



BioMates

Bio-oil, validating AFP

Version 02



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Summary

In the second task in WP 3, 3.2, the modified ablative fast pyrolysis (AFP) pilot plant (TRL5) at RISE has been used to produce bio oil fractions for further use in the mild hydrotreatment to produce BioMates. Until September the modified plant has been used to produce bio-oil fractions from both straw and Miscanthus, in total about 1 045 kg of bio-oil, separated in two to three oil fractions, has been produced. Thereby the deliverable 3.2 has been fulfilled. The production of oil was separated in time and the final volume of bio oil was produced in September (M48) to avoid storage under the hot summer months as well as to abide the TRL5 upgrading at CETH which was delayed due to COVID-19.



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1. Introducing BioMates

1.1. The BioMates Project

The BioMates project aspires in combining innovative 2nd generation biomass conversion technologies for the cost-effective production of *bio*-based intermediates (BioMates) that can be further upgraded in existing oil refineries as renewable and reliable co-feedstocks. The resulting approach will allow minimisation of fossil energy requirements and therefore operating expense, minimization of capital expense as it will partially rely on underlying refinery conversion capacity, and increased bio-content of final transportation fuels.

The BioMates approach encompasses innovative non-food/non-feed biomass conversion technologies, including **ablative fast pyrolysis (AFP)** and single-stage **mild catalytic hydroprocessing (mild-HDT)** as main processes. Fast pyrolysis in-line-catalysis and fine-tuning of BioMates-properties are additional innovative steps that improve the conversion efficiency and cost of BioMates technology, as well as its quality, reliability and competitiveness. Incorporating **electrochemical H₂-compression** and the state-of-the-art **renewable H₂-production** technology as well as **optimal energy integration** completes the sustainable technical approach leading to improved sustainability and decreased fossil energy dependency. The overall BioMates-Concept is illustrated in Figure 1.

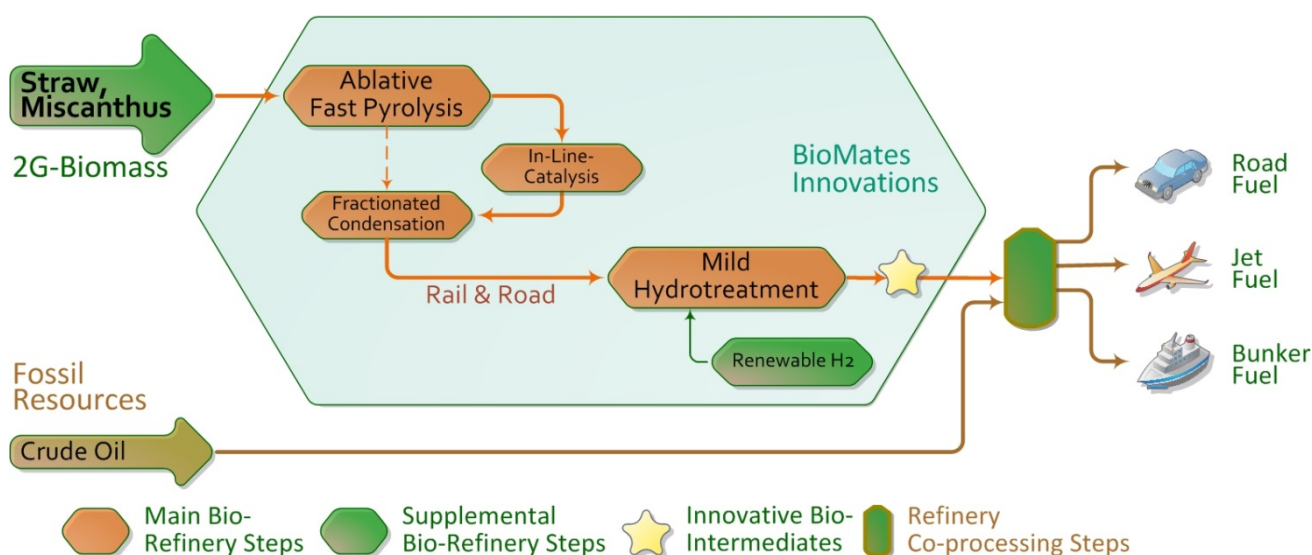


Figure 1: The BioMates-concept

The proposed technology aims to effectively convert residues and non-food/feed plants or commonly referred to as 2nd Generation (straw and short rotating coppice like miscanthus) biomass into high-quality bio-based intermediates (BioMates), of compatible characteristics with conventional refinery conversion units, allowing their direct and risk-free integration to any refinery towards the production of hybrid fuels.

1.2. European Commission support

The current framework strategy for a Resilient Energy European Union demands energy security and solidarity, a decarbonized economy and a fully-integrated and competitive pan-European energy market, intending to meet the ambitious 2020 and 2030 energy and climate targets /EC-2014a, EC-2014b/. Towards this goal, the European Commission is supporting the BioMates project for validating the proposed innovative technological pathway, in line with the objectives of the LCE-08-2016-2017 call /EC-2015/. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 727463.



1.3. The BioMates team

The BioMates team comprises nine partners from industry, academia and research centres:

- Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT, Germany (Project Coordination) - www.umsicht.fraunhofer.de
- Centre for Research & Technology Hellas / CERTH - Chemical Process & Energy Resources Institute / CPERI, Greece - <http://www.cperi.certh.gr/>
- University of Chemistry and Technology Prague UCTP, Czech Republic - <http://www.vscht.cz>
- Imperial College London ICL, United Kingdom - www.imperial.ac.uk
- Institut für Energie und Umweltforschung Heidelberg GmbH / ifeu, Germany - www.ifeu.de
- HyET Hydrogen B.V. / HyET, Netherlands - www.hyet.nl
- RANIDO, s.r.o., Czech Republic - <http://www.ranido.cz/>
- BP Europa SE, Germany - www.bp.com/en/bp-europa-se.html
- RISE Research Institutes of Sweden - www.ri.se

For additional information and contact details, please visit www.biomates.eu.

2. Preface

The BioMates project aims to combine innovative 2nd generation biomass conversion technologies for cost-effective production of bio-based intermediates (BioMates) that can be further upgraded in existing oil refineries as renewable and reliable co-feedstocks. The BioMates approach covers innovative biomass conversion technology, including ablative fast pyrolysis (AFP) and single-stage mild catalytic hydroprocessing (mild-HDT) as main processes. In earlier work packages the technology was proven at TRL 4. For examples in WP1, Fraunhofer used an ablative pyrolysis plant of the rotating-disc-type at TRL4 to produce bio-oil from straw and Miscanthus. It was found that fractional condensation using different condensation temperatures was successful in producing single phase oil fractions, which improved the collection of organic compounds.

In WP3 the objective is to validate the BioMates production in TRL 5 scale and produce sufficient amounts of intermediates that should be used in a downsize petroleum refinery system. In the first task in WP 3, Task 3.1, the AFP plant at RISE should be modified to enable production of the amount of bio-oil requested and be adapted to produce bio-oil fractions suitable for further mild hydrotreatment to BioMates. In the second task, Task 3.2, in total 1000 kg of bio oil from Miscanthus and straw should be produced in the modified AFP plant and thereby validating the technology at continuous operation in TRL 5.

3. Approach

After the modification made in task 3.1 the TRL5 AFP-plant at RISE the production of bio oil fractions should be used to produce the requested amounts of bio-oil fractions from straw and Miscanthus and thereby validate the AFP plant at continuous operation.

4. Production of bio-oil in the AFP pilot plant

After the modifications made in task 3.1, it was possible to perform stable production of bio oil, from both the feedstocks straw and Miscanthus. The bio-oil has been fractionated in two to three oil fractions based on condensation temperature and aerosol content. In order to separate out most of the water a set up using two

condensers and one aerosol collection device was used. In the first condenser a temperature of 40 °C were used to condense a homogenous oily fraction, then an aerosol collection device was used to collect the aerosols in another homogenous oily fraction and then the rest of the pyrolysis vapours were collected at approximate 10 °C and the results was a liquid fraction containing most of the water. The total liquid yield is approximate 44 wt%, where the first condensed fraction correlates to 27 wt%, the aerosol fraction 11 wt% and the second condensed fraction corresponds to 6 wt%.

According to the project plan, the bio oil validation and production of oil should be done by M43, i.e. April 2020. To avoid storage under the hot summer months as well as to abide the TRL5 upgrading at CERTH which was delayed due to COVID-19 the delivery date was postpone to September (M48). Until September in total 1,045 kg of bio-oil has been produced in the AFP plant.

5. COVID-19

Even though RISE's site was operational as Sweden did not undertake specific COVID mitigation measures, the TRL5 bio-oil production was put on hold as the two integrated parties UCTP and CERTH have not operable experimental facilities since 15.03.2020, limiting the bio-oil TRL5 validation. More specifically, bio-oil qualitative validation and compatibility assessment with the TRL3 bio-oil could not be supported by UCTP since 15.03.2020 that the university experimental sites were closed respecting COVID-19 mitigation measures. Moreover, the alignment of bio-oil production with the downstream validation via TRL5 mild-hydrotreatment at CERTH was not feasible post CERTH's site closure on 15.03.2020 due to COVID-19 measures. As bio-oil is an unstable intermediate product that has to be handled and upgraded downstream within a limited timeframe, the uncertainty of COVID-19 imposed the temporary interruption of the TRL5 AFP bio-oil production at RISE.

6. Disclaimer

This Deliverable report reflects only the authors' view; the European Commission and its responsible executive agency INEA are not responsible for any use that may be made of the information it contains.

7. Literature

- EC-2014a European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - A policy framework for climate and energy in the period from 2020 to 2030, COM(2014) 15 final, Brussels, 22.01.2014, http://www.europarl.europa.eu/meetdocs/2009_2014/documents/nest/dv/depa_20140212_06/depa_20140212_06en.pdf; <http://bit.ly/1LUcJKL>
- EC-2014b European Commission, Energy Union Package - Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions and the European Investment Bank - A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy, COM(2015) 80 final, Brussels, 22.01.2014, http://eur-lex.europa.eu/resource.html?uri=cellar:1bd46c90-bdd4-11e4-bbe1-01aa75ed71a1.0001.03/DOC_1&format=PDF, <http://bit.ly/198SAUf>
- EC-2015 European Commission, LCE-08-2016-2017 "Development of next generation biofuel technologies", Publication date: 14 October 2015, <https://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/lce-08-2016-2017.html>, <http://bit.ly/2ndtvPc>