ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 12, December 2014

Review on “Heat Transfer Enhancement Analysis of Flow over the Bumps on Divergent Channel”

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ABSTRACT: Effective fluid mixing is one of the requirements in food processing and chemical industry. The effect of divergent channels is a good way to promote the flow mixing in channel flow. When if we use divergent channel then we get flow difference means low pressure drop it is also called pressure recovery. By using bump in the divergent channel it can help us to increase the heat transfer enhancement and bump surface present the highest performance of the heat transfer enhancement. The bump surface act as extended surface (fin surface) and the main purpose of extended surface to increase the heat transfer rate. The advantages of the divergent channel with internal Bumps are fluid mixing is more as compared to cylindrical pipe, pressure drop is less and boundary layer separation occurs in divergent channel which will help in heat transfer.

KEYWORDS: Heat transfer enhancement, Divergent channel, Surface bump, Heat transfer rate.

I. INTRODUCTION

Heat exchangers are used in different processes ranging from conversion, utilization & recovery of thermal energy in various industrial, commercial & domestic applications. Some common examples include steam generation, condensation in power & cogeneration plants, sensible heating & cooling in thermal processing of chemical, pharmaceutical & agricultural products, fluid heating in manufacturing & waste heat recovery etc. Increase in Heat exchanger’s performance can lead to more economical design of heat exchanger which can help to make energy, material & cost savings related to a heat exchange process. The need to increase the thermal performance of heat exchangers, thereby effecting energy, material & cost savings have led to development & use of many techniques termed as Heat transfer Augmentation. These techniques are also referred as Heat transfer Enhancement or Intensification. Augmentation techniques increase convective heat transfer by reducing the thermal resistance in a heat exchanger. Use of Heat transfer enhancement techniques lead to increase in heat transfer coefficient but at the cost of increase in pressure drop. So, while designing a heat exchanger using any of these techniques, analysis of heat transfer rate & pressure drop has to be done.

Heat transfer enhancement is the practice of modifying a heat transfer surface or the flow cross section to either increase the heat transfer coefficient between the surface and a fluid or the surface area so as to effectively sustain higher heat loads with a smaller temperature difference. In chapter-3 we have treated some practical examples of heat transfer enhancement. i.e fins, surface roughness, twisted tape inserts and coiled tube, which are generally referred to as passive technique. Heat transfer enhancement may also be achieved by surface or fluid vibration, electrostatic fields or mechanical stirrers. These latter methods are often referred to as active techniques because they required the application of external power. Although active techniques have received attention in the research literature their practical applications have been very limited. In this section therefore we focus on some specific example of passive techniques.

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Iftikarahamad H. Patel, Dr. Sachin L. Borse, *et al.*-[1] Heat transfer rate from the test surface increases with increase in Reynolds number of flowing fluid and heat input. The use of dimples on the surface results in heat transfer augmentation in forced convection heat transfer with lesser pressure drop penalty. The value of maximum Nusselt number obtained for staggered arrangement of dimples is greater than that for inline arrangement, keeping all other parameters constant. It shows that for heat transfer enhancement staggered arrangement is more effective than the inline arrangement. At all Reynolds number considered Nusselt number augmentation increases as the dimple density of test plates increases (all other experimental and geometric parameters are kept constant).This is because the more number of dimples produce:

(i) Increase in the strength and intensity of vortices and associated secondary flows ejected from the dimples

(ii) Increases in the magnitudes of three-dimensional turbulence production and turbulence transport. More number of dimples beyond a particular value is believed to trap fluid which then acts as a partially insulating pocket to decrease the rate of Nusselt number enhancement with increase in further dimple density. It also results in decrease in rate of Nusselt number enhancement after a certain value of dimple density of plate.

Wang.L.H, Tao.W.Q, Wang.Q.W, Wong.T.T, *et al.*-[2] Many heat augmentation techniques has been reviewed, these are (a) surface roughness, (b) plate baffle and wave baffle, (c) perforated baffle, (d) inclined baffle, (e) porous baffle, (f) corrugated channel, (g) twisted tape inserts, (h) discontinuous Crossed Ribs and Grooves. Most of these enhancement techniques are based on the baffle arrangement. Use of Heat transfer enhancement techniques lead to increase in heat transfer coefficient but at the cost of increase in pressure drop.

Sivakumar, K., Natarajan, E., Kulasekharan, N, *et al.*-[3] Thermal characteristics were tested by measuring wall temperature at selected locations, fluid temperature at the inlet and the outlet and wall static pressures at the channel inlet and the outlets. Ribbed channels show larger ressure drops than the smooth channels and the value of pressure drop increases with increase in rib height. This can be attributed to the recirculation zones in the downstream side of each rib.

Soo Wban Abn and Kang Pil Son, *et al.*-[4] found that the heat transfer can be enhanced by the use of rough surfaces. Four different shapes such as semicircle, sine wave, trapezoid, and arc were suggested to investigate the heat transfer enhancement and friction factor on rectangular duct. They measured the friction factor and heat transfer enhancement on smooth duct and compared it with the results. Square shape geometry gave the highest value because of its strongest turbulence mixing caused by rib. Non circular ducts such as equilateral triangle, Square and rectangular ducts have lower frictional factors and heat transfer as compared to circular ducts this increase in the friction factor and heat transfer depends upon properties and size of the fluid molecules.

C. Bi, G.H. Tang, W.Q. Tao, *et al.*-[5] The convective cooling heat transfer in mini-channels with dimples, cylindrical grooves and low fins is numerically studied by using the field synergy principle. We solve the synergy angle distribution to examine the mechanisms of the heat transfer enhancement in the enhanced surfaces. The results show that the dimple surface presents the highest performance of heat transfer enhancement. The geometry size effects of dimple are studied over a Reynolds number range of 2700-6100, and the most favorable dimple geometric structures are optimized by using the performance evaluation plot of enhanced heat transfer techniques.

Hemant C. Pisal, Avinash A. Ranaware, *et al.*-[6] this investigation presents experimental and numerical results for the heat transfer characteristics of a heat sink for laminar airflow conditions using two different types of dimples. The average heat transfer and heat transfer enhancement were obtained experimentally. Heat transfer, pressure drop, thermal performance and flow conditions were numerically simulated. Experiments using aluminum plates with a flexible heater were conducted to obtain heat transfer characteristics for a heat sink with dimpled surfaces in laminar airflow. Three different aluminum plates were fabricated and used to obtain the average heat transfer: flat, circular, and oval dimpled plates. Dimples were placed on both side of the aluminum plate. Each plate was located in the middle of the rectangular channel and a uniform heat flux was applied from the top of the plate.

Dr. Mohammed NajmAbdullah, *et al.*-[7] the aim of this study is to investigate the heat transfer and pressure drop characteristics in an Eccentric Converging-Diverging Tube (ECDT) with twisted tape inserts. Experiments were

ISSN: 2319-8753

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conducted with tape inserts of three different twist ratios. Cold and hot water are used as working fluids in shell and tube sides, respectively. The effect of the twist ratio and other parameters on heat transfer characteristics and pressure drop are considered. The experimental data for the plain tube and (ECDT) without inserts are compared with (ECDT) with twist tape insert. The results show that the twist tape insert has significant effect on the enhancement of heat transfer. The Nusselt numbers for the (ECDT) are found to be 15% to 45% higher than of the plain tube while for the (ECDT) combined with twisted tape insert is found 52% to 280% higher and pressure drop is found 6.8 times the plain tube. Moreover, (ECDT) combined with a twisted tape insert gives higher heat transfer rate and pressure drop than the (ECDT) alone around 23% to 35% and 98% to 125%, respectively.

Hemant C. Pisal, *et al.*-[8] an investigation was conducted to determine whether dimples on a heat sink fin can increase heat transfer for laminar airflows. This was accomplished by performing an experimental and numerical investigation using two different types of dimples:

1) Circular (spherical) dimples,

2) Oval (elliptical) dimples. Dimples were placed on both sides of a copper plate with a relative pitch of S/D=1.20 and relative depth of δ/D=0.2 (e.g., circular dimples). For oval dimples, similar ratios with the same total depth and circular-edge-to-edge distance as the circular dimples were used. For those configurations the average heat transfer coefficient and Nusselt number ratio were determined experimentally. For circular and oval dimples, heat transfer enhancements (relative to a flat plate) were observed for Reynolds number range from 600 to 2000 (Reynolds number based on channel height). Moreover, pressure drop, thermal performance and flow characteristic were simulated numerically.

Tang*, W.Q. Tao, *et al.*-[9] the results show that the dimple surface presents the highest performance of heat transfer enhancement. The geometry size effects of dimple are studied over a Reynolds number range of 2700-6100, and the most favorable dimple geometric structures are optimized by using the performance evaluation plot of enhanced heat transfer techniques. The study on the in-dependent geometry size effects of the dimple suggests that the deep dimple with large diameter can enhance heat transfer more easily. The performance evaluation plot of enhanced heat transfer techniques is introduced to study the dependent geometry size effects of dimple, and the most favorable dimple structures for the heat transfer enhancement are obtained.

TuqaAbdulrazzaq, *et al.*-[10] the results show that the Nusselt number increases with the increase of Reynolds number for all cases at constant surface temperature. According to the profile of local Nusselt number on ribs walled of channel, the peak is at the midpoint between the two ribs. The maximum value of average Nusselt number is obtained for triangular ribs of angel 60° and at Reynolds number of 60000 compared to the Nusselt number for the ribs of angel 90° and 45° and at same Reynolds number. The recirculation regions generated by the ribs corresponding to the velocity streamline show the largest recirculation region at triangular ribs of angle 60° which also provides the highest enhancement of heat transfer.

Francisco Oviedo-Tolentino a, Ricardo Romero-Méndez a,* Abel Hernandez-Guerrero b, Benjamin Girón-Palomares b, *et al.*-[11] the results of this investigation are important since they illustrate that promotion of mixing is possible by using a divergence of the sinusoidal wavy channel. As may be hinted from other investigations, this mixing promotion might lead to an augmentation of the heat transfer, but also to an increase in the pressure drop. It is desirable to do further research to determine the feasibility and advantages of this chaotic mixing promotion technique. To address this issue numerical and experimental techniques might be used. The results presented here could be used as a starting point.

II. RELATED WORK

In this work we are using divergent channel with the bumps in the place of cylindrical tube. Following fig 1.Shows that actual test section.

Why use divergent channel:

In the **divergent channel**, the plumes produced are greater and not stable. In addition, the deceleration of flow can effectively lead to the local increase of Gr/Re2. Therefore, stronger interaction with the neighbouring plumes and vortices are observed and form a complicated flow structure. This leads to a greater enhancement in the heat transfer.

In the **convergent channel**, it is on the contrary. The acceleration of flow can effectively lead to the local decrease of Gr/Re2. The plumes produced are smaller and stable. No interactions between plumes are found. This leads a less

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enhancement in the heat transfer. However, the deceleration flow in the divergent channel and the acceleration in the convergent make the average Nusselt numbers approach the results of the parallel plate channel, especially when the Reynolds number is higher.

In this work we are using divergent channels for heat transfer because of it is a good way to promote the flow mixing in channel flow also if use divergent channel then we get flow difference means low pressure drop it is also called pressure recovery also the new concept we using bumps in the divergent channel it can help us to increase the heat transfer enhancement and bump surface present the highest performance of the heat transfer enhancement. The Bumps surface it can also called as **artificial surface** act as extended surface (fin surface) and the main purpose of extended surface to increase the heat transfer rate. The advantages of the divergent channel with internal bumps are fluid mixing is more as compared to cylindrical pipe, pressure drop is less and boundary layer separation occurs in divergent channel which will help in heat transfer.

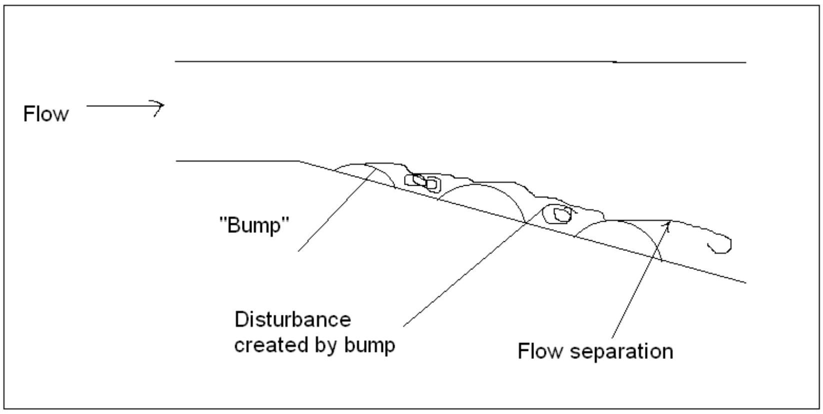

Fig 1.Creation of Disturbances in the flow

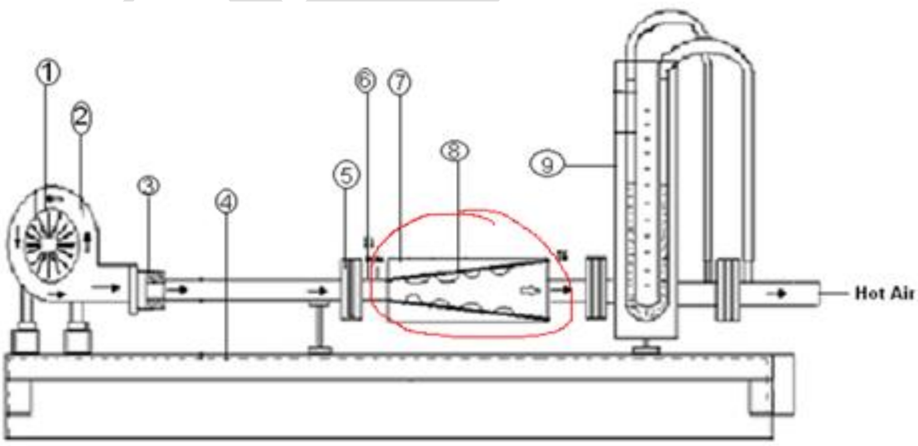

Fig 2. Set -Up

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1	Motor	2	Blower
3	Adapter	4	'C' channel
5	Orifice	6	Air temperature
7	Heater	8	Test section
9	Manometer		

Table No.1

III CONCLUSION

This paper work show that the divergent channel with using "bumps" is leads to greater heat transfer enhancement. The Bumps surface it can also called as artificial surface act as extended surface (fin surface) and the main purpose of extended surface to increase the heat transfer rate. The advantages of the divergent channel with internal bumps are fluid mixing is more as compared to cylindrical pipe, pressure drop is less and boundary layer separation occurs in divergent channel which will help in heat transfer.

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