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Real Gas Effects on Supercritical Kerosene/Oxygen Combustion in a Bi-Swirl Injector

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This study conducted RANS simulations on a bi-swirl injector under supercritical conditions at an oxidizer-rich preburner. Two equations of state, the ideal gas and Soave–Redlich–Kwong [1], were compared to assess their influence on flow and flame structure. For the chemical mechanism, Nada et al.'s four-step mechanism is used [2]. For thermodynamic/transport properties, Chung's correlations for viscosity and thermal conductivity [3], and Takahashi's species diffusivity formula are used [4]. For the turbulence model, the RNG k–ε is used [5]. To reduce computational cost, a 1/4 sector of the cylindrical domain was modeled. For both equations of state, results show that the flame anchors at the recess tip and the flame is rapidly quenched by an additional annular oxidizer injection. The SRK equation reduces the central recirculation zone, causing the flame location to shift downstream. Future work will use the RANS-derived flow field as the basis for large-eddy simulations (LES) and will conduct a parameter study on the recess length.

References

[1] Soave G. Equilibrium constants from a modified Redlich–Kwong equation of state. Chemical Engineering Science. 1972;27(6):1197–1203.
[2] Nada Y, et al. Four-step global kinetics mechanism for diluted combustion fueled with kerosene. Fuel. 2023;346:128322.
[3] Chung TH, et al. Generalized multiparameter correlation for nonpolar and polar fluid transport properties. Industrial & Engineering Chemistry Research. 1988;27(4):671–679.
[4] Takahashi S. Preparation of a generalized chart for the diffusion coefficients of gases at high pressures. Journal of Chemical Engineering of Japan. 1975;7(6):417–420.
[5] Yakhot V, et al. Development of turbulence models for shear flows by a double expansion technique. Physics of Fluids A: Fluid Dynamics. 1992;4(7):1510–1520.