Proceedings of CHT-15
ICHMT International Symposium on Advances in Computational Heat Transfer

May 25-29, 2015, Rutgers University, Piscataway, USA

CHT-15-234

COMPUTATIONAL COST AND ACCURACY COMPARISON OF RADIATION SOLVERS WITH EMPHASIS ON COMBUSTION SIMULATIONS

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ABSTRACT A systematic comparison of cost and accuracy of three types of RTE solvers – photon Monte Carlo (PMC), discrete ordinates, and spherical harmonics – were carried out on an artificial optically-intermediate nonpremixed turbulent jet flame. Up to 16 polar and 32 azimuthal ordinates for discrete ordinates, up to the seventh-order of spherical harmonics (P_N) method, and third- and fifth-order simplified spherical harmonics (SP_N) methods were used in the current study. The PMC solver was used for benchmarking all other solvers. The discrete ordinate method (DOM) solver converged at as low as four polar and azimuthal ordinates. The P_N solver, on the other hand, showed rapid increase in accuracy with increase in order. Computational cost of the P_N method increases quadratically with its order, whereas cost increase was found to be linear with increase in ordinate resolution for DOM. Computational memory requirement for DOM was found to be higher than for P_N and is expected to become a bottleneck in complex combustion simulations.