REVIEW ON STUDY OF HEAT TRANSFER COEFFICIENT FOR CORRUGATED SURFACE AND HEAT EXCHANGER

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Abstract-

Energy economy is major substance in our overall world, and heat exchanger is very useful for energy economy, of course heat exchanger is most significant component for chemical reaction, distillation, dissolution, crystallization, fermentation etc. So the perfect selection of heat exchanger is significant in these process industries. The flow of the two fluids is counter-current, which makes it possible to have a close temperature move toward between the two medias being treated in the heat exchanger. A large collection of fluids can be apposite for a spiral heat exchanger solution e.g. fouling liquids containing solids and fibers, waste water, slurries, mixtures with inert gases, cooling and heat recovery . Plate heat exchanger has set up a wide range of application in different industries like food industries, chemical industries, power plants etc. It reduces the wastage of energy and improves the overall efficiency of the system. Hence, it must be designed to obtain the maximum heat transfer possible. This paper is presented in order to study the various theories and results given over the improvement of heat transfer performance in a plate heat exchanger. However, there is still a lack in data and generalized equations for the calculation of different parameters in the heat exchanger. It requires more attention to find out various possible correlations and generalized solutions for the performance improvement of plate heat exchanger. Compact heat exchangers are one of the vital components in micro level turbo machinery engineering systems. The compact heat exchanger is used as recuperators or intercooler. Due to its high volume integrity and light weight, the cross-corrugated surface heat exchanger is a capable alternate for application to a superior intercooled-cycle gas turbine engine. This paper presents a study of heat transfer and frictional uniqueness of a corrugated compact heat exchanger.

Keywords :-Heat Transfer Coefficient ,Corrugated Surface, Global warming, Compact Heat Exchanger

Introduction

A heat exchanger is a appliance to transfer heat from a hot fluid to cold fluid across a resistant wall. Fundamental of heat exchanger principle is to make easy a proficient heat flow from hot fluid to cold fluid. This heat flow is a straight function of the temperature difference between the two fluids, the area where heat is transferred, and the conductive/convective properties of the fluid and the flow state. The general mode of generating electrical energy for distant area, for disaster power situations etc, was using diesel power plants. Recuperator is needed for improving efficiency of micro turbine above 35%. Recuperators are heat exchanger device, which should give the highest heat transfer under such conditions. Further requirements on recuperators, of which low cost is identified above, are the following:

• High thermal effectiveness and low pressure losses. These influence the gas turbine cycle efficiency.

• High consistency and stability give low maintenance expenditure and long operational life time.

• Minimum weight and volume. The weight is directly proportional to material price and a little volume of the part makes the gas turbine packages easier to handle. Heat exchangers are classified according to process purpose, compactness, flow directions, construction of geometries etc.. The equivalent friction coefficient f was establish to reduce with the Reynolds number roughly as Re -1/2. The angle dependence of f was much larger than that of the Nusselt number. The friction coefficient increased with P/H**,** an asymptote is suggested by the

experimental data for P/H, > 4.

Fig.1 Image of corrugated tube

BASIC TYPES OF HEAT EXCHANGERS

Over the years, many models have been recommended for heat exchangers, with changes being made in the conventional designs to reach maximum heat transfer areas, higher heat transfer coefficients, and also to design reasonably practical models. Some of the conventional models are:

- Shell and Tube Heat Exchanger: - This comprises of a shell that contains a number of tubes held mutually between two tube sheets at any end. It is mostly used for the cooling of hydraulic fluids, boilers etc.
- Plate Heat Exchanger :-This consists of alternate square plates and frames which hold the plates together. There are holes at the four corners which form four continuous channels for the fluids to flow. It is widely used in chemical, pharmaceutical and food industries.
- Double Pipe Heat Exchanger :- It is a relatively primitive model consisting of two concentric pipes. One fluid flows through the inner pipe and the other flows through the annulus formed by the

two pipes. It can be used instead of plate heat exchangers but is rarely an option as it occupies more space.

The type of Heat Exchanger that is to be used depends upon which type of fluid is to be handled, operating temperature range, floor spacing, and type of flow required. In general, Heat Exchangers are designed with the sole aim of achieving maximum heat transfer area and heat transfer coefficients within the specified temperature range. In order to increase the area of heat transfer, fins or corrugated plates may be used. To increase the heat transfer coefficient, baffles are placed to introduce turbulence. Ultimately, all these factors are taken into consideration for developing a Heat Exchanger required for particular operation. Spiral heat exchanger maintenance is easy. Each side of the closed spirals can be accessed by opening the side frame of the heat exchanger without any special tools. When opening the side frame there will be full access to the heat transmission area on one side, which can be cleaned without getting in contact with the other side of the heat exchanger. The side frame is designed with hinges which make lifting equipment unnecessary. The spiral heat exchanger is a compact solution. The design only requires a small space for installation compared to traditional heat exchanger solutions. This saves valuable production space and costs.

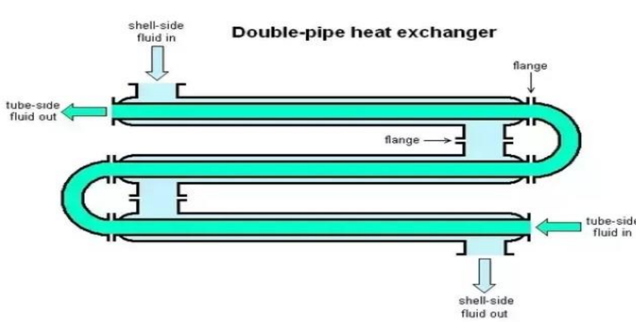

Fig. 2 Heat Exchanger Flow Pipe

2 . Literature survey

Focke. W.W. et. al [1] accomplished that inclination angle between plate corrugations and overall flow directions are the main constraint in thermodynamic performance of any heat exchanger. Greatest heat transfer is observed at an angle of 800 from the experimental data. At an angle above that, heat transfer decreases as the flow pattern becomes less effective due to its separation.

Mehrabian M.A. and Pouter R. [2] studied the effect of change of corrugation angle on local hydrodynamic and thermal characteristics between two identical APV SR3 keepings the plate spacing fixed.

Metwally H.M. and Mbanglik R.M. [3] observed the corrugated plate channels with uniform wall temperature and establish that flow field is greatly subjective by aspect ratio (γ) and Reynolds Number (Re). The observations gave two different regimes that is one having low Reynolds Number or γ- undistributed laminar flow regime and the other one having a high Reynolds Number or γ- swirl flow regime.

Paisarn Naphon, Somchai Wongwises et al [4] They have done an experimental investigation on comparative heat transfer study on a solvent and solution using spiral heat exchanger. They used steam as the hot fluid and water and acetic acid - water miscible solution as cold fluid. They carried out series of runs between steam and water, steam and acetic acid solution .The flow rate of the cold fluid was varied from 120 to 720 lph and the volume fraction of Acetic acid was varied from 10-50%. Experimental results such as exchanger effectiveness, overall heat transfer coefficients were calculated. Generalized regression model was used for artificial neural network simulation using matlab and the data obtained was compared with experimental findings and found to be valid.The research was carried out by Naphon and Wongwises on study of the heat transfer characteristics of a compact spiral coil heat exchanger under wet-surface conditions

Dr M A. Hossain, M I. Islam, S A. Ratul, MT U R. Erin et al [5] The objective of their work was to find the heat transfer features and the performance of a spiral coil heat exchanger under cooling and humidifying conditions. Air and water were used as working fluids. A mathematical model based on mass and energy conservation is developed and solved by using the Newton–Raphson iterative method to determine the heat transfer characteristics. They found that enthalpy, effectiveness and the humidity effectiveness decreased with increasing air mass flow rate for a given inlet-water temperature, inlet-air humidity ratio and water mass flow rate. The increase in the outlet enthalpy and outlet humidity ratio of air was larger than those of the enthalpy of saturated air and humidity ratio of saturated air. Therefore, the enthalpy effectiveness and humidity effectiveness tend to decrease with increasing air mass flow rate. They also observed that the effect of inlet-air temperature on the tube surface temperature. At a specific inlet-air temperature, the tube surface temperature generally increases with increasing air mass flow rate; however, the increase of the tube surface temperature at higher inlet-air temperatures was higher than at lower ones for the same range of air mass flow rates. They found that at a specific air mass flow rate, the tube surface temperature decreases as water mass flow increases. Finally the results obtained from the developed model are validated by comparing with the measured data .The research was carried out by Hossain et. al.on comprehensive study on heat transfer co-efficient and effectiveness for water using spiral coil heat exchanger .

Kaliannan Saravanan,Rangasamy Rajavel et al [6] They shown experiment by using spiral plate heat exchanger with hot water as the amenity fluid and the two-phase system of water - palm oil in different mass segments and flow rates as the cold process fluid. They investigated heat transfer coefficients. The research was carried out by Kaliannan Saravanan etl. on Spiral plate heat exchangers play a vital role in cooling high density and high viscous fluids.

Working Principle of Heat Transfer Coefficient Corrugated Heat Exchanger

In a heat exchanger, the fluid flows can be performed in several arrangements. One can easily show that thermodynamically, the most competent heat exchanger is the counter flow heat exchanger , but other concerns than the thermodynamic effectiveness are taken into account when designing a heat exchanger: the maximum acceptable temperatures in one fluid, or more often considerations of size, weight or price. It follows that the configurations of exchangers that are encountered in perform are relatively different.

However, we can gather these configurations in three main geometries:

• counter-flow, in which fluids flow in parallel and in opposite directions;

• parallel-flow, in which fluids flow in parallel and in the same direction;

• cross-flow, in which fluids flow in perpendicular directions.

We will denote the hot fluid by index h, and the cold fluid by index c. Besides the geometric configuration, exchanger sizing or performance depends on many parameters and variables:

• mass flows m_h and m_c passing through them;

• inlet temperatures T_{hi} and T_{ci} and outlet temperatures T_{ho} and T_{co} of both fluids;

• heat exchange coefficients U_h and U_c of each fluid;

• thermal resistance of the walle/λ

• the surface A of the exchanger;

• the pressures of both fluids, almost constant;

• the thermophysical properties of fluids, which are used to determine coefficients U_h and U_c. It is essentially the heat capacity c_p, the density ρ, thermal conductivity λ, and viscosity μ.

In what follows, we will assume that the heat exchange coefficients U_h and U_c and thermophysical properties of fluids maintain a constant value at any time in the entire heat exchanger.

If this assumption is not verified, then in order to study the performance of the exchanger, it is necessary divide it into small volume elements, in which these properties can be considered constant. The calculations are then much more cumbersome.

Finally, we always assume that the heat exchanger is globally adiabatic, that is to say there is no heat exchange with the surroundings.

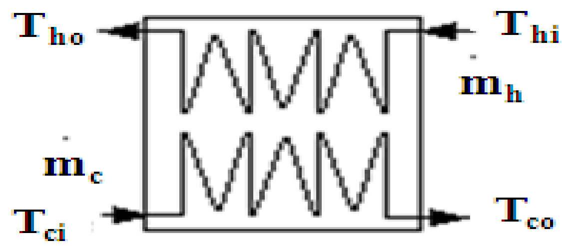

Figure 3: Heat exchanger sketch

Conclusions

Many experiments have been performed to learn the effect of unlike parameters on the different types of plate heat exchangers. It has been observed that even at modest velocities plate heat exchanger can reach maximum heat transfer coefficient, low fouling factor etc. Nusselt Number is found to be very much depending upon the Reynolds Number and it increases with the increase in Reynolds Number. At the various feasible conditions different correlations have been planned for Nusselt Number, Reynolds Number, Prandtl Number, heat transfer coefficient, friction factors etc. Dimensionless correlations have also been planned for the plate heat exchanger. Models have been developed for the learn of compact heat exchanger with several passes and several rows for the development of better generalized equations

It was observed that the heat transfer rate increases nearly linearly with increasing Reynolds number. Study on the different things of feed flow rate and the coil diameter was ready and accomplished that on increasing the feed flow velocity the pressure drop increases and vice versa. A relation between the pressure drop and the feed flow rate for the steady state

Newtonian fluid into the Archimedean spiral tubes was developed

Future Scopes

On the basis of various studies made till today, we can further go for the studies on other types of plates. We can also study for the two phase flow and boiling flow over the plate heat exchanger. Improvements can also be done by varying the rib angle3 of attack. Investigations can be made for the effect varying geometries on heat transfer of the plate heat exchanger. There can be enhancement of heat transfer by providing turbulence in fluid motion.

Reference

[1] **Focke W.W. Zachariades J. Oliver I, 1985**, "*The effect of the corrugation inclination angle on the thermo hydraulic performance of plate heat exchangers*". International Journal of Heat Mass Transfer, 28 [8] pp 1469-1479

[2] **Mehrabian M.A., Poulter R. , 2000** "*Hydrodynamc and thermal characterstics of corrugated channels: Computational approach*", Applied Mathematical Modelling, 24, pp 343-363.

[3] **Mwtwally H.M., Manglik R. M., 2004** "*Enhanced heat transfer due to curvature induced lateral vortices in laminar flows in sinusoidal corrugated-plate channels*", International Journal of Heat and Mass Transfer, 47, pp 2283-2292.

[4] **Paisarn Naphon, Somchai Wongwises**, "A study of the heat transfer characteristics of a compact spiral coil heat exchanger under wet-surface conditions" Experimental Thermal and Fluid Science" 29 ,2005, 511–521.

[5] **Dr M A. Hossain, M I. Islam, S A. Ratul, MT U R. Erin**, " Comprehensive Study on Heat Transfer Co-efficient and Effectiveness for Water Using Spiral Coil Heat Exchanger" Proceedings of the Global Engineering, Science and Technology Conference 2012, Dhaka, Bangladesh, 28-29 December 2012.

[6] **Kaliannan Saravanan,Rangasamy Rajavel**, "An Experimental Investigation of Heat Transfer Coefficients for Spiral Plate Heat Exchanger" Modern Applied Science,Vol.2,No.5,September 2008.

[7] **J.G. Mannix**, Evaluation of the convective heat transfer coefficient of an evaporative cooling pad (Mphil thesis), Virginia Polytechnic Institute and State University, 1981.

[8] **Ratti, C., Crapiste, G.H.,** Determination of heat transfer coefficients during drying of foodstuffs, *Journal of Food Processing Engineering*, *18* (1995), pp. 41-53.

[9] **Anwar, S.I., Tiwari, G.N.,** Evaluation of convective heat transfer coefficient in crop drying under open sun drying, *Energy Conversion. Management*, *42* (2001),5, pp. 627-637.