

# Design and Numerical Simulation of Heat Transfer Rate of Triple Concentric Copper Tube Heat Exchanger

Gautam Yadav<sup>1</sup>, Ravi Jatola<sup>2</sup>, M. L. Jain<sup>3</sup>, B. More<sup>4</sup>

<sup>1,2,3,4</sup>Department of Mechanical Engineering, S.G.S.I.T.S. Indore, M.P., India

**Abstract** - Enhancement of heat transfer rate leads to lower energy consumption rate which results improved efficiency and performance of heat exchanger and produces lower adverse effects on environment. Triple concentric pipe heat exchanger was modeled and analyzed its heat transfer rate, efficiency and performance as instead of conventional heat exchanger. The triple pipe heat exchanger is the improved and modified version of the conventional double pipe heat exchanger. The analytical analysis of the triple concentric tube heat exchanger for compact size of heat exchanger is compared to double pipe heat exchanger. In this research work, design of compact size length of triple concentric heat exchanger is calculated through the overall heat transfer coefficient and log mean temperature differences. The 1.2 meter length of heat exchanger was calculated through analytical analysis. This triple concentric tube heat exchanger theoretical analysis results show that better performance and increased heat transfer coefficient rate in compact size heat exchanger.

**Key Words:** Triple concentric tube heat exchanger, Compact size, Overall heat transfer coefficient, Surface Roughness and LMTD.

## 1. INTRODUCTION

The heat exchanger is a device which transfers the heat energy of a hot fluid to the cold fluid. In heat exchanger transfer of thermal or heat energy between two or more fluids and fluids separated by solid surfaces at different temperature. The mostly used heat exchanger is double pipe heat exchanger. In this type of heat exchanger one pipe is placed concentrically inside a large diameter pipe with proper fitting and flow arrangements. [1,2]

In this research work triple pipe heat exchanger designed on the basis of double concentric pipe heat exchanger. A pipe is inserted at the mid of the double pipe heat exchanger and double pipe heat exchanger modified as the triple pipe heat exchanger. [3] Three pipes of different diameters were arranged concentrically and three fluids exchange heats between them, it was given better heat transfer rate as compare to double pipe heat exchanger. [4] Triple concentric pipe heat exchanger comprises of three pipes of various widths and three liquids trade warms between them. Subsequently for this situation, there are three segments: middle pipe, inward pipe and external pipe. In triple pipe heat exchangers, a heated liquid is gone through an middle pipe and cold liquid gone through the inner pipe and normal

liquid flows through the external pipe. Triple concentric pipe heat exchangers are utilized for sustenance preparing, purification of thick nourishment items (milk, cream, thick squeezed orange, apple crush), sanitization, refrigeration, cooling, energy transformation.[5]

The most well-known issues in heat exchanger design are evaluating (rating) and estimating (sizing).[6] The rating issue is worried with the determination of the heat exchange rate and the liquid outlet temperatures for recommended liquid stream rates, inlet temperature, and admissible pressure drop of a current heat exchanger. Then again, the issue of the size of boiler is regarding the determination of measurement of heat exchanger, for selecting a suitable size of heat exchanger and deciding the size to meet the predetermined hot and cool liquid inlet & outlet temperatures and flow rates.[7]

The present research work is based on the enhanced heat transfer rate with compact size of the heat exchanger. In this, triple concentric pipe heat exchanger was designed and performance of heat exchanger were analyzed at various different temperature and mass flow rate of all three fluids to approach the maximum temperature drop of hot fluid as compare to double pipe heat exchanger.

## 1.1 Design and Theoretical Analysis of Heat Exchanger

Before you considerations and assumptions made for sizing of triple concentric tube heat exchanger.

1. Two cold water streams enter the heat exchanger at same mass flow rates and same inlet temperatures. Heat transfer from hot water to cold water streams are assumed symmetrical.
2. Heat exchanger is made of three copper pipes of different diameters and has no deposit of dirt on the pipe because pipes are thin. Hot water temperature drop is considered as 40°C.
3. Calculate unknown outlet temperatures of cold water streams C1 and C2 from energy balance equation. ( $Q_H = Q_{C1} + Q_{C2}$ ).
4. Determine the convective heat transfer coefficients for inner pipe, intermediate pipe and outer pipe from the physical properties of fluid.
5. Calculate two overall heat transfer coefficients, one based on outside area of inner tube and other based on inside area of intermediate tube & logarithmic

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