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Design and analysis of air cooled radiator

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ABSTRACT

In this work discussed about the problems associated with treatment and disposal of water have become more costly with government regulations and environmental concerns. The objective of the work is to increase the performance of thermic fluid heat exchanger by utilizing the single thermic fluid instead of double fluid presently used in the process industries. Thermic fluid offers outstanding high temperature performance including thermal stability and low vapor pressure. The project design comprises the idea of implementing two 3 way control valves to by – pass the inlet of thermic fluid to the air cooled radiator when the temperature of thermic fluid has increased after cycling through the process. The fluid flow simulation is conducted using commercial software, fluent. The pressure and temperature distribution along the tube length and tube width are presented and analyzed.

Keywords: Heat Exchanger, Fluent, Thermic fluid

1. INTRODUCTION

The Air-cooled heat exchanger is a device for rejecting heat from a fluid or gas directly to ambient air. When cooling both fluids and gases, there are two sources readily available, with a relatively low cost, to transfer heat to air and water. The obvious advantage of an air cooler is that it does not require water, which means that equipment requiring cooling need not be near a supply of cooling water. In addition, the problems associated with treatment and disposal of water have become more costly with government regulations and environmental concerns. The air-cooled heat exchanger provides a means of transferring the heat from the fluid or gas into ambient air, without environmental concerns, or without great ongoing cost. An air-cooled heat exchanger can be as small as your car radiator or large enough to cover several acres of land, as is the case on air coolers for large power plants where water is not available.

2. MODELLING AND ANALYSIS

A CFD analysis of fluid flow and heat transfer is carried out in Carbon Steel radiator, in which FLUENT's pre processing (ICMCFD), Post Processing (CFD) with incompressible heat transfer, is used as the tool. In this study, shell side airflow pattern and tube side Therminol oil 66 flow pattern are studied and presented the variation of overall heat transfer coefficients across the radiator of 523.014 W/m2-K. This study established the capability of FLUENT code to handle such problems. I made an experimental investigation of the heat transfer characteristics of a tube-and-fin radiator for Process and developed the regression equations of heat dissipation rate, therminol oil 66 pressure drop and temperature. The influences of the air velocity, inlet therminol oil 66 temperatures and volume flow rate of therminol oil 66 on heat dissipation rate, therminol oil 66 pressure drops have been discussed in detail by means of the numerical analyses.

2.1 Modelling

The Numerical experimentation of the work carried out involved reverse engineering of a Process Industry radiator for the required fluid domain, discretising the fluid domain, simulation of the fluid flow and heat transfer at steady state and post processing the results and drawing suitable conclusions. The details of the geometry of the radiator were obtained by the process of reverse engineering. The dimensions of individual components of the radiator were measured using suitable measuring instruments and given in Table 1. The measurements obtained were used to generate the CAD model in CATIA V5 R9 and shown in Figure 1.

Table 1: Specifications of the radiator

Radiator type	Cross Flow
Tube size	19.45 mm
Core rows	6
Core columns	20
Core dimensions (L x W x H)	1.5 m x 1.2 m x 0.4 m
Tube and fin material	Carbon steel
No. of tubes	120

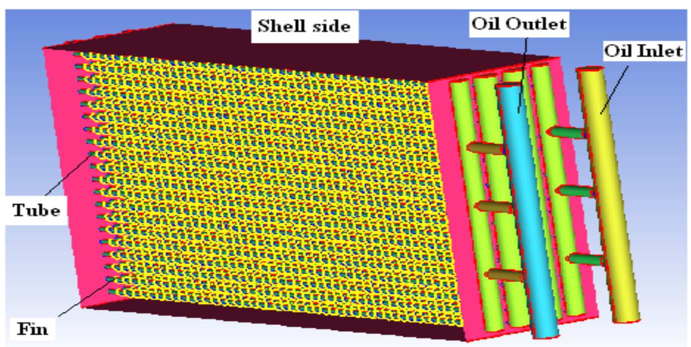


Fig 1. Assembled CATIA model of the radiator

2.2 Analysis

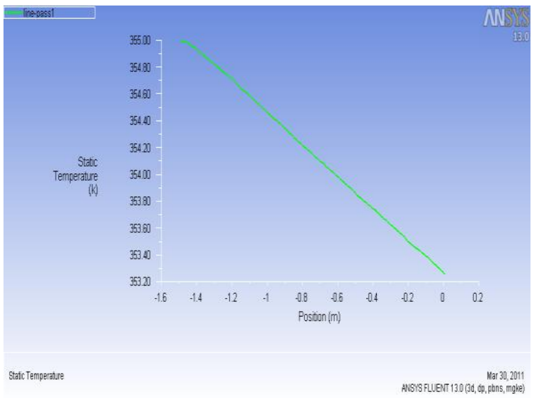
The CFD analysis is carried out using fluent software. The analysis in carried out for every pass separately. The output results obtained from one pass is used as an input for the subsequent pass. The temperatures contours, variation and pressure contours are obtained for every tube pass in the radiator.

3. RESULTS AND DISCUSSION

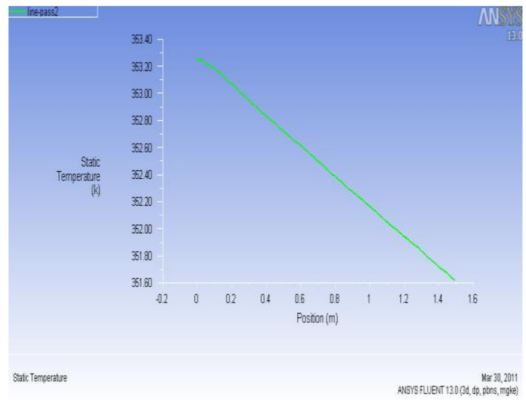
The results obtained from the simulation analysis are presented in Figures 6.1 to 6.3. Figure.6.1 shows the temperature contours of the coolant along the direction of flow for various tube passes. A drop in temperature of the coolant from 82 ^{o} C to 72 ^{o} C is observed in these plots. In every pass, approximately a 2°C drop is observed. The analytical calculation made for the heat exchanger analysis assuming a temperature drop of 10°C shows a surface area requirement of 10.25 m2.

In the CFD analysis considering this surfaces area with the same configuration assumed in the analytical calculation, approximately a similar temperature drop is observed which shows the correctness and capability of the CFD analysis. Hence this model and analysis procedure adopted can be extended for simulation and optimization analysis. The temperature drop obtained in every pass is also shown separately in Fig. 2.

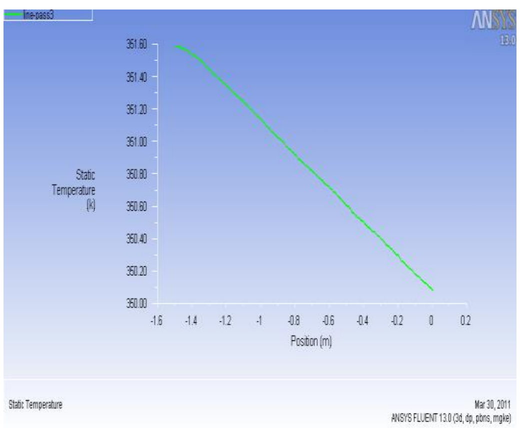
Fig. 3. Shows the pressure contour of the HTF region of analysis. The pressure shows a steady variation across the length of the tube. This trend is expected results in any radiator performance. A total pressure drop of 0.827 kg / cm2 in observed from the analysis.



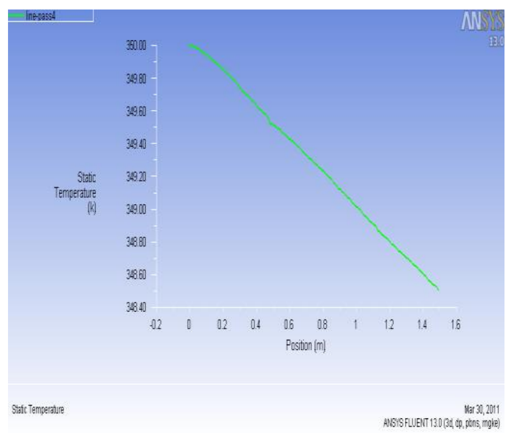
1st Row Tube pass



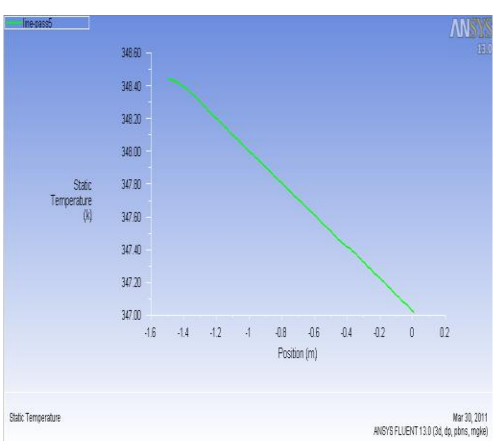
2nd Row Tube pass



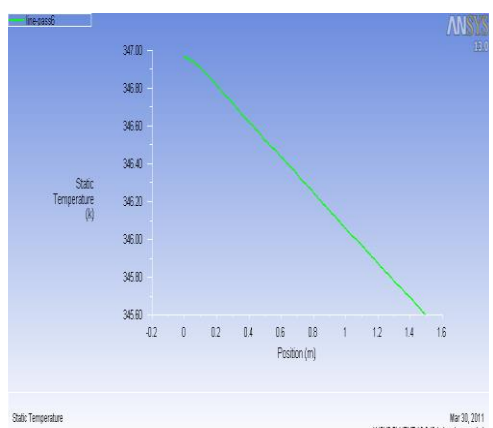
3rd Row Tube pass



4th Row Tube pass



5th Row Tube pass



6th Row Tube pass

Fig 2. Variation of oil temperature (K) across the tube length

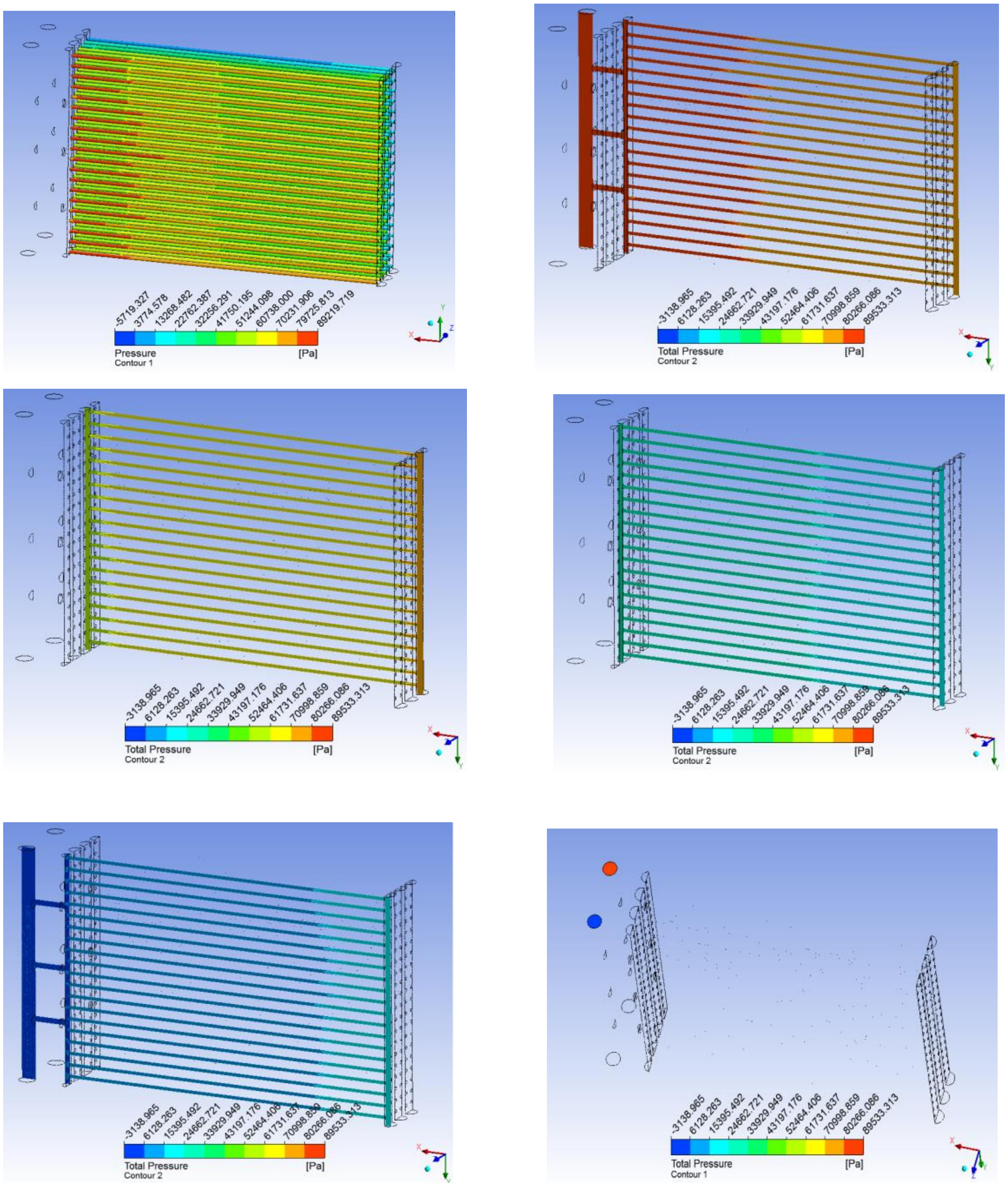


Fig .3 Pressure contours of oil along the tube

4. CONCLUSION

The fluid flow and heat transfer analysis of a multi tube-fin arrangement of the process radiator is successfully carried out using numerical simulation built in commercial software FLUENT. The variations in the pressure, temperature of the heat transfer fluid along the direction of flow and presented and analysed. It is observed that the temperature of Therminol oil drops by 10^0C and the HTF experience a pressure drop of 0.872kg/cm^2 which is in good agreement with the theoretical results. In the present study the fluent software capability is studied for the analysis of a radiator. The software is able to provide accurate results and hence it is construed that the analysis can be extended for optimising the geometrical and flow parameters.

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