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Experimental and Numerical Study on the Effects of Oxygen Methane Flames with Water Dilution for Different Pressures

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Abstract : Among all possibilities to combat global warming, CO₂ capture and sequestration (CCS) is presented as a great alternative to reduce greenhouse gas (GHG) emission. Several strategies for CCS from industrial and power plants are being considered. The concept of combined oxy-fuel combustion has been the most alternative solution. Nevertheless, due to the high cost of pure O₂ production, additional ways recently emerged. In this paper, an innovative combustion process for a gas turbine cycle was studied: it was composed of methane combustion with oxygen enhanced air (OEA), exhaust gas recirculation (EGR) and H₂O issuing from STIG (Steam Injection Gas Turbine), and the CO₂ capture was realized by membrane separator. The effect on this combustion process was emphasized, and it was shown that a study of the influence of H₂O dilution on the combustion parameters by experimental and numerical approaches had to be carried out. As a consequence, the laminar burning velocities measurements were performed in a stainless steel spherical combustion from atmospheric pressure to high pressure (up to 0.5 MPa), at 473 K for an equivalence ratio at 1. These experimental results were satisfactorily compared with Chemical Workbench v.4.1 package in conjunction with GRIMech 3.0 reaction mechanism. The good correlations so obtained between experimental and calculated flame speed velocities showed the validity of the GRIMech 3.0 mechanism in this domain of combustion: high H₂O dilution, low N₂, medium pressure. Finally, good estimations of flame speed and pollutant emissions were determined in other conditions compatible with real gas turbine. In particular, mixtures (composed of CH₄/O₂/N₂/H₂O/ or CO₂) leading to the same adiabatic temperature were investigated. Influences of oxygen enrichment and H₂O dilution (compared to CO₂) were disused.

Keywords : CO_2 capture, oxygen enrichment, water dilution, laminar burning velocity, pollutants emissions
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