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Computational Fluid Dynamics Design and Analysis of Aerodynamic Drag Reduction Devices for a Mazda T3500 Truck

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Abstract : In highway driving, over 50 percent of the power produced by the engine is used to overcome aerodynamic drag, which is a force that opposes a body's motion through the air. Aerodynamic drag and thus fuel consumption increase rapidly at speeds above 90kph. It is desirable to minimize fuel consumption. Aerodynamic drag reduction in highway driving is the best approach to minimize fuel consumption and to reduce the negative impacts of greenhouse gas emissions on the natural environment. Fuel economy is the ultimate concern of automotive development. This study aims to design and analyze drag-reducing devices for a Mazda T3500 truck, namely, the cab roof and rear (trailer tail) fairings. The aerodynamic effects of adding these append devices were subsequently investigated. To accomplish this, two 3D CAD models of the Mazda truck were designed using the Design Modeler. One, with these, append devices and the other without. The models were exported to ANSYS Fluent for computational fluid dynamics analysis, no wind tunnel tests were performed. A fine mesh with more than 10 million cells was applied in the discretization of the models. The realizable k-ε turbulence model with enhanced wall treatment was used to solve the Reynold's Averaged Navier-Stokes (RANS) equation. In order to simulate the highway driving conditions, the tests were simulated with a speed of 100 km/h. The effects of these devices were also investigated for low-speed driving. The drag coefficients for both models were obtained from the numerical calculations. By adding the cab roof and rear (trailer tail) fairings, the simulations show a significant reduction in aerodynamic drag at a higher speed. The results show that the greatest drag reduction is obtained when both devices are used. Visuals from post-processing show that the rear fairing minimized the low-pressure region at the rear of the trailer when moving at highway speed. The rear fairing achieved this by streamlining the turbulent airflow, thereby delaying airflow separation. For lower speeds, there were no significant differences in drag coefficients for both models (original and modified). The results show that these devices can be adopted for improving the aerodynamic efficiency of the Mazda T3500 truck at highway speeds.

Keywords : aerodynamic drag, computation fluid dynamics, fluent, fuel consumption
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