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Liquid Vortex Fluid Dynamics for Fusion Energy Applications

PHILIPPE BARDET, OMER SAVAS, University of California Berkeley — A turbulent annular swirling liquid contiguous wall jet is characterized experimentally in a "vortex tube." The flow is proposed for use in a thick liquid first-wall chamber concept for inertial fusion power plants. The three components of planar velocity vector fields are measured with a single camera split-screen stereoscopic particle image velocimetry scheme. The combined use of fluorescent particles and cut-off filters effectively blocks glare reflected from the liquid-air interface. Flow field measurements in the vicinity of a free surface are thus successfully obtained in the presence of strong surface deformations. The jet is studied for Reynolds numbers ranging from 3,200 to 14,000 and between 1.5 and 11 "vortex tube" diameters downstream of the injection nozzle. Between 1.5 and 8 diameters, the average azimuthal velocity profile alone is non uniform away from the wall. Large vortical structures are consistently observed. Their wavelength increases with the distance from the nozzle. The turbulent kinetic energy decreases slowly with distance while the dissipation decreases rapidly. At 11 diameters, the wall effect influences strongly the average velocity profiles. The vortical structures disappear and the turbulent kinetic energy increases.

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