International Journal of Scientific Modern Research and Technology ISSN: 2582-8150
(Volume: 4, Issue: 3, Number: 8)

Enhancement of Heat Transfer in Microchannel with Twisted Tape Insert: A Perspective Review

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Abstract- - The main aim is to compare the heat transfer rate, axial wall shear stress, skin friction coefficient, Nusselt number, wall fluxes and heat transfer coefficient for the channel with twisted tape with respect to the without twisted tape. It is found that the increase in turbulence occurs in microchannel due to the twisted tape insert. Also it is found that heat transfer characteristics like axial wall shear stress, skin friction coefficient, surface Nusselt number and surface heat transfer coefficient are greater in with twisted tape with respect to without twisted tape. The result revealed that when we use micro channel with twisted tape as compare micro channel with straight tape convective heat transfer increase, convective heat transfer increases because of turbulence in the twisted tape increase.
Keywords: CFD, Twisted tape, Nusselt number, Reynold number, Micro-channel, Turbulence.

1. INTRODUCTION

The study of compact devices has been prominence in the past two decade. It is known that the main cause for damaging the device's component is the high heat flux generated in the devices. To save the component from the damage the heat removal mechanism must be analysed. Micro devices are micron in size and have much application in micro electro mechanical system, integrated circuit, biochemical application because it is most suitable method for removing heat flux. Material used for making the twisted tape is Aluminium, copper, stainless steel carbon steel. Al and stainless steel are very commonly used twisted tape because Al has light weight property, ease of accessibility and rate of corrosion is very low and price is also low. Same mechanical properties are found in stainless steel but only difference is the cost of manufacturing is high. So for industrial and laboratory purpose there two materials are very commonly used. To enhance the heat transfer twisted tape has been widely used. These twisted tape causes the flow to swirl which improve the mixing the fluid an also increases the fluid velocity. The stream line and velocity of flow field for a swirl flow induced by the twisted tape is higher than the plain tube. This phenomenon affects the heat transfer coefficient by increasing the turbulence higher tangential velocity near the walls.

2. LITERATURE REVIEW

Khwanchit Wangcharee[2020] in their paper, have made the Techniques to augment heat transfer. They end up with the detailed analysis of heat transfer applications. This introductory chapter on the augmentation of convective heat transfer provides background for the many applications of this "second generation heat transfer technology" cited throughout this volume. The many available augmentation techniques are described, and some representative performance data and correlations are given for the popular passive techniques.

A. A. Rabienataj Darji[2019] also have discussed the comparison of wire coil inserts and twisted tape in their work. It was observed and noted that to disturb the central core flow the twisted tapes are the solution but if peripheral annular flow is to be mixed with core flow the wire coil inserts perform better. In context with heat transfer rate they have concluded that twisted tape perform better than the wire coil inserts. In process industries the fluids used have high density because of high viscosity and dirt and thus they need high pumping power. In such cases the pumping power is the important element and is drive to put constraints on selection of passive device. When pumping power is an issue pressure drop adds limitation on type of insert, as twisted tape cause more pressure drop than wire coil inserts.

C. Thianponget. Al [2018] works in the condition of force convection by using twisted tape insert of width 16 mm thicknesses 1.2mm, length 0.5m and twist ratio 5.5, 6.5, 8.5 with circular holes of diameter 6mm and conclude that for Re number range 2000 to 12000, the Nussult number for

twisted tape insert with twist ratio 8.5,6.5 and 5.5 was found to be 23.99%, 25.64% and 29.32% respectively also the Friction factor is increased approximately by 0.20%, 0.2673 % and 0.4545 % with twist ratio 8.5, 6.5 and 5.5 respectively.

A. E. Kabeelet. al [2017] Give a Analysis of Heat Transfer in Pipe with Twisted Tape Inserts to understand the effect of change in pitch of twisted tape on the flow physics, results of Re no.800 and twist ratio 2, 3, 4 and 5 are considered and conclude the variation of twist ratio and Re no.on heat transfer and flow characteristics using twisted tape inserts and also the heat transfer increases with decrease in twist ratio and increase in Reynolds number.

M. M. K. Bhuiyaet. al [2016] found in double pipe heat Exchanger of diameter 0.015 m and length of 2.5 m with variable twisted type insert in ANSYS fluent that a trend of increase in heat transfer with the provision of insert on the heat exchanger. The heat transfer was found to increase as the Re number was varied over the range. The result shows that effect of insert on the enhancement of heat transfer depends on both the pattern of insert and Re no.of the flow.

3. METHODOLOGY

A 3D laminar and unsteady state flow through a square micro channel has been analysed. Dimension of the micro channel are in micro meter. The cross section of micro channel is 0.15×0.15 mm and length of the channel is 100 mm and the thickness of the channel is 0.15 mm along all four side of the wall over the entire length. The side wall of the micro channel is considered to be isothermal condition i.e. constant temperature. At the inlet fluid is entering at ambient temperature i.e. 300 K and leaving at the outlet where the gauge pressure is zero. Pressure driven flow is considered. The isothermal wall considered as a temperature of 335 K.

4. CONCLUSION

It is found that the axial wall shear stress increases when the twisted tape insert is employed with the conventional microchannel. It can be concluded that the skin friction coefficient increases when the twisted tape insert is employed with the conventional micro channel. From the above results it is found that surface Nusselt number increases when the twisted tape insert is employed with the conventional microchannel.

REFERENCES

[1] Aydın, Orhan, and Mete Avcı. "Heat and fluid flow characteristics of gases in micropipes." International Journal of Heat and Mass Transfer 49, no. 9 (2006): 1723-1730.

[2] Hadjiconstantinou, Nicolas G., and Olga Simek. "Constant-wall-temperature Nusselt number in micro and nano-channels." Journal of Heat Transfer 124, no. 2 (2002): 356-364.

[3] Tunc, Gokturk, and YildizBayazitoglu. "Heat transfer in rectangular microchannels." International Journal of Heat and Mass Transfer 45, no. 4 (2002): 765-773.

[4] Tyagi, V. P., and K. M. Nigam. "On closedform analytical solution for circular duct, thermally developing slug flow under mixed boundary condition." International Journal of Heat and Mass Transfer 18, no. 11 (1975): 1253-1256.

[5] Jeong, Ho-Eyoul, and Jae-Tack Jeong. "Extended Graetz problem including streamwise conduction and viscous dissipation in microchannel." International Journal of Heat and Mass Transfer 49, no. 13 (2006): 2151-2157.

[6] Tuckerman, D. B., and R. F. W. Pease. "Optimized convective cooling using micro-machined structures." In Journal of the Electrochemical Society, vol. 129, no. 3, pp. C98-C98. 10 SOUTH MAIN STREET, PENNINGTON, NJ 08534: ELECTROCHEMICAL SOC INC, 1982.