ABDULAFEEZ ADEBIYI, KONSTANTIN KEMENOV, V'YACHESLAV AKKERMAN, Department of Mechanical and Aerospace Engineering, West Virginia University, Morgantown, WV, 26506. Numerical Simulation of Oxy-Fuel Premixed Combustion in a Supercritical CO_2-diluted Environment.

Development of advanced supercritical carbon dioxide (sCO_2) combustors for next-generation gas turbines requires deeper understanding of the dynamics and structure of CO_2-diluted flames at supercritical conditions. To address this question, the key parameters of premixed supercritical oxy-methane combustion, such as the velocity, temperature and thickness of the flame front are scrutinized in the present work. The analysis is performed by means of the computational simulation of the combustion equations with fully-compressible hydrodynamics, transport properties (heat conduction, diffusion and viscosity) and one-step Arrhenius chemical kinetics. In addition, the real-gas thermodynamics and molecular properties are incorporated into the reacting-flow Navier-Stokes solver along with the Peng-Robinson equation of state. It is shown that an increase in a CO_2-dilution rate makes the flame front thicker and reduces the unstretched laminar flame speed, as compared to that of non-diluted oxy-combustion. Starting with the planar flames, attained by means of the slip boundary conditions at the computational domain, the analysis is subsequently extended to the corrugated flames, produced by non-slip walls of the computational domain. While a corrugated flame front generally propagates faster than the planar one of similar thermal-chemical characteristics, the corrugated flame velocity not only diminishes with the dilution rate, but it also depends on the size/geometry of the combustor.