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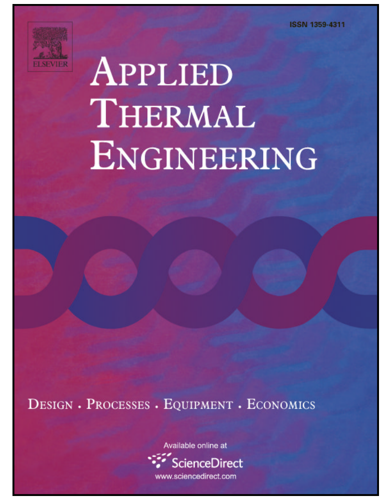

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Inverse analysis for simultaneously estimating multi-parameters of temperature-dependent thermal conductivities of an Inconel in a reusable metallic thermal protection system

Miao Cui*, Yi Zhao, Bing-bing Xu, Shengdong Wang, Xiao-wei Gao

State Key Laboratory of Structural Analysis for Industrial Equipment, Dalian University of Technology, Dalian 116024, P.R. China

Abstract

Metallic materials such as an Inconel and an alloy steel play very important roles for bearing in the reusable metallic thermal protection system (TPS) for a hypersonic aircraft. Accurate determination of temperature-dependent thermal conductivities of these metallic materials is a key issue for both design and optimization of the TPS, which determines transient temperature field and further thermal stress distribution. However, it is very difficult to directly measure these temperature-dependent thermal conductivities with high temperatures, or analytically calculate them. Inverse problems provide new insights for accurately determining temperature-dependent thermal conductivities of these materials with high service temperatures, by using additional temperature measurements. In the present work, multi-parameters of temperature-dependent thermal conductivities of an Inconel in a reusable metallic TPS are simultaneously estimated by solving a transient nonlinear inverse heat conduction problem (IHCP). The Levenberg-Marquardt (LM) algorithm, the conjugate gradient method (CGM) and the Least-squares (LS) method are employed for the solution. The accuracy, the efficiency, the robustness and the convergence stability of these three methods for estimating temperature-dependent thermal conductivities of the Inconel are investigated in detail. A relaxation factor is introduced into a LM algorithm for the first time, attributed to which the convergence stability of the LM algorithm is improved.