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COMPARISON OF VARIOUS RANS MODELS FOR CONJUGATE TURBULENT NATURAL CONVECTION WITH RADIATION IN A CAVITY

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ABSTRACT In this study conjugate turbulent natural convection with radiation transfer in a three-dimensional air-filled differentially heated cavity is numerically investigated using various RANS (Reynolds Averaged Navier-Stokes) turbulence models. The purpose is to evaluate the accuracy of five different two-equation eddy-viscosity models including the standard k-ε model, the renormalization group (RNG) k-ε model, the realisable k-ε model, the standard k-ω model and the shear-stress transport (SST) k-ω model. The numerical results are compared against experimental and DNS (direct numerical simulations) data. The present results show that all the five RANS models are capable of capturing the main features of the flow and the overall performance of these turbulence models in terms of predicting time-averaged quantities is acceptable. It is found that the variation between the three k-ε models is very small, whereas the discrepancy between the two k-ω models is significant. The SST k-ω model has the best performance in terms of predicting time-averaged temperature and velocity profiles. All the RANS models produce similar results of the local and the average Nusselt numbers along the hot wall, which agree well with experimental measurements and DNS results. The standard k-ω model has the worst overall performance.