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Coupling Between Turbulent Boundary Layer and Radiative Heat Transfer Under Engine-Relevant Conditions[1] A SIRCAR, C PAUL, S FERREYRO, A IMREN, D C HAWORTH, Penn State, S ROY, W GE, M F MODEST, UC Merced — The lack of accurate submodels for in-cylinder radiation and heat transfer has been identified as a key shortcoming in developing truly predictive CFD models that can be used to develop combustion systems for advanced high-efficiency, low-emissions engines. Recent measurements of wall layers in engines show discrepancies of up to 100% with respect to standard CFD boundary-layer models. And recent analysis of in-cylinder radiation based on recent spectral property databases and high-fidelity radiative transfer equation (RTE) solvers has shown that at operating conditions typical of heavy-duty CI engines, radiative emission can be as high as 40% of the wall heat losses, that molecular gas radiation can be more important than soot radiation, and that a significant fraction of the emitted radiation can be reabsorbed before reaching the walls. That is, radiation changes the in-cylinder temperature distribution, which in turn affects combustion and emissions. The goal of this research is to develop models that explicitly account for the potentially strong coupling between radiative and turbulent boundary layer heat transfer. For example, for optically thick conditions, a simple diffusion model might be formulated in terms of an absorption-coefficient-dependent turbulent Prandtl number.

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