Optimization of Combustion Parameters for Improved Thermal Efficiency in Hydrogen Gas Turbines using Computational Fluid Dynamics Modeling

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Abstract:

Hydrogen emerges as a cleaner fuel for power generation as the global energy landscape tilts towards cleaner alternatives but its unique combustion properties in gas turbines necessitates careful tuning of operational parameters to maximize overall efficiency and further reduce emissions. This paper researches on the optimization of the combustion parameters in a Hydrogen gas turbine to enhance thermal efficiency through the application of Computational Fluid Dynamics (CFD) modelling presenting important insights for the design and operation of Hydrogen gas turbines of the future and contributions to the advancement of cleaner energy technologies. A comprehensive CFD model which incorporates chemical kinetics, turbulence-chemistry interactions and heat transfer mechanisms was developed to simulate the combustion process within the Hydogen gas turbine examining parameters such as fuel-air mixing ratios, injection strategies, combustor geometry and operational conditions such as pressure and temperature. For the purpose of identifying optimal combinations of these variables which can significantly enhance combustion stability and thermal efficiency, parametric studies were carried out and also combustor geometry modifications particularly in the primary zone to show potential improvement in flame characteristics and NOx emissions reduction.