

## Hydrothermal Liquefaction – advanced carbon recycling for natural and synthetic polymers

**Date: Tues, 22 March 2022**
**Presenter: Dr Alan Del Paggio  
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The Bioenergy Association would like to thank you all for your participation. Please feel free to contact Dr Alan Del Paggio directly if you have any further questions or comments. His contact details are below:

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### Questions / Comments submitted during the webinar

<b>Question</b>	<ul style="list-style-type: none"> <li>• Alan presented the Cat-HTR technology in two main modes Biomass and plastics</li> <li>• He also volunteered that a level of cross contamination...plastic in a biomass feed and vice versa...entrained biomass in predominantly plastic feed was workable.....perhaps even an “accommodating” selling point for the technology?</li> <li>• A major project opportunity we are currently developing could directly reflect exactly this minor cross contamination potential issue.</li> <li>• We would be most grateful if Alan could discuss this issue and perhaps place some percentage values on the optimum/maximum/possible levels of such cross contamination, and perhaps explain the consequences/boundary limits. For example, 50/50 would presumably be unsuitable whereas 98/2 might be acceptable...it’s the matrix in-between these two “bookends” that are of considerable interest, and the efficiency/yield consequences that could be expected?</li> </ul>
<b>Answer</b>	<p>Thanks for the question. The answer to your question is ‘it depends’.</p> <p>The most refractory plastic is PE. If you have a combination of biomass with any appreciable content of PE the plastic won’t convert at the lower temperatures the biomass will.</p> <p>We’ve spent some time working with mill owners to address whether or not they can process fibre reject streams in this way and it’s problematic. If the contamination of the biomass is with small amounts with other plastics, say PET there is less concern.</p>
<b>Follow on Question/ Comment</b>  1	<p>We are considering torrefying the proposed Bio feedstock because:</p> <ul style="list-style-type: none"> <li>• We have a handy waste heat source such that we would torrefy in the 280c/300c range</li> <li>• Once dry and friable minor inert contaminants (glass/ceramics/stones/even minor metals etc) are easy to separate ballistically, and most organic chemical contaminants (if present for any reason) would report to the overheads, (for dedicated treatment) thus leaving us with the residual “bio” carbon and most of the valuable minerals to present as broadly consistent ingredients for subsequent product</li> </ul>

	<b>blending.....but the Cat-HRT option seem very attractive....hence the question.</b>
<b>Answer</b>	<b>Only comment is that torrefaction will reduce the overall yield of biocrude since most of the extractives are lost. Torrefaction ‘carbonizes’ the structure of the biomass making conversion by HTL more difficult. Think of processing virgin wood vs charcoal as an extreme. Lower total carbon, more difficult to convert by HTL.</b>
<b>Follow on Question/ Comment 2</b>	<b>Your response to the plastics (basic PE materials with only minor bypass/missed PVC/PET) presence in a biomass stream is understood....so how about entrained biomass in a predominantly plastic operation? Would plastic pre-treatment need to include shredding, sink/float separation &amp;or washing to remove mainly food residues?</b>
<b>Response</b>	<b>This is less of a problem for minor contamination of plastic streams by biomass. Biomass will convert at lower temperatures than most plastics, much lower temperature than for PE so you will in the case of PE, lose majority of the biogenic carbon to the overhead gas as CO, CO2 and H2.</b>

<b>Question</b>	<b>Could you ask Alan if this process can tolerate preservative treated (Cu, CCA) wood? Thank you.</b>
<b>Answer</b>	<b>It can. Heavy metals will generally accumulate in one of two locations in the process, both isolable and manageable.</b>

<b>Question</b>	<b>What's the maximum level of lighthaptha you could tune the process to output if your feedstocks were plastics?</b>
<b>Answer</b>	<b>This is somewhat difficult to pinpoint exactly as naphtha is the most reactive species so as you push heavier molecules into naphtha and make more of it, you will begin to get more and more light gas make. An estimate might be 50-60% of the upgraded biofuel.</b>

<b>Question</b>	<b>Can the system process tanalised/treated timber?</b>
<b>Answer</b>	<b>YES</b>

<b>Comment</b>	<b>Thanks for an excellent presentation!</b>
<b>Response</b>	<b>Thank YOU!</b>

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<b>Response</b>	<b>Thank YOU!</b>

<b>Question</b>	<b>Hi Alan, thanks for the presentation and hope you are going well. Can you comment on the lifetime effects on the infeed/outfeed mechanisms and the materials challenges for the plant? Is the catalytic focus purely on the outfeed upgrading or within the hydrothermal phase? What water use and contaminants need treatment?</b>
<b>Answer</b>	<b>Lots of good questions Paul. Hope you are well as well.</b>

	<p>For biomass, Cl management is only important when one has to consider stress corrosion cracking and those locations are well known in the design.</p> <p>Catalytic focus is primarily on biocrude upgrading to fuel.</p> <p>Water use depends upon solids content in the reactor - runs of 20 to 50% are all possible, higher solids means lower water usage. If one uses a feedstock that needs to be dried to 20 or so wt% water for sizing, that can affect water usage. So in general HTL is not a huge consumer of water like many people want to portray it as. Reclaim of wastewater to process water standards is something for next generation however.</p>
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<b>Comment</b>	Thanks for the insightful webinar
<b>Response</b>	Thank YOU!

<b>Comment</b>	I have worked on and off on hydrothermal liquefaction, mainly in the 1970-80s at the old DSIR, and again on the 2000s of Aquaflow Bionomic. The interesting thing about the making of natural polymers is the best ones to come from biomass will make polymers we are unfamiliar with. Thus, most such liquefactions will produce what we need to make polystyrene, but the special ones are things like water permeable polyimides. Super-strong (in theory) and should make excellent means of desalinating water. However, the problem is they remain only a modest fraction of the product, and that product varies in composition depending on how you do the liquefaction.
<b>Question</b>	Do we currently have appropriate work-up technology to maximise the value of the products? Is anyone doing any work on characterising nitrogen-rich aromatic heteropolymers?
<b>Answer</b>	HTL biocrude, naphtha cut, is comprised of known molecular types – paraffins, isoparaffins, olefins and cycloparaffins. These are all normal feeds to the steam cracker or cat cracker depending upon whether you are chasing C2/C3 olefins or C3/C4 olefins respectively. The goal is not to attempt to make novel polymers but recycle carbon back into polyolefin plastics like PE and PP.  It would be great if we could tweak the process to produce novel monomers, but I'm afraid that's not possible when recycling plastics or converting biomass to naphtha for olefin production.

<b>Question</b>	Hi Dr Del Paggio, Thanks for the presentation. Regarding the energy balance for this process, how much of energy is required as a % of produced?
<b>Answer</b>	Again, energy use depends upon plant size and feedstock. In order for this to make sense economically, you need to preserve as high a ratio of initial bioenergy as possible. I will have to get an exact number back to you based upon a specific set of circumstances.

<b>Comment</b>	Just say thanks to Alan for a great presentation
<b>Answer</b>	Thank YOU!