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A Review on Enhancement of Heat Transfer Rate of Heat Exchanger: Use of Coil Insert and Nano Fluid

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ABSTRACT

One of the best ways to utilize heat that would otherwise go to waste is to transfer it to the medium that is going to be used. To make use of this waste heat, heat exchangers are used, and they come in a variety of shapes and sizes. Also, the techniques that can be used are either active or passive. Spiral tube heat exchangers, concentric tube heat exchangers, and helical coil heat exchangers along with coil inserts and use of nanofluids are some of the most recent advancements in the field of heat exchangers. Recent breakthroughs in the field of heat exchangers for waste heat recovery have been briefly discussed in this paper. . It is possible to ascertain that there is a lot to improve in heat exchanger heat conduction and still a lot is possible.

Keywords: Nanofluids, coiled inserts, Reynold's Number, Heat Exchanger, Thermal Performance Factor, Heat Transfer, Friction Factor.

INTRODUCTION

A heat exchanger is a device that transfers thermal energy from one fluid to another or from a solid object to a fluid. The fluids could be separated by a solid wall to keep them from mixing, or they could be in direct touch. Many researchers have worked for describing recent advances in the field of heat exchangers [Hussain et al. 2016] [Nilay et al., 2017] [Sahu et al., 2016]. Also many have worked for validating the numerical work with available one and further modifying the design and try to get better heat transfer results [Kumar et al., 2017] along with the various uses of that heat [Gupta et al., 2021]. Few of the important recent work by various researchers have been discussed below.

LITERATURE REVIEW

Nakhchi et al., 2021 investigated experimentally heat transmission and thermal performance factor of double-pipe heat exchanger pipes with rotating inclined elliptical (RIE) inserts. The perforated rotating inserts can significantly increase flow unpredictability and disturb the thermal boundary layer, improving thermal performance without affecting pressure drop. When RIE turbulators are used instead of non-rotated elliptic (NRIE) turbulators, heat transport is enhanced by up to 30.7 percent, according to the results.

Padmanabhan et al., 2021 worked for improving the thermal efficiency of heat exchangers directly affects the materials utilised, the energy obtained, and the cost saved. Heat exchange efficiency and the cost-effectiveness of design and operation in applications requiring thermal transfer processes will both benefit from improvements in heat exchange. Double tube heat exchangers are best suited for high temperature and high pressure applications due to their narrow diameters. They are inexpensive, but the amount of information they disseminate to other forms is considerable. Several strategies were developed to provide the required heat transfer rate while maintaining a cost-effective pumping capability within the confines of the heat transfer design and duration.

For a spirally coiled heat exchanger, Kumar et al., 2017 discovered flow parameters such as pressure drop, temperature variation, and heat transfer rate. The temperature of the entering fluid is supposed to be 293 degrees Fahrenheit, while the temperature of the wall is estimated to be 320 degrees Fahrenheit. For each diameter of coil, the mass flow rate was varied between 0.06 Kg/s, 0.08 Kg/s, and 0.10 Kg/s. The Reynolds number, Euler number, temperature change, pressure drop, and heat transfer rate were all calculated and compared.

To improve the effectiveness of heat exchangers, Hussain et al., 2016 conducted a detailed review of several heat exchangers. It was concluded that numerical technique has emerged as boon for researchers to predict the performance of heat exchangers in design phase only.

CFD simulation of a aelical coil heat exchanger for various diameters and mass flow rates was performed by Nilay et al., 2017. Temperature decrease, heat transfer rate, heat transfer coefficient, and Nusselt number have all been determined, and the findings have been compared.

The temperature drop lowers as the diameter of the coil drops as well as the mass flow rate increases, whereas the heat transfer rate increases as the coil diameter and mass flow rate increase.

Andrzejczyk et. al., 2021, demonstrated the use of inexpensive wire coil inserts to induce turbulent flow in the boundary layer as well as air blowing into the pipe's annulus to improve heat transfer efficiency. Four heat exchanger structures, namely plain double tube, turbulized double tube, plain U-bend double tube, U-tube with turbulator, plain double tube, and U-bend double tube functioning with two-phase flow conditions, were investigated experimentally (air-water mixture). The pressure drop and heat flux figures for these geometries were calculated. The heat transmission efficiency of the two systems was compared using the NTU method. The influence of coiled wire inserts and air bubble injection on heat transfer, pressure decreases, and overall efficiency in double tube heat-exchangers was also investigated using the computational fluid dynamics (CFD) technique. Six heat exchanger layouts were meshed and simulated at various flow conditions using the CFD programme for this purpose

Nilay et al., 2017 emphasized the relevance of various types of heat exchangers as well as new innovations taking place around the world to improve heat exchanger performance.

Chompookham et al., 2022 used wire coil as a turbulence generator to improve heat transfer in heat exchangers is being researched and presented all the time. A new wire coil turbulator was designed in this study with properties that differ from those previously proposed. It is based on the concept of a serrated wire coil, which is a combination of a coiled wire structure and a continuous V–shaped rib turbulator (SWC). Under isothermal–flux conditions, the turbulent air flow behaviour and heat transfer properties in a tube heat exchanger with SWC insert were explored experimentally in this article.

Hussain et al., 2016 studied a corrugated plate heat exchanger numerically. The outcomes were compared to the calculated values. The results were determined to be in good agreement. The heat transfer rate of a corrugated plate heat exchanger is influenced by the corrugation angle. However, excessive corrugation causes fluid blockage in the areas of rapid crest and dip, resulting in a reduction in heat transfer. Numerical and analytical values were used to discover dimensional less numbers.

Ebrahimi-Moghadam et . al., 2020, optimised TiO2/W-EG nano-fluid flow within the inner tube of double-pipe heat exchangers with helical coil inserts (with 60% water and 40% ethylene glycol). The target function is entropy creation, and it is to be minimised. To accomplish this, a comprehensive sensitivity analysis is performed in the first step, taking into account all nano-fluid flow conditions (including nanoparticle volume fraction (phi), Reynolds number Re, and Prandtl number Pr) as well as geometric parameters of the helical coil inserts (including the pitch-to-diameter ratio of coil (Pi)).

Sharifi et. al., 2020 optimized the heat-exchangers' performances under specific conditions. CFD was used to numerically simulate a three dimensional fluid flow under non-isothermal condition. Artificial Neural Network (ANN) and genetic algorithm (GA) were together applied. Twelve wire coil insertion tubes were evaluated using the validated numerical model to determine their heat transfer and friction coefficients at various Reynolds ranges. The findings show that while a suitable helical wire improves heat transfer efficiency, the improper wire inserts can reduce the heat-overall exchanger's improvement efficiency unexpectedly.

Nakhchi & Esfahani, 2020 numerically investigated turbulent flow properties of CuO-water nanofluid through a heat exchanger pipe augmented with louvred strips. The volume fraction of nanoparticles ranged from 0% to 2%. Single and double geometries are used to mount the louvred strips. It was concluded that the recirculating flow inside the holes can increase the thermal performance greatly.

CONCLUSION

A lot of advances are taking place in the design and development of heat exchangers to improve their effectiveness. Various types of heat exchangers have their specific use. Experimental and numerical techniques both have their own advantages. But importance of any one cannot overcome the benefit of other. Coil inserts and use of Nanofluids can significantly increase rate of heat transfer in heat exchangers.

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