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LIFE TIME EVALUATION OF REUSABLE FILM-COOLING JACKET OF RAMJETS UNDER THERMAL SHOCK CONDITION

Abstract

Ramjet, TBCC and RBCC may be used as the main propulsion engines for the next generation cruise vehicles. The engines are expected to be reusable and it makes the reliability and life time evaluation as the critical design factor for this kind of engines. Thermal shock fatigue is one of the main damage modes in film-cooling jacket of a ramjet combustion chamber. Thermal shock means the high-level thermal stresses generated as a result of significant temperature gradients which occur during engine start-up, shut-down and thermal transient conditions. Therefore, determination of the jacket temperature field distribution and the precise thermal structure analysis of corresponding structure stress and strain are the key for life time estimation. An analytical procedure called multi-physics coupled simulation is conducted in this paper and it is focused on simulating thermo-fluid behavior in the cooling passage and thermal structure response of the chamber jacket simultaneously. On the basis of the multi-physics coupled simulation, the mechanism of the jacket deformation observed in the firing test is discussed. The life time of the jacket structure under the testing condition has been predicted based on a cumulative fatigue damage rule. Some simulation results were compared with the date measured during engine hot tests.