JOURNAL OF CRITICAL REVIEWS

ISSN- 2394-5125 VOL 7, ISSUE 04, 2020

STUDY OF PARALLEL AND COUNTER FLOW HEAT EXCHANGER WITH SPIRAL FINS

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Received: 14 Feb 2020 Revised and Accepted: 25 March 2020

Abstract— The main application of employing a device is to emit the warmth from high side to low side. This warmth transfer rate and efficiency of warmth exchanger are often improved in several ways which depends upon design, flow arrangements, sort of fins, and material type. This study focuses on the comparison of same side and opposite flow device given spiral fins around each tubes inside the shell. The investigation is administered by using various boundary conditions (Inner high , Outlet low side , Inner low fluid temperature, Outer low fluid parameter, flow rate, and warmth transfer coefficient). The analysis is administered using CFD and therefore the results of each flow arrangements is compared. it's observed that opposite path arrangements contribute more to the performance of shell and tube device than parallel flow setups.

Index Terms— Boundary conditions, CFD analysis, Counter flow, flow setups, same side flow, Tube and shell pass HE, Spiral fins.

1 INTRODUCTION

Heat transmitter is employed to emit the warmth from high side to low side using medium or without medium. for instance , the unnecessary heat emitted during the flow process can be reused for some other purpose or it can be left on to the atmosphere. In order to get an effective range the coolant fluid is first cooled so that it absorbs more amount of heat and transmits the remain to the other fluids. The definitive illustration of a device is originate in an indoor ignition engine during which a mingling flow referred to as engine coolant, which reduces the temperature of the coolant and heats the incoming air. Formerly, thermal emitters have a very good scope in the future applications, they're broadly utilized in all the engineering applications. Based on the need the fluid is made to flow at various velocities at various ranges with an effective viscosity ratio. As the viscosity ratio increases he turbulence of the fluid increses which also increases the effectiveness of the heat exchanger.

Tube and shell pass type of the device consists of multiple number of tubes and shells for the purpose of heat emission and transmission. The devices can be designed and manufactured based on the application like boilers and high pressure regions.Fins are provided on the top of the heat exchanger to avoid the heat loss which occur on the device during the flow occurs.

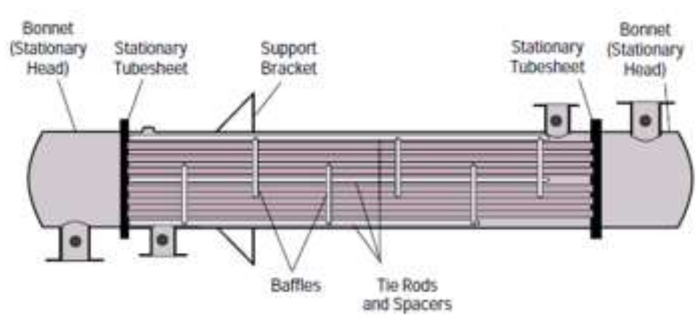

Figure 1: Tube Pass shell HE

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2 SELECTION OF HEAT EXCHANGER

Infact due to various parameters the selection of material in designing of the heat exchanger has become much more complicated and needed to be more practical. Hence the heat transmitter is designed with various considerations like the thermal conductivity of the material , Thermal emmisivity of the material and also other factors. Not only on the inner side of the equioment but also the outer side of the equipment is also considered to design this setup with an efficient performance.The factor of Viscosity plays an major in determining the effectiveness rate of the flow path:

- Various limits of bar
- Efficient heat range
- Viscosity ratio
- Various combinations of fluids
- Pressure variation in the device
- Flowing range and viscosity
- Esay to clean and maintain
- Construction materials
- Future acceciblity

Usage of various materials

3 EXPERIMENTAL SETUP

IN AN COMMON TYPE OF HEAT EXCHANGER THE FINS ARE USUALLY PRESENT ON THE INNER SIDE OF THE TUBE TO INCREASE THE HEAT TRANSFER RATE. BUT IN THIS TYPE OF HEAT EXCHANGER THE FINS ARE PRESENT ON BOTH THE HOT SIDE AS WELL INNER SIDE OF THE THERMAL TRANSMITTER DEVICE TO INCREASE THE TRANSMISSION OF HEAT.MOST COMMONLY USED TYPE OF HEAT EXCHANGER IS NOT USED IN THIS DEVICE IN ORDER TO INCREASE THE HEAT TRANSFER RATE OF THE BOTH HOT AND COLD FLUID SIDE. THUS INCREASING THE HEAT TRANSFER RATE WILL RESULT IN IN INCREASED EFFECTIVENESS OF THE TUBE AS WELL AS THE FINS PRESENT ON THE HEAT EXCHANGER.

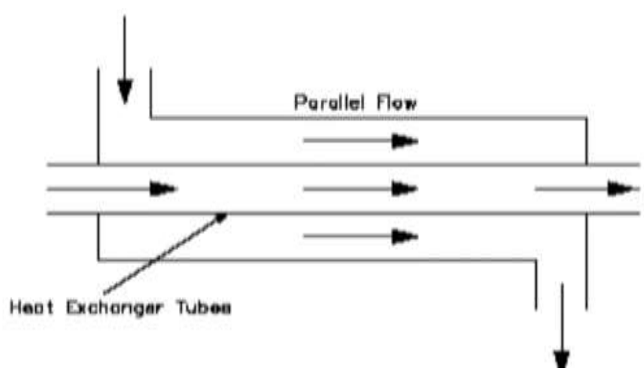

Figure 2: Same side setup

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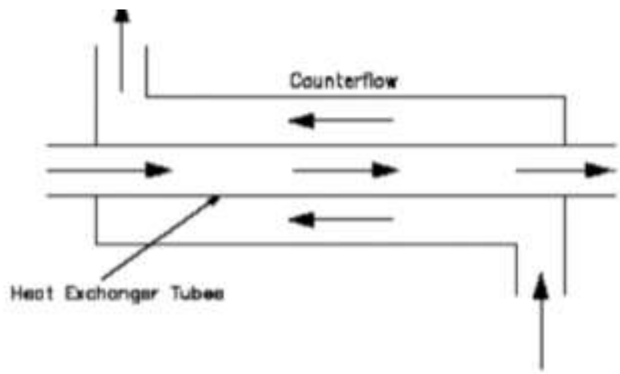

Figure 3: Opposite flow setup

4 DESIGN SPEIFICATION

Shell specification :

Material: Copper

Inside dia: 158 mm

Outside dia: 218 mm

Setup: 500 mm

Tube Specification :

Material: Copper

Inside dia: 14 mm

Outside dia: 16 mm

Setup: 500mm

Totaltubes: 5

No of fins: 25 fins/tube

Shape of fin: Spiral

Size of fin: 2 mm

5 DESIGN

Type of fin used : Spiral fin around each tubes

Figure 4: Spiral fin around tube

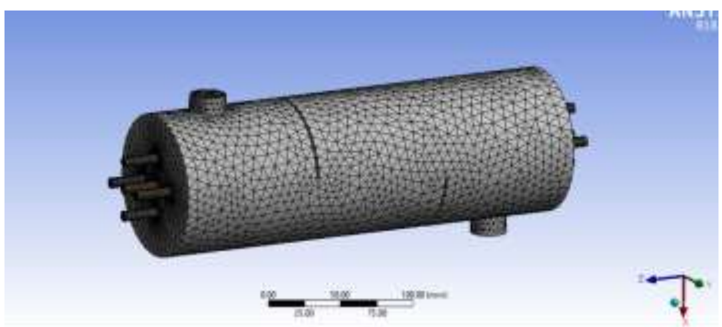

Figure 5: Meshing in an Heat transmitter

Name Selection: A different a part of the warmth exchanger and fluid flowing inside the warmth exchanger is chosen and therefore the names are given to them in order that boundary conditions are often applied on different boundary.

Model Selection: In this section 3 parameter are shortlisted and left out are kept constant

The three parameters are:

Eulerian, Calory – on ,

k-e turbulence model – on

6 RESULTS

6.1 Boundary conditions

The boundary conditions that are applied on the model are as below:

Fluid: Water

Heat Exchanger: Material **-** Copper,

Flow type: Counter and Parallel

velocity: Hot & Cold side = 0.0027 m3/s

Ambient temperature: 27˚C, 1 atm

H : 8 W/m²K

Table 1: Boundary conditions for high temperature and low temperature

Fluid	Inlet Temperature	Outlet Temperature
Hot fluid	90˚C	40˚C
Cold fluid	20˚C	50˚C

6.2 Findings and Discussion

Energy transfer through heat trnamiting depends on the amount rate and temperature of fluid movement inside the heat transmitter. In this flow rate of 0.09 Kg/ms of cold side at 0.60 Kg/ms of hot side have been considered. Fins are provided on the tube is kept triangular to maximize the area of heat emitted. To analyse the total impact of nanofluid and fins on the heat exchanger rate, the CFD model of heat exchanger has been developed. The main purpose of the design is obtaining the maximum value of heat emitted rate by improving the heat transferring rate. Which is calculated by using :

$Q = K A \theta m \times$ No. of tubes

Where, Q = Heat transfer rate in watt

A = Surface Area in square meter

θm = LMTD in kelvin

After validation validation of CFD model of heat exchanger, the flow path is changed in the H.E by changing the direction of coolant liquid or cold fluent.

Finally, the same heat exchanger is analysed with different types of fluent which are majorly used in industries.

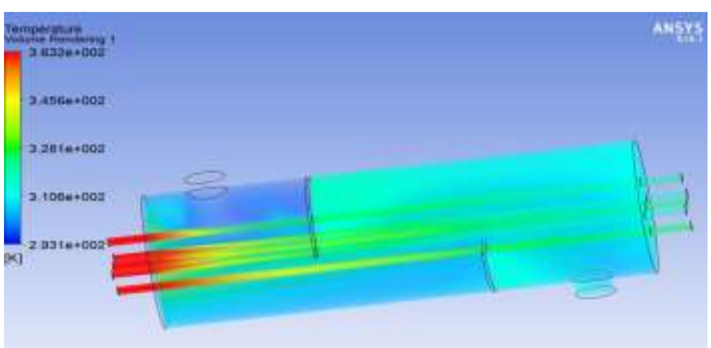

Figure 6: Parallel flow: Volume rendering of Temperature variation along the tubes

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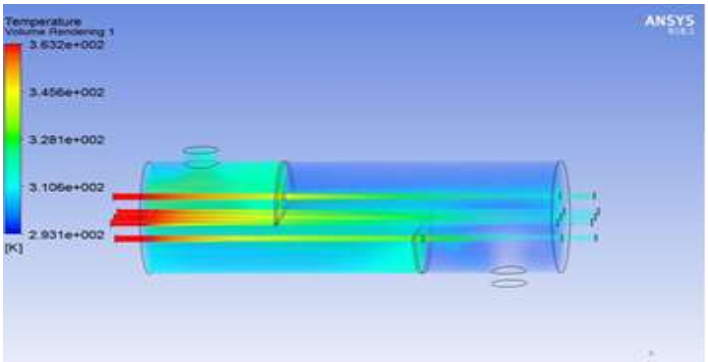

Figure 7: Counter flow: Volume rendering of Temperature in the tubes

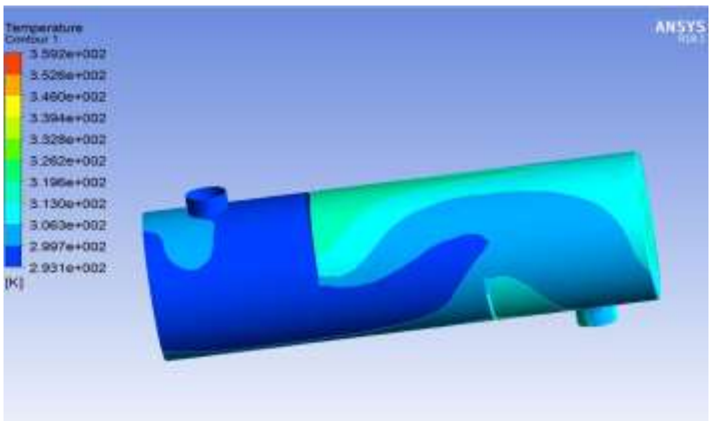

Figure 8: Parallel flow: Contour of Temperature variation on shell

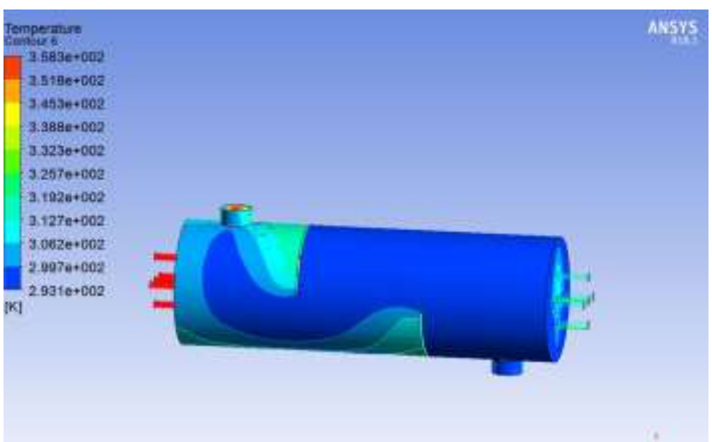

Figure 9 : Counter flow: Contour of temperature variation on the shell

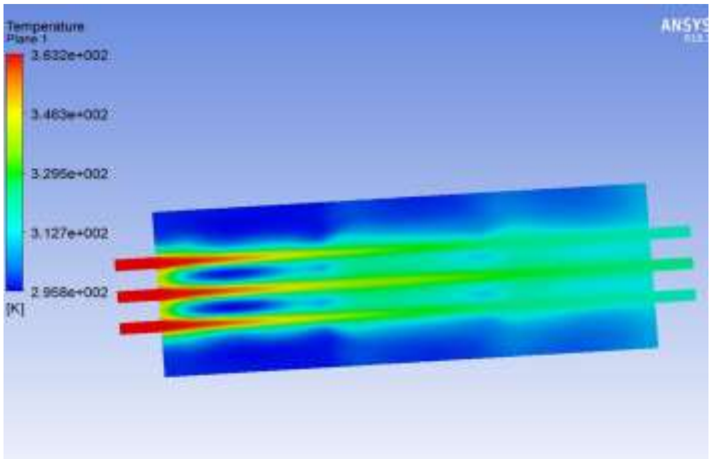

Figure 10: Parallel flow: Variation of temperature on one of the plane

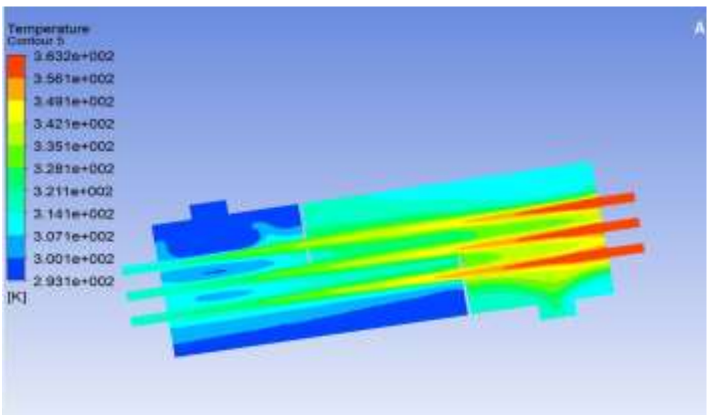

Figure 11: Counter flow: Contour of temperature variation on one of the plane

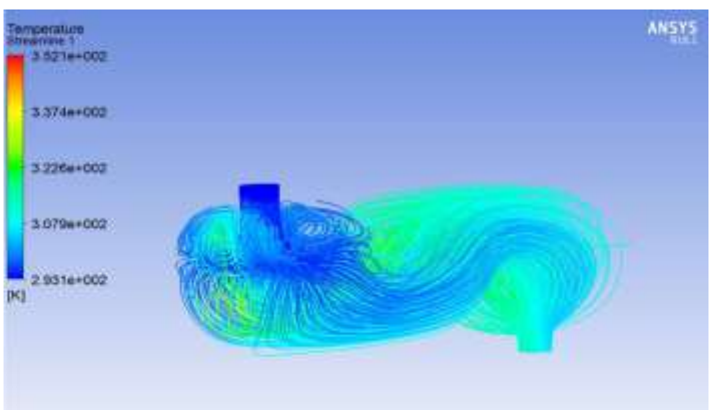

Figure 13: Parallel Flow: Streamline of Coolant or Cold fluent Temperature variation

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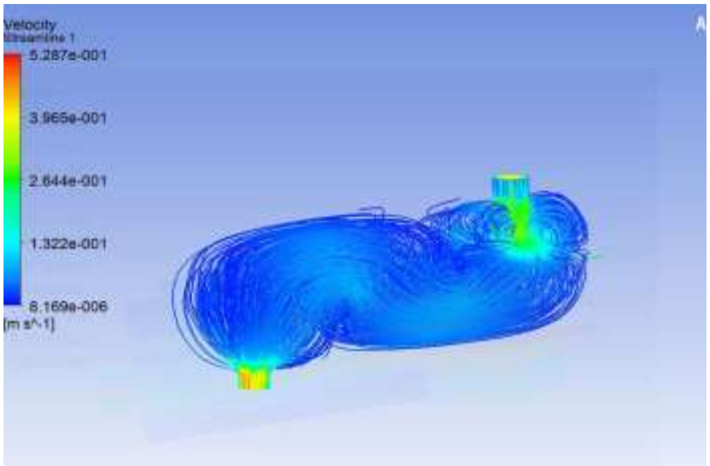

Figure 13: Counter flow: Streamline of Coolant or Cold fluent Temperature variation

6.3 Boundary conditions and Results for various fluids

Here are the various fluids which are majorly used in industries for various purposes. Using these fluids, the inlet temperature and outlet temperature provided in the below table is used for analysis to determine the type of fluid is mainly suitable for this method.

Fluent	Velocity	Parallel Flow			Counter Flow		
		Cold Fluid Outlet Temp	Hot Fluid Outlet Temp	LMT Difference	Cold Fluid Outlet Temp	Hot Fluid Outlet Temp	LMT Difference
Gas Oil	0.56	294.2	396.52	185.65	294.01	395.92	103.45
Toulene	0.055	294.1	397.21	184.64	293.31	396.21	103.92
Benzene	0.22	294.2	396.92	184.21	290.61	396.32	103.97
Ethylene glycol	0.72	293.5	396.21	184.31	294.12	397.11	103.88
Glycerene	0.56	294.1	397.21	184.32	294.92	396.56	103.51
Water	0.002	300.2	396.11	184.57	397.13	397.12	103.95

Figure14: Inlet and Outlet temperature of various fluids used in industries

By fixing those boundary conditions for each fluid, the results are derived below and made to compare:

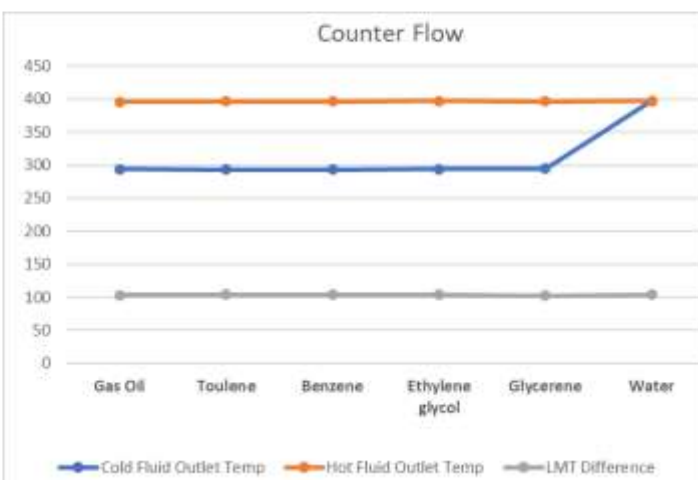

Figure 15: Graph plotted for counter flow

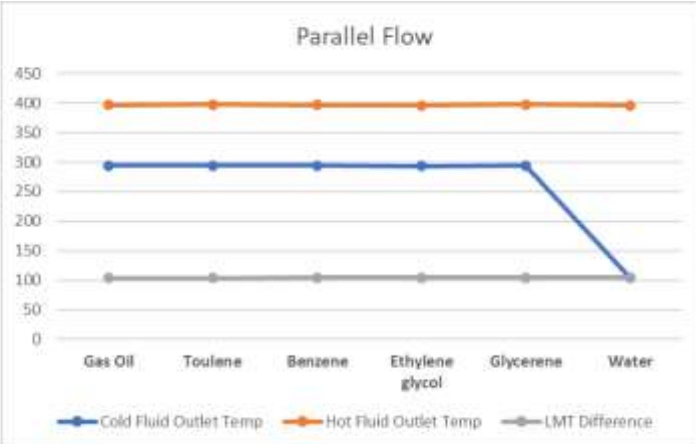

Figure 16: Graph plotted for parallel flow

7 CONCLUSION

In this analysis, the idea is carried out with water as both hot and cold fluent. The Fluent's which are commonly and commercially used in the industries are brought into analysis for verification. From the above results and graph, the water has higher heat transfer rate when compared between two flow setups. Thus, the heat exchanger is suggested to design in such a way of counter follow to achieve higher efficiency and high heat transfer rate.

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