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Research paper

A comparative study on temperature variance and compact heat exchanger performance by using different fluid blends

Basawaraju S. Hasu [1] *, Dr. G. V. Satyanarayana Rao [1]

[1] *Research Scholar Osmania University Hyderabad, 2 RTD. Professor CMRIT Hyderabad*
**Corresponding author E-mail: aruna.anveshanaindia@gmail.com*

Abstract

Compact heat exchangers are the critical cryogenic components which are characterized on its heat transfer which is enhanced as per the transfer rate per unit volume surface area of the exchanger. The design can be varied and authorized based on the flow (counter) which is fabricated for industrial and future applications. The performance of the exchanger is found by obtaining difference in mass flow rates. In this research we have taken blends of three different fluids which are mixed up with water to find the temperature variance and performance during different time with varying different flow rates and temperatures. Here in such cases the pressure is kept constant for both hot and cold sides. Due to variance in different temperatures and flows the mass flow rates according the time variance which gradually increases. Various working fluids considerations have been done for minimizing the pressure losses that are presented or obtained. The fluid blends like IPEX coolant, Castrol, Shell Diala S4ZX-1 has taken as blends with 2% and 4% blend mixtures with distilled water. The temperatures are varied two times during the flow that is 600c and 800c and each fluid is enhanced at both these temperatures. Finally we can obtain the better flow rate for the mixtures taken for all the fluids. Temperature variance is shown for all the blends with respect to the time intervals taken that is for 600sec and the values is authorized for each 60sec. with this we have present the best blend percentage mixture among the fluid blends taken with respect mixed proportions.

Keywords: *Compact Heat Exchanger; Temperature Variance; IPEX Coolant; Castrol; Shell Dial S4ZX-1.*

1. Introduction

Heat exchanger is a unit which mediates the transfer of heat from a hot fluid to the cold ones as an impermeable wall. In this we have developed a compact heat exchanger with specifications mentioned below in table. The design is considered on multiple applications and with enhancement the heat exchanger is fabricated. The need for development of heat exchanger by considering industrial applications to fulfill requirement with less occupation area due to industrial globalization. Researches needed to develop as a consideration and this is an attempt of developing fin type heat exchanger with better performance.

Table 1.1: Datasheet for Compact Exchanger

Design data	
Item no.	1
Quantity	1
Plate quantity	20nos
Thickness/material	0.5mm / ss304
Hot tank dimensions	550*400*400
Cold tank	600*450*450
Pump capacity hot side	300lit
Cold side	3000litres

The compact heat exchanger are said be light in weight such that they can admire many highly desirable applications.
Objectives:

- To develop a model that is used in optimizing the counter flow rate of compact heat exchanger
- To find the temperature variance and performance of the compact heat exchanger with relevant characteristics taken
- To analyse the performance of the counter flow heat exchanger over a range of different fluids taken by varying the flow paths for the targeted heat exchanger

2. Methodology

The temperature increases the passage size in order to increase free-flow area. This however tends to increase the ridge/fin leg thickness required, and so the iteration becomes self-defeating. A more optimal solution is to reduce passage size – this has the following effects: 1. Ridge/fin thickness can be reduced. 2. Passage base/parting sheet thickness can be reduced. 3. Free-flow area per unit face area is increased. 4. Heat transfer surface density is to be increase. Another potential pitfall is related to exchanger assemblies. Where the heat exchanger size required exceeds manufacturing capabilities, heat exchanger blocks may be welded in parallel to achieve the desired size.

Table 2.1: Core Data

Parameters	Internal (Hot Side)	External (Cold Side)
Fin	Honey Comb	Honey Comb
No. Of Passage	4	5
No. Of Pass	1	1
Flow Rate	Counter Flow	Counter Flow

To calculate the performance parameters like, effectiveness, overall heat transfer coefficient of the plate fin heat exchanger. In order to find the performance of present heat exchanger a number of experiments were carried out at different mass flow rates and at different hot fluid inlet temperature under balanced flow

- Calculation of velocity, pressure and temperature distribution in the airflow region and temperature distribution in clamshell heat exchanger using the temperature distribution in the clamshell heat exchanger as initial condition.
- Calculation of temperature distribution in clamshell heat exchanger after the air flow
- Calculation of thermal stress distribution in the clamshell heat exchanger using the temperature distribution in clamshell heat exchanger as input. From this stress distribution we will determine the minimum thermal stress to calculate the number of cycles under which the material is safe subjected to fatigue loading.

Finally using the maximum and minimum thermal stress, we calculate the number of cycles under which the material is safe subjected to fatigue loading

Liquid Flow through the Heat Exchanger

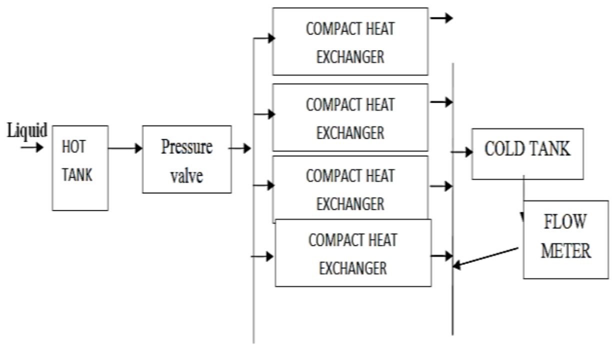

Table 2.2: Parameters of the Blends Used

Parameter	Water	IPEX		Castrol		Shell Diala S4 ZX-1	
Density (kg/m^3)	997	1040	1065	959	959	861	861
Boiling point (^{0}c)	100	40	40	110	115	120	140
Melting point (^{0}c)	0	104	104	-20	-20	70	70
Thermal conductivity (W/m^{0}c)	0.591	5.628	5.628	4.727	4.726	5.231	5.231
Specific heat (Kj/Kg/K)	4.18	0.523	0.523	0.089	0.089	0.689	0.689

Here the optimization is done for pure water and blends of Ipex for 2% and 4% at different temperatures 600c and 800c. Initially the hot tank containing the water is gradually heated to 600c. Then the process is started T1, T2, T3 and T4.

T1= heat inlet

T2=heat outlet

T3=cold inlet

T4=cold outlet

In this we are going to take initial Hot pressure P1 and cold pressure P2 which are constant during the flow. The flow is done in two ways for each temperature that is complete floe and half sectional flow.

We are taking flow initially as X1 and final X2 is final flow reading after completing the process.

The process is continued for 10min and the readings are taken for each minute.

3. Results

The enhancement is done for the all the blends with their respective 2% and 4% with varying two different temperatures of 600c and 800c at two sectional flows (complete and half flow)

Temperature variance for all fluids with 2% blends along hot side:

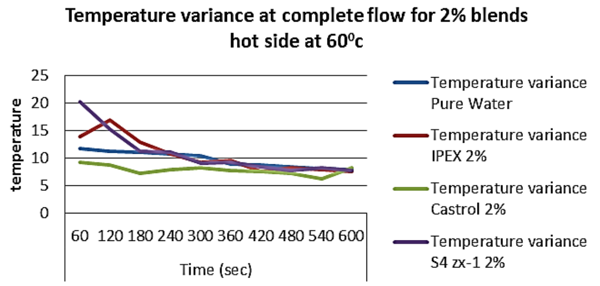

Fig. 1:

Above graph enhances the flow rate of different blends taken at 2% with temperature of 600c along hot side. Here the flow is complete which means liquid is circulated with maximum variance. The temperature is taken by calculating the mean ∇t. the temperature is varied along with regular time interval of each 60sec

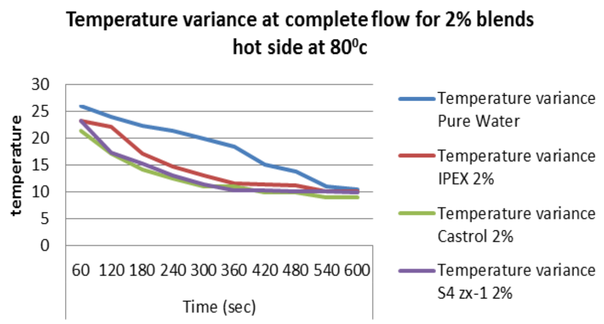

Fig. 2:

Above graph enhances the flow rate of different blends taken at 2% with temperature of 600c along hot side. Here the flow is half which means liquid is circulated with some stage variance. The temperature is taken by calculating the mean ∇t. the temperature is varied along with regular time interval of each 60sec

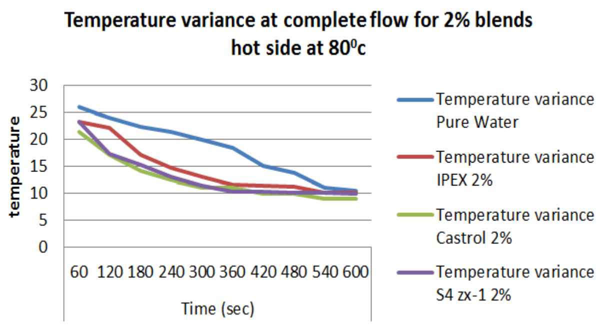

Fig. 3:

Above graph enhances the flow rate of different blends taken at 2% with temperature of 800c along hot side. Here the flow is complete which means liquid is circulated with maximum variance. The temperature is taken by calculating the mean ∇t. the temperature is varied along with regular time interval of each 60sec

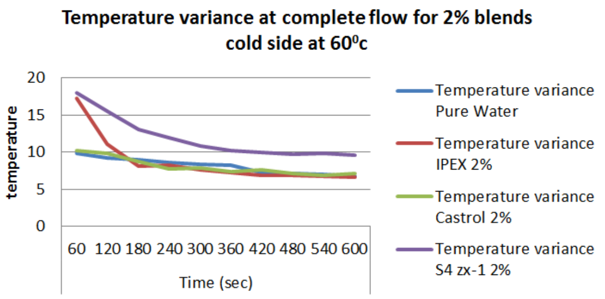

Fig. 4:

Above graph enhances the flow rate of different blends taken at 2% with temperature of 800c along hot side. Here the flow is half which means liquid is circulated with some stage variance. The temperature is taken by calculating the mean ∇t. the temperature is varied along with regular time interval of each 60sec

Temperature variance for all fluids with 2% blends along cold side:

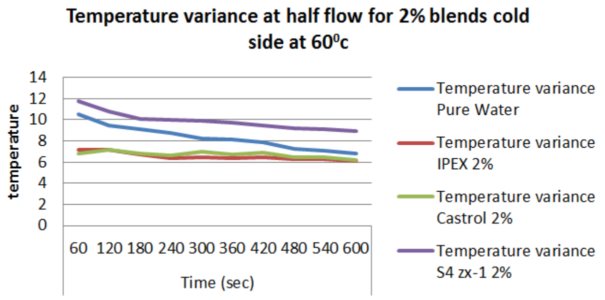

Fig. 5:

Above graph enhances the flow rate of different blends taken at 2% with temperature of 600c along cold side. Here the flow is complete which means liquid is circulated with maximum variance. The temperature is taken by calculating the mean ∇t. the temperature is varied along with regular time interval of each 60sec

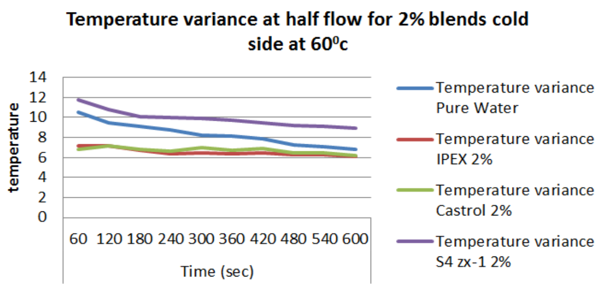

Fig. 6:

Above graph enhances the flow rate of different blends taken at 2% with temperature of 600c along cold side. Here the flow is half which means liquid is circulated with some stage variance. The temperature is taken by calculating the mean ∇t. the temperature is varied along with regular time interval of each 60sec

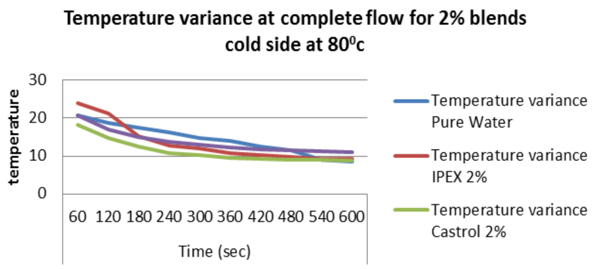

Fig. 7:

Above graph enhances the flow rate of different blends taken at 2% with temperature of 800c along cold side. Here the flow is complete which means liquid is circulated with maximum variance. The temperature is taken by calculating the mean ∇t. the temperature is varied along with regular time interval of each 60sec

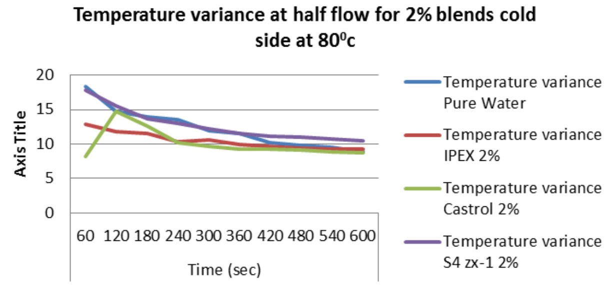

Fig. 8:

Above graph enhances the flow rate of different blends taken at 2% with temperature of 800c along cold side. Here the flow is half which means liquid is circulated with some stage variance. The temperature is taken by calculating the mean ∇t. the temperature is varied along with regular time interval of each 60sec

Temperature variance for all fluids with 4% blends along hot side:

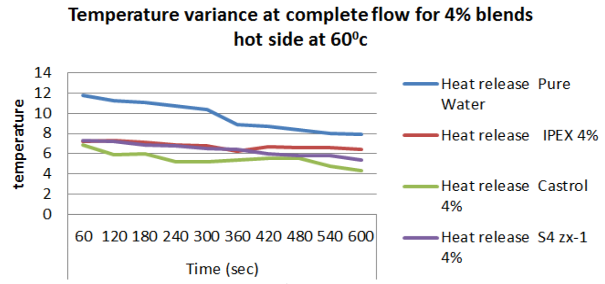

Fig. 9:

Above graph enhances the flow rate of different blends taken at 4% with temperature of 600c along hot side. Here the flow is complete which means liquid is circulated with maximum variance. The temperature is taken by calculating the mean ∇t. the temperature is varied along with regular time interval of each 60sec

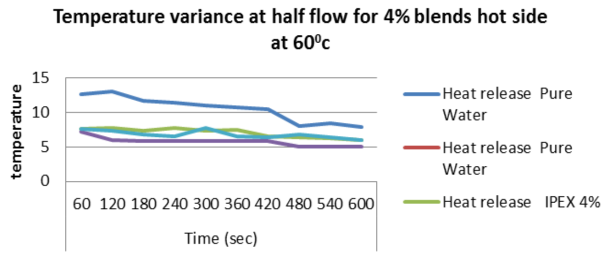

Fig. 10:

Above graph enhances the flow rate of different blends taken at 4% with temperature of 600c along hot side. Here the flow is half which means liquid is circulated with some stage variance. The temperature is taken by calculating the mean ∇t. the temperature is varied along with regular time interval of each 60sec

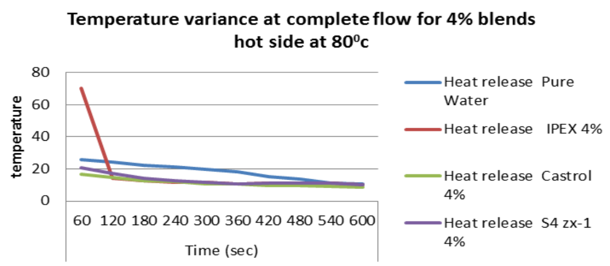

Fig. 11:

Above graph enhances the flow rate of different blends taken at 4% with temperature of 800c along hot side. Here the flow is complete which means liquid is circulated with maximum variance. The temperature is taken by calculating the mean ∇t. the temperature is varied along with regular time interval of each 60sec

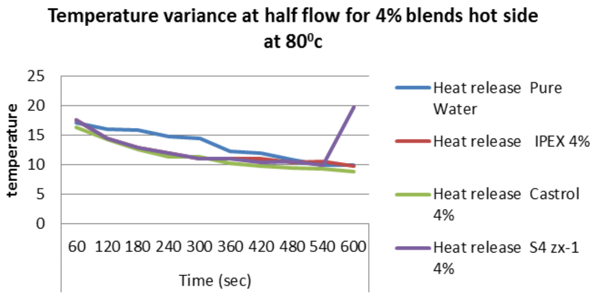

Fig. 12:

Above graph enhances the flow rate of different blends taken at 4% with temperature of 800c along hot side. Here the flow is half which means liquid is circulated with some stage variance. The temperature is taken by calculating the mean ∇t. the temperature is varied along with regular time interval of each 60sec

Temperature variance for all fluids with 4% blends along cold side:

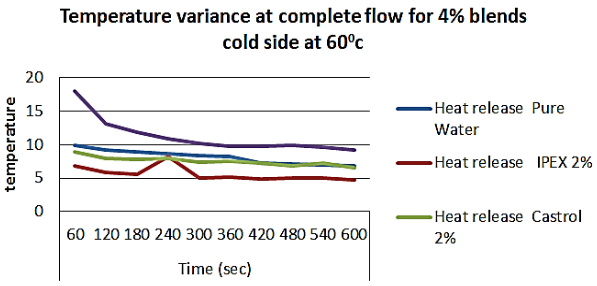

Fig. 13:

Above graph enhances the flow rate of different blends taken at 4% with temperature of 600c along cold side. Here the flow is complete which means liquid is circulated with maximum variance. The temperature is taken by calculating the mean ∇t. the temperature is varied along with regular time interval of each 60sec

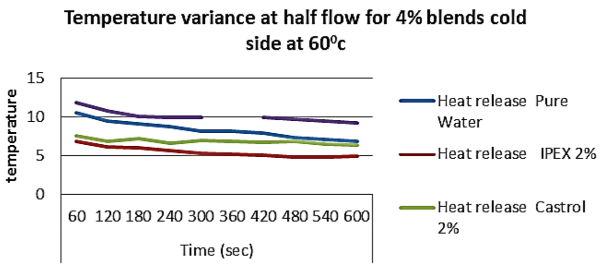

Fig. 14:

Above graph enhances the flow rate of different blends taken at 4% with temperature of 600c along cold side. Here the flow is half which means liquid is circulated with some stage variance. The temperature is taken by calculating the mean ∇t. the temperature is varied along with regular time interval of each 60sec

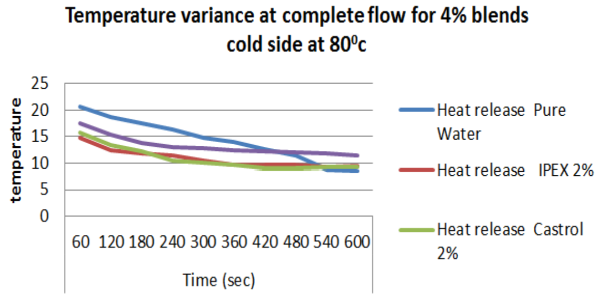

Fig. 15:

Above graph enhances the flow rate of different blends taken at 4% with temperature of 800c along cold side. Here the flow is complete which means liquid is circulated with maximum variance. The temperature is taken by calculating the mean ∇t. the temperature is varied along with regular time interval of each 60sec

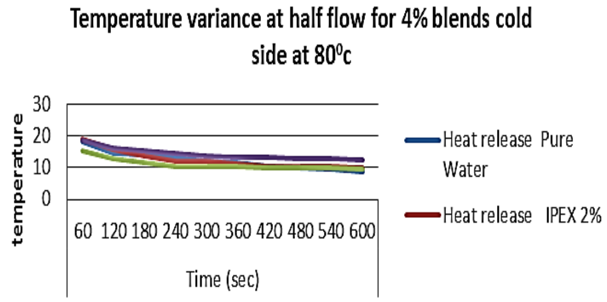

Fig. 16:

Above graph enhances the flow rate of different blends taken at 4% with temperature of 800c along cold side. Here the flow is half which means liquid is circulated with some stage variance. The temperature is taken by calculating the mean ∇t. the temperature is varied along with regular time interval of each 60sec

4. Conclusions

In this paper an attempt done for evaluating the temperature difference for the fluids used in compact heat exchanger which are pure water and IPEX with 2% and 4% blends at a temperature of 600c. We are enhancing the features so that it is observed that the temperature difference at 600c for IPEX with a blend of 4% is giving higher temperature variance so that it is found that the 4% blend is giving the better efficiency. we are evaluating the temperature difference for the fluids used in compact heat exchanger which are Shell Diala S4 ZX-1 and Castrol with 2% and 4% blends at a temperature of 600c and 800c. We are enhancing the features so that it is observed that the temperature difference at 600c and 800c for Shell Diala S4 ZX-1 and Castrol blends with a blend of 2% and 4% where the blend Shell Diala S4 ZX-1 is giving higher temperature variance so that it is found that the 2% and 4% blend is giving the better efficiency for Shell Diala S4 ZX-1.

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