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A Review on Heat Transfer Enhancement of Double Pipe Heat Exchanger with FDM Delta-Channel Winglet Inserts

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Abstract - *The performance of the heat exchanger, it is decided to increase the turbulence and intermixing of flow of hot fluid inside the hot fluid pipe by means of specially design delta winglets that will be placed either in the straight line configuration or staggered configuration. The added winglets serve dual purpose of increasing the surface area for heat transfer and to improve the intermixing of particles and thereby increasing heat transfer.*

Key Words: Double pipe heat exchanger, FDM, Heat transfer, Inserts, Delta winglet etc.

1. INTRODUCTION

Heat transfer augmentation techniques refer to different methods used to increase these techniques and broadly divided in two groups, passive and active. Active techniques involve some external power input for the enhancement of heat transfer. Passive heat transfer augmentation method does not use any external power input. One of the ways to enhance heat transfer performance in passive method is to increase the effective surface area and residence time of the heat transfer fluid.[4]

A double pipe heat exchanger, in its simplest form is just one pipe inside another larger pipe. One fluid flows through the inside pipe and the other flows through the annulus between the two pipes. The wall of the inner pipe is the heat transfer surface.

A primary advantage of a hairpin or double pipe heat exchanger is that it can be operated in a true counter flow pattern, which is the most efficient flow pattern. That is, it will give the highest overall heat transfer coefficient for the double pipe heat exchanger design.

Also, hairpin and double pipe heat exchangers can handle high pressures and temperatures well. When they are operating in true counter flow, they can operate with a temperature cross, that is, where the cold side outlet temperature is higher than the hot side outlet temperature.[5]

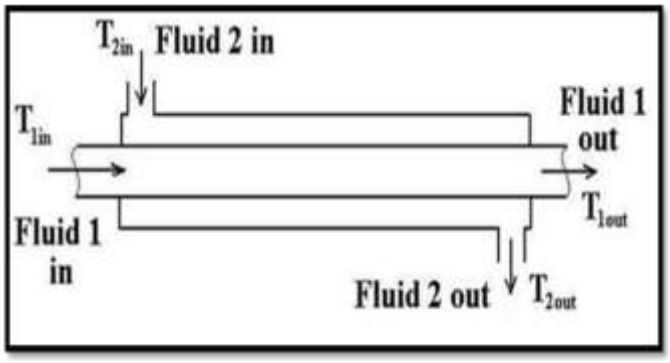

Fig-1: Double pipe heat exchanger in parallel flow

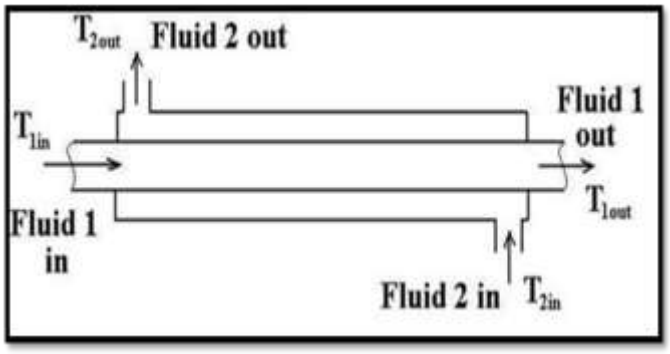

Fig-2: Double pipe heat exchanger in counter flow

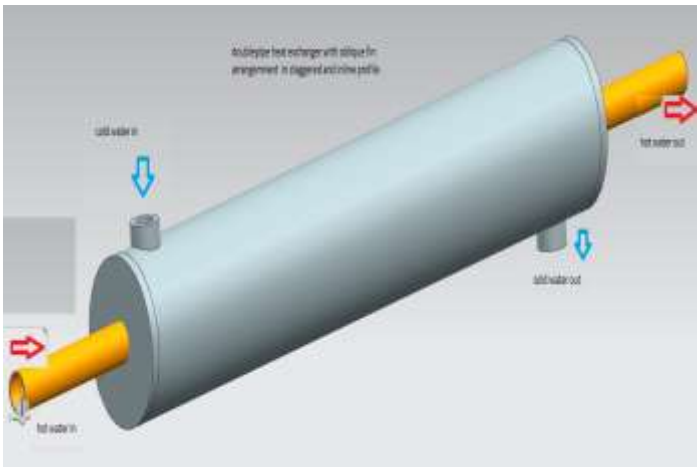

Fig-3:Double pipe heat exchanger

2. LITRATURE SURVEY

Amol Ashok Patil et al. studied the field of design, analysis, testing & experimental investigation of Double pipe heat exchangers with enhancement liners. They concluded that number of inserts can be increased by reducing the pitch. The entire tube can be placed in a casing of water to improve heat transfer. The outer tube can be lined with fins to enhance heat transfer. 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.
Experimental Investigation of Double Pipe Heat Exchanger by using Semi Circular Disc Baffles in this paper Sarmad A. Abdal Hussein studied heat transfer and friction factor characteristics of double pipe heat exchanger fitted with inserted semicircular disc baffles with spacing of 15cm and 45 cm. The heat transfer coefficient and friction factor increases with the decrease in baffle spacing compared with smooth tube. Inserted semicircular disc baffle (15 and 45) cm proves the heat transfer rate by 1.9 and 1.3 times that of smooth tube respectively.

Numerical and experimental investigation of heat transfer in double pipe heat exchanger with inner and annular twisted tape in this paper Gamit Sandip D et al. conducted experiment as well as simulation result shows that heat transfer rate of double pipe heat exchanger with outer twisted tap and hot fluid flowing outside of inner tube has maximum and log mean temperature difference is linearly with respect to different mass flow rate and also increase heat transfer coefficient at interchanging domain results obtained from CFD are validating with experimental values and % deviation from it is also very small.

3. Fused Deposition Modeling (FDM)-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 elastomeric, 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 model is 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.[6]

Advantages of the FDM process

- High strength material
- Less cost- effective and waterproof
- ABS material use for impact resistances and toughness
- Multiple material colors are available

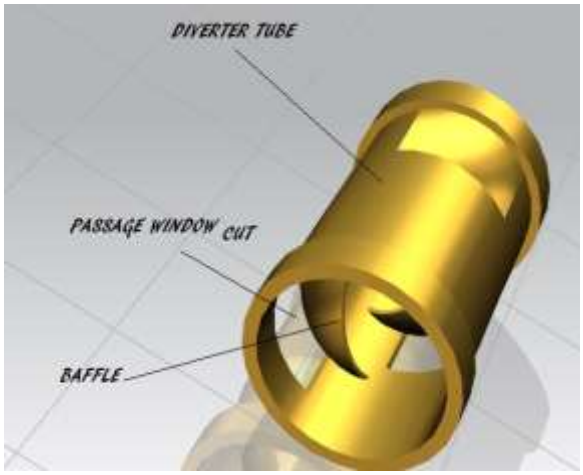

Fig- 4:Delta channel FBM inserts

CONCLUSIONS

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 delta winglet. Many of authors have given various methods of design, analysis testing & experimental investigation of Double pipe heat exchangers with heat transfer enhancement inserts. The future scope is regarding to

1. Number of winglets can be increased by reducing the pitch
2. The entire tube can be placed in a hot pipe of water to improve heat transfer.
3. Winglets are inserted inside of hot tube by using FDM method for heat transfer enhancement.

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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