

Ammonia Combustion Technical Working Group Meeting
July 11, 2023 1:00 pm EST - 3:00 pm EST

Original agenda

1. Introductory remarks
2. CPS Presentation by Hassan Abdulsater
3. CSP Q&A
4. LSU Presentation by Shyam Menon
5. LSU Q&A
6. Open discussion and review of Mendi poll results from May meeting
7. Closing remarks

Introductory remarks

- Discussion of presentations and discussions at ASME Turbo Expo
 - Potential of RQL combustors
 - Liquid ammonia
 - Need to measure NO₂ and N₂O in addition to NO
 - Need for high pressure data
- Working group overview and format
- Next meeting Tuesday, September 5, 2023

Creative Power Solutions presentation by Hassan Abdulsater

- DOE SBIR Phase I Award along with UC Irvine
- Objective - define optimum operating conditions for the design of an ammonia combustor that is most competitive and provides a stable combustion environment
- 1-D chemical kinetics study
- CFD - 6 burner configurations compared
 - Top 3 designs then tested in UCICL test rig
- NO_x measurements in 1 atm burner
- Phase II preview - higher pressure experiments
- Summary
 - Can burn 100% ammonia and achieve low NO_x
 - Challenges includes engine startup, low emissions

CSP Q&A

- Matt Hamilton - When would this be commercially available?
 - Expect 2025 for engine prototype testing
- David Zamora (UCF) - Questions about CFD simulations - elaborate on flame impingement in some cases
 - Primary reason is the way fuel and air are introduced in these designs
 - High swirl number designs produce strong recirculation zone that produced flame impingement
- David Zamora - What were residence times in PSR from 1D simulations?
 - Around 40 ms across the entire combustor
 - Targeting power generation applications
- Lance Smith - Are Fluent models tuned to hydrocarbons and are they appropriate for ammonia/hydrogen?
 - They are looking into it
 - Model used for Phase I found not to be that accurate for NO_x
 - Now using a better model that more closely agrees with Phase I experiments
 - Available in Fluent - eddy dissipation - calculates species concentration at every iteration
- Jackie Chen - Did you test sensitivity of chemical mechanisms in 1D modeling?

- Did not conduct sensitivity studies in Phase I
 - Have done some in Phase II
- Jackie Chen - Any changes in NO formation pathways at higher pressure?
- Jackie Chen - Measurements of N₂O?
 - Yes, they measure NO, NO₂, N₂O, NH₃ with QCL
- Chat - What is meant by external firing?
 - Have combustor external to industrial GT
 - For sizing and modification reasons
- Clint Bedick - What is planned pressure ratio for GT?
 - 4 bar

LSU Presentation by Shyam Menon

- Ammonia swirl combustion research at Louisiana State University
- Strategies for improving combustor stability and NO_x emissions
 - Methane addition
 - Improved air-fuel mixing
 - Inlet air preheating
 - Two-stage combustion (RQL)
- Experiments, CFD, reactor network
- Everything experimental at 1 atm so far but rig can achieve 4 or 5 bar
- Ongoing work with reactor network - where and how is NO_x/NH₃ formed?

LSU Q&A

- Pete Strakey - Have you looked at other reaction mechanisms?
 - They have not looked yet, but plan to. They use Okafor mechanism currently.
- Chat - Lowest NO_x under rich conditions?
 - 50 ppm (1 bar)
- Hassan Abdul Sater - Slide 20, have you run single stage in rich conditions?
 - Have not yet
 - Still analyzing surprising results, maybe an issue with the analyzer (Enerac M700)
- Nathan Weiland - Have you considered implementing turbulent mixing in second stage?
 - This is their first iteration but would like to achieve better mixing through turbulence

Closing remarks

- Mendi poll results from last meeting
- Future meetings will have a common "theme" if possible