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Evaluation of Wall Models for Internal Combustion Engines using Direct Numerical Simulation[1] MUHSIN AMEEN, SAUMIL PATEL, Argonne National Laboratory — Accurate modeling of the mass, momentum and energy transfer processes in the near-wall boundary layer region are critical to capture the internal combustion engine processes such as combustion phasing, wall heat loss and wall film formation. In multi-dimensional engine simulations, the grid requirements for accurately resolving the boundary layers are too expensive and hence wall models are employed which specify the wall shear stress and wall heat transfer using empirical correlations. The accuracy of these correlations for realistic engine simulations have not been analyzed in detail due to lack of experimental or high-fidelity simulation results. In the current study, we performed direct numerical simulations (DNS) of the Transparent Combustion Chamber (TCC-III) optical engine under motored operating conditions. Nek5000, a leading high-order spectral element code, was used to perform these simulations. The simulation results were used to evaluate and improve the accuracy of traditionally used wall models. The analysis was performed across a range of near-wall grid sizes. The improved wall models developed as part of this work can be used to perform accurate wall-modeled large eddy simulations (LES) at significantly lower computational expense as compared to wall-resolved LES.

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