International Journal of Engineering Applied Sciences and Technology, 2017
Vol. 2, Issue 4, ISSN No. 2455-2143, Pages 52-54
Published Online February-March 2017 in IJEAST (http://www.ijeast.com)

GEOMETRIC EFFECT AND SLIP FLOW ON MICROCHANNEL HEAT EXCHANGER A REVIEW

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ABSTRACT: The following review paper is based on the study of heat transfer in micro channel heat exchanger. This review paper contains slip flow effect on micro channel and influence of channel geometry. To increase the performance of micro channel some points like; slip flow effect on micro channel, influence of channel geometry etc. are important to consider.

KEYWORDS: **Micro channel, Heat transfer rate, Hydraulic diameter**.

I. INTRODUCTION:

In 1981,the two scientist Tuckerman and Pease[1] first proposed the concept of micro channel heat sinks. Micro channel has a higher heat transfer performance low to moderate pressure drops. It has smaller geometric size. In the comparison of conventional heat exchanger micro channel has lower coolant requirement and also micro channels are operated at low cost. Many researchers have explained micro channel with their own way, criteria. According to Mehendale et al [2] the description of micro channel on the basis of the hydraulic diameter are the followings bellow:

Micro heat exchanger: $1\ \mu m \le D_h \le 100\mu m$

Macro heat exchanger: $100\mu m \le D_h \le 1mm$

Compact heat exchanger: $1mm \le D_h \le 6mm$

Conventional heat exchanger: $D_h \ge 6mm$

According to the Serizawa et al [3] the criterion for classification of micro channels as follows:

$L \ge D_h$

Here, L=Laplace constant

D_h=Channel diameter

NOTE: To calculate channel Hydraulic diameter, we will use the following equation-

$D_h=4A/P$

Here, A=Cross –sectional area

P=Perimeter

According to Kandlikar and Grande [4] the classification of single-phase and two-phase heat exchanger by using the hydraulic diameter are the followings:

Microchnnels:$10\mu m \le D_h \le 200\mu m$

Minichannels-$200\mu m \le D_h \le 3mm$

Conventional channels: $D_h \ge 6mm$

II. LITERATURE SURVEY

Palm [5] described that the micro channels are heat exchanger, but the classical theories (Continuum approach) can't correctly predict the heat transfer and friction factor of micro channels. On the basis of Stefan's [6] description (Micro scale system) it is not suitable to differentiate micro and mini channels by a specific diameter every time.

The applications of micro system are increasing rapidly day by day. Micro fluidic systems have many applications like –

- Micro-flow pumps
- Heat exchangers
- Valves
- Thin film coating
- Combustion
- Micro-flow sensors and

- Bio medical and bio chemical analysis instruments [7,8].
- Micro channel mostly used in micro electro mechanical systems (MEMS).

Experiments conducted by Pfahler et al.[9] , Harley et al.[10] and Arkilic et al.[11] on the transport of gases and liquids in silicon micro-machined channels deals that conventional analyses are unable to predict flow rates in micron-sized devices with any degree of accuracy .

2.1 SLIP FLOW:

It is a phenomena which is related to wall of fluid flow. It is mentioned on the basis of assumption that slip is depend on shear stress at the wall but according to the performed experiments, it is also depends on the normal stress. After investigating it is said by Rao and Rajagopal [13] that the flow field is not fully developed and rectilinear flow is not achieved if the slip velocity depends on normal stress.

Errol B.Arkilc et al. [14] mentioned on the basis of their investigation the effect of the slip velocity on the mass flow prediction of Navier-Stokes equations.

Yu and Ameel [15] studied slip flow heat transfer in micro channel and mentioned that heat transfer increases, decreases and remains unchanged compared to no slip flow condition depending upon two dimension variables.

According to Gad –el –Hak[16] the conventional no slip boundary condition impose at a solid fluid interface will begin to break before the linear stress-strain relationship becomes invalid.

Hence, the studies about the slip and no slip boundary in the micro channel heat exchanger is very important.

2.2 INFLUENCE OF CHANNEL GEOMATRY:

Some different shaped micro channels are discussed with conclusion are the followings-

On the basis of experimental studies performed by Peng and Peterson[17] it is found that that cross sectional aspect ratio had significant influence on the convective heat transfer and pressure drop in laminar and turbulent flows.

Rachkovskij et al.[18] performed his studies on heat transfer in micro tube size and relative length. Their result shows when the size of tube then changes in heat transfer is also occurs. As the size of micro tube is decreased then the heat transfer is increased.

When Brandner et al [19] studied various micro structure cross flow heat exchangers, they comes to know that heat transfer can be enhanced by decreasing the hydraulic diameter of the micro channels.

According to Foli's et al.[20] approaches the combined CFD and analytical solution is used to optimize aspect ratio of channels. And the other approach demonstrate that performance of a micro channel depends on the operating conditions.

Ngo's et al [21] investigation is based on micro channel heat exchanger with S-shaped and zigzag fins. In this investigation he found that the micro channel with S-shaped provided 5-6 times lower pressure drop. According to the Mushtaq's et al [22] investigation on the counter flow heat exchanger with different channel cross sections like circular, squareetc.,the same volume of heat exchanger increase effectiveness and pressure drop due to increasing the number of channels. He also found the circular channels as a best performer.

In micro channel the impact of channel geometry can't be avoid. On the basis of above performed study we can conclude that it is very important to keep accurate size and shape for the design of the micro channel heat exchanger.

III. CONCLUSION:

In this review paper we have covered the factors like slip flow concept, effect of channel geometry affecting heat transfer in micro channel. With the help of above performed study we can conclude following-

1. Make such a type of micro channels which works on no slip condition as much as possible. But we can't ignore the effects of velocity –slip and temperature jump at the walls.
2. Above performed study examined the influence ofchannel geometry clearly (Shape and Size) on heat transfer performance. Circular shaped channels give best performance in case of counter flow micro channel heat exchanger.
3. These results are very important to design an efficient micro channel heat exchanger.

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