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The Effect of Aspect Ratio and Temperature-dependent Fluid properties of Effective Parameters in Micro Heat Exchanger

ABSTRACT

In this work a rectangular micro heat exchanger with constant hydraulic diameter at various aspect ratios was considered. The pressure drop and thermal parameters of the micro heat exchanger in laminar flow at different Reynolds numbers (25, 50, 100, 150, 225 and 300) at constant heat flux of 0.3 MWatt/m^2 were analyzed and compared. Also, the effect of temperature-dependent fluid properties (viscosity, conductivity coefficient) on the pressure drop and the average and maximum temperature rise of fluid and thermal resistance of micro heat exchanger were investigated. Finally, a new criterion based on pumping power and transmitted heat per temperature gradient unit was proposed as a tool to evaluate micro heat exchangers' performance.

KEYWORDS: Micro exchanger, Re Number, Aspect Ratio, Heat flux, Hydraulic Diameter.

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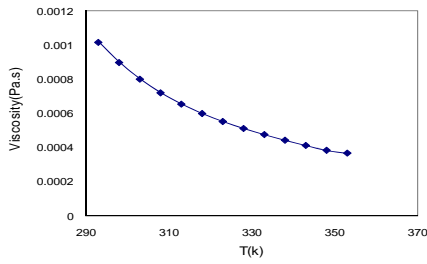
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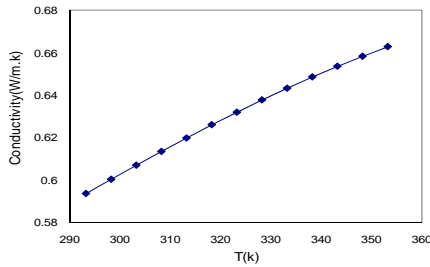
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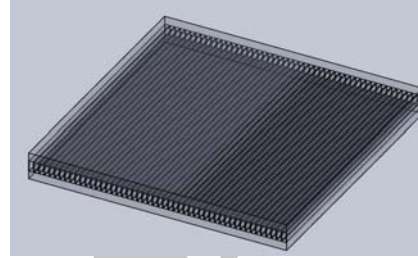
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LGA775 P4 Intel

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$$k(T) = 4.161838e - 7T^2 - 3.846472e - 4T + 1.7656953e - 2$$

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$$\frac{\partial \rho}{\partial t} + \frac{\partial(\rho u_i)}{\partial x_i} = 0$$

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$$\frac{\partial(\rho u_i)}{\partial t} + \frac{\partial(\rho u_i u_j)}{\partial x_j} = \frac{\partial}{\partial x_j} \left(\mu \frac{\partial u_i}{\partial x_j} \right) - \frac{\partial p}{\partial x_i} + s_i$$

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$$\frac{\partial(\rho C_p T)}{\partial t} + \frac{\partial(\rho C_p u_j T)}{\partial x_j} = \frac{\partial}{\partial x_j} \left(\mu \frac{\partial T}{\partial x_j} \right) + s$$

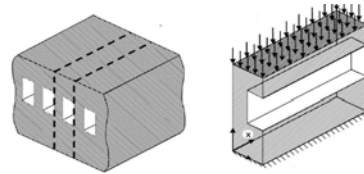
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$$\mu(T) = 1.532244 e - 7T^2 - 1.094678 e - 4T + 1.989050 e - 2$$

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- $\dot{m} = 8.11e-6 \text{ kg/Sec}$ @ Channel inlet
- $T = 293 \text{ K}$ @ Channel outlet
- $\frac{\partial}{\partial x} = 0$ @ Channel bottom
- $\dot{q} = \tau e \Delta \frac{W}{m^2}$ @ Top wall
- $\dot{q} = \cdot \frac{W}{m^2}$ @ Top wall
- $\frac{\partial}{\partial y} = 0$ @ Side wall

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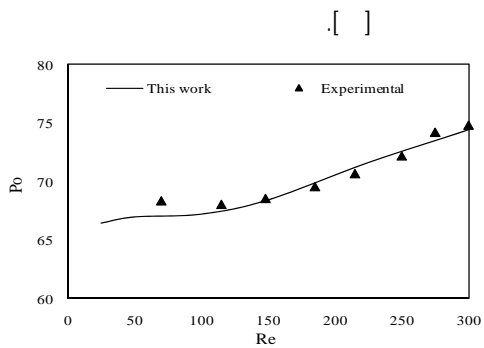
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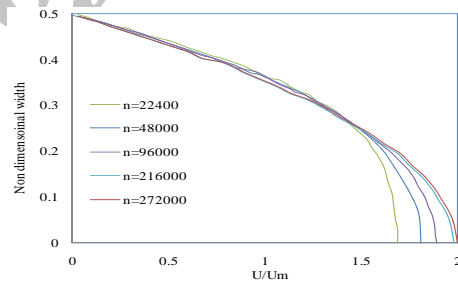
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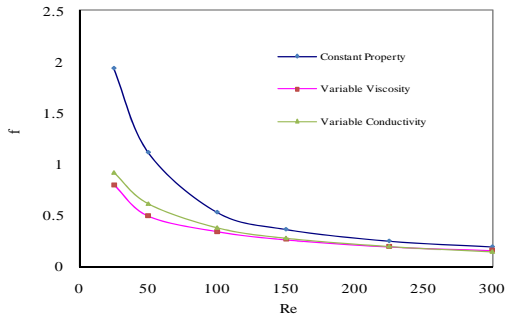
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$$\left(\frac{\partial}{\partial x} = 0\right)$$

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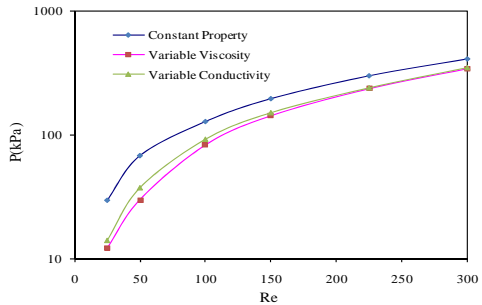
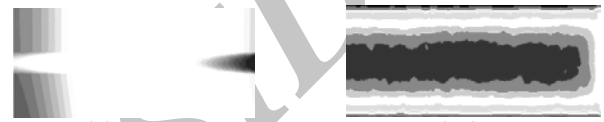
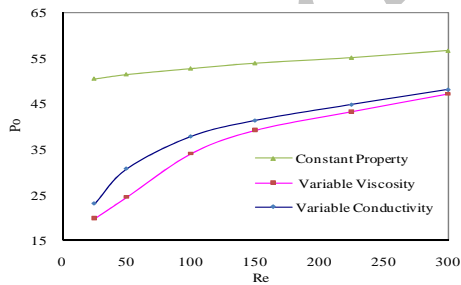


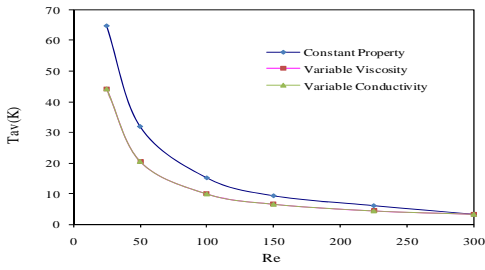
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$$f = \frac{8\Delta P}{\rho u_m^2 L/D}$$

$$Po = f \cdot Re = 64$$

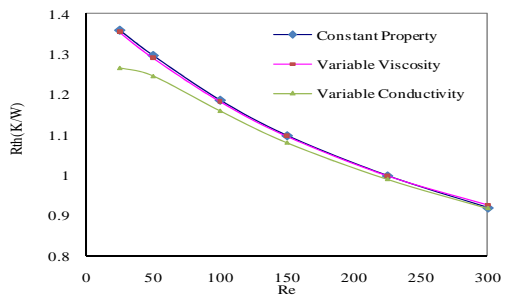




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$$R_{th} = \frac{T_f - T_b}{q} \quad ()$$

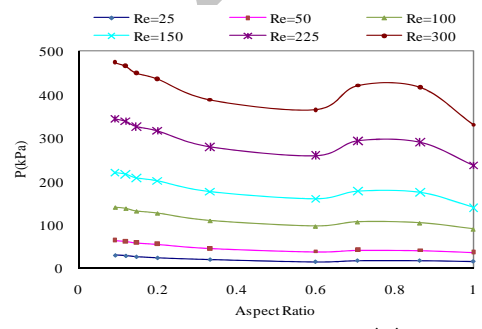
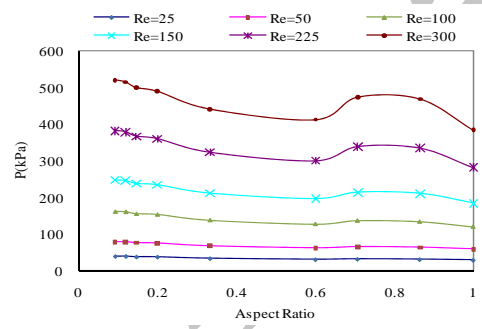
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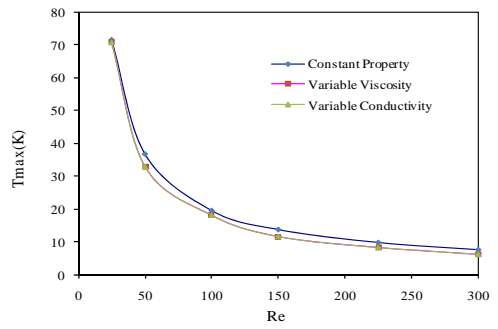
$$q = hA\Delta T \quad ()$$

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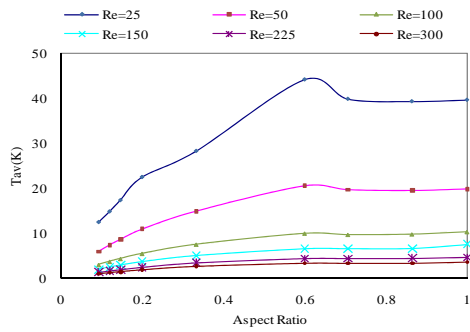
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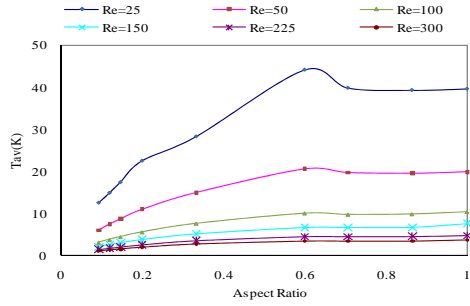


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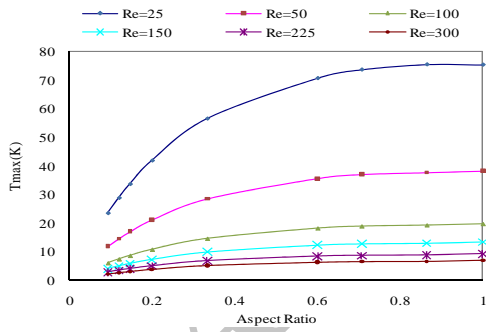
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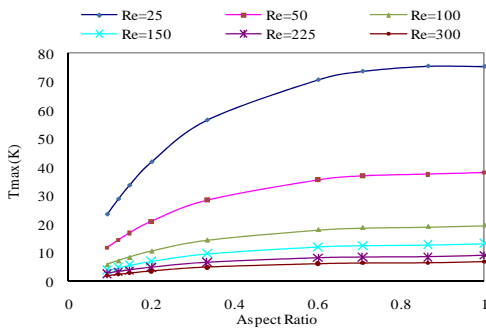
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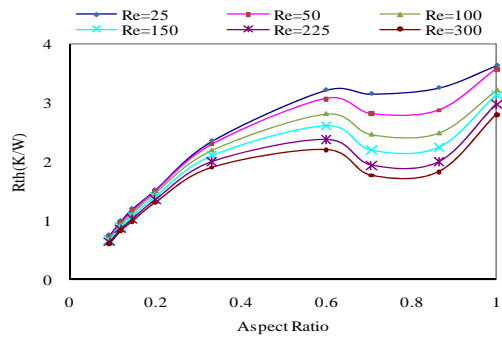


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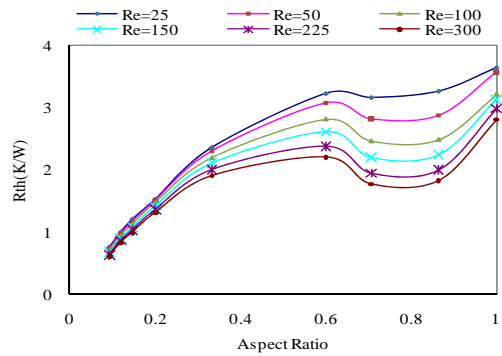
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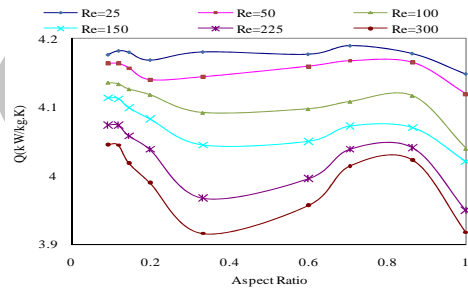
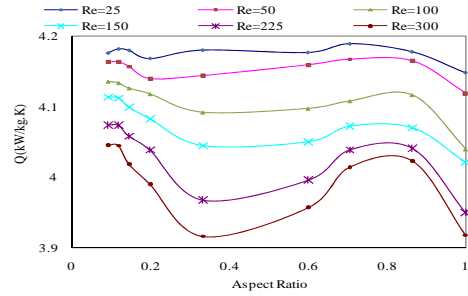
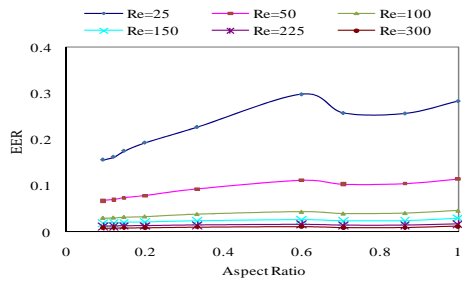
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$$EER = \frac{\dot{q}}{\Delta P} \quad (1)$$

$$\dot{q} = \frac{q/\dot{m}}{T_{av}} \quad (2)$$



$$w = \dot{v}\Delta P \quad (3)$$



ΔP_f
 Re
 Po
 ΔT
 q''
 \dot{q}
 q
 EER
 w

D_h
 L
 n
 \dot{m}
 \dot{v}
 ρ
 μ
 C_p
 k
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¹ Property Constant

² Variable Viscosity

³ Variable Conductivity

⁴ EER(Energy Efficiency Ratio)