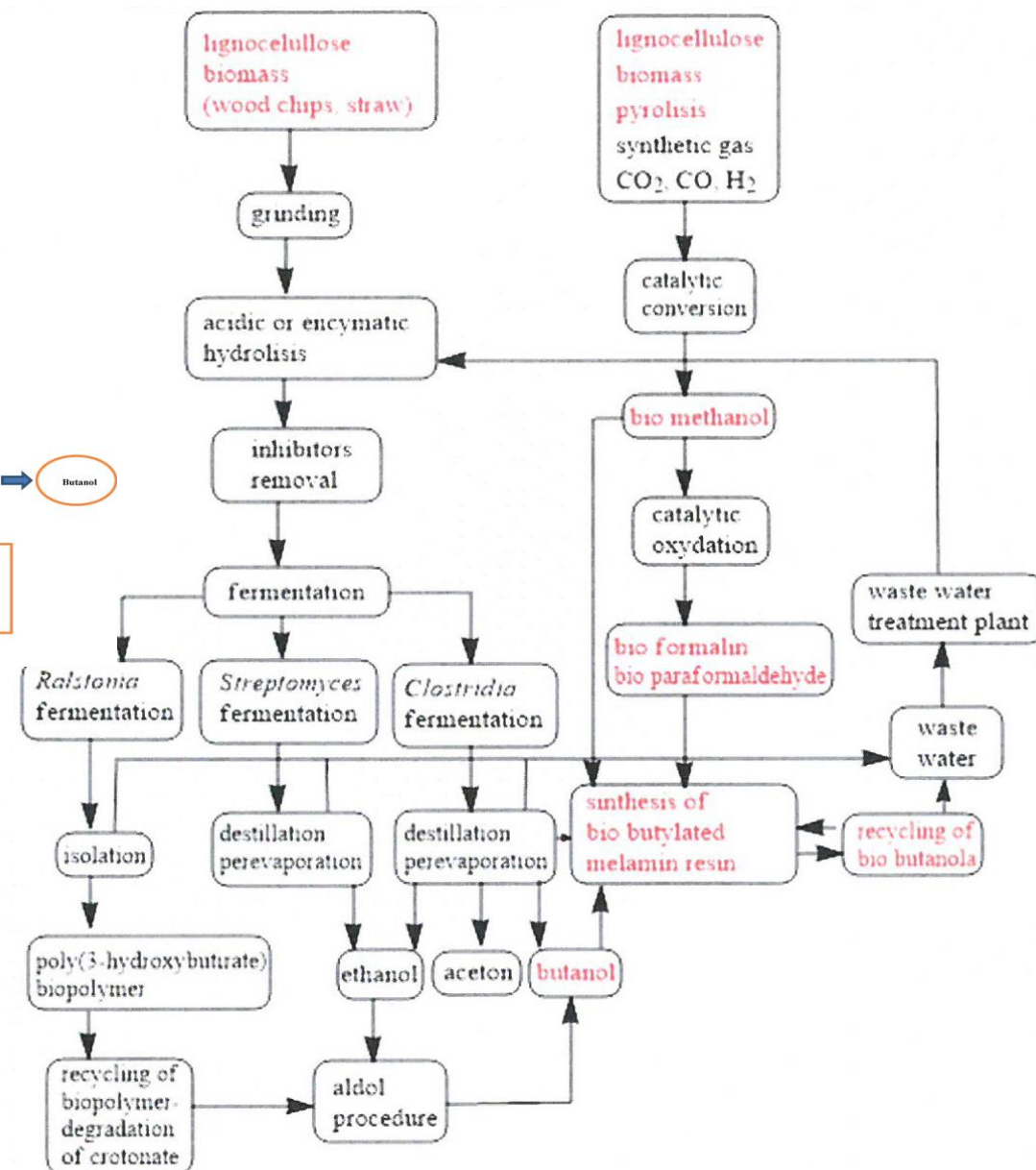
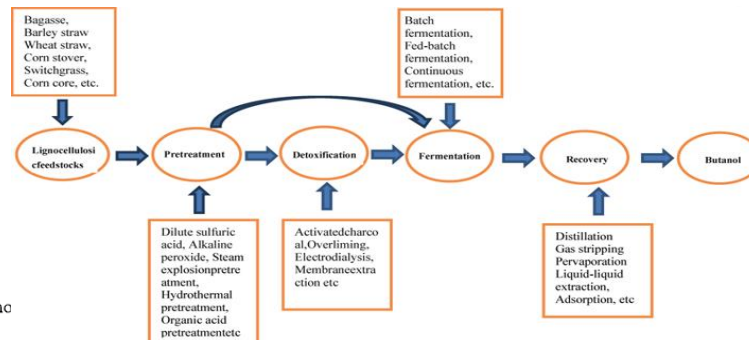
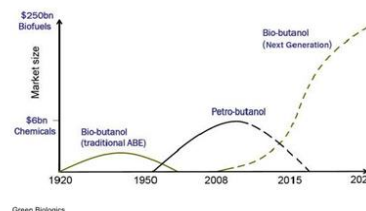
Gruber synthesis of n-butanola:



Carbonylation synthesis of n-butanola:



Bio-Butanol Projecting the 3rd Wave

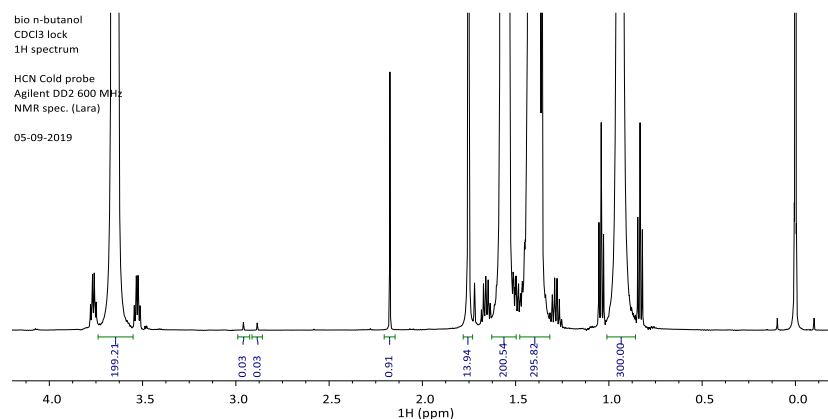


WP 1-IR: Bio-butanol as a raw material for the synthesis of butylated amino resins (industrial research). The activity will take place from 01.10.2018 until 01.09.2019 (11 months). We will quantitatively evaluate the global production of bio n-butanol and assess its potential as a raw material. The existing processes for the production of n-bio butanol will also be evaluated, with a special emphasis on the conversion of bio ethanol (from wood biomass) into n-bio butanol according to the aldol process, where there is also the possibility of preparing a number of commercially interesting compounds. These are acetaldehyde as a potential substitute for formaldehyde in new types of resins and bioaldol, which could be converted into bio poly (3-hydroxybutyrate), which is a known polymer and represents one of the options for action against contamination with non-degradable plastics products. A commercial sample of bio n-butanol will be qualitatively evaluated by the 14C isotope analysis (subcontractor). The goal of the evaluation will be to determine the actual content of raw materials of biological origin, and the presence of normally present components that might interfere with the synthesis, e.g. acetone and ethanol.



^1H and ^{13}C NMR spectra show that acetone is present in the examined sample of bio n-butanol. The acetone content of the sample is approximately 0.15% by weight. The percentage by weight of the other compounds is substantially lower than 0.1%.

Ethanol signals were not observed in the spectra.



^1H NMR spektra vzorca bio n-butanola CDCl_3 pri 25 °C

A sample of bio n-butanol (250 L) was purchased from **Green Biologics** with subsidiary **Caldix Benelux** (for Slovenia). Green Biologics has manufacturing facilities in Minnesota, USA, where bio-n-butanol is obtained by fermenting biomass from industrial crop wastes (eg corn, cereals).

Analysis of the **bio-renewable content**:

According to the procedure LSC-DN-13 (ver.2), the sample can be prepared in two ways:

- direct method
- CO2 absorption method.

We used the standard addition method using Quantulus 1220, Wallac Oy system.

A scintillation cocktail was used, namely ProSafe LT + and GoldStar scintillators.

Preliminary measurements of the samples brought here test Komelol bio and n-butanol bio show that:

It is possible to measure the content of the biocomponent directly as no problems were detected with the scintillation cocktail / sample mixture.

Preliminary results show that the bio sample of n-butanol is made from a fully renewable carbon source.

Moreover, its content is slightly higher than expected, suggesting the production of biomass that is still growing, which still contains activity released into the environment through above-ground experiments in the 1950s and 1960s.

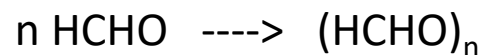
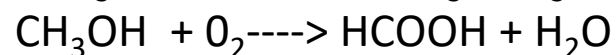
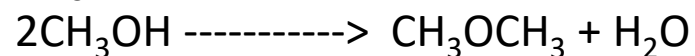
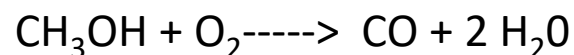
CO2 absorption must be performed for the final results.



WP 2-IR, WP 2-ER: Optimization of the pilot line for bio formalin with a higher HCHO concentration (Industrial research and experimental development). The activity will be from 01.10.2018-01.03.2020 (17 months). The research will focus on the optimization of the technological parameters for the synthesis of bio formalin on a pilot unit ($\geq 25\%$ conc. HCHO in water, the pilot plant is owned by Melamin dd Kočevje) and modeling the concentration of formalin aqueous solutions to para formaldehyde in a laboratory scale and identifying a pilot model.



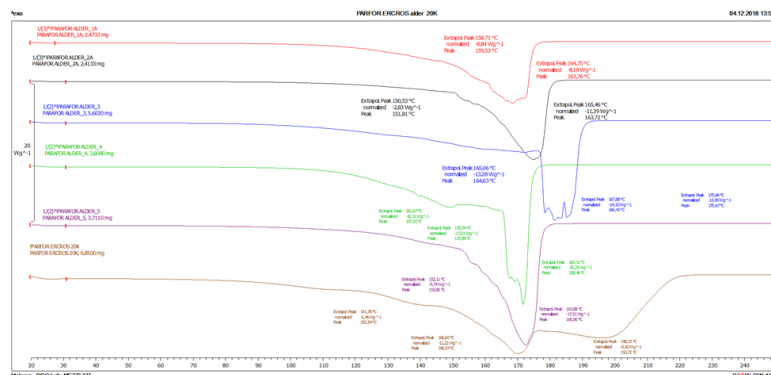
Side reactions:



Analysis of polymerisation mixture:

-HPLC using HFIP

-DSC



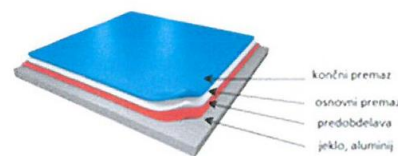
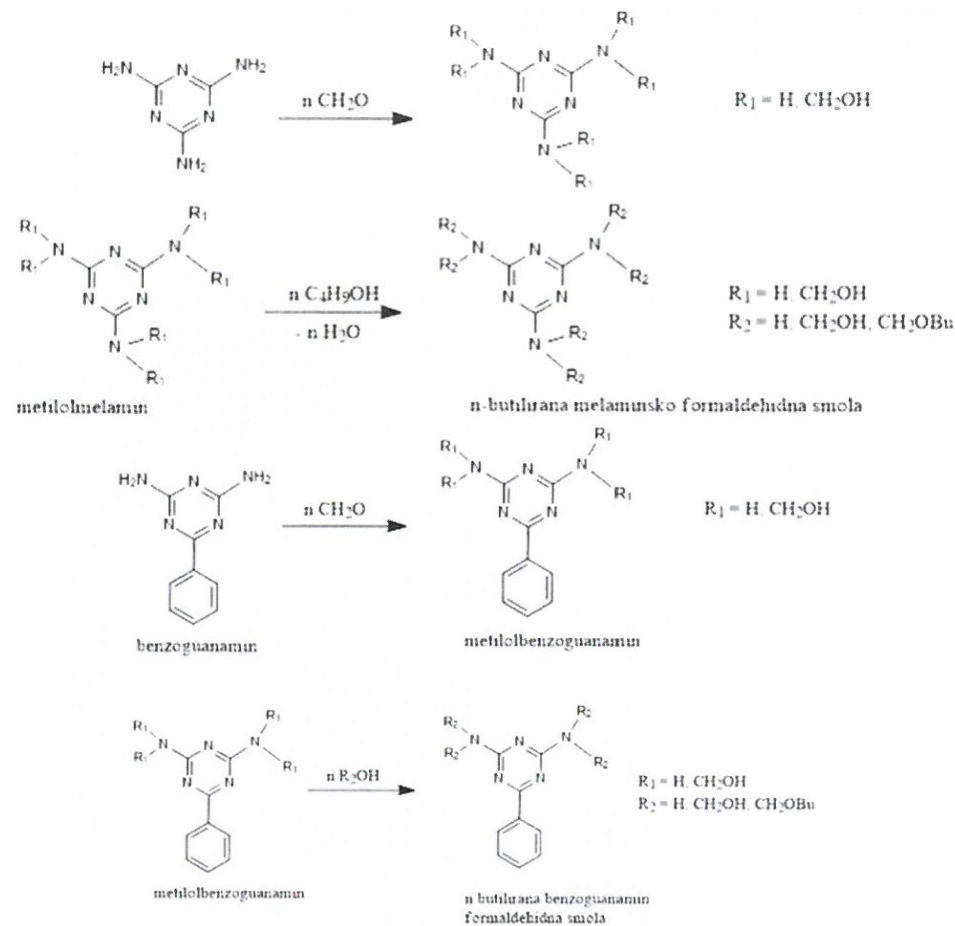
WP 3-IR, WP 3-ER: Optimization of the synthesis conditions of bio-butylated amino resins (industrial research and experimental development). The activity will take place from 01.10.2018-31.12.2021 (39 months) and will be related to the optimization of the synthesis conditions of bio-butylated amino resins at the laboratory level with an emphasis on bio-amino resins for the coating industry using prepared bio formalin and commercially available n-bio butanol. The resulting amino resins will be characterized by ¹H NMR, LC-MS, FTIR, DMT, ¹⁴C isotope analysis, electron microscopy, porosimetry (partially with external subcutaneous).

The main objective of the project is the development of a new product with higher added value, the so called bio-butylated amino polymer for the coating industry on a laboratory scale (**5 types of prototypes of 1 kg +**), which are the equivalent of existing products:

- **Komelol NB-70 / C** (n-butylated melamine formaldehyde resin)
- **Komelol MB-92** (n-butylated melamine formaldehyde resin)
- **Komelol ME 633** (methylated / n-butylated melamine formaldehyde resin)
- **Komolol BG-01** (n-butylated benzoguanamine formaldehyde resin)
- **Komelol BG-05** (n-butylated benzoguanamine formaldehyde resin)

WP 4-IR: Recycling of azeotropic mixtures formed in the synthesis of bio butylated amino resins (industrial research). The activity will take place from 01.10.2018-31.12.2021 (39 months). The research activities will be focused theoreticall and experimental distillation separation of azeotropic n-butanol / water / formalin. The acquired knowledge will enable the installation of a pilot line (pilot design) for the separation / regeneration of industrial waste and the return of regenerated n-bio butanol back to production, which will potentially contribute to reducing the amount of liquid waste for incineration, returning raw materials to synthesis and reducing emissions.

WP 5-ER: Applicative testing of the new product of bio-butylated amino resin in end users / customers (experimental development). The activity will take place from 02.03.2020-31.12.2021 (22 months).



Display the coating structure for sheet metal



Examples of using coated sheet metal

