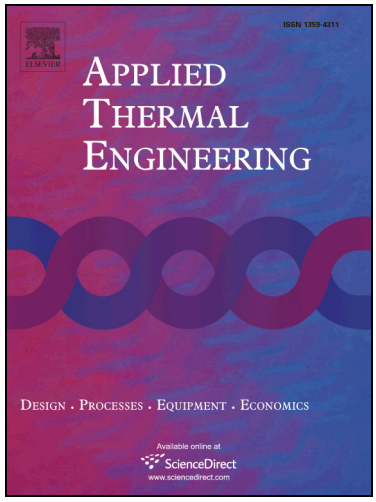

Performance evaluation of multi-layered porous-medium micro heat exchangers with effects of slip condition and thermal non-equilibrium

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PII: S1359-4311(16)33140-4
DOI: http://dx.doi.org/10.1016/j.applthermaleng.2016.12.090
Reference: ATE 9710

To appear in: *Applied Thermal Engineering*

Received Date: 7 November 2016
Revised Date: 9 December 2016
Accepted Date: 16 December 2016

Please cite this article as: H. Xu, Performance evaluation of multi-layered porous-medium micro heat exchangers with effects of slip condition and thermal non-equilibrium, *Applied Thermal Engineering* (2016), doi: http://dx.doi.org/10.1016/j.applthermaleng.2016.12.090

Performance evaluation of multi-layered porous-medium micro heat exchangers with effects of slip condition and thermal non-equilibrium

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Abstract

Porous-medium micro heat exchanger can be employed for dissipating heat in high heat flux applications. In this work, thermal performance of multi-layered micro heat exchangers with porous medium is theoretically studied. Forced convective heat transfer in porous microchannel is analytically investigated by considering the velocity/thermal slips at the wall. With the local thermal non-equilibrium (LTNE) model, analytical solutions for velocity and solid/fluid temperatures are obtained. Thermal resistance network method is presented for thermal transport in porous micro heat exchangers with the temperature jump thermal resistance. Based on the analytical solution, thermal performance of multi-layered porous-medium micro heat exchangers is evaluated for counter-flow (CF) and parallel-flow (PF) arrangements in terms of the local temperature distribution, log mean temperature difference, and effectiveness. It is found that the Nusselt number of porous microchannel first increases and then decreases with an increase in Knudsen number. The performance evaluation criteria (PEC), integrating flow resistance and heat transfer, is employed for evaluating thermal performance of porous microchannel. A maximum PEC, corresponding to an optimal pore density, exists with the increased pore density. Thermal performance of micro heat exchanger with porous medium is much better than that without porous medium, and the CF heat transfer is superior to the PF heat transfer. This work is useful for analysis in porous microchannels and design of micro heat exchangers with porous materials.

Keywords: forced convection; slip phenomena; porous media; micro heat exchanger; performance evaluation

Nomenclature

a_{sf} Specific surface area, m^{-1}