Review on "Comparison of Heat Transfer Enhancement between Cylindrical Pipe & Diverging channel by using artificial surface."

Sandeep Patil, Nivrutti Raut, Pravin Khandagale, Pradip Karad, Sunil More

Abstract— This paper is a review on "comparison between heat transfer enhancement in a cylindrical pipe and divergent channel". Many industries utilize the thermal system because overheating can damage components of the system that can result into failure of system. The excessive heat that generate due to overheating must be dissipated to surrounding to avoid the problems of overheating for proper functioning of system. For heat transfer enhancement active and passive methods are used. Passive method uses the insertion of fins, ribs, bumps, dimples in the flow passage to improve the heat transfer rate. Because of insertion in the flow passage more turbulence occurs in the flow passage which helps in augmentation of heat transfer.

Keywords— Augmentation, Bumps, cylindrical pipe, divergent channel, heat transfer Coefficient.

I. INTRODUCTION

Enhancement of heat transfer rate is very important in all types of thermo technical applications for industry. Because of this there is savings in primary energy and also reduction in size and weight. Enhancement of heat transfer is essential in drying of food (food preservation) application. The drying time is dependent on the temperature and flow rate of the air. Because to reduce the drying time temperature of air or flow rate must be increased. Also, to increase the temperature if heater input is increased excessively, due to excess heating the system may not work efficiently or at the extreme it may fail. Therefore, the dissipation of the heat from the pipe surface to the flowing air through the pipe is very important for maintaining the efficient and reliable functioning of the plant.

Generally there are two main types of enhancing the heat transfer rate.

a) Active method.
b) Passive method.

Passive heat transfer enhancement techniques are mostly used due to their simplicity and applicability in many applications. in passive techniques, there is no need of any external power source except to force the fluid. The devices in this category include surface coating, rough surfaces, extended surfaces, turbulent flow devices, twisted tube, and tube inserts. Enhanced tubes with different inserts are used in the refrigeration, air-conditioning, and commercial heat pump industries as well as in the chemical, petroleum, and numerous other industries. Using inserts in tubular heat exchangers not only reduced the heat exchanger size but also provided thermal, mechanical, and economic advantages in heat exchangers.

II. LITERATURE SURVEY

Suhas V. Patil and P.V.Vijay Babu, *et al*.-[1] The insertion of twisted tape mixes the fluid flow well and it performs better in laminar flow. They also concluded that twisted tape is more effective if pressure drop is not considered.

C. Bi, G.H. Tang*, W.Q. Tao, *et al*.- [2] They concluded that The dimple surface presents the highest performance of the heat transfer enhancement, the performance of cylindrical groove surface is slightly lower than that of the dimple surface, and the low fin surface presents the lowest performance. The study on the independent geometry size effects of the dimple suggests that the deep dimple with large diameter can enhance heat transfer more easily.

HONG Mengna**, DENG Xianhe, HUANG Kuo and LI Zhiwu, *et al.* - [3] They investigated that the pressure drop and compound heat transfer characteristics of converging-diverging

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tube with evenly spaced twisted tapes experimentally. In this paper they made comparison of experiment between smooth circular tube and converging diverging tube without carrying the twisted tapes.

Kirti Chandra Sahu, Rama Govindarajan, *et al.* - *[*4] although the critical Reynolds number for linear instability of the laminar flow in a straight pipe is infinite. They shown that the critical Reynolds number for linear instability of laminar flow is finite in case of divergent channel and it approaches to infinity as the inverse of the divergence angle.

A Dewan, P Mahanta, K Sumithra Raju and P Suresh Kumar, *et al.* - [5] In this paper it is shown that heat transfer can be enhanced by the use of passive techniques that is by modifying the geometrical shape of the pipe or duct and by insertion of twisted tapes, ribs, fins, dimples. They also stated that insertion of twisted tapes performs better in laminar flow and insertion of ribs, dimples performs better in turbulent flow.

Dr. Anirudh Gupta, Mayank Uniyal, *et al.* - [6] The researchers are taking interest in enhancing heat transfer rate with passive methods. dimple, protrude and rough surfaces etc. passive methods are used in heat exchangers, air heaters and heat sinks to enhance heat transfer. Passive methods can easily manufacture and applicable too.

Dr. Mohammed Najm Abdullah, *et al.* - [7] they performed the experimental study on fully developed turbulent flow in a eccentric converging-diverging tube (ECDT) with twisted tapes. The influences of twist ratio on the heat transfer rate and friction factor characteristics have also been investigated.

Pradip Ramdas Bodade, Dinesh Kumar Koli, *et al.* - [8] in this paper the following heat transfer intensifiers are described and reviewed. Surface roughness, plate baffle and wave baffle, perforated baffle, twisted tape inserts etc. in heat transfer application if area of tube is changes then heat transfer rate also changes.

Vijay D. Shejwalkar, M.D. Nadar, *et al.* – [9] Found that in the experiment which was carried out for three heater input & with three different flow rates of air. The effect on heat flow rate and outlet temperature for air is calculated and observed respectively threaded part and these results are compared with plain pipe. They also found that more number of threads increases the swirl (turbulence) formation which improves the contact surface of air with the heated pipe which results in heat transfer enhancement.

Kumbhar D.G, Dr. Sane N.K, *et al.* – [10] Found that insertion of twisted tapes increases the performance in laminar flow. They also found that if pressure drop is not considered twisted tape insert is more effective method. But in turbulence flow it is not effective for wide range of Reynolds number. Because it blocks the flow and pressure drop increases hence performance of twisted tape is not good in turbulence flow.

David j kukulka, Rick smith, *et al.* – [11] they stated that the improving of heat transfer rate and modifications of tube are necessary. The flow optimization study of the character that is used to build the enhanced surface using computational fluid dynamics method was performed.

III. Cylindrical pipe with artificial surface

Cylindrical pipes are used because they can withstand large pressure differences between the inside and the outside without undergoing significant distortion. To enhance the heat transfer rate, some kind of insert is placed in the flow passages and because of that the hydraulic diameter of pipe will get reduced. Heat transfer enhancement in a tube blockages the flow, partitioning of the flow and secondary flow. Flow blockages increase the pressure drop and leads to viscous effects, because of a reduced free flow area. The selection of the insertion element depends on performance and cost

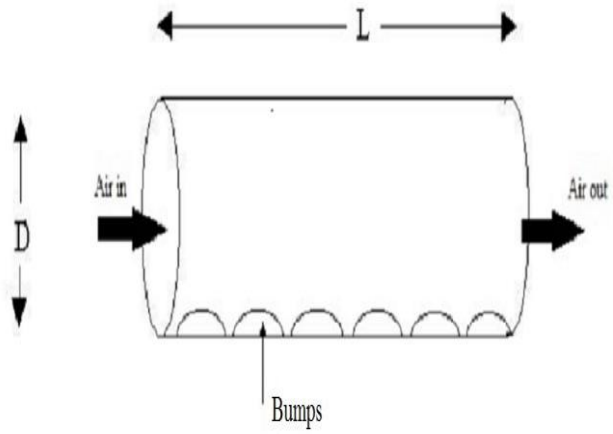

Figure 1:-cyllindrical pipe with insertion of bumps.

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Figure shows the cylindrical pipe with the insertion of ribs. Cylindrical tube is mostly suitable for laminar flow. Due to constant cross-sectional area of the cylindrical pipe pressure drop is less and mixing of fluid is not proper. And the flow is whether laminar or turbulent is identified by Reynolds number. Cylindrical pipe is not suitable for wide range of Reynolds number. Laminar flow through the cylindrical tube is linearly stable for any Reynolds number.

IV. Divergent channel with artificial surface

Divergent channel are used where pressure difference required is relatively small. The main advantage of divergent tube over cylindrical pipe is that the divergent tube has greater area than the cylindrical pipe and in divergent tube fluid mixing is proper between the flow passages. Divergent channel is suitable for wide range of Reynolds number because it posses greater amount of turbulence. And to improve the heat transfer rate we can apply the passive techniques i.e., by inserting ribs, bumps, fin etc. and if turbulence in flow is more then it helps to improve the contact of air with heated pipe and this phenomena helps to improve heat transfer rate. Heat transfer rate increases with increase in internal area of channel.

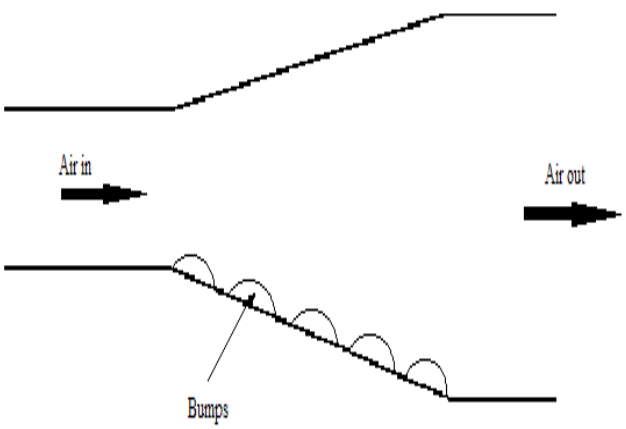

Figure 2 :- divergent duct with insertion of bumps.

Heat transfer enhancement in a tube by inserts such as twisted tapes, wire coils, ribs, bumps and dimples is due to flow blockage, partitioning of the flow and secondary flow. Because of Flow blockage there is increases in the pressure drop and leads to increased viscous effects due to the reduced free flow area. Blockage also increases the turbulence and flow velocity and in some situations leads to a significant secondary flow. In Secondary flow there is a better thermal contact between the surface and the fluid because secondary flow creates turbulence and the resulting fluid mixing improves the temperature gradient, which leads to enhancement in heat transfer coefficient. With proper selection of physical parameters, significant heat transfer enhancements and pressure drop reductions can be achieved simultaneously with bumps and the overall heat transfer performances in diverging channels are much better than that of in circular pipe.

V. SUMMARY

Heat transfer enhancement in diverging channel is more as compared to cylindrical pipe. In diverging channel boundary layer separation is very good and also it can achieve high Reynolds number in the order of 25000 to 50000. Diverging channel can create more turbulence than cylindrical pipe. Pressure drop in case of diverging channel is more at the outlet as compared to cylindrical pipe.

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