

## Decarb Meeting Chat: 18 August 2023

10:05:25 From Fletcher, Kristen (CIV) to Everyone:

Link to Bill's lab: <https://www.mustainlab.com/>

10:07:57 From John Heinzl - NAVSEA 05Z to Everyone:

Literature is insufficient to insert into ship design tools - tangible equipment with its sizes, scales, efficiencies, etc. really are essential. And when these items do not exist, the error bars need to be tracked closely.

10:12:10 From John Heinzl - NAVSEA 05Z to Everyone:

For fuels that are not at 60C flashpoint, we need to identify if there is a path to handling and storing them safely. That may be a non-starter to begin with. Need to consult safety/fire/damage control SMEs.

10:40:29 From Bryant Fuller to Everyone:

How does the overall energy balance work? It takes energy with thermodynamic inefficiencies/losses to make ammonia. There are inefficiencies in burning any fuel such as ammonia. The LHV of ammonia is ~18.6 MJ/kg so it takes 2.9 times as much volume compared to F-76.

10:42:19 From Hyatt Moore to Everyone:

Is the S3D tool, akin to LabView/Simulink, or more of a documentation of mathematical models?

10:44:22 From John Heinzl - NAVSEA 05Z to Everyone:

Thanks. My microphone is on and usually works... NMCI strikes again!

10:44:28 From Fletcher, Kristen (CIV) to Everyone:

Thanks for the questions. We'll go in this order: Bryant Fuller, Saniya, Hyatt Moore.

10:44:49 From Subith Vasu (UCF) to Everyone:

JP 8 has 100s of components, modeling the combustion itself is a challenge. Are you going to use surrogates?

10:47:16 From John Heinzl - NAVSEA 05Z to Everyone:

SV - we don't run JP-8; that said, the issues are the same. Tend to have a bit more of the heavier cyclic compounds.

10:49:22 From Paul DeSario (NRL) to Everyone:

Do you need to continually supply H<sub>2</sub>SO<sub>4</sub> and KOH to your electrolyzer, and if so, do you have estimates as to the consumption rate?

10:50:23 From Bryant Fuller to Everyone:

I too seem to have audio challenges. I don't think you can have a ship that is making ammonia for a fuel without operating at a large energy deficit, unless it was nuclear powered

10:50:59 From John Heinzl - NAVSEA 05Z to Everyone:

RE S3D - I suspect it is more a variant of MBSE/parametric modeling at most. If that's not the case, that would be helpful to know. Regardless, the primary question related to physics-based modeling is, how are we sourcing "dynamic" physics based modeling and queuing it up? Generic models don't necessarily allow us to make real design decisions due to the lack of surety in certain conditions.

10:51:45 From Sang Hee Won to Everyone:

Hi Bryant. I agree with you regarding fuel making ship. It will require lots of energy.... But probably making ammonia might be cheaper than trying to make JP-5 or F-765...

10:51:48 From Sang Hee Won to Everyone:

F-76

10:52:57 From Fletcher, Kristen (CIV) to Everyone:

We'll do one more question from Paul Desario and then move to our Roadmap discussion.

10:55:10 From Paul DeSario (NRL) to Everyone:

that's why you are trying to balance the flux rate and the electrolysis rate...got it

10:56:37 From Paul DeSario (NRL) to Everyone:

thanks Bill!

10:58:18 From Jochen Lauterbach to Everyone:

Regarding the overall energy balance - ammonia has been shown to be better in "well to wheel" than going from crude oil to jp-8 etc.

10:59:05 From Jochen Lauterbach to Everyone:

Also, ammonia synthesis can much easier be modularized than a crude oil refinery, so a distributed production (maybe not on a ship) is much easier to accomplish.

10:59:51 From John Heinzl - NAVSEA 05Z to Everyone:

JL - I would assume that that point assumes a F-T synthesis with poor alpha, lots of post processing of waxes, etc. Otherwise, can you provide basis? I'd tend to agree... but we need to

think about the ability to handle this stuff. Every additional piece of complexity (new tankage, cryo, membrane reactors, etc.) becomes a bit of a demerit.

11:01:00 From William Mustain to Everyone:

To John Heinzl's comment "SV - we dont run JP-8; that said, the issues are the same. Tend to have a bit more of the heavier cyclic compounds." - We definitely know that JP-8 is not run. I copied/pasted the original language from the proposal. We are considering F-76. We do want to get some regular access to some for the experiments by Sang Hee and Kevin Huang. Would be great to be put in contact with someone who can get us a sample.

11:03:13 From William Mustain to Everyone:

To Bryant Fuller's comment "I too seem to have audio challenges. I don't think you can have a ship that is making ammonia for a fuel without operating at a large energy deficit, unless it was nuclear powered" - This is a great point and one we have discussed quite a bit. It is outside of our program to say what power source should be used. I do agree that renewables at sea (solar, wind/kites) would not be sufficient. Nuclear appears to be a reasonable power source in many ways, but also comes with risks that would need to be considered and managed in the future.

11:03:14 From John Heinzl - NAVSEA 05Z to Everyone:

WM - Thanks. Also include JP-5 which is 60C flashpoint jet fuel to that. The issue is the same spirit, the hundreds of components issue is the same, just a heavier cut so different species to model. Especially the remnant sulfur compounds (substituted dibenzothiophenes), since these tend to be the soot precursors.

11:04:12 From Sang Hee Won to Everyone:

Hi John,

11:05:46 From Sang Hee Won to Everyone:

Our group has worked on JP-5 previously. For combustion application, we are not considering these sulfur compounds yet, since they don

11:06:46 From Sang Hee Won to Everyone:

don't play significant role on overall combustion process much.

11:07:14 From William Mustain to Everyone:

I also agree that storage and handling of ammonia are very complicating. H<sub>2</sub> would be as well. In our 6.1 program, we are trying to determine the fundamental boundaries and constraints and we aim to give the Navy enough information to make informed decisions regarding the balance between advantages (e.g. decarbonizing fuel) versus the complications. Something that we should think about (that we have not yet done frankly) is to determine what operational advantages (if any) are enabled by ammonia; the ability to make it underway at high efficiency might by one of those. We will hopefully be able to answer that in the course of our program.

11:08:24 From John Heinzl - NAVSEA 05Z to Everyone:

SH - agree. Main point is that its a different set of heavier hydrocarbons. If anything that is sensitive to poisoning, then the DBT and other S-bearing compounds are a consideration, otherwise they dont affect the energetics much. Soot producton and particulates potentially a bit more but not necessarily enough to matter for these initial studies, especially if we can secure the lower S stocks.

11:12:18 From Sang Hee Won to Everyone:

JH - thanks for comment. Yes, although combustion engines are not much sensitive in terms of their performance to these DBT and S-compounds, but certainly they will play a role once we consider SOFC applications or pollutant emission..

11:14:15 From Jochen Lauterbach to Everyone:

I can dig up some references that compare ammonia synthesis to crude oil refining.

11:20:42 From Bryant Fuller to Everyone:

Keep perspective on lower carbon fuels

11:22:02 From Bryant Fuller to Everyone:

Volume to energy content, and complexities of storage/handling

11:22:22 From Saniya LeBlanc (GWU) to Fletcher, Kristen (CIV)(Direct Message):

The GWU, NPS, ABS project should include USNA in the list, as well.

11:23:21 From Fletcher, Kristen (CIV) to Saniya LeBlanc (GWU)(Direct Message):

Great. will share that with Bill.

11:33:14 From John Heinzl - NAVSEA 05Z to Everyone:

Regarding collaboration strategy, two thoughts. 1) Kind of going back to some of the discussion on the USC brief, I think we need to get to the basis of a set of design reference missions relative to energy, and ship concepts (rubber ship, not backfit, etc.) that identifies what capabilities it is going to have (e.g., cryo H2 or ammonia, fuel cells, bottoming cycles, etc.) in order to ensure that the consortium has some basis of what a notional decarbinized platform and use scenario range of courses of actions is well defined and documented (as starting points subject to change). And, 2) inclusion of OPNAV logistics folks and other stakeholders (TYCOMs, warfighters) that allow some of the considerations to be poked at by a broader range of logistics and deckplate experience.

11:36:06 From Brian Fronk to Everyone:

JH - This would be very valuable to get everyone on the same page, to at least allow apples-to-apples comparison and analysis.

11:38:05 From Saniya LeBlanc (GWU) to Everyone:

I agree with the idea to get everyone on the same page with respect to set of design references.

11:39:09 From John Heinzl - NAVSEA 05Z to Everyone:

BF - I do think that ultimately S3D can support covered ship design concepts in a set based design approach to give us some notional decarbonized ships for the future, to then weigh options against. need S3D folks to weigh in on that.

11:45:04 From Bryant Fuller to Everyone:

Do we really mean decarbonization or GHG emissions reductions?

11:48:27 From Bryant Fuller to Everyone:

90% of the Fleet we will have in 2040 is in operation, under construction or under contract today

11:50:23 From Paul DeSario (NRL) to Everyone:

@Bryant: per the DON Climate Action 2030 document its net-zero GHG emissions by 2050

11:51:02 From Bryant Fuller to Everyone:

Understand, but physics, thermodynamics and economics get a vote

11:51:43 From Bryant Fuller to Everyone:

All constrained by the nature of ship design

11:52:43 From Fletcher, Kristen (CIV) to Everyone:

We'll hear from Dan and then go to Saniya L.

11:57:52 From John Heinzl - NAVSEA 05Z to Everyone:

If some generic info on loading and load scenarios is needed, contact me. We can think about how we might sanitize some of the speed-time profiles and electric load profiles taken from ship DAS systems, and provide it as a start.

11:58:31 From Hyatt Moore to Everyone:

Saniya, if I understand your question or point, it was how can we share data centrally (i.e. verified and securely) and not have separate repositories here and there between each PI partnership

11:58:40 From John Heinzl - NAVSEA 05Z to Everyone:

john.heinzl@navy.mil

11:59:20 From Saniya LeBlanc (GWU) to Everyone:

HM - Yes, that is correct. Perhaps it is NPS handling this. It would be helpful to make this clear to the consortium performers.

12:04:29 From Hyatt Moore to Everyone:

I agree. It may come to NPS, but I don't know yet. I can look into it if we aren't able to address it by the end of the meeting.

12:07:08 From ronald giachetti to Everyone:

A lot of the data is marked CUI so the repository needs to be compatible with that designation.

12:08:29 From Bill Muras to Everyone:

@Bryant - Cayle had a chart in his briefing last time, that exactly hit on your point re: ships in the fleet well past 2050, showing a high level projection of the annual fuel consumption for ships already "locked in". It is considerable.

12:11:18 From Bill Muras to Everyone:

@Bryant, on the question of decarbonization versus GHG emissions reductions, we had a discussion on what the best terminology to use is/was. We morphed more towards decarb, as if we say emissions reductions, does that also come with the connotation of reducing operations, which is not on the table? So it was more of a terminology choice, versus anything deeper.

12:18:25 From Michele Anderson (ONR) to Everyone:

Thank you.