

Ammonia Combustion Technical Working Group #9;3-Sep-2024

Meeting Minutes

- University of Orleans; Christine Rousselle
 - Ammonia light duty-engines: main issues
 - Q&A
 - Sreenath Gupta
 - Why not recommending cracking fuel
 - Depends on compression ratio. May need for cold start and low load. Always a compromise between efficiency and fuel consumption.
 - Sreenath Gupta
 - Still IMEP is much lower compared to diesel engine?
 - Can go higher to match.
 - Cody Diaz
 - Question about emissions, have them normalized by power produced?
 - Yes, they have them but did not present as such.
 - Is the trend similar with normalized emissions?
 - Yes
 - Clint Bedick
 - Have you done testing with SCR?
 - No, they only run single cylinder engine so far. SCR should work though.
 - Tay Wo Chong
 - Have you compared performance of liquid vs gas ammonia in ICE?
 - Yes, they have done the comparison, but injector was not optimized for ammonia. Have to be careful about material compatibility.
 - David Hagen
 - What was lowest ammonia NO_x achieved?
 - Function of piston bowl and equivalence ratio. But difficult to say, because higher equivalence ratio could lead to less NO_x but higher fuel consumption.
- Imperial College; Peter Lindstedt
 - Implications of the Chemical Kinetics of Ammonia Combustion Behaviour
 - Q&A
 - Wesley Boyette
 - Is ammonia combustion a more difficult problem than hydrocarbon?
 - Yes, very good work on ammonia in the 80's and 90's. But much of the new data is flawed and quickly gathered. New parameter space and applications. Not very careful assessment. Progress is being made, but we are nowhere near where we want to be in terms of our understanding of chemistry across a wide range of parameters.
 - Are kinetics of ammonia chemistry more sensitive to pressure?
 - Yes, pressure dependence potentially more difficult because of the role of three body termination reactions. Need more data, including more speciation.

- Clint Bedick
 - What is meant by more comprehensive data sets: more conditions, lower uncertainty, multiple groups?
 - All of the above. As one example, look at heat loss effects on burning velocity. Is it optically thin? Could have huge implications on turbulent flames. But it's very difficult to work with pure ammonia so many groups add hydrogen, but then the hydrogen chemistry completely takes over, except for the NO_x emissions.
 - David Hagen
 - How useful is 12 bar data for gas turbine? How useful is both 4 and 12 atm?
 - Should be very useful going from 12 to 30 than from lower. Would be interested to see ammonia slip and HCN information as well.
 - Cody Diaz
 - Thoughts on emissions associated with blending ammonia with hydrocarbons, specifically coal?
 - Can't answer straight away. Could be modeled with reasonable accuracy if you know what is in the coal. Probably less soot and we understand fairly well the implications on soot formation.
 - Clint Bedick
 - Can you promote hydrazine pathways to help with reactivity?
 - Can significantly change ammonia combustion with small addition of hydrazine, but may not be practical.
 - Clint Bedick
 - Importance of equivalence ratio?
 - Important across the board, not just importance of pyrolysis on rich side.
 - Ajeya
 - If small changes in temperature play a role in ammonia kinetics, will climate in cold regions play a role?
 - Difficult to say, but maybe in IC engines it is not so sensitive.
 - David Hagen
 - How important wall temperature vs combustion temperature?
 - Very important, much more important for ammonia combustion versus hydrocarbon combustion.
- Open discussion