

Effect of a pintle orifice on planar turbulent jet flows: a DNS study

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Recently, we reported distinct patterns in jet flow dynamics for a planar jet with a pintle-shaped orifice at the inlet¹. Introducing a pintle wall at the orifice of a free jet leads to intense flapping and obliqueness in the vortex pattern. Continuing with the previous work, here we consider direct numerical simulation (DNS) of the jet flow with three different pintle configurations (30° , 45° and 60°), which vary only by the chamfering angle (α) between the diverging pintle-wall and the jet centerline. The Reynolds number of the jet is 4000 based on the inlet bulk mean velocity and the jet width. Instantaneous flow fields show the large-scale flapping phenomena of jets and how the obliqueness of spanwise structures depend on the pintle angle. As α decreases, it shows intense flapping, high turbulence intensity in the far-field and less coherence in Kelvin-Helmholtz (KH) vortices in the near-field. The vortex dynamics is studied using Q-criterion, λ_2 -criterion and enstrophy dynamics, and the effects of the pintle angle on the onset of large-scale motions are investigated.

Instantaneous enstrophy contours for three jets are shown in Fig. 1, where we can observe the flapping phenomena downstream. Note that jet oscillation intensifies with smaller α . It has been found that the disturbances in the near-field KH instabilities influence the far-field flapping intensity. This interesting behaviour of large-scale instabilities together with small-scale dynamics will be presented by means of spatio-temporal analysis, quadrant analysis of the dominant Reynolds shear stress, and turbulent microscales. In addition, the anisotropic behaviour of large- and small-scale turbulence will be presented in terms of the barycentric maps.

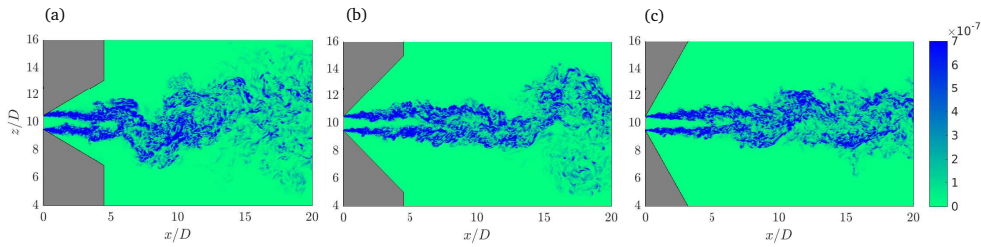


Figure 1: Instantaneous enstrophy contours at the mid-span location of the pintle-jets: (a) 30° jet (b) 45° jet (c) 60° jet.

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