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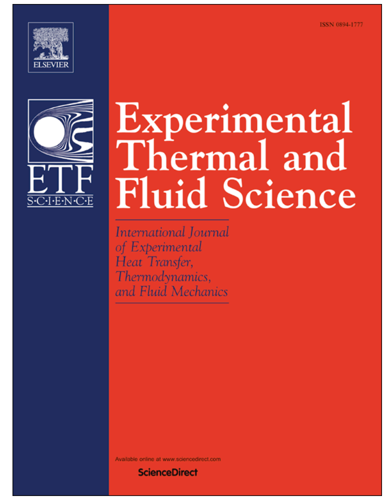

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Surya Kumar, Andallib Tariq

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Determination of thermal contact conductance of flat and curvilinear contacts by transient approach

Surya Kumar, Andallib Tariq[1]
Department of Mechanical and Industrial Engineering,
Indian Institute of Technology Roorkee,
Roorkee, Uttarakhand-247667, INDIA

ABSTRACT

Accurate knowledge of the thermal contact conductance (TCC) across fixed metallic contacts of flat-flat as well as curvilinear surfaces is becoming vital for the safety and performance in the critical fields like nuclear energy production, thermal management of electronics packaging, aviation sector, etc. In this regard, a steady state methodology is well acceptable as a reliable approach for estimating the TCC for specimen under pressed contact conditions, which requires long hours of experimental run. Whereas, a transient methodology aims to determine the time varying estimate of TCC or the heat flux related with the specific application areas requires a very short duration experiment. Research works on the estimation of TCC through transient methods are available for only flat-flat contacts. Moreover transient methods have seldom been used for estimating the steady state TCC. Present investigation systematically explore and develop a better understanding of transient methodology towards estimating TCC between flat-flat as well as curvilinear metallic contacts under consistent loading conditions by using the inverse analysis. A sequential function estimation algorithm based on the analytical solution for a semi-infinite body has been used for solving inverse heat conduction problem (IHCP), and subsequently, the transient TCC is determined by using an estimated transient heat flux and an instantaneous temperature jump at the interface. Firstly, the inverse problem has been tested by a numerically generated measurement. Later a customized experimental facility has been used to conduct transient, as well as steady state experiments for flat-flat, cylinder-flat and cylinder-cylinder configurations under similar working parameters. Experimental results of transient heat flux show a quasi-static thermal equilibrium at the end of test run, which form the basis to successfully extract the steady-state TCC measurement with greater reliability. An under prediction in transient TCC up to 60 % is found to be inevitable, if compared against the steady state TCC estimate based upon the linearly extrapolated temperature drop measurements of each contacting specimens. However, a close agreement between the stabilized transient TCC and the steady state TCC has been observed, when steady TCC values are directly based upon the actual interfacial temperature drop measurements without any extrapolation. Eventually, this work establishes the viability of present transient approach in suitably predicting the steady state TCC values of different contact configurations.

Keywords: Thermal contact conductance (TCC), Inverse heat transfer, Transient heat flux, Transient TCC, Steady state TCC, Curvilinear contact.

[1] Corresponding author. Tel.: +91-1332-285728; fax: +91-1332-285665
E-mail address: tariqfme@iitr.ac.in