SURVEY OF A WAKE FIELD

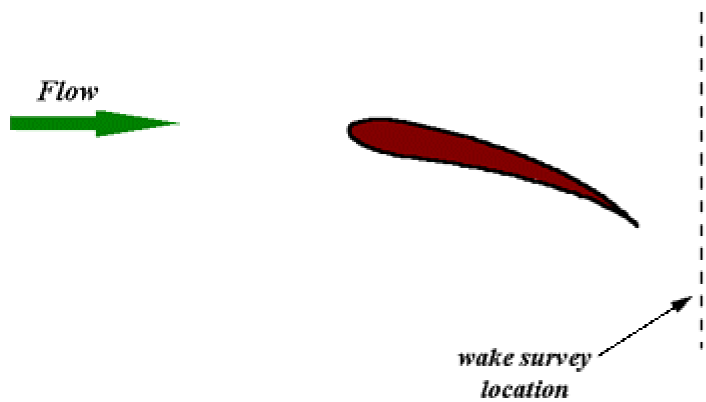
APPLICATION NOTE LDV-005

Wake field measurements behind vehicles such as ships and aircraft, and objects such as airfoils and cylinders have been carried out to study energy dissipation, noise generation and suppression, interaction with propulsive devices and aerodynamic improvements. This type of information is generally obtained by mapping the flow field at various locations downstream of the vehicle or the body.

TSI's fiberoptic LDV systems make this process of mapping the flow field by traversing the measuring volume a simple and straightforward process. The non-invasive nature combined with its ability to handle high turbulence and flow reversals makes the LDV technique ideally suited for these types of measurements.

The purpose of this experiment was to measure the wake field behind a two-dimensional airfoil. The flow field was surveyed to obtain velocity distribution and other flow properties in the wake region.

Experimental setup

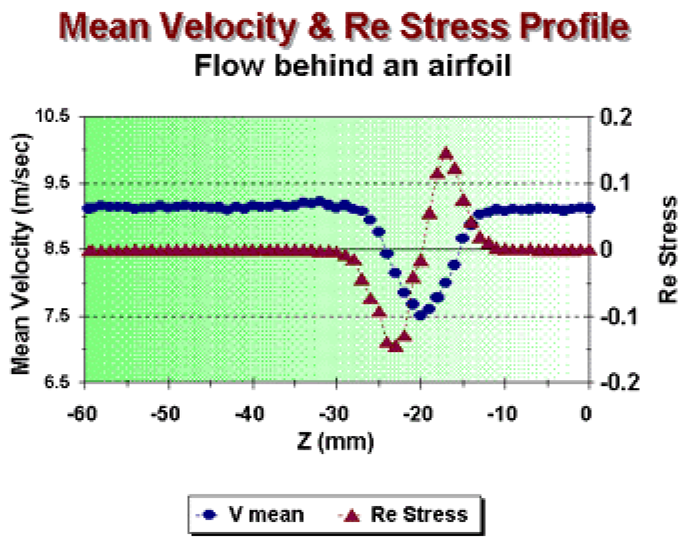


A three component LDV system was used to measure the flow field behind the airfoil. The airfoil was mounted in a wind tunnel about a horizontal axis and set to have an angle of attack of about 5 degrees. The measurements were carried out with a 5 Watt water-cooled argon-ion laser-based system to enable a high three channel coincident data rate from system. Two 83 mm fiberoptic probes allow flexibility in third component resolution. The measuring volume was traversed in a vertical plane to get the velocity variation. Using both the Fourier transform (FFT) and autocorrelation techniques, TSI's FSA signal Processor provides the highest possible resolution of measured velocity data. This should be a key factor in choosing a LDV system to be used for measurement of turbulence statistics and correlations.

The free stream velocity of the air flow was about 9.5 m/sec. The flow was seeded using water droplets. The LDV system was operated in the coincidence mode to measure all three components of velocity simultaneously.

Results

The variation of the axial velocity mean (V_{mean}) plotted as a function of Z shows the velocity defect in the wake field behind the airfoil. All three components of velocity were also measured. The spanwise (w) and the vertical (u) components of velocity were significantly smaller than the streamwise velocity. The figure also shows the variation of the Reynolds stress component (u'v') contributed by the u' and the v' fluctuations.



From these measurements all the higher order statistics, including Reynolds stress values, were calculated. The FlowSizer™ system software package, included with the FSA signal processor, is used for data acquisition and analysis. Optional XPD60 beam expanders can be used when the measurement distance (stand-off) is greater than about 500mm. This will maintain a favorable f# and this signal quality and data rates will be high.

Comments

These results show the ability of the LDV system to measure velocity very accurately so that mean velocities as well as higher order statistics (e.g., Reynolds stress) can be obtained accurately.

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