Preliminary correlations between strain rates, vorticity and particle clustering in a turbulent pipe-jet

Timothy C. W. Lau[1], Jonathan H. Frank[2] and Graham J. Nathan[1]
[1]Centre for Energy Technology, School of Mechanical Engineering, University of Adelaide, SA 5005, AUSTRALIA
[2]Combustion Research Facility, Sandia National Laboratories, Livermore, CA 94550, US
timothy.lau@adelaide.edu.au

ABSTRACT

High speed tomographic particle image velocimetry was utilised to measure the four-dimensional distributions of particles at the exit of a particle-laden turbulent pipe-jet under conditions where particle clustering was previously shown to occur. The flow was seeded with monodisperse particles of diameter d_p=10μm at sufficiently high loadings such that the flow was in the two-way coupling regime. The resultant particle Stokes number, based on the large-eddy timescale, was Sk_D=1.4, while the flow bulk Reynolds number was Re_D=10,000. The results show that the strain rates and vorticity are lower in the particle-laden jet than in the equivalent single-phase flow, and, importantly, that these parameters are lower inside of clusters compared to outside of clusters. Furthermore, the results show that particle clusters are temporally correlated to regions where both the vorticity and strain rates, i.e., where the total magnitudes of the velocity gradients, are low.