

ETIP Bioenergy: Webinar on *Pyrolysis Oil* by Working Group 2 – Conversion Processes

25 May 2020

Questions to Gerhard Muggen, BTG Bioliquids B.V.

1.	What types of feedstocks cause phase separation?	Residues that are high in ash content, such as certain types of straw, etc. Ash causes increased biomass cracking, resulting in more water, finally causing phase separation. However, in case phase separation of pyrolysis oil occurs this is not a problem. Continuous stirring of the oil during storage will make the oil easily deployable without extra treatment. Or a certain amount of water can be removed from the oil by our patented moisture reduction equipment, which can be delivered with our pyrolysis plant.
2.	Where will the BTG fuels be used?	Our FPBO is currently used as heating oil by FrieslandCampina in the Netherlands. The FPBO from our new projects will be used as both heating oil and refinery feedstock in Scandinavia.
3.	When will the Swedish and Finnish plants be operational?	Finland by the end of this year (2020) and Sweden in the course of next year. So far the Covid-19 situation has not caused delay to the project timelines
4.	How stable is the pyrolysis oil?	Under normal storage conditions, around or below 25 °C, our FPBO remains stable for at least a year. Stirring the oil, or recirculating it, increases its stability and reduces the risk of phase separation or the settling of heavy molecules or particles. The stability of FPBO depends mainly on the water and solids content. A high water content (>30 wt-%) makes FPBO sensitive to phase separation, yielding a dark-coloured aqueous phase, and a tarry organic phase. A high solids content may lead to increased ageing of the oil due to mineral-catalysed (exothermal) polymerisation reactions. The BTG-BTL FPBO contains less than 30 wt-% water, has a very low solids content (<0.1 wt-%) and has shown to be very stable.
5.	Have you extracted the phenols to be used as a binder?	For examples of the use of pyrolysis oil fractions (e.g. for phenolic resins), please check out the Bio4Products project
6.	Is rotating a sort ablative reactor? Is biomass melting on a hot surface?	No. The heat is carried by sand, not by a hot reactor surface
7.	I thought Ensy had the first commercial plant in Red Arrow?	Correct but not 24/7 and at a much smaller scale, for specialty food ingredients.

8.	Buying bio-oil online is great. But if a refinery that is interested, to purchase a few hundred of barrels of bio-oil, is it possible at the moment? What might be the cost per barrel?	Yes that is no problem, we can source such volumes from the Empyro plant. Please contact us for more details and/or a quote.
9.	Is there a seasonal impact on the availability of biomass (wood in the case of BTG)? If so, how do you compensate for the seasonal differences?	Not really as we use residues from wood industry (e.g. sawmills) for the current projects
10.	Can you please give us an indication of the CapEx and the cost of production?	Order of magnitude Capex for a 24 kta FPBO production plant is 25 M€. Cost of production depends on many factors, e.g. heavily on feedstock costs. SGAB and IEA recently published production cost estimates, although we believe the IEA estimates are on the high side.
11.	Given a 5 tonne per hours of capacity, what is the annual capacity in litres? What is the volume of wood required in dry tonnes? What is the rough capital expenditures?	20 million liters or 24 kt tons pyrolysis oil are produced per year at a capacity of 5 t/hr wood (35 kt/y input. Capex see Q10
12.	How does the FPBO mixed with natural gas (slide on the Friesland campina process) affect the combustion properties? Were there any retrofit of burner or equipment required?	A dual fuel burner was installed. Due to the nitrogen in the FPBO, the NOx emission is increased. Although the ash content in the FPBO is low, dust emissions are above the stringent emission requirements in the Netherlands (5 mg/Nm ³) making it necessary to install a baghouse filter. Combustion itself is very much comparable to LFO.
13.	Could you explain the present condition of your project in Malaysia? Is it still running?	Mothballed
14.	How is the large decrease in fossil fuel prices (oil, LNG, etc.) affecting deployment of bio-oil investments?	So far we haven't seen an impact yet, that would probably depend on how long the fossil fuel prices stay low as well as on legislation and other aspects.
15.	Does PREEM expect for FPBO processing/polishing to get different specs for the bio-oil liquid feed?	Please refer to Preem for this question.
16.	Is water content and metals a problem for PREEM as it relates to FCC performance?	Please refer to Preem for this question.

17.	What are the possible difficulties in co-processing refinery?	Please read our whitepaper for more details
18.	Could you please provide your position paper to the processing options (you mentioned it on your second- or third-last slide)?	This will soon be available from our downloads section on the website
19.	What is the effect of variation of biomass feed on bio-oil quality?	Main impact is on the water content (see Q1), furthermore biomass that has a high ash content will lead to an increase in FPBO ash content as well.
20.	Do you know if the product distribution of the FPBO input in the FCC is similar as for crude oil (e.g. is it not more concentrated in heavy products)?	This would depend on the FCC operating conditions, catalyst, as well as on the fossil feedstock properties so is difficult to say in general terms. Using a heavy VGO Petrobras observed an increase in LPG, gasoline and LCO and a decrease in dry gas, bottoms and coke (Pinho <i>et al.</i> 2015)
21.	Do you use bark and low quality wood residues?	Not in the current projects but those can be used.
22.	It is generally considered that pyrolysis oil is not stable – do you use any method to maintain the stability?	See Q1 and Q4, that assumption is incorrect for our pyrolysis oil. In the Empyro oil storage tank we use recirculation to keep the FPBO moving. Nothing else. After 4 years of operation we did not see deposits in the Empyro oil storage tank when it was opened up for regular maintenance, which is a very strong indication that the oil is stable.
23.	What is the fraction of the cost for grinding and drying the feedstock?	That really depends on the type of feedstock.
24.	In your energy balance, you mention hot condensate. Do you add it to the (dried?) feedstock or is the hot condensate used otherwise?	(hot) condensate is used by our heat recovery system to generate steam. The steam can be used to generate electricity and provide heat for drying the biomass. Excess steam can be sold as renewable steam.
25.	You mention C-14 is not suitable and advocate a book keeping approach. Can you elaborate on the latter?	Please check out our position paper on the topic: see Q18
26.	What application do you give to the water condensate?	See Q24
27.	From the economic perspective and biomass availability: Do you foresee the pyrolysis oil being a good alternative to bunker oil?	After upgrading the pyrolysis oil and to replace at least a part: yes.

