# Performance Analysis of Double Pipe Helical Shaped Heat Exchanger for Various Shape" A Review

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***Abstract* - In many industrial applications, heat exchangers such as thermal radiators, solar collectors, classical industrial heat exchangers or complex networks are usually a part of a system. During their normal operation or operating conditions such as time varying inlet temperature or flow rates, they can be submitted to unsteady behaviour. So, an accurate knowledge of the thermal response of such a system during an unsteady period of operation is very important for effective controls, as well as for the understanding of the adverse effects which usually result in reduced thermal performance or increased thermal stresses. In many situations, the remelts of steady state are extrapolated to describe the behavior of the unsteady state, but this method does not suit well in most of the cases, so there is a need to develop models for the unsteady state.**

**The aim of present review study is "To get with the impact of decrease of one hub and augmentation of other axis on the warmth move execution of twofold line helical molded warmth exchanger with the assistance of limited component investigation."**

***Index Terms* - Double pipe heat exchanger, LMTD, NTU, CFD analysis, etc.**

## INTRODUCTION

Nowadays, heat exchangers are widely used in industrial and engineering applications. It is believed that coming up with design of an efficient heat exchanger is quite complicated for engineers. The reason towards that is not only an accurate assessment of the long-term performance and the regarding financial costs is needed, but a comprehensive investigation of heat transfer, pressure drop, and the effectiveness is also inevitable which all require arduous work. Upon using heat transfer enhancement methods, pressure drop will also be increased which results in a higher pumping power.

So, it is firmly stated that some of these heat transfer enhancement methods may just adversely affect the need to an optimum case containing the heat transfer rate and pressure drop. As a result, choosing the methods wisely is of great importance. It is also believed that having a high and appropriate heat transfer rate in devices such as computers, electric power systems, automobile engines and other numerous examples is inevitable.

Heat Exchanger may be classified based on the mechanical design.

1. Concentric tube heat exchanger
   Also called a double pipe heat exchanger, it is one wherein one fluid flows through the inner tube, and the other fluid flows through the annulus, as shown in Figures.

2. Shell and tube heat exchanger
   In this type of heat exchanger, one of the fluids flows through a number of tubes stacked in a shell, and the other fluid flows outside the tubes. Depending on the requirement, there can be multiple tube or shell passes. Flow conditions in a shell and tube heat exchanger are neither parallel flow nor counter flow. Fluid flow outside the tubes is directed by separators known as baffles placed in the shell. A concentric tube heat exchanger is the simplest form of a shell and tube heat exchanger.

3. Multipass heat exchanger
   Shell and tube heat exchangers and crossflow heat exchangers can be of multipass type to enhance their heat transfer capability. Multiple tube passes or shell passes are chosen based on the velocity consideration, the total heat transfer area requirement, and the space (the heat exchanger length) constraints.

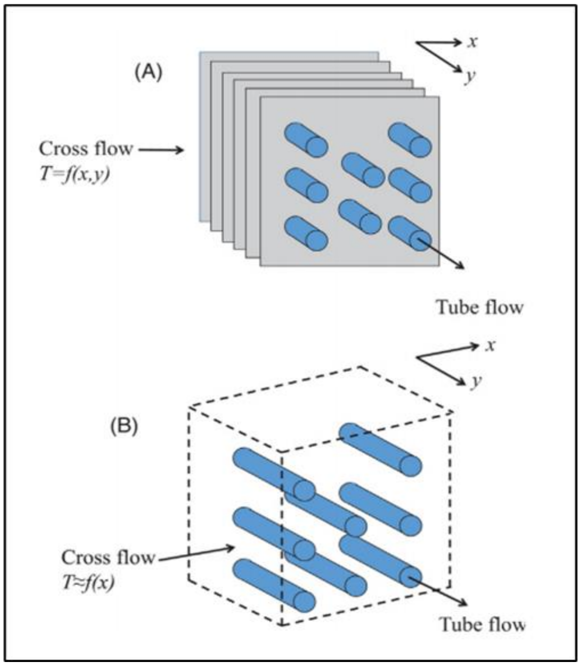
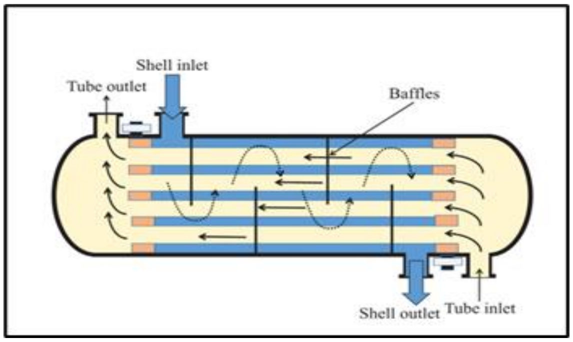


Figure 1.1 Crossflow heat exchanger with (A) both fluids unmixed and (B) one fluid mixed and the other unmixed.



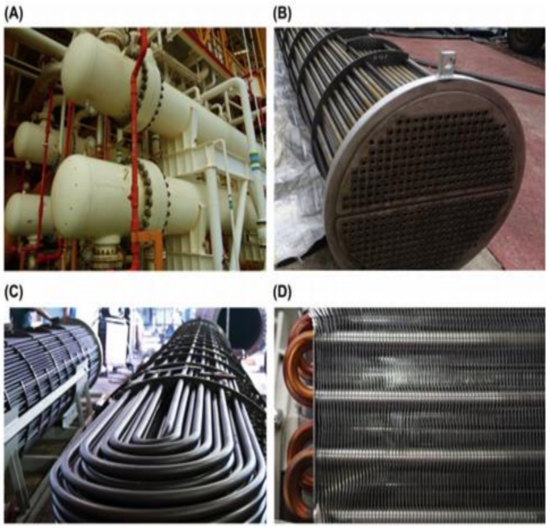


Figure 1.2 Shell and tube heat exchanger

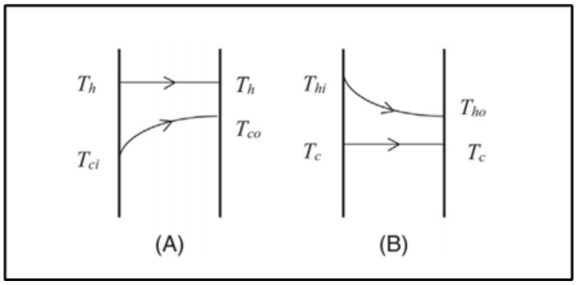


Figure 1.3 Temperature profiles of the hot and cold fluids in (A) a condenser and (B) an evaporator.

Based on the physical state of working fluid

1. Condenser

   The hot fluid condenses as the heat is transferred to the cold fluid. The temperature of the condensing (hot) fluid remains constant, as shown in Figure. 1.3A.

2. Evaporator

   The cold fluid evaporates due to the heat transfer from the hot fluid. The temperature of the evaporating (cold) fluid remains constant, as shown in Figure. 1.3B. It may be noted that the convection heat transfer coefficients associated with condensation and evaporation are very high compared to single-phase heat transfer coefficients.

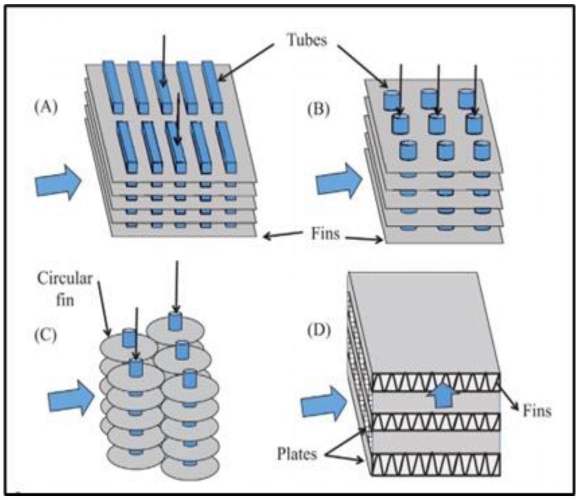


Figure 1.4 Compact heat exchangers: (A, B, C) fin-type heat exchanger and (D) plate-fin heat exchanger.

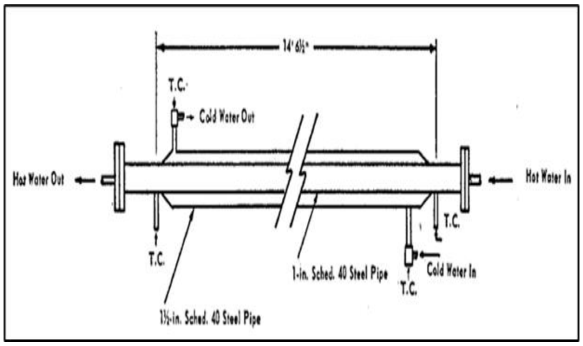
Based on the compactness

Compact heat exchangers pack a large amount of heat transfer surface area (≥400 m2/m3) per unit volume of the heat exchanger. Gas flow is normally associated with poor heat transfer coefficients, so compact heat exchangers are employed when the heat transfer is between two gases or between a gas and a liquid. Fin-tube heat exchangers and plate fin heat exchangers, as shown in Figure. 1.4, are examples of compact heat exchangers.

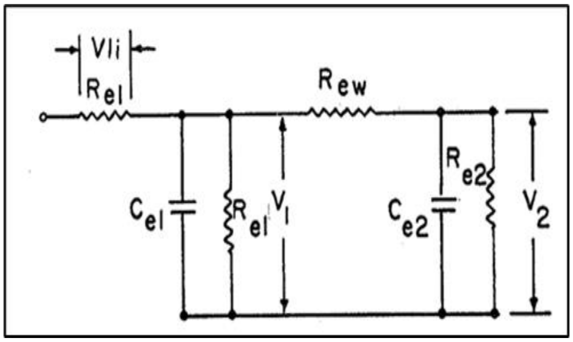
## II- LITERATURE REVIEW

### Previous Researches on Various Fields

One of the earliest researches done on DPHEs was the one by J. M. Mozley, 1956 who both numerically and experimentally made a case for the study and prediction of dynamic characteristics of a special DPHE using two automatic control methods. These methods were based on simple mathematical models and also passive electrical network analogues. He also compared the frequency responses which were based on basic analogue results and concluded that the numerical results were in a good agreement with experimental results.



(a)



(b)

Figure 2.1 (a), (b) Electrical analogue and Physical diagram of heat exchanger consider by J. M. Mozley, 1956

The performance of automatically controlled process plants T depends on the dynamic interaction of all the components in the control loop. To undertake the intelligent design of the control system necessitates knowing the dynamic characteristics of all the components in the control loop as well as having an understanding of closed-loop dynamic behaviour. In the same year 1956, Cohen and Johnson 1956 also studied dynamic characteristics of DPHEs. This numerical and experimental work shaped some thinking for years to come. In this study, equations of dynamic characteristics were obtained for a simple system and it was reported that the characteristics of DPHE’s components could be easily determined by frequency responses of the data. They also observed that these data were so close to experimental results.

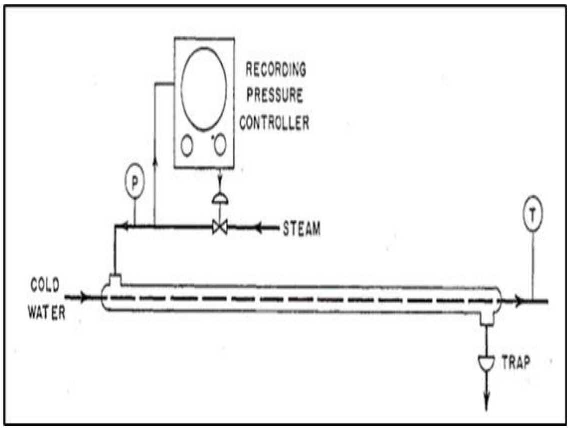


Figure 2.2 Experimental arrangement of heat exchanger consider by Cohen and Johnson 1956

Later on, Lachi et al 1996 studied time constant of a DPHE and a shell and tube heat exchanger. The particular purpose of this investigation was to classify the characteristics of these heat exchangers in a transient condition, especially the time when abrupt changes in inlet velocities are considered. Upon carrying out this study, a model with two parameters of time delay and time constant have been employed. It is also noted that the analytical term was derived by applying energy balance equation. Moreover, it was stated that an experimental method was used to validate the numerical data which the highest observed difference found to be less than ten percent.

Furthermore, in an experimental study, Aicher and Kim, 1998 investigated the effect of counter flow in nozzle section of a DPHE which were mounted on the wall of the shell side. It turned out that the counter flow in nozzle section had a significant effect on heat transfer and pressure drop. It was also concluded that the very effect would be more conspicuous, if the heat exchanger were small and also the ratio of free cross section areas were low enough. They also presented experimental correlations to predict heat transfer rate in turbulent flow.

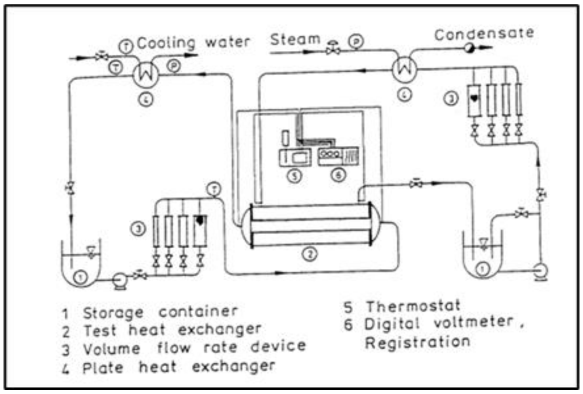


Figure 2.3 Experimental arrangement of heat exchanger consider by Aicher and Kim, 1998

Maré et al. 2008 studied mixed heat transfer with back flow in concentric DPHEs both numerically and experimentally. The working fluid in this investigation was water which flowed in laminar regime. The corresponding velocity vectors were also visualized by PIV technique which is one of the most prominent flow visualization methods. Velocity distribution showed that a high-volume rate of the flow in the annulus results in constant temperature boundary condition of the inner tube. It was also observed that a back flow appeared in both inner tube and the annulus in which the phenomenon was more noticeable at low flow rates and Richardson amount of unity.

Furthermore, Ma et al. 2016 experimentally investigated the effects of supercritical carbon dioxide (SCO2) in a DPHE in which the effects of pressure, mass flux and buoyancy force of the SCO2-side were broadly studied. On one hand, it was observed that pressure increase of the gas-side conspicuously caused both the overall and the gas-side heat transfer rates to be decreased. On the other hand, it was obvious that the flow rate of the waterside, in comparison with the gas-side, was the key element of the heat transfer rate. Moreover, a mathematical correlation based on Genetic Algorithm was presented for predicting heat transfer rate.

Iman Bashtani et. al. 2019 numerically investigates a double pipe heat exchanger with a simple and corrugated tube assuming three different wave amplitudes. The simulation is performed using ANSYS package, considering turbulent flow and k-ω SST turbulence model. Accordingly, the heat exchanger type is considered to be water-to water and the corresponding flow is parallel so that the hot and cold fluids pass through the inner tube and the shell, respectively. The results show that, in the similar Reynolds number, corrugating increases Nusselt number so that at the maximum state the average Nusselt number of the corrugated heat exchanger is about 1.75 times as compared to the simple heat exchanger.

## III-CONCLUSION

On the basis of previous study, A finite element analysis for the assessment of shape changes of inner tube with respect to heat transfer characteristics has been carried out. The following conclusions can be made:

- The use of the LMTD arises directly from the analysis of a heat exchanger with constant flow rate and fluid thermal properties. It can be observed that the LMTD is varies on the basis of major and minor axis.
- Changing in Major to Minor Axis ratio cause increasing the effectiveness of the heat exchanger. As increasing in the NTU, the effectiveness is also increased.

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