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INVESTIGATION OF GRID GENERATED TURBULENCE IN AN AERO-ACOUSTIC WIND TUNNEL

Abstract

Grid generated turbulence, when properly devised, is the simplest of physically realizable homogeneous and isotropic turbulent flow that provides researchers a fundamental way of getting deep insight into as well as modeling practical turbulent flows.

Free decaying turbulence flows generated by a regular grid with blockage ratio of 29.44% at two different inlet velocity (20m/s and 25m/s respectively) are experimentally investigated in a small low-noise aero-acoustic wind tunnel. All data are taken with a two component hot-wire anemometer, which operating in constant-temperature mode (CTA), at the centerline. The measurement zone range from 2.6M to 13.6M downstream the grid (M is the grid mesh size). Measurement uncertainties, based on the standard deviation of 90 data records for each measurement location, are estimated to be less than 3%.

According to centerline profile of mean streamwise velocity, it is found that the mean streamwise velocity decrease quickly as the fluid leaves the grid, which reveals a jet like region right after the grid. Close to collector, however, the mean streamwise velocity increase slightly.

Both streamwise and spanwise turbulence intensity downstream the grid decreases as the inlet velocity decreases. A peak can be find at the centerline profiles of both streamwise and spanwise turbulence profile, which reveals the existence of turbulence production and turbulence dissipation downstream the grid. It is also find that the downstream position of peak of turbulence intensity moves closer to the grid as inlet velocity increases.

All power spectral density (PSD) of both streamwise and spanwise velocity fluctuations exhibits a power-law close to -5/3 at medium frequency region and a fast decaying characteristic at high frequency region. At low frequency region, nevertheless, PSD results show that the measurements are disturbed by a low frequency signal (around 10Hz) at downstream positions far away from the regular grid.

Taylor micro-scale(λ), streamwise integral length scale(l) and local Reynolds number (Re=$\sqrt{k}\lambda/\nu$, k is the turbulence kinetic energy) are also calculated. It is find that the distribution of Taylor micro-scale under is parabolic, and higher inlet velocity produce smaller Taylor micro-scale. Streamwise integral length scale and local Reynolds number decreases as the measurement position moves downstream the grid. Both streamwise integral scale and local Reynolds number increase as inlet velocity increases.