IJARES/June 2016/Volume-4/Issue-6/2407-2413 **ISSN 2347- 9337**

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH IN ENGINEERING AND SCIENCE

COMPUTATIONAL FLUID DYNAMIC ANALYSIS ON DIFFERENT PRINTED DUCTS IN PCHE

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ABSTRACT:

Because of small-scale as well as compact ability of printed circuit heat exchanger, they are more and more being used within viscous media. Printed circuit heat exchanger has attained its name from process used for manufacturing of flat metal plates that makes heat exchanger core which is made by chemical milling. Printed circuit heat exchanger, are well recognized within upstream hydrocarbon processing, petrochemical as well as refining industries and can include more than two process streams into a particular unit. This feature contains space as well as weight advantages, decreasing of exchanger size together by piping and valve necessities. Our work deals with the introduction of printed circuit heat exchanger, its features and applications. We also deal with the computational fluid dynamic analysis of flow in different shaped ducts like zig zag shape and custom shapes that are analysed in computational method with different viscous media.

Keywords: Printed circuit heat exchanger, Computational fluid dynamic, Viscous media, Process streams, Zig zag shape.

1. INTRODUCTION:

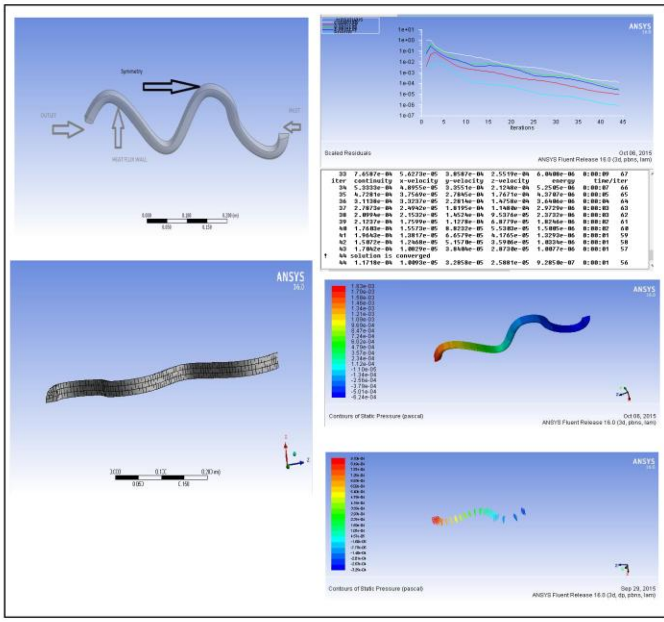
Printed circuit heat exchanger (PCHE) is a compact type of heat exchanger which is offered as an option for shell as well as tube heat exchangers. Printed circuit heat exchanger is four to six times smaller as well as lighter when compared to conventional designs for instance shell-and-tube exchanger [1]. The name of printed circuit heat exchanger was derived from the process used for manufacturing of flat metal plates that makes heat exchanger core which is made by chemical milling. These metal plates are later stacked and diffusion bonded, changing the plates into solid metal block that contains specifically engineered fluid flow passages. These Printed circuit heat exchangers make use of the technique of interruption of boundary layer on solid surface and restore it by means of fluid from core hence forming a novel boundary layer by an improved temperature gradient. Etched plates are stacked as well as diffusion bonded together for fabrication of a block. The blocks are welded collectively for forming the entire heat exchanger core. Channels of fluid flow are etched chemically above metal plate. The association of chemical etching as well as diffusion bonding processes into a particular product permits the usage of an extensive range of materials of structure that permits usage of an extensive range of clean fluids within heat exchanger that includes corrosive ones. Generally they contain circular shaped straight ducts. We deal with the computational fluid dynamic analysis of flow in different shaped ducts like zig zag shape with different viscous media [2]. Because of disturbance of boundary layers that are formed near solid surface as well as replacement of boundary layer with fluid from core, hence creating a novel boundary layer by means of an improved temperature gradient general heat transfer coefficient in addition to pressure drop penalty in case of Zig-Zag ducts enhance when compared to the straight ducts.

2. CHARACTERISTICS OF PRINTED CIRCUIT HEAT EXCHANGER:

Printed circuit heat exchanger was manufactured commercially by HEATRIC™ and is virtually unspecified within the literature works of heat exchanger until late 1990's. There are several techniques that are used for increasing heat transfer rate within compact heat exchangers moreover means that they include comparatively low inventory, when compared to shell as well as tube exchangers. The printed circuit heat exchanger possesses several features such as: High Pressures: The cores of printed circuit heat exchanger cores are considered for containment of extremely high pressures. Printed circuit heat exchanger by means of design pressures of 500 are in the process. Severe Temperatures: construction materials such as austenitic stainless steel permit temperatures from cryogenic to 900°C. Improved Safety: printed circuit heat exchanger is not liable to hazards that are normally connected with shell as well as tube exchangers, for instance flow induced tube vibration as well as tube rupture. Hence overpressure relief systems can be considerably reduced. Flexible Fluid Pressure Drop: in spite of compact nature of printed circuit heat exchanger there is no limit on pressure drop requirements for fluids that pass through them, still with gases or else highly viscous liquids. Close Approach Temperatures: Fluid contact may be counter flow, cross flow, or else a combination of these to suit for the process necessities. Multi-Fluid Contact: plate type heat exchangers are capable of containing more than two process streams within a single unit. Plate type heat exchangers expand multi-stream ability to high temperature as well as pressure processes. Multi-stream heat exchangers have noticeable space as well as weight benefits all the way through reduced exchanger as well as piping weight. Fluids can enter or else depart the heat exchanger core at the points of intermediate, and are contacted in series or else in parallel, permitting flexibility on inlet or else outlet temperatures [3]. High efficiency: plate type heat exchangers have met process necessities for high thermal efficiency in excess of 97% within a single compact unit. High efficiency heat exchangers can decrease duty as well as cost of heating or cooling operations within the overall procedure.

Geometry boundary conditions of zig zag duct includes: Properties of water includes: Density=998 kg/m3; Thermal conductivity=0.6w/m-k; Viscosity = 0.00100kg/m-s; Specific heat at constant pressure=4182J/kg-k Properties of air includes: Density=1.225 kg/m3; Thermal conductivity=0.0242 w/m-k;

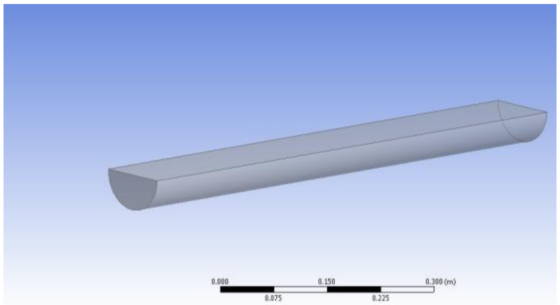
Viscosity=1.7894e-05kg/m-s; Specific heat at constant pressure=1006.43 J/kg-k



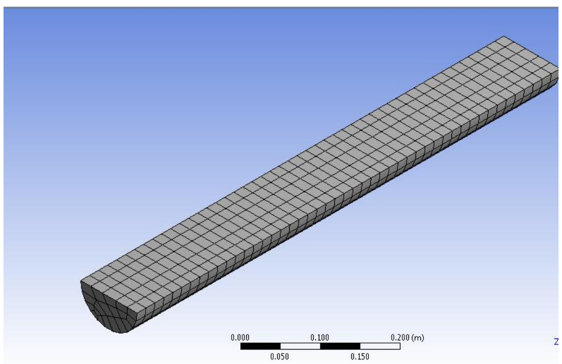
3. APPLICATIONS AND ADVANTAGES OF PRINTED CIRCUIT HEAT EXCHANGER:

The amount of data regarding Printed circuit heat exchanger in literature is quite insufficient. While the idea of usage of micro channels within heat exchangers has been identified for decades, real units were produced only since about 1985. Up until 1985, manufacturing knowledge was not satisfactorily developed. In addition, micro channel heat exchangers were fabricated simply by one company HeatricTM. Regrettably, its section on Printed circuit heat exchanger is mostly of qualitative nature and thus provides small assistance within technical design [4]. Printed circuit heat exchanger includes several applications such as processing of hydrocarbon gas & NGL Processing Gas, recovery of Liquids, production of Synthetic fuels, processing of chemicals, Refining, Reactor feed exchangers, separation of air, Power and Energy, Geothermal production Nuclear applications. Printed circuit heat exchanger includes numerous advantages such as: optimization of channels for counter current flow, High heat transfer surface area for each unit volume of exchanger that results in reduced weight, space, as well as supporting structure. It is used for temperature in the ranges of -200 to 900 C, used for reduced energy necessity and cost, for improved process designing, for low fluid inventory when compared to traditional designs [5]. Printed circuit heat exchanger is four to six times smaller as well as lighter when compared to conventional designs for instance shell-and-tube exchanger. Tremendously high heat transfer coefficients are attainable by small-hydraulic diameter flow passages; it is used for gases, liquids, as well as two-phase flows.

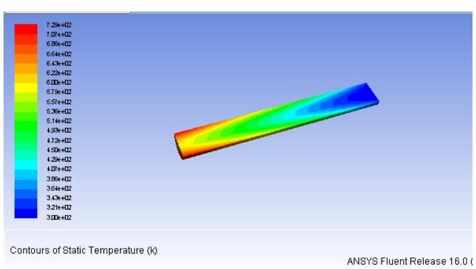
4. RESULTS:



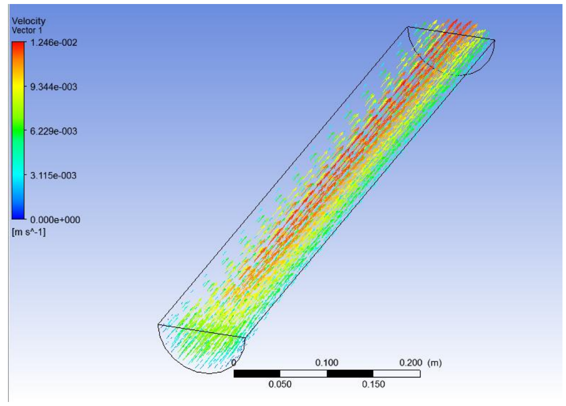
Circular duct



Circular duct mesh

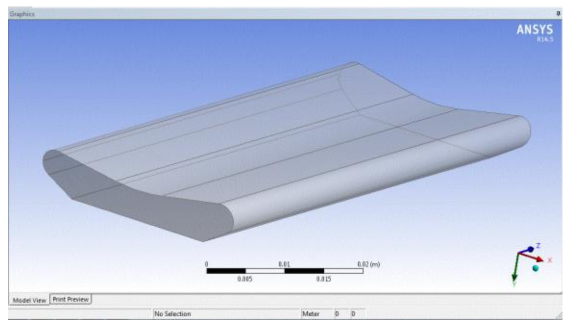


Temperature contour of circular duct

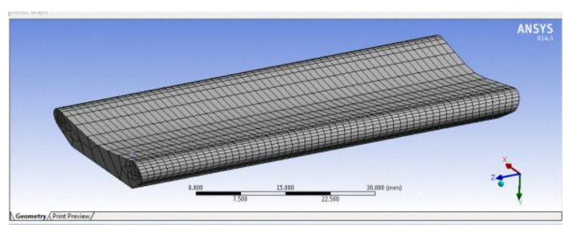


Velocity stream line in circular duct

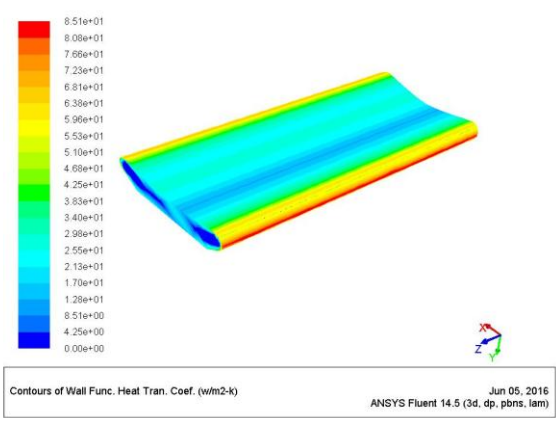
CUSTOM SHAPE 1



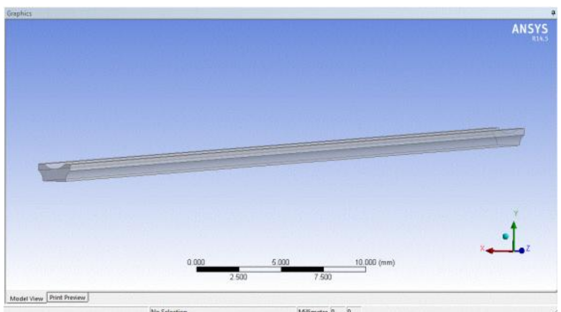
Ansys custom shape 1



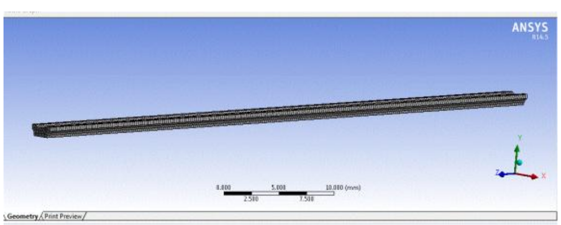
Mesh for custom shape 1



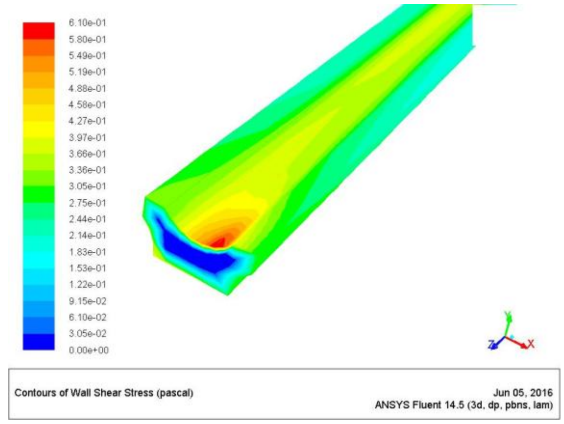
Custom shape 2



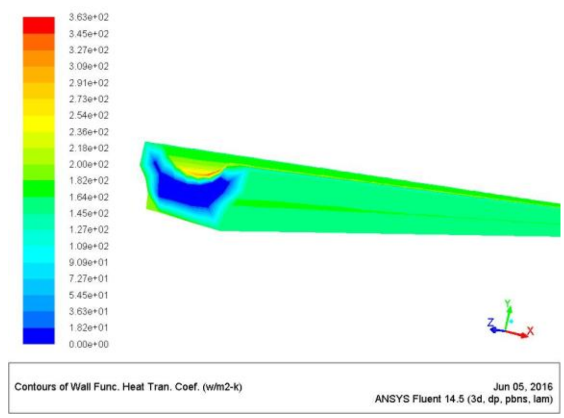
Geometry custom shape.



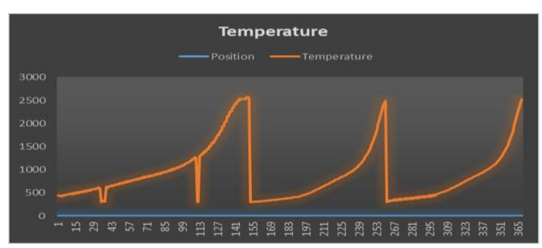
Mesh custom shape



Wall shear stress

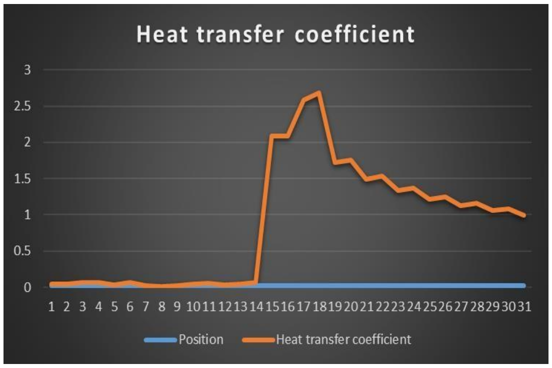


The following results were obtained after convergence



Temperature of the Zig –zag duct

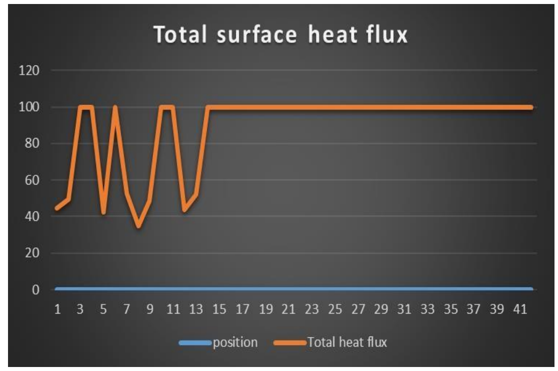
Total surface heat flux



Heat transfer coefficient

5. CONCLUSION:

The Flow through circular duct elliptical as well as zig zag duct is analyzed by means of computational facilities. Our works helps in analyzing the printed circuit heat exchanger in a better means that leads to a variety of parameter change and calculating very efficiently by means of computational Fluid Dynamics. Design as well as analysis of printed circuit heat exchanger on improvising of effective heat transfer. Using this type of technique we can able to decrease prototyping cost and this method is fast reliable as well as effective. The important features of diffusion Printed Circuit heat exchangers are their size and weight ratio as well as broad operating capabilities makes them perfect for operation in controlled space or else under extreme conditions for instance most recent



concentrated solar power thermal as well as cryogenic energy storage systems.

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