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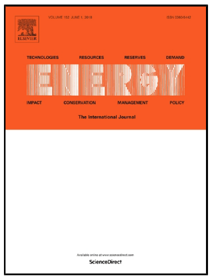

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Experimental Investigation of the stability of a turbulent diffusion flame in a gas turbine combustor

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Abstract

The stability of a turbulent diffusion flame temperature in an atmospheric gas-turbine combustor is investigated experimentally over a range of operating conditions to study the combined effect of hydrogen-enriched- methane (as fuel) and oxygen with carbon dioxide (oxy-fuel, as the oxidizer) on the combustion flame stability. These conditions included varying fuel and oxidizer mixture compositions, swirl angles, and equivalence ratios. The fuel (i.e. methane) is enriched with hydrogen (H_2) in a ratio that ranged from zero to 50%; where the oxidizer (pure oxygen) is mixed with carbon dioxide (CO_2) in a ratio that ranged from zero up to the value of flame blow-off. Different swirl vane angles corresponding to different swirl numbers were considered. The results indicated that stable regime (flame) is achieved close to stoichiometric conditions at high oxygen (O_2) to CO_2 ratio and high H_2 (50%) enriched fuel; while the flame blow-off occurred at low O_2 to CO_2 ratios (20% or less). High-level flame stability with moderate flame length and temperature were observed at the highest swirl vane angle.

***Keywords*:** **F**lame stability; gas turbine combustor; hydrogen enrichment; oxy-combustion; swirl effect.

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1. Introduction

Combustion instability is a phenomenon that normally arises in the combustor of a gas turbine engine. Several efforts to subdue or eradicate this instability have been in place for the past decades. One of the breakthroughs is to utilize swirling flow in a sudden expansion configuration for the gas turbine engine. This leads to stabilizing the flame as well as achieving clean and efficient combustion as a result of enhancing the mixing high turbulence intensities generated by the swirl. In this regard, several investigations are ongoing on how and to what extent such flow impacts the performance of gas turbine combustor.

Palies et al. [1] used a flame describing function to compare the responses of swirling flames surrendered to acoustic velocity instabilities obtained when the flow rotation is produced by either radial or axial swirler. It was observed that the response and flame dynamics are fundamentally alike for both swirler geometries and that the value of swirl number distinctly sways the response gained. Huang and Yang [2] conducted an extensive review of the improvements made in the area of combustion instability in a gas turbine combustion systems. The study showed that the most important parameter describing the flame and flow dynamics is the swirl number. Huang and Yang