Heat Transfer Enhancement Studies in Double Pipe Heat Exchanger Using Variant Plain Tape Inserts.

ABSTRACT

Heat exchangers are important devices that are generally used in various manufacturing process such as petroleum refining, chemicals, oil, paper industries & power plants. The demand for high efficiency heat exchangers has been driven by energy and material saving requirements as wellasenvironmentalchallengesintheindustry.Toimprovetheefficiencyof heat exchanger one must think of heat transfer enhancement of the system. In addition, heat transfer improvement also reduces the size of the heat exchanger. To make a heat exchanger compact, it should be designed with high heat transfer rate and accommodate minimum space.

There are different types of flow patterns available for a heat exchanger. Common types include parallel flow, counter flow & cross flow. The most effective flow method of the three is the counter flow for a heat exchanger. Also, Counter flow heat exchanger is considered as the most efficient type.

The present research reports the use of variant cut tapes equipped in a double pipe heat exchanger to improve fluid mixing and results in increased rate of heat transfer compared to the plain tape. Heat transfer, friction factor, and thermal enhancement factor characteristics in a double pipe heat exchanger equipped with plain and variant cut tapes are investigated using water as working fluid. Experimental investigation is performed for both laminar and turbulent flow Reynolds number ranges. The experimental results were validation for plain tube & plain tapes using the standard correlations obtainable from the literature.

Four different modifications of plain tape inserts are used that include Plain tape, Plain Tape-Step Cut Arc, Plain Tape-Step Cut Rectangle and Plain

Tape-Horizontal Wing Cut. Friction factor and thermal enhancement factor arealsopresentedforalltheinserts.Theexperimentaldataarecomparedwith the results of the CFD simulation. On the basis of the studies the following important conclusions have been arrived at:

Nusselt number, Friction factor and Thermal enhancement factor of plain tapes inserts with variant cut tapes are higher than that of plain tape's performance. The variant cut tapes heat transfer enhancement is better in the laminar flow than that of turbulent flows. Among the variant cut tape inserts used in the present research work, the horizontal wing cut plain tape gives better enhancement in laminar and turbulent flow due to the effect of increased turbulence that provides effective fluid mixing near the test tube wall.Hence it is recommended that plain tape insert can be replaced with horizontal wing cut insert to reduce the size of the heat exchanger for industrial applications.

Subsequently, the empirical correlations are also established for the Nusselt number and Friction factor for plain tape and variant cut tapes under laminar & turbulent flows. For all the tapes used in this study, the predicted data match the experimental data within the maximum deviation of ±6% for Nusselt number and ±22% for the friction factor respectively. Similarly, the simulated results are comparable with experimental results and a maximum deviation of ±14% was observed for both, the Nusselt number and the Friction factor.