A Review on Enhancement of Performance of Double Pipe Heat Exchanger Augmentation Techniques with Different Inserts And Enhancement Liners

Pooja J. Pingale[1], Prof. Ujwal S. Gawai[2]
[1]Dept of Mechanical Engineering
[2]Assistant professor, Dept of Mechanical Engineering
[1, 2] JSPM's Imperial college of Engineering and Research, Wagholi, Pune, India

Abstract- *Heat exchanger is an important device in all the thermal systems. The heat exchanger is widely used equipment in different industries such as process, petroleum refining, chemicals, pharmaceutical and paper etc. after studying different literature about heat exchanger and double pipe heat exchanger problem is identified as The system has followed different types of flow arrangement and geometric dimension with twisted tape to attain heat transferred in experimental result and compare with simulation result. To perform simulation and experimental investigation of double pipe heat exchanger with inner and annuals twisted tape at different mass flow rate was done earlier by many researchers, but with the advent of FDM process it is possible to fabricate different arrangements of heat transfer augmentation.*

These techniques are more applicable in various industrial areas such as cryogenics, process industries, HVAC systems etc. There is need to improve the outside heat transfer coefficient, effectiveness and thermal performance of heat exchanger, thereby reducing the cost and size of heat exchanger. In present paper importance is work related to double pipe heat exchanger with various types of inserts and extended surfaces are helpful in increasing the heat transfer rate.

Keywords- Double pipe heat exchanger, Twisted tape, FDM, Heat transfer augmentation

I. INTRODUCTION

Heat Exchanger is one of the most commonly used process equipments in industry and research Heat exchangers are used to transfer heat energy from one fluid to another in order to control the temperature of a system or substance. Heat exchangers contain two streams of fluid, one hot and one cold, which are separated by a thermally conductive tube or plate unless the fluids are immiscible. The two streams are directed such that one transfers thermal energy to the other. Examples of heat exchanger applications include automotive radiators, boilers, furnaces, refrigerators, and air conditioning systems. Heat exchangers are used to transfer heat from one fluid to another. A heat exchanger is a component that allows the transfer of heat from one fluid (liquid or gas) to another fluid. Reasons for heat transfer include the following:

1. To transfer the heat from hot fluid to cold fluid.
2. To condense the hot gases by means of cold fluid.
3. To boil the cold fluid by means of hot fluid.

Some typical examples of heat exchanger applications are:

- Thermal power plants (boilers, superheaters, steam condensers).
- Automobile industry (radiators, all engine cooling and fuel cooling arrangement).
- Cryogenics industry (condenser-reboilers used in distillation columns, evaporators etc.).
- Research (superconducting magnet systems, ceramic heat exchangers).

Earlier Methods of Heat Transfer Enhancement:

Insertion of tabulators in the flow passage is one of the favorable passive heat transfer augmentation techniques due to their advantages of easy fabrication, operation as well as low maintenance. The purpose of this review presents the effect of various insert on the heat transfer rate.

Fig: Inserted Louvered Strip.

New Method:

Fused Deposition Modeling (FDM) is a rapid prototyping (RP) process that integrates computer aided design, polymer science, computer numerical control, and extrusion technologies to produce three dimensional solid objects directly from a CAD model using a layer by layer deposition of molten thermoplastics extruded through a very small nozzle FDM is one of the few commercially available rapid prototyping technologies offering the possibilities of producing solid objects in a range of different materials including metals and composites. The FDM systems, currently fabricate parts in ABS, investment casting wax and elastomer, and the machines can operate in a user friendly office environment. FDM machines which is used in this study, allows building layer thickness from 0.178 mm to 0.356 mm and the achievable accuracy in the parts is ±0.127 mm. The process starts with the creation of a part on a CAD system as a solid model or a closed surface model. The models converted into an STL file using a specific translator on the CAD system. The STL file is then sent to the FDM slicing and pre-processing software called up-mini, where the designer selects proper orientation, creating supports and slicing and other parameters to prepare the part program for sending to FDM machine. A proper orientation of STL model is necessary to minimize or eliminate supports. The STL file is then sliced into thin cross sections at a desired resolution, creating an SLC file. Each slice must be a closed curve. So any unclosed curves are edited and closed. Supports are then created if required, and sliced. Supports can also be created as part of the CAD model and imported as part of the STL file. FDM machine tip to follow specific tool paths, called roads, to deposit the extruded material to create each cross section. . Material on a foam foundation until the part is completed. The part is then taken out, supports are detached carefully, and is ready for use. The layout of the micro-channel after 3-d Printing and fitting of the aluminum fins is to be of shape as shown below :

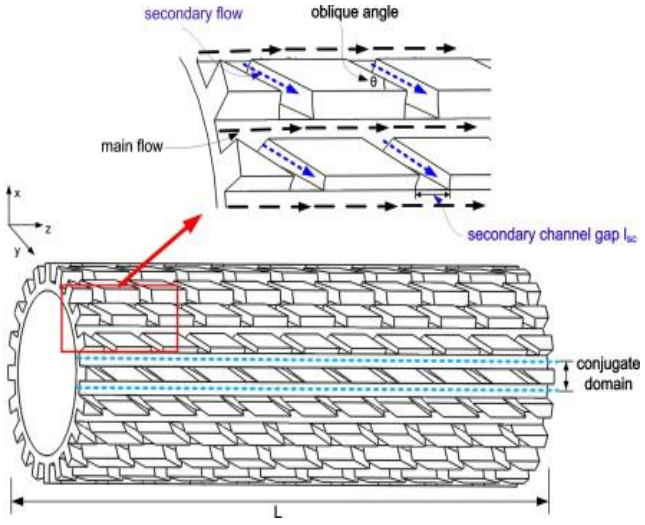

Fig: Cylindrical Oblique Microchannels

II. LITERATURE REVIEW

Pramod Purandarea et.al [1] studied that heat exchangers are the important engineering systems with wide variety of applications including power plants, nuclear reactors, refrigeration and air-conditioning systems, heat recovery systems, chemical processing and food industries. Helical coil configuration is very effective for heat exchangers and chemical reactors because they can accommodate a large heat transfer area in a small space, with high heat transfer coefficients. This paper deals with the parametric analysis of the helical coiled heat exchanger with various correlations given by different researchers for specific conditions. The parametric analysis of these various correlations with specific data is presented in this paper.

Bodius Salam et.al [2] investigated the tube side friction factor and heat transfer of circular tube fitted with rectangular-cut twisted tape insert. They concluded that the Nusselt number increased with the increase of Reynolds number. The heat flux is enhanced by 68% for tube with rectangular-cut twisted tape insert. Heat transfer enhancement effectiveness was found to be increased with Reynolds number and effectiveness values ranged between 1.9 and 2.3.

C.K.Pardhiet.al[3]investigated the various techniques for achieving improved heat transfer are usually referred to as “heat transfer augmentation” or “heat transfer enhancement” and the heat exchanger provided with heat transfer enhancement techniques as “Augmented Heat Exchanger”. The objective is to reduce as many of the factors as possible: Capital Cost, Power Cost, Maintenance Cost, Space and Weight, Consistent with safety and reliability. Present work describes the principal techniques of industrial importance for the augmentation of single phase heat transfer on the inside of

tubes namely twisted tapes. So twisted tape should be used in heat exchanger when high heat transfer rate is required and pressure drop is of no significance.

Sarmad A. et.al [4]stated that Asset of the experiments were carried out to investigate the turbulent flow and heat transfer behavior in a double pipe counter water flow heat exchanger with inserted semi circular disc baffles on the opposite distances from the outer surface of the length of the inner tube. The test section is a horizontal annular passage formed by two concentric tubes with an inner to outer diameter ratio of 0.3. Heat is only transferred from the annulus to the inner tube while outer tube is well insulated. Semi circular disc baffle with dimensions of 18 mm outer radius, 6.25 mm inner radius, and 1 mm thickness are used in the present study. The effect of turbulence on heat transfer and pressure drop was compared with the values for smooth tube.

The effect of semi circular disc baffle was depended on the basis of varying the baffle spacing. All the results and readings were compared with the standard data from the smooth tube. In the beginning we conducted the experiment without any baffle to get the value for plane heat exchanger and with baffles with varying baffle spacing (15 and 45) cm.

Gamit Sandip et.al [5] stated that a double pipe heat exchanger was developed to perform simulation and experimental investigation of double pipe heat exchanger with inner and annuals twisted tape at different mass flow rate. The system has followed different types of flow arrangement and geometric dimension with twisted tape to attain heat transferred in experimental result and compare with simulation result. The objective of these experiments is to Performance analysis of double pipe heat exchanger with inner and outer twisted tape at different mass flow inlet of hot. The experimental setup consists of double pipe heat exchanger experiment. The apparatus includes tube-within-a-tube heat exchangers and twisted tap with threaded thermocouple at each end, a water pump and electric motor. These methods used to find out the heat transfer rate from the surface and related temperature of fluid motions also used to found the effectiveness. The Annular method in which twisted tape is outside the inner tube has higher rate of heat transfer than other three methods. Also same result near found by simulation using ANSYS.

III. PROBLEM STATEMENT

The aim of augmentative heat transfer is to accommodate high heat fluxes or heat transfer coefficient. Also to reduce the sizes and cost of the heat exchanger and energy consumption. As well as to reduce Cost of energy, cost of materials and Gain higher thermal efficiency

IV. PROPOSED TEST RIG

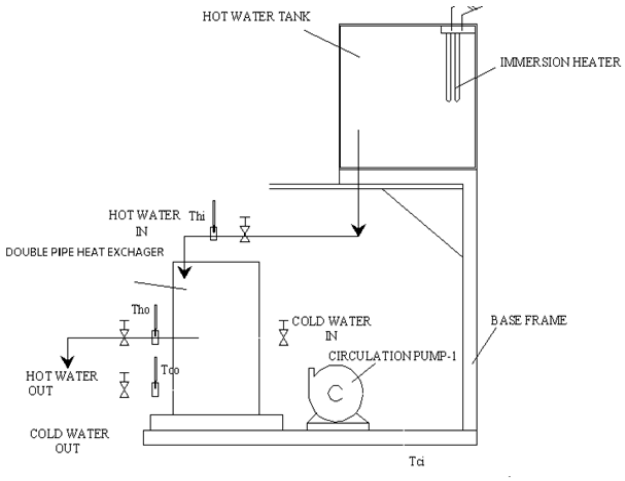

Fig: Experimental Setup

V. PROPOSED METHODOLOGY

System design as to and theoretical derivation of dimensions of the inner tube, outer tube, number of coil for desired temperature gradient.

1. System Design and theoretical derivation of coil structure as for closed coil structure

2. System Design and theoretical derivations of the hot water tank and cold water tank capacities for desired flow rates.

3. Selection of pump drive for cold water circulation, and head selection for hot water circulation.

4. Selection of material for pipe fittings in circuit , preparation of PID and Flow circuit diagrams from test rig set up

5. Mechanical design of the inner and outer tube structures for thermal stresses using theoretical method and using ANSYS

The following components of the drive will be designed using ANSYS

- Inner tube
- Outer tube

VI. CONCLUSION

A lot of research, work & study have been done by many researchers in the field of design, analysis, testing & experimental investigation of Double pipe heat exchangers with enhancement liners. Many of authors have given various methods of design, analysis testing & experimental investigation of Double pipe heat exchangers with heat transfer enhancement liners. But they have found that need of various heat transfer enhancement liners. The future scope is regarding to

1. Number of Inserts can be increased by reducing the pitch.
2. The entire Tube can be placed in a casing of water to improve heat transfer.
3. The outer tube can be lined with fins to enhance heat transfer.
4. Heat transfer enhancement such as twisted tapes can be used in the inner tube to increase turbulence of hot fluid and thereby the heat transfer rate.

REFERENCES

[1] Pramod S. Purandarea, Mandar M. Leleb, Rajkumar Guptac, Parametric Analysis of Helical Coil Heat Exchanger, International Journal of Engineering Research & Technology (IJERT), Vol. 1 Issue 8, October 2012.

[2] Bodius Salam, Sumana Biswas, Shuvra Saha, Muhammad Mastafa K Bhuiya, Heat Transfer Enhancement In A Tube Using Rectangular Cut Twisted Tape Insert, Procedia Engineering 56 (2013) 96-103.

[3] C.K.Pardhi,Dr.PrasantBaredar,Performance Improvement Of Double Pipe Heat Exchanger By Using Tabulat,International Journal Of Engineering Science & Advanced Technology [IJESAT] ,Vol.2,Issue 4,881-885.Auust 2012.

[4] Sarmad A. Abdal Hussein , Experimental Investigation of Double Pipe Heat Exchanger by using Semi Circular Disc Baffles, International Journal of Computer Applications(IJCA), Vol.115 ,Issue 2, April 2015.

[5] Gamit Sandip D, Gopal Kumar Deshmukh, Numerical And Experimental Investigation of Heat Transfer In Double Pipe Heat Exchanger With Inner And Annular Twisted Tape, International Journal of Engineering Research & Science (IJOER),Vol.1, Issue 5, August-2015.

[6] Sanjay P. Govindani, Prashant R. Walke, Dr. M. Basavaraj, Experimental Analysis Of Heat Transfer Enhancement In A Double Pipe Heat Exchanger Using Inserted Rotor Assembled Strand, International Journal of Emerging Technology and Innovative Engineering(IJOETE) ,Vol.2, Issue 2, January 2016 .

[7] Dr.Bhramara Panitapu, T. Kanthimathi, Krishna Chaitanya, Numerical and Experimental Comparison of Heat Transfer Enhancement in A 2-Pass Double Pipe Heat Exchanger with and without Inserted Twisted Tapes, International Journal of Applied Engineering Research (IJAER),Vol. 11, Issue 1, (2016) .