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Review on Heat Transfer Rate in Various Types of Heat Exchangers with Modifications

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ABSTRACT

Heat transfer to the incoming medium which is going to be used is one of the best way to utilize waste heat which otherwise would be of no use. Heat exchangers are employed to use this waste heat and they can be of various types. Also, techniques that can be employed can be active ones or passive ones. Few types of latest developments in heat exchangers are spiral tube heat exchangers, concentric tube heat exchangers, and helical coil heat exchangers. In the present work, recent advances in the field of heat exchangers to recover the waste heat have been discussed in brief. It can be concluded that there exists a wide scope to increase the heat transfer of heat exchangers.

Keywords: Heat exchanger, Parallel & counter flow, spiral tube heat exchangers, concentric tube heat exchangers, helical coil heat exchangers

INTRODUCTION

The energy in transit mainly due to change in temperature is termed as Heat. In power plants and other industrial applications, a lot of energy is wasted as heat and it can be recovered using heat exchangers. With time a lot of advances have taken place in the design of heat exchangers. A lot of work has been done to increase the heat transfer rate under various operating conditions. Few of the noteworthy contributions are described below

LITERATURE REVIEW

Kumar et al., 2017, found out flow parameters such as pressure drop, temperature variation, heat transfer rate for spirally coiled heat exchanger. Entering fluid has been considered at 293K and wall is assumed to be at 320K. Variation in Mass flow rate has been done from 0.06 Kg/s, 0.08 Kg/s and 0.10 Kg/s for various diameter of coil Reynolds number, Euler number, temperature variation, pressure drop and heat transfer rate have been found out & compared for all the cases.

Nilay et al., 2017, did CFD simulation of a Helical coil heat exchanger for various diameters and varying mass flow rates. Parameters which have been found out are temperature drop, heat transfer rate, heat transfer coefficient and Nusselt number and the results have been compared.

It has been concluded that the temperature drop decreases for decrease in diameter of coil and also for increase in mass flow rate whereas heat transfer rate increases with increase in coil diameter and mass flow rate.

Hussain et al., 2016 carried out detailed review on various heat exchangers to increase the effectiveness of heat exchangers.

Nilay et. al., 2017 discussed the importance of various types of heat exchangers and the recent developments worldwide taking place to enhance the performance of heat exchangers.

Hussain et al., 2016 did numerical study of corrugated plate heat exchanger. The results were compared with the analytical values. It was concluded that the results were in good agreement. Corrugation angle plays and important role in the heat transfer rate of corrugated plate heat exchanger. But too much corrugation also leads to blockage of fluid in the areas of sudden crest and trough leading to lower in the heat transfer. Dimensionless numbers were also found out using numerical as well as analytical values.

Xia et al., 2012 used a passive heat transfer enhancement approach using spiral corrugation on the inner wall of a smooth helical tube heat exchanger. The turbulent flow and temperature fields in helical tubes cooperating with spiral corrugation were calculated using numerical simulation. The flow and heat transfer effects of spiral corrugation parameters and Reynolds number were investigated. The results demonstrated that the spiral corrugation can improve heat transmission of the smooth helical tube due to the increased swirling motion. The pitch of spiral corrugation can also be reduced to improve heat transfer. It was discovered that helical tubes in conjunction with spiral corrugation boost heat transfer by 50% to 80%.

Olasiman et al., 2016 designed and simulated a heat exchanger. The numerically computed findings were compared to the data from the experimental tests. The test was repeated five times to determine the values of various variables. The values were discovered to have various relationships. There was a correlation between the exit temperature, pitch size, heat gases, and mass flow rate. The heat exchanger's efficiency was found to be related to the temperature of the diesel fuel.

Alimoradi, 2017 looked into the effect of operational and geometrical aspects on the thermal effectiveness of shell and helically coiled tube heat exchangers. Water was used as the working fluid in the study state analysis. Fluid viscosity and thermal conductivity were considered to be temperature dependent. Using a wide variety of mass flow rates, dimensionless geometrical factors, and Reynolds numbers, two correlations were constructed to predict thermal effectiveness. The electiveness was found to be 12.6 percent less than the effectiveness of parallel flow heat exchangers for the identical values of NTU and Cr, and this difference was nearly constant.

The tube in tube helical coil heat exchanger was explored by Vijaya Kumar Reddy et al., 2017 for its compact structure, larger heat transfer area, and higher heat transfer capabilities, among other things. Due to their superior heat and mass transfer coefficients and compact shape, helical coils are often utilised as heat exchangers and reactors. Using Computational Fluid Dynamics, the authors designed a tube in tube helically coiled heat exchanger and investigated its heat transfer characteristics for various fluid flow rates (CFD). The LMTD increased by 1.33 percent as the inner tube flow rate climbed from 400 to 600 lph while the outer tube flow rate remained constant at 700 lph, according to the authors.

Eiamsa-Ard et al., 2010 compared the effects of inserting single twisted tape, full-length dual, and regularly-spaced dual twisted tapes as swirl generators in a circular tube under axially uniform wall heat flux (UHF) conditions on heat transfer and pressure loss. The Reynolds number was calculated using a range of inlet tube diameters (D) ranging from 4000 to 19,000. Single twisted tapes, full-length dual twisted tapes with three different twist ratios (y/w = 3.0, 4.0, and 5.0), as well as regularly-spaced dual twisted tapes with three different space ratios (s/D = 0.75, 1.5, and 2.25), are used in the tests. The impacts of important parameters on heat transfer and friction factor are discussed, and findings from single and dual twisted tape inserts are compared to plain tube results. It was found out that the heat transfer of tube with dual twisted tapes was higher than those of plain tubes with or without single twisted tape inserts.

Aghayari et. al., 2020, examined the performance of Fe_2O_3/water nanofluid (20 nm) in a double-pipe heat exchanger with twisted-tape inserts for improved heat transmission. Because Fe_2O_3/water nanofluid has a better thermal conductivity, it is employed. The mass flow rate, tape twist ratio, temperature, and the volumetric fraction of nanoparticles to water are all factors to consider. The Nusselt number is greatly improved up to 103.45 percent in the test instance when the good effects of nanofluid and twisted tape are combined. Furthermore, there is no significant change in the friction factor.

Singh and Sarkar, 2021 investigated the hydrothermal features of an Al_2O_3 + TiO_2 hybrid nanofluid flowing under turbulent conditions in a double-tube heat exchanger with various modified V-cuts twisted tape inserts, experiments were carried out. The hybrid nanofluid has a volume concentration of 0.1 percent and is made by dispersing Al_2O_3 and TiO_2 nanoparticles in distilled water in an equal volume ratio. For different twist ratios, V-cut depth ratios, V-cut width ratios, and hybrid nanofluid inlet temperatures, the effect of utilising twisted tape turbulator (with and without V-cuts) and hybrid nanofluid on heat transfer and pressure drop characteristics is investigated. The results reveal that decreasing the twisting ratio, increasing the depth ratio, decreasing the width ratio, and decreasing the nanofluid inlet temperature increases the Nusselt number and friction factor. When compared to the water in the tube without twisted tape, the Nusselt number improves by 132 percent and the friction factor improves by 55 percent. For all adjusted twisted tape inserts, the thermal performance factor and entropy generation ratio are greater than unity for hybrid nano-fluid.

CONCLUSION

There is a lot of scope to enhance heat transfer in heat exchangers. Various types of heat exchangers can be worked upon. Twisting tapes in heat exchangers can prove to be one of the boons for researchers. Increasing the mass flow rate will lead to increase in Reynolds number and it will surely lead to increase in heat transfer upto a good extent. Numerical techniques have emerged with time with computational power. Still experimental work cannot be underestimated as validation is must.

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