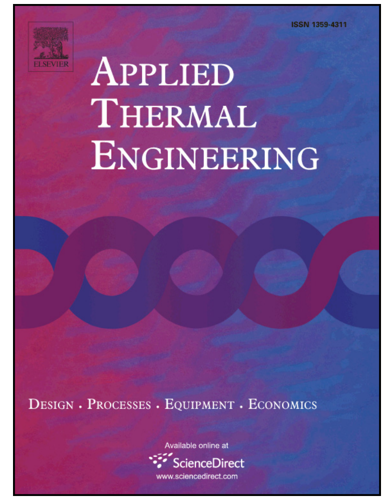

Inverse Estimation of Heat Flux from a Hollow Cylinder in Cross-flow of Air

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Inverse Estimation of Heat Flux from a Hollow Cylinder in Cross-flow of Air

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Abstract:

The heat flux at the surface of an initially heated cylinder under the cross-flow of air has been investigated. The aim is to propose an inverse heat conduction method to avoid expensive measuring processes or that eliminates difficulties in direct measurements such as applying the sensors directly to the surface which may either burn it or affects the flow field. In addition, to develop empirical correlations to predict local and average heat transfer from a cylinder under subcritical range of Reynolds number $1.1\text{x}10^4 \leqslant Re \leqslant 6.2\text{x}10^4$. The inverse method makes use of Levenberg-Marquardt approach for parametric estimation to determine the surface heat flux. It requires the computation of sensitivity matrix, which has been computed by using the Duhamel's theorem. An analysis of heat transfer data obtained from the proposed inverse method and the predictions from the developed empirical correlations revealed an average deviation of less than 1% compared to reported literatures.

Keywords: *Inverse method; Sensitivity matrix; Duhamel's theorem; Nusselt number; cylinder.*

Introduction

A crosswise flow past circular cylinders is a typical configuration in heat exchangers like radiators and condensers, chemical and food industry processes, reactors, recuperators, etc. and the available literatures have significant information on heat transfer under this configuration. The empirical correlations for the average heat transfer reported in earlier studies, have mainly emphasized on Prandtl number (*Pr*) of the fluid in a typical power law correlation expressed as $Nu=\boldsymbol{C}\,Re^{\boldsymbol{m}}\,Pr^{\boldsymbol{n}}$. The investigation emphasizing on the power index $\boldsymbol{m}$ of *Re* as well as constant $\boldsymbol{C}$ is still unheeded. Almost in all the reported correlations, the effects of *Pr* on heat transfer over the front and the rear portions of the cylinder are similar, while the power index $\boldsymbol{n}$ of *Pr* varies as $Pr^{0.3}$ to $Pr^{0.4}$. For air, this range of $\boldsymbol{n}$ produces negligible effect on heat transfer. The Table1 shows some power law correlations, reported in experimental studies conducted on the heat transfer contributions from the front and rear portions of the cylinder.