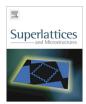


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## Conjugate heat transfer with rarefaction in parallel plates microchannel



Yassine Kabar a,\*, Rachid Bessaïh b, Mourad Rebay c

- <sup>a</sup> Université de Jijel, Laboratoire d'Energétique Appliquée et des Matériaux, Faculté des Sciences et de la Technologie, BP. 96, 18000 Jijel, Algeria
- <sup>b</sup> Université Constantine I, Laboratoire d'Energétique Appliquée et de Pollution LEAP, Faculté des Sciences de la Technologie, Route de Ain el Bey, 25000 Constantine, Algeria
- <sup>c</sup> Université de Reims Champagne-Ardenne, GRESPI/Laboratoire de Thermomécanique, Faculté des Sciences, BP. 1039, 51687 Reims, France

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#### ABSTRACT

In this paper, we study numerically the effects of axial wall conduction and rarefaction in parallel plates microchannel. The simultaneously developing laminar flow with a constant heat flux (H2) boundary condition will also be considered. The finite volume method is used to solve the two-dimensional Navier–Stokes and energy equations, with slip velocity and temperature jump boundary implemented at the fluid/solid interface. The results obtained by our computer code are compared to the analytical results found in the literature. For different Knudsen number Kn, thermal conductivity ratio K and dimensionless thickness E, the influence of axial conduction is demonstrated for Kn = 0, especially for large values of K and E. Concerning slip-flow, the effect of axial conduction proved to be negligible for all values of K and E.

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#### 1. Introduction

The use of micro-channels for removal heat is undertaking a great interest in various industrial fields, such as electronics, micro heat exchangers and bio-engineering. This type of cooling offers high performances in heat transfer. However, to conceive and manufacture such channels, it is necessary to understand and characterize flows as well as heat transfer in micro-scale heat transfer problems. It is also important to examine the interaction of convective heat transfer in the fluid with conduction in

<sup>\*</sup> Corresponding author. Tel.: +213 34 50 14 00; fax: +213 34 50 35 35. E-mail address: kabar\_yassine@yahoo.fr (Y. Kabar).

```
Nomenclature
          coefficient in the discretization equation
а
b
          source term in the discretization equation
Сp
          specific heat (I/kg K)
D_h
          hydraulic diameter (m)
          dimensionless thickness of the plate
Е
Н
          height of microchannel (m)
          heat transfer coefficient (W/m<sup>2</sup> K)
h
K
          thermal conductivity ratio K = k_s/k_f
k
          thermal conductivity (W/m K)
          Knudsen number Kn = \lambda/D_h
Kn
I.
          length (m)
          Nusselt number
Nu
Nu_x
          local Nusselt number
          dimensionless pressure
          pressure (N m<sup>-1</sup>)
р
Pe
          Péclet number Pe = Pr-Re
Po
          Poiseuille number Po = f Re
Pr
          Prandtl number
          heat flux (W/m<sup>2</sup>)
q_0
          dimensionless heat flux at the interface
q
q^*
          normalized heat flux q^* = q/q_m at the interface
          Reynolds number Re = \rho u_m D_h / \mu
Re
Τ
          temperature (K)
U. V
          dimensionless velocity
          velocity components in Cartesian coordinates (m s<sup>-1</sup>)
u, v
          dimensionless axial coordinate X^* = x/PeD_h
X*
X^{+}
          dimensionless axial coordinate X^+ = x/ReD_h
          Cartesian coordinates (m)
x, y
Υ
          dimensionless coordinate
          ratio of accommodation coefficient
β
γ
          heat capacity ratio
          thickness of the plate (m)
4
          dimensionless temperature
\theta
          molecular mean-free-path (m)
λ
μ
          viscosity dynamic (kg/m s)
          density (kg/m<sup>3</sup>)
ρ
          shear stress (N/m<sup>2</sup>)
τ
\sigma_T
          thermal accommodation coefficient (\sigma_T = 1)
          momentum accommodation coefficient (\sigma_v = 1)
\sigma_v
          independent variable
Subscripts
b
          Bulk
          Fluid
N, S, E, W neighboring grid points
in
          inlet
int
          interface
          mean
m
          solid
S
slip
          slip
          wall
```

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