

Experimental Investigation of Parallel and Counter flow Heat Exchanger

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ABSTRACT:In this paper, we are modifying our previous paper, performance of Parallel and Counter Flow Heat Exchanger considering temperature changes in water and lubricating oil (Synthetic oil) are to be studied. By going through research paper we came to know that heat exchanger performance varies from fluid to fluid and temperature to temperature. Also we have calculated LMDT by varying flow rate and temperature of hot water and cold fluid. The performance of Parallel and Counter flow are compared. The performance of such heat exchangers under different operating conditions is calculated in this paper.

KEYWORDS:Parallel flow, Counter flow, heat transfer coefficient, LMTD, effectiveness.

I. INTRODUCTION

Heat exchangers are the devices in which heat is transferred from one fluid to another. Common examples of heat exchangers are radiator of motor car, Condenser at the back of a domestic refrigerator and Steam boiler of a Thermal power plant.

Counter Flow:-

An arrangement of a heat exchanger where the hot and cold fluids enter at the opposite end and flow to the exit is known as Counter Flow.

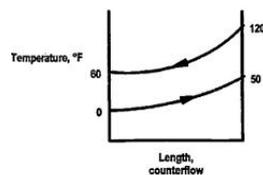


Fig 1.2

Parallel Flow:-

An arrangement of a heat exchanger where the hot and cold fluids enter at the same end and flow to the exit is known as Parallel Flow.

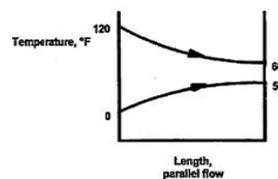


Fig 1.1

Applications:-

Cryogenics, in heating and air conditioning systems, in food industries, in chemical industries, in dairy industries, in petroleum industries, in nuclear power plant, in surface condenser in power plants.



II. LITERATURE REVIEW

Prabhat et al. [1] studied on a performance evaluation of counter flow heat exchanger considering for low temp application. He found those Counter flow heat exchangers are commonly used in cryogenic systems because of their high effectiveness. They observed that losses such longitudinal conduction through wall, heat in leak from surrounding, flow maldistribution etc. They extended their study to understand quantitative effect of heat in leak and axial conduction parameters on degradation of heat exchanger performance for 300-80k and 80-20k temperature range.

P.C. Mukeshkumar et al. [2] has discussed about the experimental study on parallel and counter flow configuration of a shell and helically coiled tube heat exchanger using Al₂O₃ / water nanofluid. This study was done by changing the parallel flow configuration into counter flow configuration under laminar flow regime. The Al₂O₃ / water nanofluid at 0.4% and 0.8% particle volume concentration were prepared by using two step methods. The overall heat transfer coefficient is 5-9% higher than that of parallel flow at 0.8% nanofluid.

Mushtag I. Hasan et al. [3] studied about Investigation of a counter flow micro channel heat exchanger performance with using nanofluid as coolant. In this paper the performance of counter flow micro channel heat exchanger (CFMCHHE) is numerically investigated with a Nano fluid as cooling medium. Two types of Nano-fluids are used a: Cu- water b: Al₂O₃. They found that nanofluid cooled CFMCHHE when the flow rate was low. For high flow ate the heat transfer was dominated by the volume flow rate and nanoparticles did not contribute to extra heat absorption. It means that, at high flow rate they found that the nanoparticles could not absorb more heat than water cooled counter flow heat exchanger.

Swapnil et al. [4] has discussed about fabrication and analysis of counter flow helical coil heat exchanger. The heat transfer coefficient increases with increase in Reynolds no. as Nusselt no. increases. Greater will be the turbulence higher will be the heat exchange. As the Dean no. is increasing with increase in Reynolds no. so, the heat transfer rate will also increase with the Reynolds number.

Christian et al. [5] has discussed about experimental Investigation on the Effect of Fluid Flow Rate on the Performance of a Parallel Flow Heat Exchanger. The effect of fluid flow rate on the performance of parallel flow heat exchangers in an extended plate with regard to thermal efficiency, overall heat transfer coefficient, convective heat transfer coefficient, flow rate, and Reynolds number. Physical characteristics and thermal performance of a real heat exchanger were studied in this work. Also the convective heat transfer coefficient increases with both Reynolds and Nusselt numbers, which increases the overall heat transfer coefficient.

R. W. Tapre et al. [6] has discussed about Review on Heat Transfer in Spiral Heat Exchanger Energy saving is major matter in our global world, and heat exchanger is very useful for energy saving. Study on the various effects of feed flow rate and the coil diameter was done and concluded that on increasing the feed flow rate the pressure drop increases and vice versa. A relation between the pressure drop and the feed flow rate for the steady state Newtonian fluid into the Archimedean spiral tubes was developed

A. Magadum et al [7] has discussed about Review of Experimental analysis of parallel and counter flow heat exchanger. In this paper, we have discussed about various literature review of various paper and we are now going to calculate LMTD by varying flow rate and temperature of hot water and cold fluid.

III. EXPERIMENTAL SETUP

SETUP SPECIFICATIONS:-

- 1) Digital Temp. Indicator: 2000C -1 No.
- 2) Geyser for hot water
- 3) Inner tube: I. D. – 11mm
- 4) Outer tube: O.D. –13mm.

- 5) Length of the heat exchanger – 1600 mm.
- 6) Ball valves for flow arrangement.



Fig. 1.3 Experimental Set up

IV. PROPOSED WORK

In this heat exchanger hot fluid flows through inner tube and cooling water flows through the annulus. The apparatus is a conventional tube in tube type of heat exchanger. The apparatus is mounted on a board & is provided with a system of pipes & valves. Parallel & Counter type of flow arrangement can be done by opening & closing of ball valves as per requirement. Hot fluid flows always in one direction & cold fluid flow direction can be changed from either parallel flow to counter flow or vice versa. Temperature Indicator along with selector switch is provided for measurement of temperature of hot fluid & cold fluid. An electric geyser is used to heat the water. Outer tube of the heat exchanger is provided with adequate insulation to minimize the heat the heat losses. Material used for the construction in G.I

The flow arrangement for parallel & counter flow is as shown in below fig. 1.1 & 1.2.

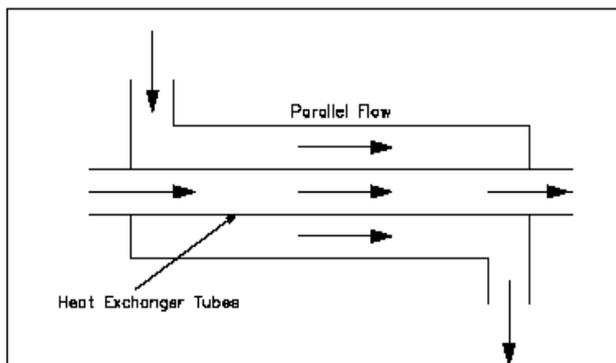


Fig. 1.4 Parallel Flow

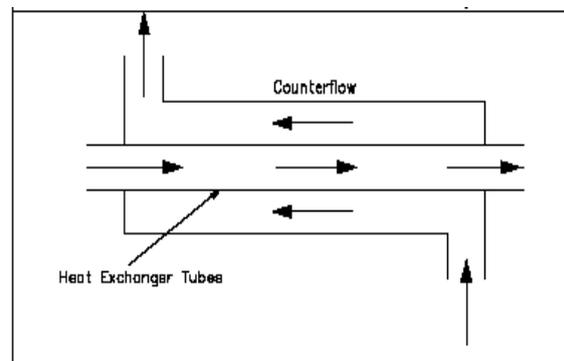
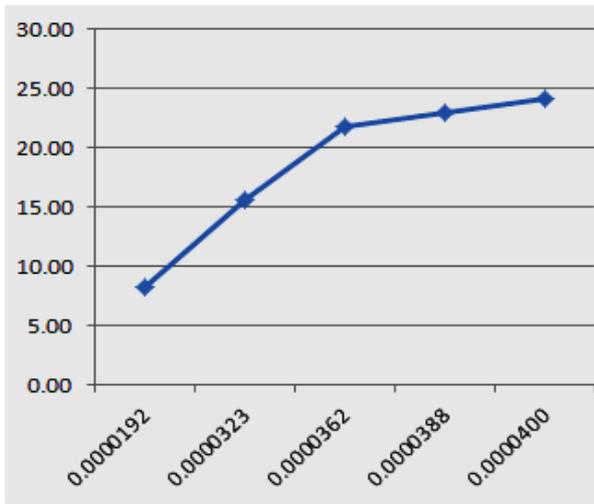


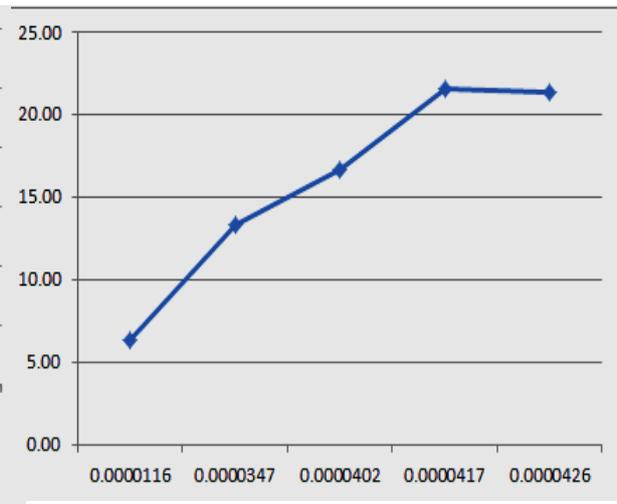
Fig. 1.5 Counter Flow

V. RESULT AND DISCUSSION

PARALLEL –FLOW :-



Graph No.1.1

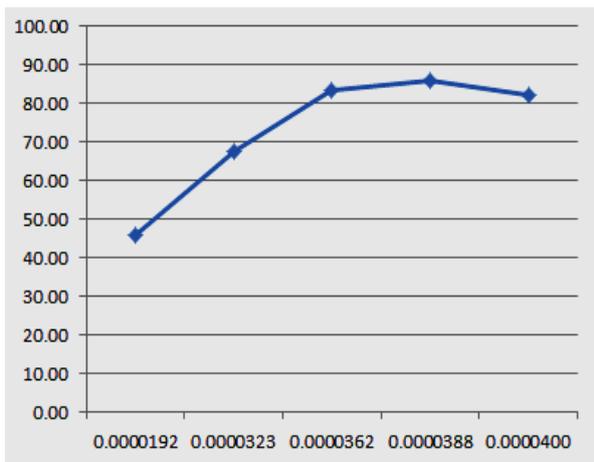


Graph No.1. 2

LMTD VS DISCHARGE

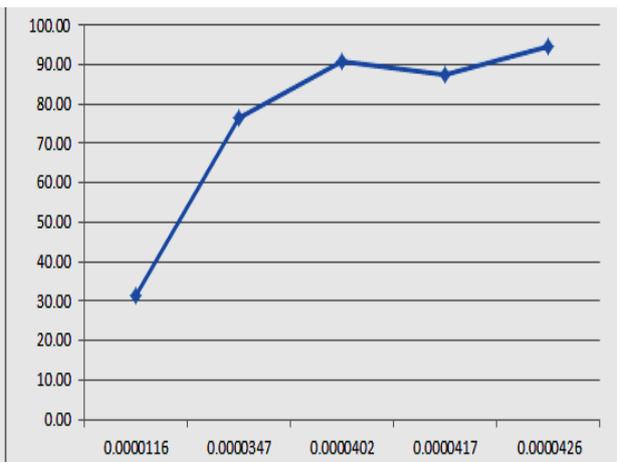
LMTD VS DISCHARGE

From above graph we can conclude that as discharge increases, log mean temperature difference (LMTD) increases.



GRAPH NO.1.3

EFFICIENCY VS DISCHARGE

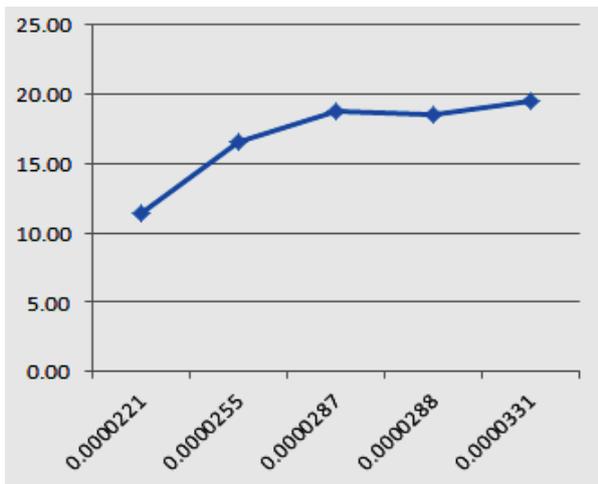


GRAPH NO.1.4

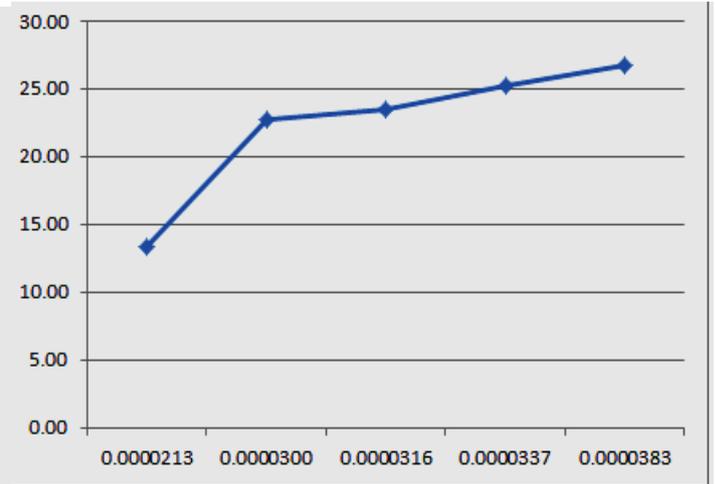
EFFICIENCY VS DISCHARGE

From above graph we can conclude that as discharge increases, efficiency increases.

COUNTER –FLOW:-

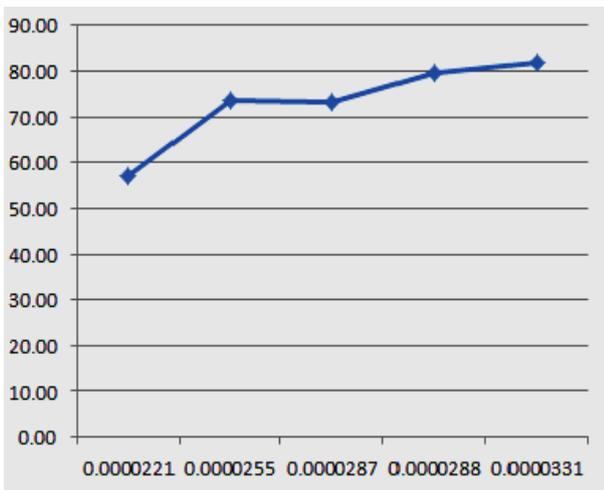


GRAPH No.2.1
LMTD VS DISCHARGE

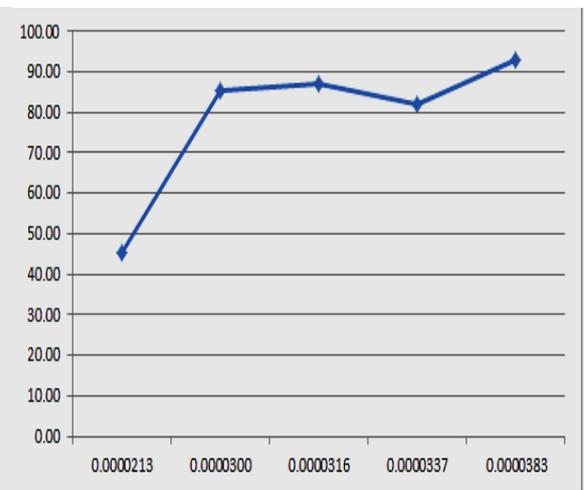


GRAPH No.2.2
LMTD VS DISCHARGE

In case of counter flow heat exchanger we can conclude that as discharge increases, log mean temperature difference (LMTD) increases.



Graph No.2.3
EFFICIENCY VS DISCHARGE



Graph No.2.4
EFFICIENCY VS DISCHARGE

From above graph we can conclude that as discharge increases, efficiency increases.



ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 3, Issue 3 , March 2016

VI. CONCLUSION

From the literature review of experimental investigation of performance of parallel & counter flow heat exchanger we came to the conclusion that:

1. Heat transfer is more in case of counter flow heat exchanger using water or any other oil as heat carrying medium.
2. Most of the research is done taking water as a working fluid both as heat carrying & heat absorbing medium.
3. Heat transfer can be enhanced by changing the material of construction of pipes, taking liquid as a heat absorbing medium having high specific heat, changing mass flow rates.

From the result and conclusion we can conclude that,

1. Heat transfer is more in case of counter flow heat exchanger by 30%.
2. As LMTD increases discharge increases and so efficiency increases.

By studying all the results we have come to the conclusion that Counter Flow Heat Exchanger is more efficient than Parallel Flow Heat Exchanger.

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