

- IDEALFUEL -

Lignin as a feedstock for renewable marine fuels

GRANT AGREEMENT No. 883753

HORIZON 2020 PROGRAMME - TOPIC LC-SC3-RES-23-2019

“Development of next generation biofuel and alternative renewable fuel technologies for aviation and shipping”



Milestone Report

MS1 – Lignin Oil Extraction (1 kg-scale)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 883753

Milestone No.	IDEALFUEL MS1	
Related WP	WP2	
Milestone Title	Lignin Oil Extraction (1 kg-scale)	
Milestone Date	31-10-2020	
Written By	Florent Héroguel (BLOOM)	27-10-2020
Checked by	Panos Kouris (Vertoro)	30-10-2020
Approved by	Project Coordinator	30-10-2020
Status	1.0	30-10-2020

Disclaimer/ Acknowledgment



Copyright ©, all rights reserved. This document or any part thereof may not be made public or disclosed, copied or otherwise reproduced or used in any form or by any means, without prior permission in writing from the IDEALFUEL Consortium. Neither the IDEALFUEL Consortium nor any of its members, their officers, employees or agents shall be liable or responsible, in negligence or otherwise, for any loss, damage or expense whatever sustained by any person as a result of the use, in any manner or form, of any knowledge, information or data contained in this document, or due to any inaccuracy, omission or error therein contained.

All Intellectual Property Rights, know-how and information provided by and/or arising from this document, such as designs, documentation, as well as preparatory material in that regard, is and shall remain the exclusive property of the IDEALFUEL Consortium and any of its members or its licensors. Nothing contained in this document shall give, or shall be construed as giving, any right, title, ownership, interest, license or any other right in or to any IP, know-how and information.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 883753. The information and views set out in this publication does not necessarily reflect the official opinion of the European Commission. Neither the European Union institutions and bodies nor any person acting on their behalf, may be held responsible for the use which may be made of the information contained therein.

Publishable summary

The EU H2020 project IDEALFUEL aims to develop an efficient and low-cost chemical pathway to convert lignocellulosic biomass into a Biogenic Heavy Fuel Oil (Bio-HFO) with ultra-low sulphur levels that can be used as drop-in fuel in the existing maritime fleet. The document presents the first milestone within this project, MS01, concerning Lignin Oil Extraction (1 kg-scale).

While technical lignins are cheap and available in large quantities, their characteristics are not suitable for the development of high-performance marine fuels. Among others, these lignins suffer from low solubilities, large molecular weight, high sulfur content and are generally non-uniform in their chemical nature. One strategy consists in solvent fractionation of technical lignins to extract a high-quality fraction, which can be more suitable for fuels applications. A second strategy consists in the production of high-quality lignin from biomass with alternative bio-refining process. Within IDEALFUEL, the partners selected solvolysis and Aldehyde-Assisted Fractionation (AAF) as the most relevant technologies for the production of high-performance lignin for fuels applications.

The AAF biomass pretreatment technology has been recently developed at the Laboratory of Sustainable and Catalytic Processing at EPFL (Shuai L. et al., *Science* **2016**, 354, 329-333; Talebi Amiri et al., *Nature Protocols*, **2019**, 14, 921-954). This approach – based on a “stabilizing strategy” that prevents the condensation of the most recalcitrant fraction, lignin – is the first of its kind. This chemical process is regarded as a paradigm shift in the field of biomass upgrading, as it is the first method able to extract a lignin that can be converted to i) aromatic monomers and ii) highly soluble lignin oligomers. These two fractions have been shown to have high-value application in the replacement of petrochemicals.

BLOOM has performed Aldehyde-Assisted Fractionation (AAF) of beechwood at the 10 litres scale to produce stabilized lignin in the 100g-scale. Lignin has been isolated as a solid by precipitation and characterized by HSQC NMR which revealed low degree of condensation (high β -O-4 content). In a second step, AAF lignin depolymerization by hydrogenolysis under pressure at the 1 litre scale has been performed to produce lignin oligomers and monomers. Lignin oligomers have been isolated by precipitation and will be characterized in detail within the project. This report shows that milestone MS1 has been achieved and that lignin as a powder has been sent to the relevant project partners.

1 Milestone Achievement

1.1 Title of Milestone

This document reports the achievement of IDEALFUEL Milestone MS01 concerning Lignin Oil Extraction (1 kg-scale).

1.2 Description of Milestone and means of verification

The milestone consists in the extraction of lignin oil at the 1 kg-scale. Means of verification is the ability of the setup to perform extraction of lignin oil at the 1 kg-scale and the supply of lignin oil to the project partners CSIC and Vertoro.

1.3 Comments on completion

BLOOM has performed Aldehyde-Assisted Fractionation (AAF) of beechwood at the 10 litres scale to produce stabilized lignin. Lignin has been isolated as a solid by precipitation and characterized by HSQC NMR which revealed low degree of condensation (high β -O-4 content). In a second step, BLOOM has performed lignin depolymerization by hydrogenolysis under pressure at the 1 litre scale to produce lignin oligomers and monomers (picture of the reactor below). Lignin oligomers have been sent to partners as a powder: 10 g were sent to CSIC (picture of the powder below) and 200 g were sent to Vertoro. Due to the COVID19 situation in Europe, BLOOM identified already at an early stage that production of 1kg lignin would be difficult to achieve. In order to minimise the impact on the progress and outcome of the project the consortium carefully identified the minimum amounts of lignin that were needed to proceed without delay and that BLOOM could deliver by the end of October 2020 (about 200 g). This report is a brief description that milestone MS1 has been achieved. Furthermore, the team has run preliminary tests on 100L and 250L reactors for AAF of biomass, which were successful. A dissemination video, for the website, has been prepared by the BLOOM team to illustrate the scale at which BLOOM is currently operating. The details regarding production will be compiled in a report and delivered at M8 according to D2.1: Report on the setup of the production line and the optimization of the process for the production of oligomers.



1.4 Other relevant information

Lead beneficiary	BLOOM
Delivery date in DoA	31-10-2020
Actual deliverable date	30-10-2020
Achieved	Yes
Reference documents	Upcoming deliverable D2.1

2 Risk Register

Risk No.	What is the risk	Probability of risk occurrence ¹	Effect of risk ¹	Solutions to overcome the risk
	<p>COVID-related delays</p> <p>Whole Switzerland was coming out of a full shutdown at the start of the project. With facilities running at 50% of their capacity, BLOOM has successfully done everything to maintain the indicated deadline. However, the recent case surge on October 22nd may trigger renewed measures that limit the activity on large reactors, where several co-workers are involved and proximity can not be avoided.</p>	1	1	BLOOM takes all the measures to ensure that co-workers are safe, in their professional and private lives. Furthermore, all measures are in place in the working environment to ensure a minimal risk of contamination. Finally, all activities that do not require laboratory equipment are preformed from home-

¹) Probability risk will occur: 1 = high, 2 = medium, 3 = Low



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 883753