



Faces in 25 years of PyNe



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Preface

The current triennium 2019 – 2021 is almost finished. There are five more months to go before this interesting and exciting time comes to an end. However, we are already busy to prepare the continuation. The proposal for 2022-2024 is developing to continue our successful work in the next triennium. Even though we all miss the face-to-face meetings, laboratory and conference visits very much, we managed to work together creatively and successfully also by virtual events. We have already achieved a lot this year.

The website update is in good progress; very recently an archive with all publications originating from the Round Robins initiated by our Task is nearing completion. We could finish several work packages and reports. For example, an important report [about polar and non-polar components in Fast Pyrolysis Bio-Oil in relation to REACH registration](#) has emerged and Task 34 was involved in a report on marine biofuels together with Task 39, which will be published soon.

Of course, successful continuation of our work also includes publication of this PyNe 48. It includes a report on the EUBCE, which this year also was held in an excellently organized, virtual environment.

You will find interesting information about the EU project “Liquor to Fuel”, which develops a first of a kind integrated HTL process for pulp mills in order to produce a fuel intermediate for further upgrading in oil refineries. The National Research Council Canada contributes an article on the nature of bio-asphaltenes in biocrude from hydrothermal liquefaction for a better understanding of some of the most deleterious components of heavy crudes.

BTG company has sent an exciting article about the recovery of sustainable cycloalkanes from fast pyrolysis oil. Cycloalkanes may have

the same functional properties as the aromatics, but they have a higher specific energy and likely their combustion results in lower particulate emissions. Jet fuels like JP9 and JP10 are speciality fuels for very demanding applications, and, for example, JP-9 contains methyl-cyclohexane to achieve the required specifications.

The pictures chosen on the front page of this PyNe issue are already a foretaste of a very special and also the last PyNe (PyNe 50) in this triennium - a surprise for our valued readers and previous Task 34 members. Of course, there will be a regular PyNe 49 before, but PyNe 50 is our special double anniversary issue. Stay tuned.

Last but not least, I have the honor to welcome Pramod Kumar to Task 34 as National Task Leader of India. We are very much looking forward to work with him in our group and to have India with its manifold activities around bioenergy on board Task 34.

For more news please visit our website <https://task34.ieabioenergy.com/>.

Yours sincerely

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Sustainable cyclo-alkanes from fast pyrolysis oil

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Jet fuels consist of n-alkanes, iso-alkanes, cyclo-alkanes and aromatics. From a combustion point of view the aromatics are not desired, but its presence might be required in view of its seal swelling capacity. Cycloalkanes may have the same functional benefits as the aromatics, but they have a higher specific energy and likely their combustion results in lower particle emissions [1].

Jet fuels like JP9 and JP10 are speciality fuels for very demanding applications, and for example JP-9 contains methyl-cyclohexane to achieve the required specifications. Methyl-cyclohexane and sometimes ethyl-cyclohexane are included as a model component in jet fuel surrogate blends used in research activities. Therefore, cyclo-alkanes produced from renewable resources might be an interesting additive to jet-fuel to improve its sustainability.

Hydrotreatment of fast pyrolysis bio-oil (FPBO) can be a promising approach to obtain sustainable cyclo-alkanes from renewable resources. FPBO can be produced from a variety of biomasses and residues, and the technology is maturing and nowadays implemented commercially [2]. However, the FPBO as such is not suitable for direct use as transportation fuel; for example, it is acidic,

contains significant amounts of water, and has a relative low heating value compared to fossil fuels. Obviously, severe upgrading will be needed, and typically, a two-step hydro-treatment process is applied to change the functionalities and remove the oxygen. The hydrotreatment process is carried out at elevated pressure and temperature in the presence of a catalyst.

In the Dutch funded project called *Renewell* the upgrading of FPBO is further developed with the objective to produce a drop-in, distillate marine fuel. Compared to aviation fuel the specifications of marine fuel are less strict and initial implementation is expected to be easier.

In the *Renewell* project FPBO is first stabilized over the proprietary Picula™ catalyst at a pressure of 200 bar and temperatures of 100 – 300 °C. The product from this first step is called Stabilized Pyrolysis Oil (SPO). In the second step the SPO is further treated over a conventional, sulphided NiMo catalyst at temperatures up to 450 °C and pressures in the range of 100 – 120 bar. Depending on the severity of treatment the products are called Stabilized Deoxygenated Pyrolysis Oil (SDPO) or Mixed Transportation Fuel (MTF).



Figure 1: Process Development Unit for the pyrolysis oil hydrotreating



Table 1: Flashpoints of the fuel before and after distilling off the lights

Fuel	Flashpoint [°C]		Lights removed [wt %]
	Before	After	
SDPO (wood oil)	< 12	64	14
MTF (wood Oil)	< 12	64	26
MTF (pyrolytic lignin)	< 12	81	52
MTF (Pyrolytic sugar)	< 11	61	35



In most cases wood based FPBO is used as feedstock, but for example also FPBO from miscanthus or specific fractions of FPBO (extractives, lignin or sugars) are tested. For the experimental work four lab-scale hydro-treaters are available as well as a process development unit (PDU). The latter one has a capacity of 20 – 50 kg input per day.

The chemical/physical properties of the fuels produced have been compared to marine distillate fuels. Specifications are met with respect to e.g. heating value, acidity, sulphur content, density and viscosity. Generally, the fuels blend very well with conventional fossil fuels and no phase separation is observed. Research on the combustion properties is ongoing at the University of Eindhoven, and first results are very positive. Currently, the critical property to qualify as a true drop-in marine fuel is the flashpoint. This flashpoint is an

important property for transport, safety, and storage; for marine fuel the minimum value is 55 – 60 °C.

The MTF contains light flammable components resulting in a low flashpoint and values around 10 °C have been measured. The light components should be removed from the MTF in order to increase the flashpoint to an acceptable level. This has been achieved by a simple distillation of the MTF removing the lights and evaluate the effect on the flashpoint (trial & error approach). In Table 1 the results are shown for some samples.

After distilling off the lights the fuel properties comply with the specifications for a marine distillate fuel. The question is then what is the composition of the light fraction and how can this fraction be used.

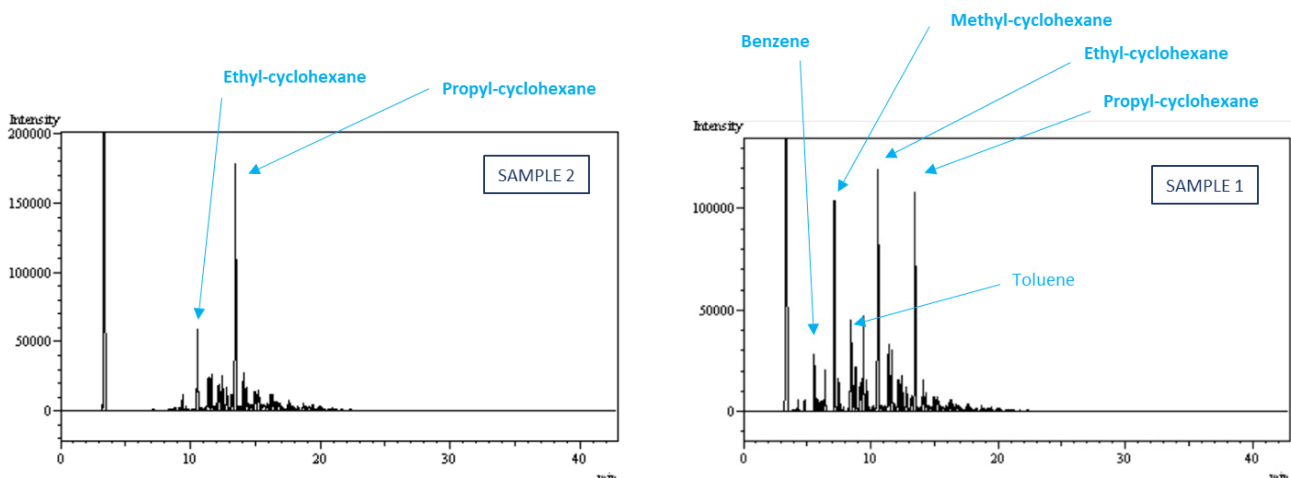


Fig. 2: Light distillates: chromatograms of GC-FID analysis of sample 1 and 2

The light fraction is a transparent liquid which burns very easily, and the flashpoint of this fraction is below zero. To get more insights in the composition of these light distillates a more detailed analysis by GC-FID was performed.

In the example below distillate fractions obtained from wood based MTF were further analysed. The first sample (sample 1) is obtained at a temperature of 85 – 100 °C, the 2nd sample (sample 2) is the fraction obtained by further increasing the temperature to 120 °C. In both cases the pressure was 100 mbar. Subsequently, the samples were dissolved in IPA and analysed by GC-FID.

The analysis of sample 1 is illustrated in the chromatogram in figure 1 at top right; the chromatogram on the bottom right corresponds to sample 2. By comparing previous GC-analysis of other samples and comparing retention times, a prediction could be made of main components present in the distillates.

Mainly methyl-, ethyl- and propyl-cyclohexane's were identified in the distillate obtained at 85 – 100 °C, while propyl-cyclohexane was mainly found in the distillate obtained at 100 – 120 °C. This was confirmed by the University of Groningen who analysed the samples by GC-MS. The cyclo-hexanes found in the distillates have ascending flashpoints with increasing (substituted) alkyl length, starting from -4 °C to 35 °C. Besides the cyclo-alkanes, benzene, toluene and octane were detected in the sample. Absolute amounts of the cyclo-hexanes in the samples were around 15 % Methyl-cyclohexane, 30 % Ethyl-cyclohexane and 35 % Propyl-cyclohexane. However, the current focus is on the production of a drop-in marine fuel, and the process nor the feedstock is optimised to produce

cyclo-hexanes. For example, the percentage of lights seems to be much higher when miscanthus derived FPBO is used instead of wood derived oil meaning that it might be a better source for cyclo-alkanes. Furthermore, the crude mix of cyclo-alkanes produced here could be further separated and purified and used as a sustainable additive to jet fuel.

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Acknowledgement

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Nature of bio-asphaltenes in hydrothermal liquefaction bio-crudes

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While significant efforts are being made for demonstration and testing of hydrothermal liquefaction processes that involve upgrading of bio-crude in standalone bio-refineries or its co-processing with petroleum crudes at specific intersection points in existing refineries[1, 2], the commercialization of these technologies, however, will depend in part on how these technologies fare in continuous long term operations[3].

In this regard, understanding of some of the most deleterious components of heavy crudes is essential. In processing of petroleum, asphaltenes are often associated with significant operational issues during upgrading: precipitation on catalyst surfaces leading to premature catalyst deactivation, fouling of refinery units and heat exchangers, lowering of product yields and thus adversely influence the economics of a process [4, 5].

Co-processing of bio-crudes with traditional petroleum feedstock could also pose incompatibility/ stability issues. As demonstrated in Figure 1, depending on the concentration of HTL bio-crude in blends, regions of incompatibility are observed at lower concentrations of bio-crude (similar issues were observed at 10 % bio-crude blend).

The behavior/issues are analogous to that observed in blending heavy petroleum crudes[6].

This study involved the production of bio-crudes from food waste and wood residues in continuous HTL system (wet feed rate of 5 L h⁻¹, 350 °C, 2800 – 2900 psig) and in batch reactors (350 °C, 2800 – 2900 psig, 30 min.).

Bio-asphaltenes were precipitated from HTL bio-crude (see Figure 2), their structure and behaviour were analyzed using techniques like nuclear magnetic resonance (NMR), fourier-transform infrared spectroscopy (FTIR), thermal gravimetric analysis (TGA), differential scanning calorimetry (DSC), etc.

The structure and behaviour were also compared with asphaltenes precipitated from heavy petroleum crude, Canadian oil sands bitumen. Details of the continuous HTL system, precipitation, and characterization techniques can be found elsewhere [3]. Bio-asphaltenes show a very different structure and behaviour depending on the source of bio-crude, and are significantly different from petroleum asphaltenes (see Table 1), their common characteristic being their precipitation under certain similar

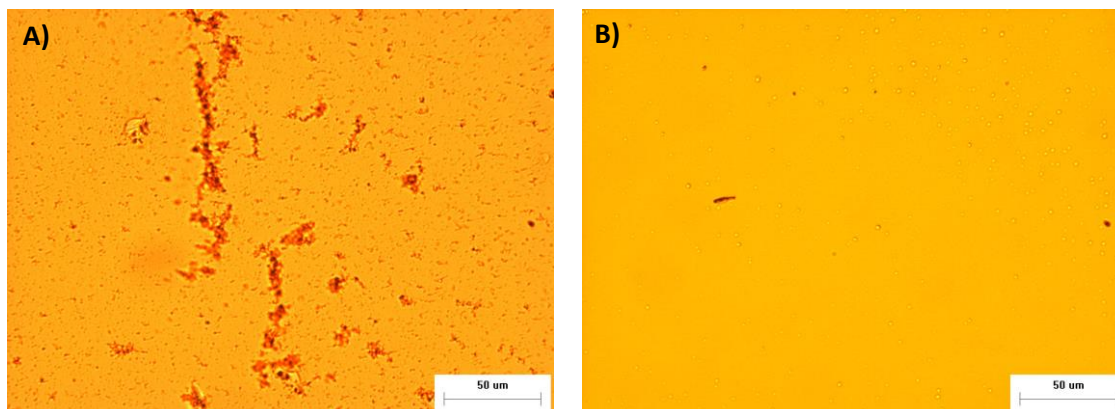


Figure 1: Microscopy images of food waste HTL bio-crude blended in commercial diesel. A) 20 vol% HTL bio-crude in commercial diesel B) 50 vol% HTL bio-crude in commercial diesel.

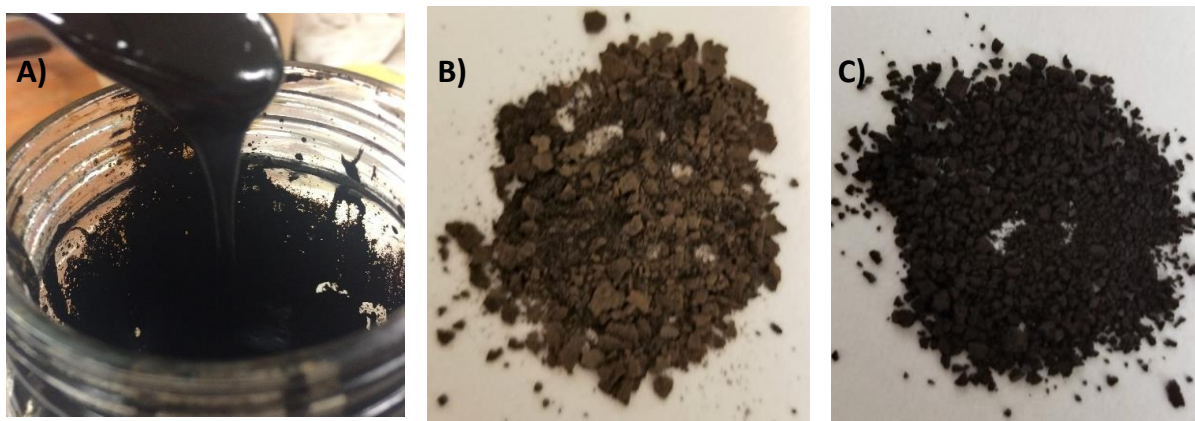


Figure 2: Images of bio-crude/asphaltenes: A) Bio-crude obtained from hydrothermal liquefaction of food waste in continuous HTL system B) Asphaltenes precipitated from food waste bio-crude C) Asphaltenes precipitated from bitumen (adapted from [3]).

conditions. Bio-asphaltene had lesser aromatic rings, lower molecular weight per unit structure, lower carbon residues and glass transition temperatures. These structures and properties indicate bio-asphaltenes may have a lower propensity for coking and catalyst deactivation compared to petroleum asphaltenes. Asphaltenes and bio-asphaltenes in some cases may also represent a loss in liquid product yields, and depending on the feedstock and process could account for a large fraction of the bio-crude[3]. Some of the future work in HTL process and catalyst development should focus on minimizing/conversion of these molecules represented by bio-asphaltenes into liquid biofuels or other valuable products, while also considering the issues or economics

associated with precipitation of bio-asphaltenes at specific intersection points in a refinery or its removal if needed.

ACKNOWLEDGMENTS

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Table 1: Properties of asphaltenes precipitated from heavy petroleum crude (bitumen) and bio-asphaltenes from different HTL bio-crudes: Bitumen-Asph, FoodWaste-BiocrudeC-Asph, FoodWaste-BiocrudeB-Asph, Wood-Biocrude-Asph are asphaltenes/bio-asphaltene samples obtained from bitumen, HTL bio-crude (continuous HTL) with food waste as the starting material, HTL bio-crude (batch HTL) with food waste as the starting material and HTL bio-crude (batch HTL) with wood residue as the starting material, respectively. Ca, Ra, N_{chain}, MW, are number of aromatic carbons, aromatic rings, substitutions, and, molecular weight, respectively, calculated per unit structure using NMR. C_{resid} is the carbon residue calculated using TGA and T_g is the glass transition temperature using DSC (adapted from [3])

	Ca	Ra	N _{chain}	MW range (average)	C _{resid} , wt%	T _g , ° C
Bitumen-Asph	26.2	7.5	7.2	589-636 (611)	39.0	85
Foodwaste-BiocrC-Asph	15.5	3.7	5.6	338-345 (342)	25.1	64.4
FoodWaste-BiocrB-Asph	15.8	3.8	5.7	347-358 (352)	22.8	32.2
Wood-Biocr-Asph	12.8	2.8	4.6	268-274 (271)	18.8	4.4

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A novel approach for converting Black Liquor to advanced biofuel

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The Black Liquor to Fuel (BL2F) EU project was launched in April 2020 to develop a first-of-a-kind Integrated Hydrothermal Liquefaction (IHTL) process at pulp mills in order to produce a fuel intermediate for further upgrading in oil refineries. The process innovations of BL2F are:

- 1) combined salt separation and HTL-reactor**, enabling direct upgrading of HTL-oil,
- 2) reforming of the aqueous phase to hydrogen**, decreasing the need for external fossil hydrogen in IHDO,
- 3) integrating the process to pulp mill**, offering cost reductions in treating of the gaseous and solid side streams by existing process installations.

The BL2F is supported by **CEPI, Avinor**, and **Rolls Royce** and covers the whole value chain: Kraft pulp producer **The Navigator Company** the technology supplier **Valmet**, catalyst developer **Ranido**, refinery company **Neste** with excellent research partners; **VTT, PSI, SINTEF, Tampere University, KIT, Brunel University London**, and consultant **LGI**.

Biofuel demand and feedstock

As part of the transition towards a net-zero-greenhouse gas (GHG) emissions, the European Union (EU) set an objective in 2009 to reduce emissions by 80 – 95 % in 2050. In the EU, transport is the only major sector where GHG emissions are still rising. In addition, decarbonisation of shipping and aviation is the most challenging area due to the projected growth of air transport (100 % more by 2050), the attractive pricing of fossil

fuels, the low energy density of current batteries as barrier for direct electrification, and the long replacement time for aircraft and vessel fleets. The European Commission (EC) expects decarbonisation in shipping and aviation to take off by 2030 [1]. Biofuels have the highest emissions reduction potential of all studied decarbonisation measures for shipping. In addition, sustainable aviation fuels (SAF) are the only significant option to reach near net-zero emissions in aviation. Thus, the EC’s strategy for shipping and aviation is a significant uptake of advanced biofuels in these two transport sectors. Europe’s demand for liquid biofuels to achieve radical decarbonisation for aviation and shipping is expected to be 13 – 15 Mtoe and 21 – 30 Mtoe in 2050, respectively.

The requirement that a fuel needs to be “drop-in” is essential for the aviation industry as drop-in fuels can be handled by existing infrastructure and fleets. For the marine sector, many of the current biofuel options (e.g. HVO) are considered too expensive and as having low sustainability. Moreover, the economic viability of novel production processes (e.g. biomass to liquids by gasification) has not been demonstrated. This is mainly due to high capital costs of the developed conversion processes and immature business environment. In general, current advanced biofuels for transport are 2 – 3 times more expensive than fossil alternatives.

Simply said, we need large quantities of affordable drop-in biofuel in order to meet climate action needs.



12 partners



8 countries



36 months

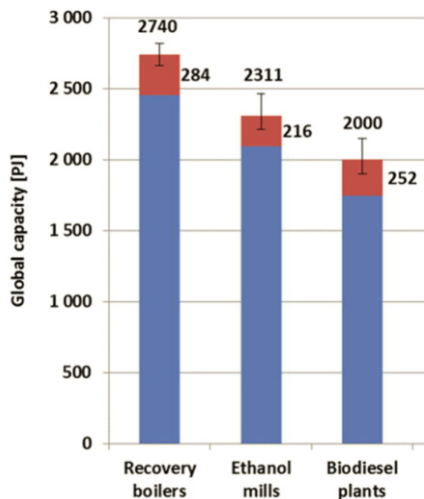


Figure 1: The global capacity of BL recovery boilers is larger than other biomass plants [2]

A very promising, and currently underutilised, abundant non-food feedstock is black liquor (BL), a side stream of chemical pulping industry. Black liquor is an attractive feedstock for biofuel production because it is available in huge amounts: 170 million tons globally.

The energy content of BL is equivalent to 43 Mtoe. This makes BL the fifth most important fuel in the world, next to coal, oil, natural gas, and gasoline [2]. Europe will be able to produce advanced biofuels of around 11 Mtoe and over 40 Mtoe from 30 % of its BL and the current non-forest wood waste & bark, respectively, by 2050.

The amount is equivalent to the more than 50 billion litres of drop-in advanced biofuel for aviation and shipping required to achieve these sectors' deep decarbonisation in Europe. The global capacity of BL recovery boilers is larger than other biomass plants (Figure 1). BL is a lignin-rich, liquid (pumpable) side product that is available on a single spot after the pulp digestion of wood chips [2]. BL organics contain about half the energy of the original wood chips and for each tonne of

Kraft process pulp around 1.5 tons of BL is produced.

The BL2F project

The BL2F (Black Liquor to Fuel) project aims to develop and pilot a first-of-a-kind Integrated HydroThermal Liquefaction (IHTL) process at a pulp mill to produce a fuel intermediate for further upgrading in oil refinery [3]. The process includes a conversion of biomass to low oxygen content HTL-oil at an elevated temperature and pressure (up to 300 bar, 400° C) and in reductive conditions [4]. The HTL-oil is converted to a further upgradable fuel intermediate (containing less than 5 mass percentage by mass of oxygen) by the Hydrothermal Hydrodeoxygenation (HDO) process integrated to IHTL (IHDO) with an expected mass yield over 45 % and energy content of 85 % from BL to fuel intermediate. Relatively hard process conditions enable a short residence time of 5 – 7 min. This keeps the required reactor volume and capital costs low.

The integration of IHTL to pulp mills offers a significant cost reduction. The fuel intermediate will be further upgraded to aviation and marine fuels using existing process units at oil refineries and renewable fuel plants. This intermediate can alternatively be used as marine fuel directly. At pulp mills, the primary invention is to combine the separation of solids from BL during conversion to HTL-oil. Due to the complex chemical composition of HTL-oil, efficient and stable supported metal catalysts are required for IHDO and further upgrading processes. These will be developed in the project. The hydrogen consumed in IHDO is generated by Aqueous Phase Reforming (APR) the aqueous phase of the HTL products.

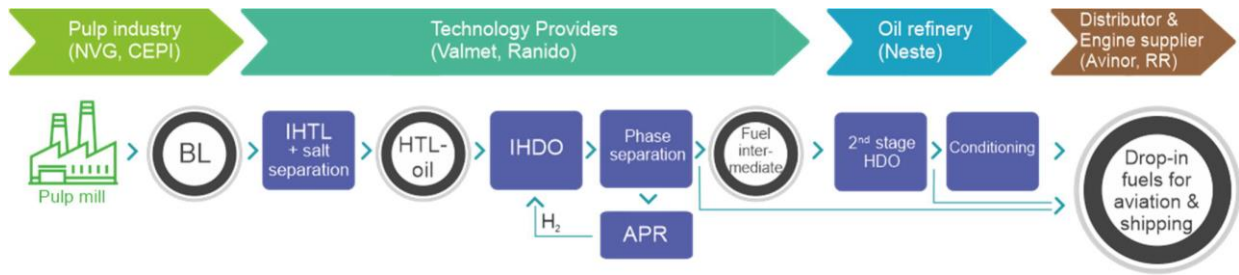


Figure 2: The value chain of the BL2F technology

Our aim is to produce a drop-in advanced biofuel for shipping and aviation at price range of 0.5-0.90 €/l. There are several benefits of integration to Pulp Mill and utilisation of BL. The most significant benefits are as follows: pumpable feedstock; homogenous quality; thermal integration (steam system of recovery boiler); existing evaporator for preheating and concentration; and handling of solids, water and gas, existing operations, and maintenance personnel. We estimate the benefit at a 45 % reduction in the production cost compared to a stand-alone plant. A similar direction of estimates is reported in the existing body of knowledge ^[5,6].

Concept

The existing HydroThermal Liquefaction (HTL) process is the most promising production pathway for the next generation of biofuels, according to a scientific analysis ^[7]. The process is called “integrated” for three reasons

- 1) the process is integrated to a pulp mill,** making, for instance, treatment of gaseous and aqueous residues and energy integration easier.
- 2) Salt separation is integrated to supercritical water liquefaction (SCWL),** and
- 3) The first stage of HDO is integrated to HTL** and conducted at elevated temperature and pressure. Phase separation of oil and aqueous phases is performed after IHDO. The aqueous phase is fed to Aqueous Phase Reforming (APR) - producing H₂ rich gas for the IHDO. This improves the sustainability of the solution, as normally applied fossil hydrogen is substituted. The fuel intermediate is transported to an oil refinery or a renewable

fuel plant for further upgrading by 2nd-stage HDO and subsequent conditioning to jet fuel.

Integration to a modern pulp mill is possible, as they have a net-positive energy balance thus there is excess BL available in the chemical recovery cycle ^[8]. Many times, the Kraft recovery boiler is the limiting step in the production capacity of the pulp mill. In addition, the current trend is for newer pulp mills to not have a paper mill nearby for utilising process steam, and the fact that modern pulp mills are more energy efficient means that it is feasible to use part of BL for purposes other than energy production at the recovery boiler. It is possible to remove a part of the BL before the recovery boiler, without interfering in the chemical recovery cycle. Therefore, a significant fraction (30 %) of BL can be directed for hydrothermal liquefaction (HTL) to produce 11 billion litres of advanced biofuels by 2050 in Europe. At the oil refinery, the bio-oil collected from several pulp mills in the 2nd-stage HDO will complete deoxygenation to the different desired level of aviation and maritime sector and produce sulfur-free refinery intermediates. The intermediates will be evaluated regarding their suitability to be used either for high purity marine fuels or aviation fuel blending components after further upgrading, or for co-feeding to the fossil refinery line to increase the renewable share of existing products. Existing HDO/HDS units of oil refineries will primarily be used, but the upgrading can also be performed at stand-alone renewable fuel plants. Novel catalysts developed in the project will also be used for this step. Furthermore, the need for fractionation to adjust distillation ranges determined by the

fuel specifications and further upgrading (jet fuel) applying oil refinery units (hydroisomerisation, hydro-cracking) will be studied. The final marine and aviation fuel components will be evaluated by performing extensive property testing. Results will be assessed based on related aviation and marine fuel standards and under consideration of the refinery units' inlet specifications.

Techno-economic and sustainability assessment

The techno-economic analysis of the BL2F concept will be assessed in the context of relevant industrial environments. It will consider an engineering approach to evaluate the complete integrated process, equipment designs and costs of the technology fulfilling current European Health-Safety-Environment regulations. A realistic quantification of uncertainties and risks that affect the economic and environmental performance of the technology will be included in the analysis. One main result from the risk analysis will be the identification and specification of plausible mitigating measures for critical risks as well as potential improvements in the design and operation of the technology. A probabilistic evaluation of the economic viability of the technology, including uncertainties, risks, and mitigation, will then be performed in the context of a realistic business case representing a relevant European industrial environment.

The evaluation and development of multi-domain data sharing mechanisms, tools for sustainability assessment, will create the methodologies and technologies to assess the socio-economic and environmental impact of the biofuel technology nexus. The outcome will be scientifically proven metrics shared with the public, industry, and regulators. Check out the #BL2Fpuzzle awareness campaign and follow the project on Twitter ([@BL2F_EU](#)), LinkedIn ([BL2F_EU](#)) and by signing up to the [newsletter](#)!

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Advances in Fast Pyrolysis session of the Industry Track EUBCE 2021

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The European Biomass Conference & Exhibition 2021 (EUBCE2021) was held as an online event from April 26 – April 29, 2021. EUBCE is the largest biomass conference and exhibition in the world. Annually, it brings together the greatest minds and latest advancements in biomass, with the aim of accelerating research and market uptake across the globe.

This year the EUBCE management decided to facilitate the participation of the industry and implement a dedicated 'Industry Track' in EUBCE21 specifically for companies and organizations operating in the deployment area of biomass and the bioeconomy. Speakers were by invitation only and without the need to submit an abstract for evaluation. One of these tracks concerned the topic "Advances in Fast Pyrolysis". Speakers from UOP, Valmet, BTG Bioliquids and Green Fuel Nordic were invited to present their activities and progress in this field.

The first presentation was given by **Joakim Autio**, the R&D program manager of Valmet Technologies. Almost a decade ago Valmet implemented the Fortum 50 MW fast pyrolysis plant in Joensuu (Finland) based on VTT's integrated pyrolysis technology. The presentation concerned recent work & developments in the field of catalytic pyrolysis to produce refinery suitable biocrude from ligno-cellulosic feedstocks. The aim is to produce a bio-oil with a low oxygen content, a low acidity, and low amounts of impurities. It should result in an oil which is easier to upgrade or to co-process in existing oil refineries. For the catalyst development a cooperation has been established with

catalyst manufacturer Johnson Matthey. The catalytic pyrolysis process is tested on pilot scale (20 kg/h) at VTT on 24/5 basis.

The 2nd presentation was given by **Dan Szeezil** -the Product Marketing Manager for Renewable Fuels at Honeywell UOP. Several years ago UOP established a joint venture with Ensyn called Envergent to facilitate the implementation of the Ensyn fast pyrolysis technology (RTP). The presentation concerned the co-processing of biocrudes - including fast pyrolysis oil - in an FCC to produce renewable fuels.

Other biogenic feedstocks considered by UOP are a.o. vegetable & animal fat waste oil, HTL biocrude and catalytic fast pyrolysis oil. For the optimal performance, the oxygenated biogenic feedstock should be fed into the FCC via a separate injection point. UOP developed a dedicated injector called Optimix™GF which was tested on pilot and commercial scale. The big advantage of the co-processing route is that it is a low capex solution. Refiners can use existing refinery assets and infrastructure, and the shift to biogenic feedstocks has a marginal impact on product yields and operation.

Ardy Toussaint -Technical Manager at BTG Bioliquids - gave a presentation on the use of pyrolysis oil to produce process steam. In 2015, a new 28 MW_{th} boiler was implemented at the Dutch dairy company FrieslandCampina. Natural gas and up to 70% of pyrolysis oil can be used as fuel. The boiler delivers 40 t/h process steam at a pressure of 20 bar. Reasons to prefer pyrolysis oil over biomass were a.o. space restriction on the specific site, higher energy density leading to reduced number of truck transport, pyrolysis oil does not produce dust and does not contain fungi & bacteria (relevant for food&feed industry),

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and a 100% back-up by natural gas is enabled. The pyrolysis oil is purchased from Empyro - the commercial pyrolysis plant using BTG-BTL technology- and transported daily by tank truck (~30 km distance). Since 2015 more than 50 million liters of pyrolysis oil have been combusted in the boiler. Recently, a SCR has been added to the boiler to further reduce the NO_x emissions and to stay within the strict Dutch emission limits. This specific application was recently discussed in more detail in one of the case studies of the IEA intertask project "Bioenergy for High Temperature Heat in Industry" (<https://itp-hightemperatureheat.ieabioenergy.com>)

The last presentation was given by **Jaakko Martikainen** from Green Fuel Nordic Oy (GFN, Finland). GFN Lieksa Oy is the Green Fuel Nordic subsidiary and has implemented an industrial-scale fast pyrolysis in the Kevätniemi industrial area in Lieksa (Eastern Finland). The plant produces the bio-oil, with parent company Green Fuel Nordic Oy responsible for sales, marketing and product development. The raw materials for the Lieksa bio-oil plant consist of sawmill by-products. The annual production capacity of the refinery is 24,000 tons of bio-oil.

Basically, the pyrolysis plant is identical to the Empyro fast pyrolysis plant in the Netherlands, and it has been supplied by the partnership TechnipEnergies and BTG Bioliquids. Successful commissioning took place in Q4-2020, and the first oil was produced in December. Initial market for the pyrolysis oil will be as heating fuel and as feedstock for co-processing in oil refineries. GFN intends to build more plants in Finland, and other applications like stand-alone upgrading to drop-in fuels and higher added value chemicals will be considered.

The recorded session can be found at <https://virtual.eubce.com> (Tuesday April 27, session IBO.4 - Advances in Fast Pyrolysis)



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Kyriakos Maniatis
EUBCE Industry Coordinator
Principal Administrator in the
Directorate General for Energy,
European Commission (recently
retired)

What happened 15 years ago?

It is interesting to see how the field of direct thermochemical liquefaction developed over the years. We are thus presenting one example highlight from the PyNe newsletter fifteen years ago in this regular feature....:



Characterisation and Analysis of Pyrolysis Liquids – Progress in PyNe

By Anja Oasmaa, VTT, Finland and Dietrich Meier, BFH-IWC, Germany

Scope

The main scope of this activity within PyNe and ThermalNet is to:

- provide data on factors affecting fuel oil quality of pyrolysis liquids (PL)
- suggest methods to characterise the critical properties
- find solutions for possible problems in liquid fuel oil use.

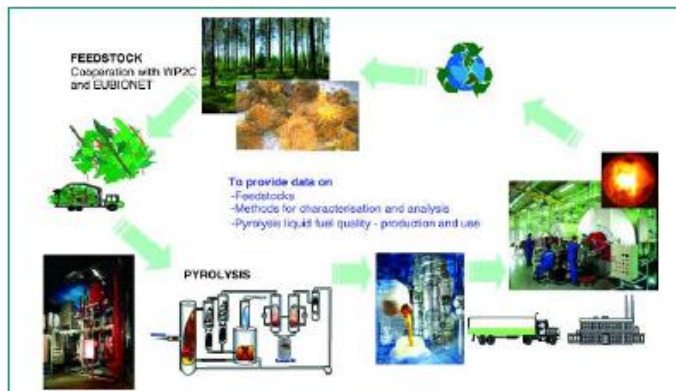


Figure 1: Scope of activity on analysis and characterisation.

Feedstocks

In feedstock issues, co-operation with the feedstock activity in ThermalNet and EUBIONET is agreed. Correlations between feedstocks and liquid quality will be studied by initiating a database containing data on feedstocks, pyrolysis process and conditions, yields, and the properties of feedstocks and products. A questionnaire on these subjects has been circulated within the ThermalNet network.

Fuel oil quality

Pyrolysis liquid fuel quality is a critical issue for most end users. Quality control should cover the whole chain from feedstock processing through pyrolysis to the customer. Feedback from liquid end-users will provide information on the critical properties to be specified and standardised. Methods for quality control and characterisation and analysis will be provided. Fuel oil analyses suitable for pyrolysis liquids have been reviewed in earlier studies.²⁴

Methods for characterisation of pyrolysis liquid

Pyrolysis liquid is a complex mixture of various compounds often present in small quantities. About 40 wt% of the components of pyrolysis liquid can be characterised by GC-MS methods.

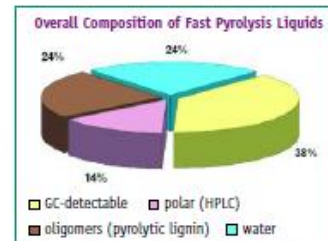


Figure 2: Overall composition of fast pyrolysis liquid.

You can access the full article by using the following link:

<https://task34.ieabioenergy.com/wp-content/uploads/sites/3/2016/10/PyNews-20.pdf>

Upcoming Events



13th July 2021

WasteEng2020 Conference, Guelph, Canada



8th International Conference on Engineering for Waste and Biomass Valorisation
July 13-16, 2020
Guelph, Canada

<https://www.wasteeng2020.org/>

19th Oct. 2021

Biofuels international, Brussels, Belgium



BRUSSELS | 19-20 OCTOBER 2021

Listen, learn and network

https://www.biofuels-news.com/conference/biofuels/biofuels_index_2021.php#about

17th Nov. 2021

European Biomass to Power Conference, Manchester, UK



<https://www.wplgroup.com/aci/event/european-biomass-to-power/>

19th April 2021 (postponed)

TC Biomass, Denver Colorado, United States



<https://www.gti.energy/training-events/tcbiomass/registration/>



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Past Issues of the Task 34 Newsletters

<http://task34.ieabioenergy.com/iea-publications/newsletters/>



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Your national

representative

<http://task34.ieabioenergy.com/country-members/>

Task 34: Direct Thermochemical Liquefaction



Disclaimer: This Task 34 newsletter was edited and produced by the Task Leader on behalf of IEA Bioenergy Task 34 Direct Thermochemical Liquefaction. Any opinions or material contained within are those of the contributors and do not necessarily reflect any views or policies of the International Energy Agency or any other organization.