Controlling Combustion Conditions of Ammonia for Eco-Friendly Energy

Alali, Ali (School: Alkifah Academy)

The combustion of fossil fuels is inflating atmospheric CO2 concentrations to an unprecedented peak. This has reached 412 ppm, a staggering 112 ppm higher than the greatest concentration to naturally occur in Earth's history. With countless ecosystems at risk, this project investigates the optimal combustion conditions required to generate electricity with ammonia, a convenient carbon-free fuel, while minimizing its byproducts, NOX and N2O, to achieve environmentally friendly energy in commercial methane turbines. First, virtual simulations were run using Chemkin Pro's freely propagating flame simulator to graph the general behavior of ammonia emissions in relation to the fuel mixture and equivalence ratio. Then, real flames were ignited in the high-pressure combustion duct to validate the simulation results and focus on flames the simulations indicated would be optimal, but could not calculate. Finally, flames in such optimal conditions were replicated to verify the readings and guarantee their stability. The results showed that a very lean, equivalence ratio (0.4) pilot flame fueled purely by cracked ammonia (75% H2, 25% N2) and a lean main flame (0.4, 0.5) fueled primarily by ammonia and some cracked ammonia (72% NH3, 21% H2, 7% N2) produced sufficiently low concentrations of NOX and N2O, ppm < 100. These exact conditions produced an efficient, environmentally-friendly, and economic energy resource. They employed ammonia's transportability, hydrogen's greater energy density, and the preexisting infrastructure for combustion to create an optimal alternative to fossil fuels.