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A Review on Design, Development & Testing of Double Pipe Heat Exchanger With Heat Transfer Enhancement Liners

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Abstract—Heat transfer augmentation techniques are used to increase rate of heat transfer without affecting much the overall performance of the system. Heat transfer augmentation techniques are commonly used in areas such as heating and cooling in evaporators, air-conditioning equipment, thermal power plants, space vehicle, automobile etc. This presentation contains literature survey of enhancement techniques in heat transfer using inserts. A novel method is proposed in the form of fin holders with oblique fins to enhance the heat transfer in double pipe heat exchanger.

Keywords- *Double Pipe Heat Exchanger, Heat Transfer, Enhancement Liners.*

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I. Introduction

All Heat exchangers are devices built for efficient heat transfer from one fluid to another and are widely used in engineering processes. Some examples are intercoolers, pre-heaters, boilers and condensers in power plants. By applying the first law of thermodynamics to a heat exchanger working at steady-state condition, we obtain: $\Sigma m \Delta hi=0$
where,
mi= mass flow of the fluid
Δhi= change of specific enthalpy of the fluid
There are several types of heat exchanger:

- This Recuperative type, in which fluids exchange heat on either side of a dividing wall
- Regenerative type, in which hot and cold fluids occupy the same space containing a matrix of material that works alternatively as a sink or source for heat flow
- Evaporative type, such as cooling tower in which a liquid is cooled evaporatively in the same space as coolant. The recuperative type of heat exchanger which is the most common in practice may be designed according to one of the following types.
- Parallel-flow
- Counter-flow
- Cross-flow

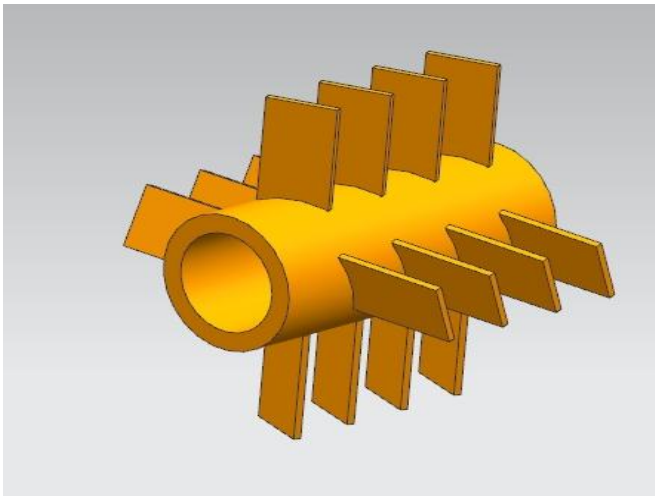

Figure 1.1 Fins Arrangement

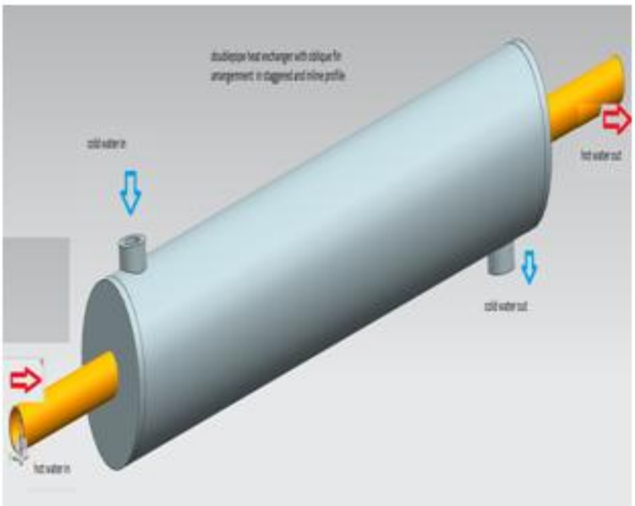

Figure 1.2 Double Pipe Heat Exchanger

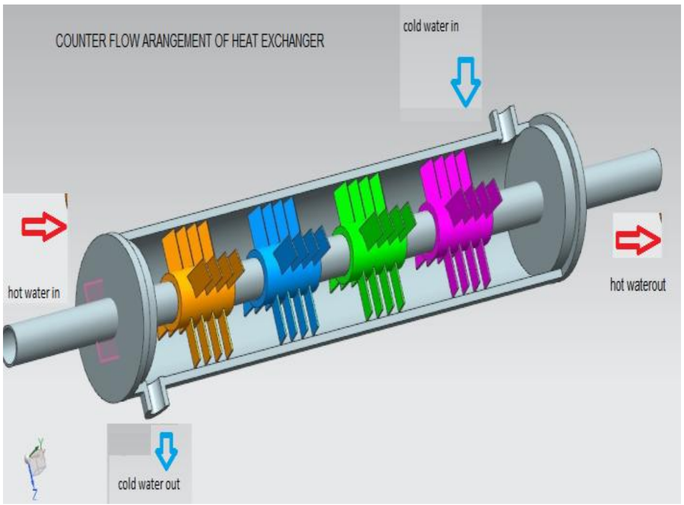

Figure 1.3 Heat Exchangers and Fins Arrangement

II. LITERATURE REVIEW

Designing a helical coil heat exchanger Ramchandra K Patil , B W Shende , Prasnata Ghosh 1982. The authors in this paper have stated that an HCHE offers advantages over a double pipe heat exchanger in some situations. The HCHE can be effectively used in cases where the space is limited and it is not possible to lay straight pipe line. Secondly in cases where there is laminar flow at very low flow rates and thirdly when pressure drop of one fluid is limited. In this research authors have illustrated a simple design procedure to determine the length of coil, dimensions of annulus, required area, number of turns of coil etc to finally determine the heat transfer coefficients.

Types of Heat Exchangers and LMTD-Design Method Professor Jung-Yang San Mech. Engg. Dept., National Chung Hsing University. The author in this paper presentation discuses the types of heat exchanger & their design procedures .The heat exchangers studied are Counter-flow Double-Tube Heat Exchanger, Shell-and-Tube Heat Exchanger (Two Tube Passes& One Shell Pass) Shell-and-Tube Heat Exchanger (Single Pass) (Condenser/Evaporation), Flat-Tube Cross-Flow Heat Exchanger, Helical coil heat exchanger. Special double pipe heat exchanger, plate heat exchanger, spiral plate heat exchanger, twisted tube heat exchanger, etc. The author discusses various heat trans fer enhancement techniques possible to implement with these heat exchangers for maximum effective use and results from heat exchangers.

Performance analysis of a compact heat exchanger- Akash Pandey Master of Technology In Mechanical Engineering Department of Mechanical Engineering National Institute of Technology Rourkela 2011. Compact heat exchangers are one of the most critical components of many cryogenic components; they are characterized by a high heat transfer surface area per unit volume of the exchanger. The heat exchangers having surface area density (β) greater than 700 m2/m3 in either one or more sides of two-stream or multi stream heat exchanger is called as a compact heat exchanger. Plate fin heat exchanger is a type of compact heat exchanger which is widely used in automobiles, cryogenics, space applications and chemical industries. The plate fin heat exchangers are mostly used for the nitrogen liquefiers, so they need to be highly efficient because no liquid nitrogen is produced, if the effectiveness of heat exchanger is less than 87%.So it becomes necessary to test the effectiveness of these heat exchangers before putting them into operation. Various correlations are available in the literature for estimation of

heat transfer and flow friction characteristics of the plate fin heat exchanger, so the various performance parameters like effectiveness, heat transfer coefficient and pressure drop obtained through experiments is compared with the values obtained from the different correlations. The longitudinal heat conduction through walls decreases the heat exchanger effectiveness, especially of cryogenic heat exchangers, so the effectiveness and overall heat transfer coefficient is found out by considering the effect of longitudinal heat conduction using the Kroeger's equation

Parametric Analysis of Helical Coil Heat Exchanger - Pramod S. Purandarea, Mandar M. Leleb, Rajkumar Gupta, International Journal of Engineering Research & Technology (IJERT) 2012.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.

Comparison of Heat Transfer between a Helicaland Straight Tube Heat Exchanger- Bibin Prasad, Sujith V, Mohammed Shaban K, Saju Haneef, Sandeep N, Vishnu Raj

International Journal of Engineering Research and Technology 2013.Helical pipes are universally used for heat transfer enhancement in heat exchangers. In the present work, CFD simulations are carried out for a counter flow double pipe helical heat exchanger by varying the flow rates of a single fluid (water). The heat transfer characteristics of the same are compared with that of a counter flow double pipe straight tube heat exchanger for the same flow rates. The results were interpreted by developing correlations between Nusselt number and Dean Number for both the inner and outer helical pipes which shows a strong linear relationship.

Experimental Analysis Of Square And Circular Helical Coil For The Heat Recovery System B. P. Kumbhare, P.S. Purandare, K.V.Mali. In the present work, an experimental analysis of heat recovery system by helical coiled tube with square and circular pattern is reported for the tube side various Reynolds number for the laminar flow. The overall heat transfer coefficient, convective heat transfer coefficients are observed as functions of the tube surface geometry, the tube side Reynolds number. Cold Water and hot air are passed inside the tube and the shell, respectively. The convective heat transfer coefficients of the helical heat exchanger under various operating conditions were determined by Wilson plot technique. The results show that the convective heat transfer coefficients, overall heat transfer coefficient for square pattern helical coil are higher than circular pattern with tube side Reynolds number.

III. METHODOLOGY

- ❑ Heat Transfer enhancement or augmentation techniques refer to the improvement of thermo hydraulic performance of heat exchangers.

- ❑ Existing enhancement techniques can be broadly classified into three different categories:

    1. Active Techniques
    2. Passive Techniques
    3. Compound Techniques

IV. DESIGN AND DEVELOPMENT OF SYSTEM:-

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

V. 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.

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