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Porous Bluff-Body Disc on Improving the Gas-Mixing Efficiency

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Abstract : A numerical study on a bluff-body structure with multiple holes was conducted using ANSYS Fluent computational fluid dynamics analysis. The effects of the hole number and jet inclination angles were considered under a fixed gas flow rate and nonreactive gas. The bluff body with multiple holes can transform the axial momentum into a radial and tangential momentum as well as increase the swirl number (S). The concentration distribution in the mixing of a central carbon dioxide (CO2) jet and an annular air jet was utilized to analyze the mixing efficiency. Three bluff bodies with differing hole numbers (H = 3, 6, and 12) and three jet inclination angles (θ = 45°, 60°, and 90°) were designed for analysis. The Reynolds normal stress increases with the inclination angle. The Reynolds shear stress, average turbulence intensity, and average swirl number decrease with the inclination angle. For an unsymmetrical hole configuration (i.e., H = 3), the streamline patterns exhibited an unsymmetrical flow field. The highest mixing efficiency (i.e., the lowest integral gas fraction of CO2) occurred at H = 3. Furthermore, the highest swirl number coincided with the strongest effect on the mass fraction of CO2. Therefore, an unsymmetrical hole arrangement induced a high swirl flow behind the porous disc.

Keywords : bluff body with multiple holes, computational fluid dynamics, swirl-jet flow, mixing efficiency
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