PIV Measurements of Cross-flow Velocity field in the Near Wake of a Pickup Truck

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SUMMARY

The flow in the near wake of pickup trucks is characterized by the interaction of separated shear layers from the cab with the bed surfaces and the tailgate. In a previous report, we examined the flow in the near wake of a pickup truck at three vertical and horizontal planes. Results show a relatively quiet region behind the cab and strong downwash at the symmetry plane. This downwash is believed to be due to the existence of strong streamwise vorticity field. Thus, this experimental investigation has been conducted to identify streamwise vortex structures in the near wake of a pickup truck using Particle Image Velocimetry (PIV). Of particular interest and complexity are the symmetric and asymmetric separated vortex flows which develop behind the cab and the tailgate. A secondary objective of the research is to obtain a comprehensive experimental data set for validation of CFD models. The experiments were conducted at moderate Reynolds numbers (~3×105) in the open return wind tunnel at the University of Michigan, which is equipped with a state-of-the-art two-frame digital PIV system. The PIV measurements of the velocity field normal to the freestream behind the cabin and tailgate have been obtained at four streamwise locations. The PIV data are processed to obtain not only the instantaneous velocity field but also the mean flow and turbulence properties by averaging 300 instantaneous realizations. The instantaneous PIV data show coherent vortex structures that move randomly in space and time. The mean velocity in the near wake of the cabin shows a pair of vortices that originate from the separated cab shear layer. These vortices travel downstream and interact with the upper edge of the tailgate near the symmetry plane. This results in strong pressure fluctuations at the tailgate edge as verified in the previous study. Moreover, the velocity data in the near wake of the tailgate shows a strong pair of contra-rotating vortices that induce strong downwash at the symmetry plane. This downwash promotes attached flow behind the tailgate, thus generating a pressure recovery that is drag reducing. Another weaker pair that may result from the interaction of the cab shear layer with the tailgate appear above the stronger pair and rotates opposite to it. Detailed mean velocity profiles at the four normal planes and a comparison with the data at the symmetry and horizontal planes are reported.