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DYNAMIC MODELING OF HEAT TRANSFER IN THERMAL-ACOUSTIC FATIGUE TESTS OF HYPERSONIC AND RE-ENTRY VEHICLES

Abstract

Rapid prediction of heat transfer is important for the development of hypersonic and re-entry vehicles. In particular, during the development, thermal-acoustic fatigue tests contain tight coupling between fluid and thermal fields and radiation. To obtain this capability, a lumped element model is developed in this work by using control oriented modeling methods, based on the corresponding physical principles. The accuracy of this model is verified by comparing to experimental and computational results. The rapid prediction capability of this model is thereafter revealed by studying various test cases. The results show that this modeling strategy clarifies the unsteady process of heat transfer in this tightly coupled physical system. The proposed method could be beneficial for a host of thermal-acoustic test applications of various aerospace vehicles.