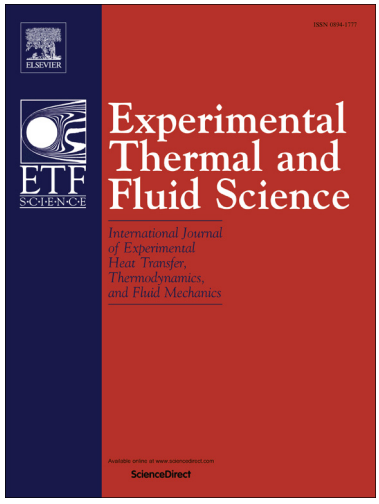

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Reduction of Fluid Forces Acting on a Square Prism Using a Planar Jet

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Abstract

This experimental study focused on the concurrent minimization of the mean and fluctuating forces acting on a square prism in crossflow by creating a continuous jet through a narrow spanwise slot in it. For this purpose, three different predetermined injection surfaces (i.e., front, top, and rear) were individually studied for the injection ratios (*IR*) of 0, 1, 1.5, 2, 2.5, and 3 at a Reynolds number (*Re*) of 8000. The results showed that the rear jet is the optimum injection surface. For the rear jet configuration, the optimum *IR* is 1.5 in terms of mean total drag coefficient reduction, $<C_{DT}>$. In this case, the reductions in the $<C_{DT}>$ and the level of root mean square (RMS) of fluctuating pressure coefficient ($C_{P\,RMS}$) on the side surfaces are about 29.7% and 68%, respectively. However, the maximum reduction in the $C_{P\,RMS}$ level on the side surfaces occurred at $IR = 2$. In this case, the reductions in the $<C_{DT}>$ and the level of $C_{P\,RMS}$ on the side surfaces are about 27.5% and 88%, respectively. The underlying mechanism of force reduction was also demonstrated. Various flow patterns were identified with respect to *IR* at incidence angle (α) of 0°. It was also proved that, at relatively small angles of incidence, from $\alpha = 0°$ to 20°, the active flow control method is still effective in reducing $<C_{DT}>$ and in suppressing the fluctuating side forces, which is indicative of periodic vortex shedding from either side of the square prism.

Keywords: Active flow control; Jet injection; Drag reduction; Square prism; Angle of incidence

Nomenclature