FORCED CONVECTION AIRFLOW IN AN ENCLOSURE

2008 Award Winner

APPLICATION NOTE V3V-010

The forced convection of airflow in an enclosure was measured by the TSI volumetric 3-component velocimetry (V3V™) system.

Figure 1 shows the enclosure where the measurements were taken. Seed particles can be seen suspended in the air and on the bottom of the enclosure.

Figure 1: Tank with seeding particles.

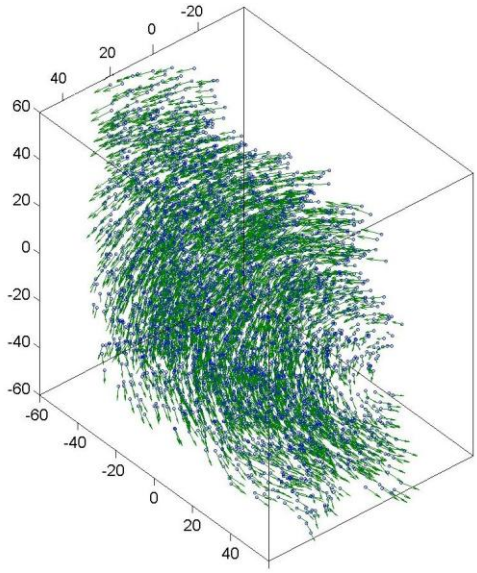

Figure 2: 3D Particle Tracking Vector Field.

The TSI V3V™ (Volumetric 3-Component Velocimetry) system was used to analyze the resulting flow structure (Fig. 2). The flow was illuminated by a model YAG120-NWL 120 mJ dual-head pulsed Nd:YAG laser operating at 7.25 Hz and 532 nm wavelength. Light cone optics were used at the exit of the laser to shape the beam into an illuminating cone. The laser cone was formed with one -25mm and one -50mm cylindrical lens mounted at 90° to each other. These cylindrical lenses diverged the beam in the horizontal and vertical directions to illuminate a volume approximately 100 mm × 120 mm × 50 mm. The model V3V-8000 3D camera, consisting of three apertures and a total of 12 million pixels, was aligned and calibrated with the CCD a distance of 670 mm from the back plane of the measurement volume.

The data capture was synchronized with the TSI model 610035 synchronizer. The images were streamed to the model HYPER2 hyperstreaming® computer, and subsequently analyzed.

The flow was seeded with 40 µm micro-balloon particles, which have a very low density near that of air. Two image captures were taken with a Δt of 2500 µs, and volumetric velocity fields were obtained through unique particle identification, triplet matching, and particle tracking algorithms in TSI's INSIGHT™ V3V software.

An instantaneous plot of the V3V data can be seen in Fig. 3. A randomly spaced vector field was obtained through particle tracking and then interpolated onto a rectangular grid. In the figure, the color of the planes represent the x-component of velocity. Three isosurfaces are shown: red indicates positive z-vorticity, blue is positive y-vorticity, and yellow is positive x-vorticity.

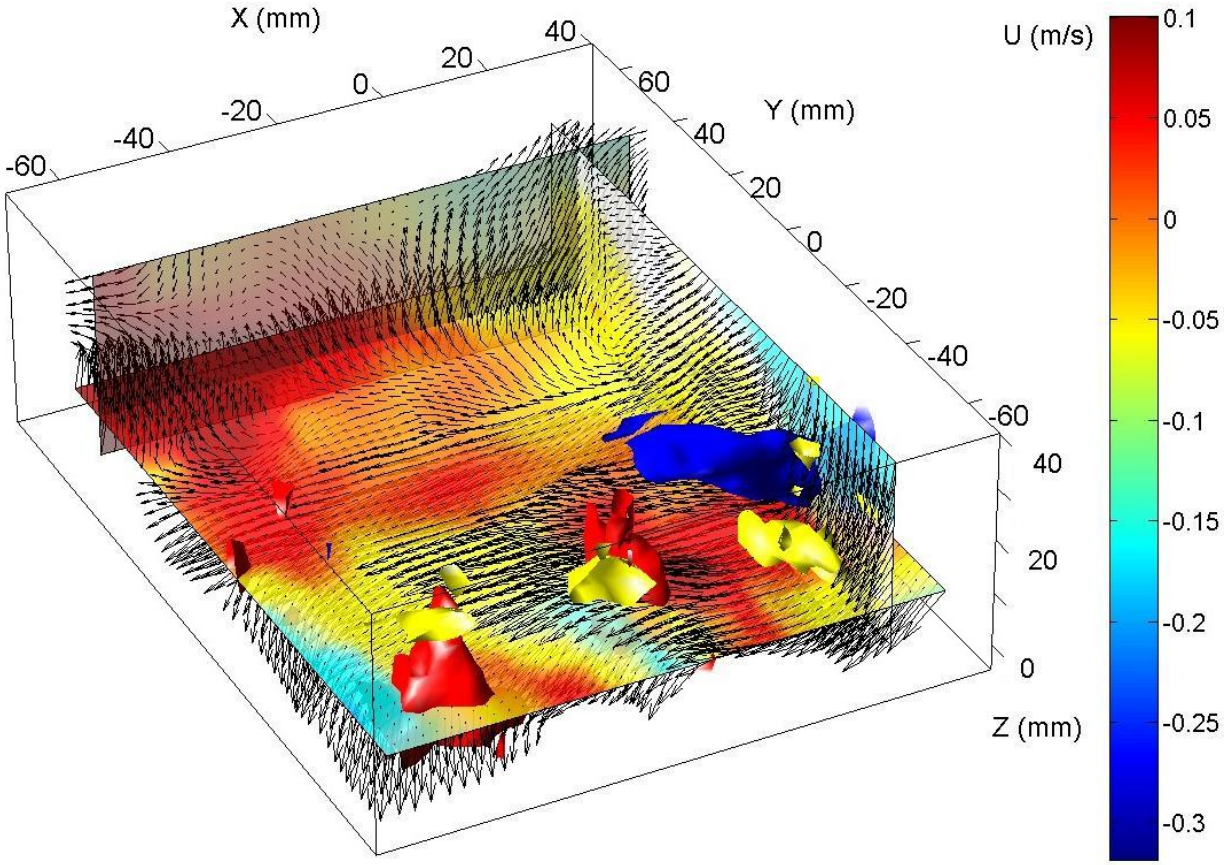

Figure 1: Volumetric 3-Component Velocity field of airflow in an enclosure. Slice colors represent the x-component of velocity in m/s. Isosurfaces are vorticity: red is positive z-vorticity, blue is positive y-vorticity, and yellow is positive x-vorticity.

In this study, the structure of airflow within an enclosure was examined with the TSI V3V™ system. Instantaneous volumetric velocity fields were obtained and analyzed for key features of the resulting flow field.

UNDERSTANDING, ACCELERATED

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P/N 5001219 Rev. B Printed in U.S.A.