

A Review on Triple Tube Heat Exchanger on Optimizing Thermal Efficiency

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Abstract: Over the past few decades, technological developments have faced challenges in meeting cooling needs. Further work is underway on optimal heat transfer in concentric heat exchangers; one of the double tube heat exchangers examined is the triple tube heat exchanger (TTHE). Three-pipe heat exchangers were found to be more efficient than two-pipe heat exchangers. This review presented is the working principle of the triple concentric tube heat exchanger and the proposed methodology is used in a computational fluid dynamics algorithm.

Keywords: CFD, TTHE, Double Tube Heat Exchangers, PCM.

I. INTRODUCTION

The basic type of heat exchanger used in many fields of application is a double pipe heat exchanger. Its phenomenon of operation is based on the transfer of heat between two pipes with cold and hot liquids. It is important in the freezing, dry boiling, dairy and pharmaceutical, food, pasteurization and chemical industries. To cope with high temperature differences, the area of the heat exchanger must be enlarged, which would only be possible by lengthening the heat exchanger. This solves this problem as the heat exchange area is increased for the same length of the double tube heat exchanger. It has three concentric tubes, specifically three compartments called inner tube, inner ring and outer ring. It is necessary to circulate the target fluid, whose temperature fluctuations are of utmost importance to fill the application, within the internal annular space to make the most of the heat exchanger. The inner ring has 2 heat exchange surfaces (outer surface of the outer tube and inner surface of the outer tube) which slightly increase the heat exchange area of the heat exchanger compared to a double tube device (not just an exchange surface thermal) which increases the rate of heat exchange. It will also increase the efficiency of the heat exchanger. Thus, together it reduces the length of the desired heat exchanger for constant temperature differentiation from dual-tube devices.

II. LITERATURE REVIEW

Vo Tuyen et al. [1] The highly effective heat-transfer characteristic of a triple-tube heat exchanger was applied to the liquid-to suction heat exchanger of an R410A refrigerator. A one-dimensional analytical model was established and validated against numerical and experimental models. The study aimed to find the optimum refrigerant flow-rate fraction and diameter of the three tubes in terms of the heat transfer rate and pressure drop. The results indicated that the liquid-to-suction triple-tube heat exchanger had a much higher heat transfer and lower pressure loss than the double-tube heat exchanger.

Abdelmagied M et al. [2] In this paper presented are the thermo fluid characteristics of a new design of curved tube called a triple spiral tube heat exchanger (TSTHE) was achieved with a brave comparative with a double spiral tube heat exchanger (DSTHE) as particular reference. The results carried out at Dean Number ranged from 1100 to 10500 in the turbulent region corresponding to Reynolds number from 6400 to 57400. The results presented that the Nusselt number obtained from a TSTHE was higher than that value of DSTHE at the same flow conditions. The results also presented that a significant effect of hot water inlet temperature on the Nusselt number while the increase in pressure drop can be approximately considered neglect.

Hossein Javadi et al. [3] geothermal heat exchangers, one of the main components of shallow geothermal systems, have been investigated by many researchers in recent years to exploit clean and renewable energies. Most of the previous studies have mostly concentrated on the common types of ground heat exchangers including U-tube and helical ground heat exchangers. The results indicate that the most effective geometric parameter on the performance of the triple helix ground heat exchanger is the length of the helical coil, while the two parameters of the distance between centers of inner/outer helical coil branches, as well as the distance between centers of inner and outer helical coil branches, have the least effect.

Nima Mazaheri et al. [4] The current investigation aims to study the second law features of an innovative nanofluid having hybrid nanoparticles of graphene Nano platelets–Pt through a ribbed triple-tube heat exchanger (RTTHX). The hot nanofluid passes inside the ribbed annulus side, the cold water enters inside the inner tube side, and the normal water moves through the outer annulus side. The total exergy destruction of whole heat exchanger decreases by increase of the weight fraction, such that it reduces about 23% with increasing the weight fraction from 0 to 0.1% at rib pitch of 150mm and rib height of 3 mm. Furthermore, the second law efficiency enhances with the weight fraction increment, while reduces with the rib pitch decrement and increasing rib height. The second law efficiency has great values in all conditions under study.

P.C. Mukesh Kumar et al. [5] over the previous many years, because of innovative turns of events, we have responded to the call of meeting our cooling needs. Further work is in progress for ideal warmth move in concentric warmth exchangers. One of the examination on twofold cylinder heat exchangers concerns three-tube heat exchangers (TTHE). Three-pipe heat exchangers have been discovered to be more effective than two-pipe heat exchangers. This article audits concentrates on three-tube heat exchangers and basically breaks down reports distributed by different scientists to lead progressed research on three-tube heat exchangers.

Navin Raja Kuppusamy & Lee Poh Seng [6] the crossover cooling framework has become a promising warm administration framework for server farms since it can efficiently disperse heat from different electronic segments. Water cooling and air cooling can be utilized to cool the dynamic segment and the detached segment individually. Another sort of triple fluid heat exchanger is utilized to move the warmth from these fluids to the coolant. The outcomes basically surveyed the compromise between TFHEX's warmth move ability and its pressing factor drop, for example H. The siphon power required. This can be a benchmark for server farm architects to pick the suitable TFHEX setup for mixture cooling.

Asif Afzal et al. [7] in this work, a heat move investigation of a three-tube heat exchanger is performed utilizing water and titanium dioxide (TiO₂) nanofluid as refrigerants. The hot fluid considered is water and the air (third fluid) goes through the focal cylinder. The wind stream in the focal cylinder is kept steady at 4.5 m/s. The variety in proficiency and all out heat move coefficient (RO) is analyzed for stream rates from 20 l/min to 60 l/min. Effectiveness diminished as efficiency expanded, while OR expanded. The RO utilizing water is somewhere in the range of 50 and 100 W/m²k, while the RO utilizing the TiO₂ nano fluid is somewhere in the range of 150 and 200 W/m²k.

III. WORKING PRINCIPLE OF TRIPLE CONCENTRIC TUBE HEAT EXCHANGER

A schematic fig of the triple concentric cylindrical warmth exchanger design is appeared in Figure 1.2. Three fluids are thought of, in particular chilled water in the internal cylinder, boiling water in the inward ring and typical faucet water in the external ring of the heat exchanger.

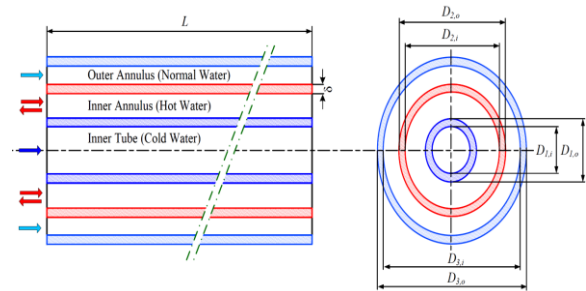


Fig. 1: Schematic diagram of the triple concentric-tube heat exchanger Possible flow patterns on triple concentric tube heat exchanger:

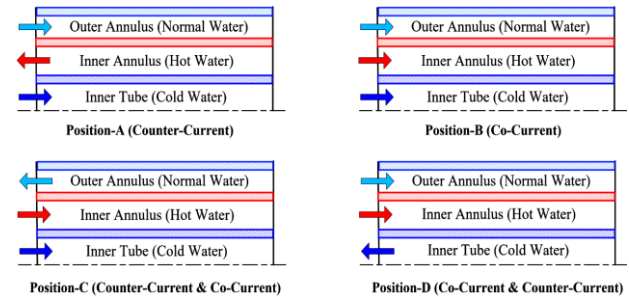


Fig. 2: Possible flow patterns on the triple tube heat exchanger Possibility of four flow arrangements as shown in figure 1.3, with positions A to D of the three liquids in the three-tube heat exchanger including countercurrent, countercurrent, countercurrent with countercurrent and countercurrent with countercurrent. These flow patterns can predict the correct placement of flow patterns which can improve the heat transfer and efficiency of the three-pipe heat exchanger. The associated heat transfer surface is connected to the medium temperature water side rather than the cooling water side, resulting in a better heat transfer rate. It can be seen from the figure that the efficiency decreases as the Reynolds number increases for all arrangements of the flow model.

The highest power values are obtained for position (A) followed by position (D) followed by position (C), while position (B) has the lowest power values.

IV. COMPUTATIONAL FLUID DYNAMICS ANALYSIS

Computational fluid dynamics is the analysis of systems involving fluid flow and heat transfer using computer-aided simulation. This technology is very powerful and covers a wide range of industrial application areas. Computational fluid dynamics used to solve a number of problems such as: Fluid flows in different fields, aircraft aerodynamics, heat

exchangers, internal combustion engines, etc. To perform this computational analysis authoritative equations such as the continuity equation, the momentum equation and the energy equations are used.

V. ALGORITHM USED FOR COMPUTATIONAL FLUID DYNAMICS ANALYSIS

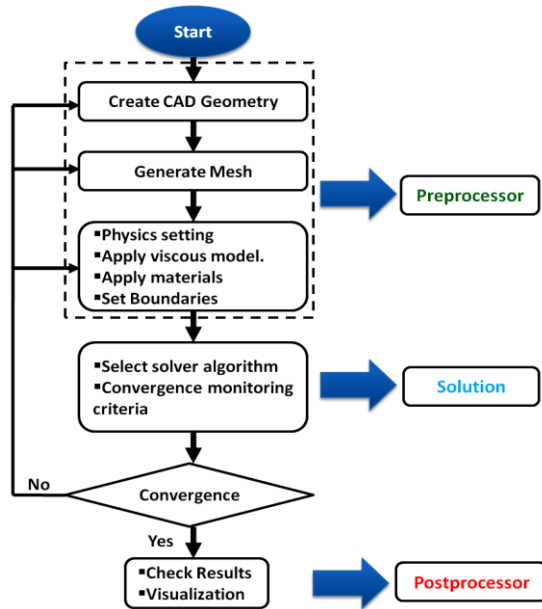


Fig. 3: Algorithm used for Computational fluid dynamics analysis

VI. CONCLUSION

Published publications on three-tube heat exchangers indicate that most of the research has been conducted using water as a heat transfer medium. In addition, it is observed that the flow rate and rate of heat transfer are directly proportional in all searches and none of the documents use an alternating heat transfer fluid instead of water. Work on three-tube heat exchangers (TTHE) is very limited when comparing double-tube heat exchangers (DTHE) due to their practical application. This article presents the principle of operation of triple tube heat exchangers and the proposed CFD algorithm.

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