

Fast computational algorithm for actively cooling TPS based on sub-structure BEM

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Abstract

With the fast development of hypersonic aircrafts, the traditional passive TPS can't afford the increasing demand of the thermal protection for aircrafts and engines. As a result, the actively cooling TPS has received more and more attentions. The popularly used technologies do require a substantially much more time due to the complexity of the structures. For the purpose of predicting the thermal and mechanical coupling analysis in active cooling TPS accurately and effectively, a novel boundary element method is proposed in this paper based on the sub-structure method. In this method, only the boundary model of one cell element containing one channel in actively cooling TPS should be built and the variables on the common boundaries between the two cell elements can be eliminated. The resulted coefficient matrix only contains the outer boundary variables of the sub-structure as unknowns. The coefficient matrix of the cell element was be evaluated only once and the final equation only concerns the outer boundary nodes of the TPS without inner channels, so the efficiency of this new method is much higher than traditional ones. A numerical example for an actively cooling combustor of scramjet engine is presented to verify the accuracy and efficiency of this method based on thermal and mechanical coupling analysis. The comparison of the computational results from the method of this paper to those from the FEM commercial ANSYS shows the potential of the proposed method.

Keywords: Actively cooling channels, Boundary element method, Sub-structure method, Fast computational algorithm