Simulation of Nitrogen Emissions in a Low Swirl Burner

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There is considerable interest in the combustion community on the development of fuel-flexible low-emissions turbines for stationary power generation. Of particular interest is the development ofsystems based on lean, premixed combustion that can burn hydrogen or hydrogen-rich fuels derivedfrom gasification of coal or biomass or other processes. Injectors based on low swirl burner technology are emerging as an important technology for meeting design requirements in terms of both reliability across a range of fuels and low emissions. High pressure tests of a low swirl burner fueled with hydrogen have shown an unexplained plateau in N Ox emissions as a function of equivalence ratio. In particular, contrary to expectations, below a critical equivalence ratio the N Ox emissions were insensitive to equivalence ratio. In this paper, we present simulations of a laboratory-scale low swirl burner fueled with hydrogen at atmospheric pressure. The study uses detailed chemistry and transport including a submechanism for computing nitrogen emissions. The simulation shows how the cellular burning structures characteristic of lean premixed hydrogen combustion lead to enhancements in the N Ox emissions from these flames. Analysis of the simulation data illustrates the chemical pathways that lead to nitrogen emissions and how they are enhanced within local regions of intense burning.