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Plasma-assisted combustion in lean, high-pressure, preheated air-methane mixtures[1] TIMOTHY SOMMERER, JOHN HERBON, SEYED SADDOUGHI, General Electric Research, MAXIM DEMINSKY, BORIS POTAPKIN, Kintech Lab Ltd — We combine a simplified physical model with a detailed plasma-chemical reaction mechanism to analyze the use of plasmas to improve flame stability in a gas turbine used for electric power generation. For this application the combustion occurs in a lean mixture of air and methane at high pressure (18.6 atm) and at "preheat" temperature 700 K, and the flame zone is both recirculating and turbulent. The system is modeled as a sequence of reactors: a pulsed uniform plasma (Boltzmann), an afterglow region (plug-flow), a flame region (perfectly-stirred), and a downstream region (plug-flow). The plasma-chemical reaction mechanism includes electron-impact on the feedstock species, relaxation in the afterglow to neutral molecules and radicals, and methane combustion chemistry (GRI-Mech 3.0), with extensions to properly describe low-temperature combustion 700–1000 K [M Deminsky et al, Chem Phys **32**, 1 (2013)]. We find that plasma treatment of the incoming air-fuel mixture can improve the stability of lean flames, expressed as a reduction in the adiabatic flame temperature at lean blow-out, but that the plasma also generates oxides of nitrogen at the preheat temperature through the reactions $e+ N_2 \rightarrow N + N$ and $N + O_2 \rightarrow NO + O$. We find that flame stability is improved with less undesirable NOx formation when the plasma reduced-electric-field E/N is smaller.

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Timothy Sommerer
General Electric Research

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