Black Liquor to Fuel by Efficient HydroThermal Application integrated to Pulp Mill

Berichterstattung

Projektinformationen

BL2F

ID Finanzhilfevereinbarung: 884111

Projektwebsite

DOI
10.3030/884111

Projekt abgeschlossen

EK-Unterschriftsdatum
25 März 2020

Startdatum
1 April 2020

Enddatum
31 März 2024

Finanziert unter
SOCIETAL CHALLENGES - Secure, clean and efficient energy

Gesamtkosten
€ 4 999 623,75

EU-Beitrag
€ 4 999 623,75

Koordiniert durch
TAMPEREEN KORKEAKOULUSAATIO SR
Finland

Periodic Reporting for period 2 - BL2F (Black Liquor to Fuel by Efficient HydroThermal Application integrated to Pulp Mill)

Berichtszeitraum: 2022-04-01 bis 2024-03-31

Zusammenfassung vom Kontext und den Gesamtzielen des Projekts

BL2F (Black Liquor to Fuel) project developed continuous and commercially viable HydroThermal Liquefaction (HTL) conversion technology to produce sustainable drop-in biofuel for aviation and marine transport. Biofuels help to reduce the carbon footprint of heavy transport. The specific targets were to (i) decarbonize the aviation and marine industry and to reduce its carbon footprint by at least 80% and (ii) utilize the abundantly available but rather underutilized, non-food, side stream of the pulp industry – Black Liquor (BL) that is abundantly available on a point source. HTL converted BL into high quality biocrude (O2 content less than 10 m-%) or fuel intermediate at high temperature and pressure using supercritical water as a solvent and/or catalyst. BL, however, contains inorganic salts acquired from the cooking process in the kraft pulping and therefore makes it challenging to use this BL directly into HTL. These salts either crystallize or form a brine solution at the supercritical condition (above 374 C and 221 bar) resulting in the plugging of the reactor walls and process tubes. These salts could be removed in the HTL process with more that 90 % better than the targeted level. A novel integrated HTL (IHTL) reactor, which was developed in the BL2F project, simultaneously removes the salts from BL and carries out the HTL reaction to produce different product phases in a novel dual zone reactor. The integration to Pulp Mill was found to be a feasible option, we maintained the economics and operability of the whole process. And according to a detailed process modelling, bio-crude can be produced with less than 1 €/kg price. To obtain that we had to first simplify the process by removing integrated hydrodeoxidation and aqueous phase reforming from the process. The capital investment and the complexity of the process would have been on unfeasible level. The second modification to the concept was extra feed. The utilization of the BL from the Pulp Mill's chemical recovery will reduce the amount of green electricity produced at the recovery boiler of Pulp Mill. Modern Pulp Mills have surplus bark, adding 20 % of it to the feed of HTL would remain a good energy balance at the Mill.

Arbeit, die ab Beginn des Projekts bis zum Ende des durch den Bericht erfassten Berichtszeitraums geleistet wurde, und die wichtigsten bis dahin erzielten Ergebnisse

Project developed reactor to IHTL, the combined HTL and Salt separation in the same reactor. Oxygen level of HTL oil below 10 % was achieved, and the salt separation was more than 90 %. The salt separation was verified and optimized. The process design and integration was developed. By utilizing 30 % of BL at the Pulp Mill and adding 20 % of bark to the feedstock a minimum selling price of HTL oil less than 1 €/kg was found based on the analyzed. The exploitation and applications were studied and found feasible. The major results are explored below WP by WP:
WP1, led by Tampere University, focused on developing the IHTL technology at the pilot plant and batch tests at KIT. In Task 1.1 Different BLs were characterized. The pilot plant was able to be operated, but the obtained sample sizes were limited. Downstream processes were able to be tested with real feedstock, but most of the development was made with model feeds. Batch tests were made in 1.2 for chemical research of the HTL of BL at KIT. Extra tests with lower pH feed were made to enhance the phase separation. In task 1.3 the novel design of the IHTL reactor (Dual zone) was made

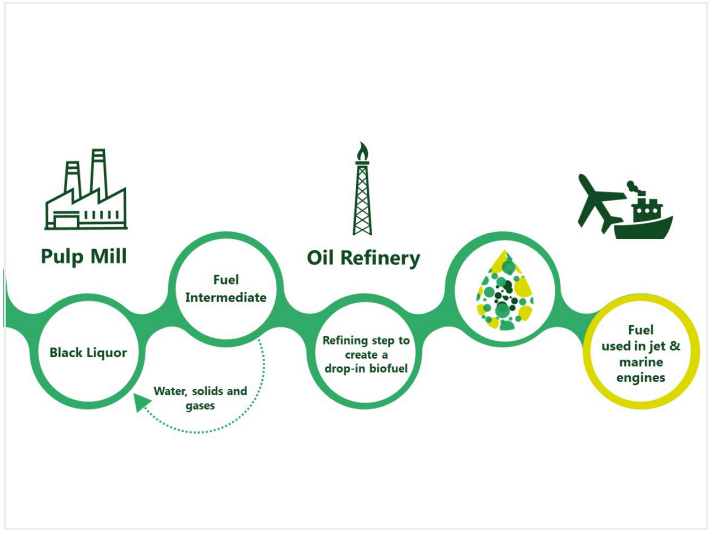
and successfully piloted without blocking and corrosion issues, the salt separation reached the targeted > 90 % level. The IHTL reactor design was based on advanced CFD calculations. An optical online measurement was tested at T1.4 and was found to have potential for further research. Task 1.5 found that X10 is a feasible alloy for the BL HTL.
WP2 focused on the behaviour of different salts in HTL environment. The phase equilibria data were obtained from HP-DSC instrument over a wide temperature range of interest (300 - 400 °C). The results indicate that carbonates were found to be more favourable for salt separation. An idea for enhancing the process was made. In addition to the salt separation, some biocrude was found in the brine. Another phase separation might be needed. In Task 2.3 APR, process design and catalyst were designed and tested. A modelling study of the Gas treatment at Pulp Mill was conducted successfully in T2.4.
For the IHDO development in WP3 (Catalyst development, HDO testing and application testing), suitable support material and catalyst were found. In the application testing, the biocrude was found to have potential, but still some further research is needed.
WP4 studied the process design and feasibility of IHTL plant, upgrading of bio-oil, and the integration of the IHTL plant into the pulp mill. A detailed process design was made and analysed for cost and performance. The original design was found too complicated and due to reducing of the CAPEX and OPEX IHDO and APR were left out from the final process design. To remain the energy balance of the Pulp Mill some bark (20 - 25 %) are added to the BL in the feeding of HTL.
WP5 evaluated the environmental and economic sustainability and circularity by developing the Life Cycle Assessment (LCA) and circularity assessment methodology. The findings are presented in academic publications.
WP6 explored the exploitation of the project results. The policy framework for advanced biofuels was investigated. Sweden and Finland were found most favourable for a successful market uptake of the technology.
The Dissemination and Communication work package (WP7) communicated, disseminated, and engaged stakeholders, via social media, website, publications, and attendance to events successfully. A successful awareness campaign was carried out in the social media.

Fortschritte, die über den aktuellen Stand der Technik hinausgehen und voraussichtliche potenzielle Auswirkungen (einschließlich der bis dato erzielten sozioökonomischen Auswirkungen und weiter gefassten gesellschaftlichen Auswirkungen des Projekts)

BL2F enhanced EU’s becoming the world leader in biofuel technology by developing a unique and cost-effective IHTL technology and integrating it to the pulp mill. We have found a feasible way to produce sustainable biofuels. The companies in the consortium covered the complete value chain – from pulp mill to transportation to biofuel production and sales. The technology provides a significant business opportunity. The produced biocrude from the HTL process is superior in quality, contains an oxygen content of 9% reduced from >45 % in the original BL and has a heating value of 37.5 MJ/kg. The BL2F project built a strong base for further development of IHTL process to commercial level and towards other applications. This approach has several benefits, for instance, the existing special

systems for gas and waste handling at a pulp mill can be adjusted to handle the waste streams from HTL. Compared to a standalone green field facility, the integration can result in a cost savings of more than 45% mainly due to lower operational and capital costs.

BL2F Project logo



BL2F develops HTL technology for converting Black liquor to drop-in fuels

Letzte Aktualisierung: 5 Dezember 2024

Permalink: https://cordis.europa.eu/project/id/884111/reporting/de