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REVIEW ON CFD ANALYSIS TO OPTIMIZE THE HEAT TRANSFER RATE OF HELICAL FIN-TUBE HEAT EXCHANGER WITH DIFFERENT FIN PITCH

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ABSTRACT:- The demand for effective and compact heat exchangers are continuously increasing in the automotive industry, refrigeration and air-conditioning applications has necessitated the use of various interrupted surfaces to augment air-side heat transfer. Fins are normally used to increase heat transfer coefficient and increasing efficiency of heat exchanger. We are using computational fluid dynamics (CFD) suitable software for analyse the heat transfer rate of heat exchanger with different boundary conditions, we can analyse easily all data as compared to experimental setup. And find out best feasible solution by CFD analysis. The objective of this study was to numerically simulate the heat transfer and flow characteristics for a helical fin-tube heat exchanger for different fin pitch (p) and different Reynolds no.(Re) using CFD analysis software Ansys FLUENT.

Keywords: - CFD, Helical Fin-tube heat exchanger, Air velocity effect, Effective heat transfer rate.

INTRODUCTION

1.1 HEAT EXCHANGER:

A heat exchanger is a perfect for efficient heat transfer from one medium to another. The medium may be separated by a solid wall to prevent mixing or they may be in direct contact. They are widely used in space heating, refrigeration system, air conditioning system, power plants, chemical plants, petrochemical plants, petroleum refineries, natural gas processing, and sewage treatment. The classic example of a heat exchanger is found in an internal combustion engine in which oil using as engine coolant flows through radiator coils and air flows past the coils, which cools the coolant and heats the incoming air.

Heat exchangers are off-the-shelf equipment targeted to the efficient transfer of heat from a hot fluid flow to cold fluid flow, in most cases through an intermediate metallic wall and without moving parts. We are focus on the thermal analysis of heat exchangers, but proper design and use requires additional fluid dynamic analysis (for each fluid flow), mechanical analysis (for closure and resistance), materials compatibility, and so on.

Heat losses of a whole heat exchanger and environment can be neglected in comparison with the heat flow between both fluid flows; i.e. a heat exchanger can be assumed as a globally adiabatic.

Fig 1.1 heat exchanger

Saving material and energy are common objectives for optimization. Material selection of fins is very important factor for effective heat transfer. The optimization function can consider minimum weight for a specified heat flow, minimum mass, minimum pressure drop etc).we can increase convection coefficient with the help of growing the fluid velocity, widen temperature difference between surface and fluid or increase the surface area across which convection occurs. Extended surfaces, in the form of radial fins is common in applications where the need to enhance the heat transfer between a surface and an adjacent fluid exist

Fig 1.2 Fin tube heat exchanger

Fins are commonly used in extended surface exchangers. Conventional fin-tube exchangers often characterize the considerable difference between liquids' heat transfer coefficients. In a gas-to-liquid exchanger, the heat transfer coefficient on the liquid side is generally one order of magnitude higher than that on the gas side. To minimize the size of heat exchangers, fins are used on the gas side to increase the surface area and the heat transfer rate between the heat exchanger surface and the surroundings. Both the conduction through the fin cross section and the convection over the fin surface area take place in and around the fin. When the fin is hotter than the fluid to which it is exposed then the fin surface temperature is generally lower than the base (primary surface) temperature. If the heat is transported by convection to the fin from the ambient fluid, the fin surface temperature will be higher than the fin base temperature, which in turn reduces the temperature differences and the heat transfer through the fin. Exchangers with fins are also used when one fluid stream is at high pressure. The temperature value is limited by the type of material and production technique. All above causes that finned tube heat exchangers are used in different thermal systems for applications where heat energy is exchanged between different media. Applications range from very large to the small scale (tubes in heat exchangers, the temperature control of electronic components). The subject, who is investigated in the chapter, is inspired by the increasing need for optimization in engineering applications, aiming to rationalize use of the available energy. The performance of the heat transfer process in a given heat exchanger is determined for different fin profiles, considering the fluid flow as a variability often neglected for the fin optimization. The optimization task, defined in the chapter, is to increase heat transfer rates.

TYPES OF HEAT EXCHANGER

- Double pipe heat exchanger
- Shell and tube heat exchanger
- Plate heat exchanger
- Finned Tube Heat Exchanger
- Air Cooled Heat Exchanger

LITERATURE REVIEW

Mohammed Saad Kamel.et.al [2015]:-
This paper describes the heat transfer enhancement and fluid flow across tube banks heat exchanger by means of vortex generator. One of the most important passive techniques to augment the heat transfer is the use of vortex generators. The vortex generator can be embedded in the plane fin and that too in a low cost with effect the original design and setup of the commonly used heat exchangers. Heat transfer and pressure drop depend on complex flow pattern of fluid in tube banks, whereas pressure drop linked directly with the fluid pumping capacity. Paper focuses to review a various design modifications which are implemented and studied experimentally and numerically by effect the shape of vortex generator, angles of attack, position and Reynolds number on wake size and vortex shedding.

Santosh D Katkade 1, Prof J H Bhangale 2, Prof D Palande et.al [2015]:-
The demand for compact heat exchangers is continuously increasing in the automotive industry, refrigeration and air-conditioning applications has necessitated the use of various interrupted surfaces to augment air-side heat transfer. Fins are normally used to increase heat transfer coefficient and increasing efficiency of heat exchanger. Spiral fins are most widely used by industry. In this study spiral fin performance is investigated with different fin thickness (0.5, 0.6, 0.7 mm) at different Reynolds number.

Jignesh M. Chaudhari.et.al [2014]:-
As far today's demand is to manufacture a compact car so there is an urgent need to design an effective heat exchanger. In this paper the effect of finned heat exchanger over a without finned heat exchanger on overall heat transfer coefficient is studied. The overall heat transfer coefficient is studied for both heat exchanger with air velocity 3m/s, 4m/s, 5m/s and 6m/s and coolant flow 180 Lit/hr, 260 Lit/hr , 340 Lit/hr, 420 Lit/hr ad 500 Lit/hr. Finned-tube heat exchangers are common and vital components in many energy systems Fin-and-tube heat exchangers are widely used in several domains such as heating, ventilating, refrigeration and air conditioning systems The fin performance is commonly expressed in terms of heat transfer coefficient and fin effectiveness, which is defined as the ratio of the heat transfer rate with fin to the heat transfer rate in without fin heat exchanger. This case is the one providing the maximum heat transfer rate because this corresponds to the maximum driving potential (temperature difference) for convection heat transfer. The research work summarized in this presents a combined analytical, experimental and numerical investigation of Overall heat transfer coefficient of coolant as water by use of circular finned tube heat exchanger and without fin tube exchanger with force convection. The heat transfer and pressure drop results for the pin fin heat exchanger were compared with the results for a smooth-pipe heat exchanger. The experimental system is quite similar to cars' cooling system. The compares the heat transfer coefficient, pressure drop, overall heat transfer coefficient with the finned tube heat exchanger and without finned tube heat exchanger. From the experiment Finned-tube heat exchanger gives the overall heat transfer coefficient 14.07W/m2K (1).

Praful Date1 and V. W. Khond.et.al [2013]:-

This paper proposed the novel approached toward the heat transfer enhancement of plate and fin heat exchanger using improved fin design facilitating the vortex generation. The vortex generator can be embedded in the plane fin and that too in a low cost with effect the original design and setup of the commonly used heat exchangers. The various design modifications which are implemented and studied numerically and experimentally is been discussed in the paper.

Rathod Pravin P *, Ravi Kumar, Akhilesh Gupta.et.al [2012]:- The objective of this paper is to present the literature review on film condensation on horizontal tubes. Film condensation of a vapour is an important phenomenon which occurs in numerous engineering applications. Studies have already been carried out to understand the various aspects of film condensation different type of condenser tube surface geometries. Over the years, a number of research publications are available in this important area of heat transfer. A review study has been carried out regarding the condensation of pure vapours over a horizontal integral fin tube. The literature review facilitates a clear insight of the phenomenon of the condensation of saturated pure vapours over horizontal integrals fin tubes. The condensation of pure vapours inside a surface condenser takes place when the saturated vapour comes in contact with the cold surface of the condenser tubes and exchange heat with the tube wall. Subsequently, the heat from the tube wall is carried away by the coolant flowing inside the tube.

CONCLUSION

By reviewing the research papers it is been concluded that CFD technique is much better than experimental as it is less time consuming. In future CFD (Computational Fluid Dynamics) technique is used to optimize the heat transfer rate of helical fin of helical tube heat exchanger at constant air inlet temperature & outlet air temperature, pressure drop, heat transfer coefficient, nusselt number, friction factor are calculated subsequently with respect to different pitches and different Reynolds numbers (inlet velocities). The material of fin should be of good thermal conductivity (e.g. Copper, Aluminium etc)

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