Numerical Modeling of Inverse Jet Diffusion Flames Using Sharp Corners' Nozzles

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Abstract

Several studies have suggested the use of sharp corners in the flow field as an approach to enhance mixing of reactants for inverse jet diffusion flames and to generate a fully developed flame having low unburned hydrocarbons. The present paper examines the effect of using nozzles having sharp corners on inverse jet diffusion flames using Computational Fluid Dynamics. Three different nozzle shapes, which are circle, square and triangle, have been examined. Commercial Package ANSYS-FLUENT 16.0 finite-volume solver has been used for the numerical modeling of the reacting flow field using mixture fraction non-premixed model. The numerical model results have been validated with experimental data. The obtained numerical results showed a favorable effect of sharp corners and direct influence of both the number of sharp corners and sharpness of angles on the stability of the inverse flame. The obtained results showed that increasing the number of these sharp corners led to increasing the turbulent kinetic energy at a range of (35 to 50%) accompanied by a decrease in both of peak temperature by about 23% and NOx emissions in good agreement with the experimental results. In addition, decreasing the vertex angle of these sharp corners enhances the mixing rates of reactants and increases vortices by 40%, consequently decreasing both CO and Hydrocarbons (HC) emissions.

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