Feasibility of Simulating External Vehicle Aerodynamics Using Spalart-Allmaras Turbulence Model with Adjoint Method in OpenFOAM and Fluent

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Abstract : The study of external vehicle aerodynamics using Spalart-Allmaras turbulence model with adjoint method was conducted. The accessibility and ease of working with the Fluent module of ANSYS and OpenFOAM were considered. The objective of the study was to understand and analyze the possibility of bringing high-level aerodynamic simulation to the average consumer vehicle. A form-factor of BMW M6 vehicle was designed in Solidworks, which was analyzed in OpenFOAM and Fluent. The turbulence model being a single equation provides much faster convergence rate when clubbed with the adjoint method. Fluent being commercial software still does not allow us to solve Spalart-Allmaras turbulence model using the adjoint method. Hence, the turbulence model was solved using the SIMPLE method in Fluent. OpenFOAM being an open source provide flexibility in simulation but is not user-friendly. It supports solving the defined turbulence model with the adjoint method. The result generated from the simulation gives us acceptable values of drag, when validated with the result of percentage error in drag values for a notch-back vehicle model on an extensive simulation produced at 6th ANSA and µETA conference, Greece. The success of this approach will allow us to bring more aerodynamic vehicle body design to all segments of the automobile and not limiting it to just the high-end sports cars.

Keywords : Spalart-Allmaras turbulence model, OpenFOAM, adjoint method, SIMPLE method, vehicle aerodynamic design

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