IMPROVING THE HEAT TRANSFER RATE OF AC CONDENSER BY OPTIMIZING MATERIAL

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ABSTRACT

In this thesis heat transfer by convection in AC by varying the refrigerants are determined by CFD and thermal analysis. The assessment is out on an air-cooled tube condenser of a vapour compression cycle for air conditioning system.

The materials considered for tubes are Copper and Aluminium alloys 6061 and 7075. The refrigerants varied will be R 22, R 134 and R407C. CFD analysis is done to determine temperature distribution and heat transfer rates by varying the refrigerants. Heat transfer analysis is done on the condenser to evaluate the better material.

3D modeling is done in CREO and analysis is done in ANSYS.

Key words: Finite element analysis, AC condenserCFD analysis, thermal analysis.

1. INTRODUCTION

In systems involving heat transfer, a condenser is a device or unit used to condense a substance from its gaseous to its liquid state, by cooling it. In so doing, the latent heat is given up by the substance, and will transfer to the condenser coolant. Condensers are typically heat exchangers which have various designs and come in many sizes ranging from rather small (hand-held) to very large industrial-scale units used in plant processes. For example, a refrigerator uses a condenser to get rid of heat extracted from the interior of the unit to the outside air. Condensers are used in air conditioning, industrial chemical processes such as distillation, steam power plants and other heat-exchange systems. Use of cooling water or surrounding air as the coolant is common in many condensersExamples of condensers

- A surface condenser is an example of such a heat-exchange system. It is a shell and tube heat exchanger installed at the outlet of every steam turbine in thermal power stations. Commonly, the cooling water flows through the tube side and the steam enters the shell side where the condensation occurs on the outside of the heat transfer tubes. The condensate drips down and collects at the bottom, often in a built-in pan called a hotwell. The shell side often operates at a vacuum or partial vacuum, produced by the difference in specific volume between the steam and condensate. Conversely, the vapor can be fed through the tubes with the coolant water or air flowing around the outside.

- In chemistry, a condenser is the apparatus which cools hot vapors, causing them to condense into a liquid. See "Condenser (laboratory)" for laboratory-scale condensers, as opposed to industrial-scale condensers. Examples include the Liebig condenser, Graham condenser, and Allihn condenser. This is not to be confused with a condensation reaction which links two fragments into a single molecule by an addition reaction and an elimination reaction.

In laboratory distillation, reflux, and rotary evaporators, several types of condensers are commonly used. The Liebig condenser is simply a straight tube within a cooling water jacket, and is the simplest (and relatively least expensive) form of condenser. The Graham condenser is a spiral tube within a water jacket, and the Allihn condenser has a series of large and small constrictions on the inside tube, each increasing the surface area upon which the vapor constituents may condense. Being more complex shapes to manufacture, these latter types are also more expensive to purchase. These three types of condensers are laboratory glassware items since they are typically made of glass. Commercially available condensers usually are fitted with ground glass joints and come in standard lengths of 100, 200, and 400 mm. Air-cooled condensers are unjacketed, while water-cooled condensers contain a jacket for the water.

A/C condenser

Air conditioner (A/C) condenser is an essential part of a car air conditioning system. Let's review how the vehicle A/C system works: The A/C system is a closed loop filled with refrigerant (typically R134) under pressure. The A/C compressor circulates the refrigerant through the system. The evaporator is a small heat exchanger installed inside the vehicle ventilation system. The cabin air flows through the evaporator fins. The condenser is a larger heat exchanger installed in front of the vehicle, typically, beside or right in front of the radiator. The ambient air is pushed through the condenser fins by an electric fan and by natural flow during driving. The system is based on a simple effect: the cabin heat is absorbed when the refrigerant vaporizes inside the evaporator. The heat is released outside when the refrigerant turns from a vapor into a liquid state inside the condenser. Through this continuous process, your cabin is kept cool even on a hot sunny day.

2. LITERATURE REVIEW

Balaji Net al [1]The majority of the research work focused large chillers. But in this paper discusses the single split air conditioning system using instead of air coolingusing liquid based cooling. The coolant used in the heat exchanger pure ethylene glycol. Compare the experimental results value of existing system withnew modified system. The compressor running time for the pure ethylene glycol based cooling system is less than the existing system. The compressor'srunning time is reduced from 44 minutes 30 seconds to 33 minutes and 4 seconds. The required indoor temperature of 18°C is reached in 11 minutes 26seconds earlier. It is evident that the time taken for cooling by the modified system is 25.69 % less than that of the existing split air condition system. Timetaken for cooling reduces automatically improve the efficiency of the air conditioning system.

M. Joseph Stalinet al[2] As the energy demand in our day to day life escalates significantly, there are plenty of energies are shuffled in the universe. Energies are put in an order of low grade and high grade energies. The regeneration of low grade energy into some beneficial work is fantastic job. One such low grade energy is heat energy. So it is imperative that a significant and concrete effort should be taken for using heat energy through waste heat recovery. This paper concentrates on the theoretical analysis of production of hot water and reduction of LPG occupies most of our condominium for our comforts. An attempt has been taken to recover waste heat rejected by the 1 TR air conditioning systems. For this water cooled condenser is exerted and the water is promulgated by until our desired temperature is acquired. Then the hot water is accumulated in insulated tank for our use.

3. PROBLEM DESCRIPTION:

The objective of this project is to make a 3D model of the AC condeserand study the CFD and thermal behavior of the heat exchanger by performing the finite element analysis.3D modeling software
(PRO-Engineer) was used for designing and analysis software (ANSYS) was used for CFD and thermal analysis.

The methodology followed in the project is as follows:

- Create a 3D model of the AC condenser assembly using parametric software pro-engineer.
- Convert the surface model into Para solid file and import the model into ANSYS to do analysis.
- Perform thermal analysis on the AC condenserassembly for thermal loads.
- Perform CFD analysis on the existing model of the surface heat exchanger for Velocity inlet to find out the mass flow rate, heat transfer rate, pressure drop.

4. INTRODUCTION TO CAD/CAE:

Computer-aided design (**CAD**), also known as **computer-aided design and drafting** (**CADD**), is the use of computer technology for the process of design and design-documentation.

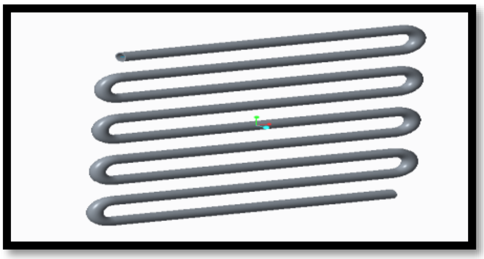
4.1. INTRODUCTION TO CREO

CREO is the standard in 3D product design, featuring industry-leading productivity tools that promote best practices in design while ensuring compliance with your industry and company standards. Integrated CREO CAD/CAM/CAE solutions allow you to design faster than ever, while maximizing innovation and quality to ultimately create exceptional products.

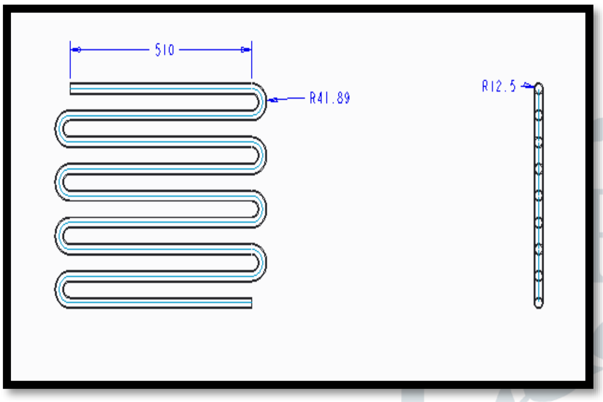
Different modules in CREO

Part design, Assembly, Drawing&Sheet metal.

3D MODEL



2D MODEL



4.2.INTRODUCTION TO FINITE ELEMENT METHOD:

Finite Element Method (FEM) is also called as Finite Element Analysis (FEA). Finite Element Method is a basic analysis technique for resolving and substituting complicated problems by simpler ones, obtaining approximate solutions Finite element method being a flexible tool is used in various industries to solve several practical engineering problems. In finite element method it is feasible to generate the relative results.

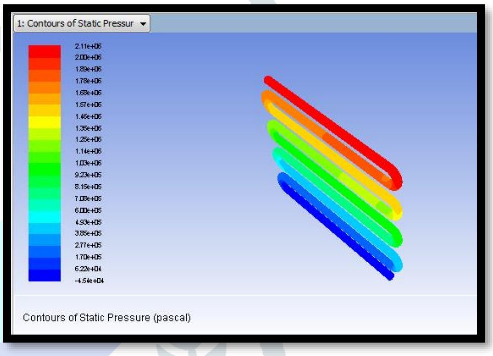
4.3 INTRODUCTION TO CFD

Computational fluid dynamics, usually abbreviated as CFD, is a branch of fluid mechanics that uses numerical methods and algorithms to solve and analyze problems that involve fluid flows. Computers are used to perform the calculations required to simulate the interaction of liquids and gases with surfaces defined by boundary conditions. With high-speed supercomputers, better solutions can be achieved. Ongoing research yields software that improves the accuracy and speed of complex simulation scenarios such as transonic or turbulent flows. Initial experimental validation of such software is performed using a wind tunnel with the final validation coming in full-scale testing, e.g. flight tests.

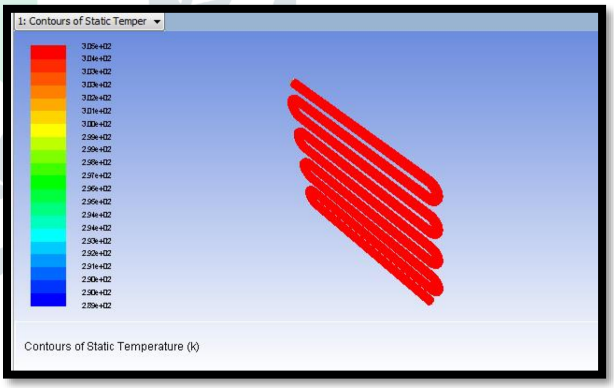
5.RESULTS AND DISCUSSIONS:

AT CONDENSER LENGTH-505mm

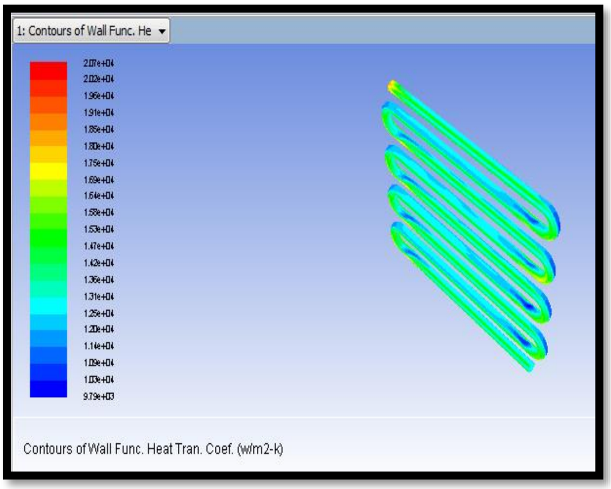
PRESSURE



TEMPERATURE



HEAT TRANSFER COEFFICIENT



MASS FLOW RATE

```
        Mass Flow Rate                          (kg/s)
-------------------------------- --------------------
                  inlet                               2
     interior-____msbr                       3092.1719
                 outlet                     -1.9881539
           wall-____msbr                               0
          ---------------- --------------------
                    Net                    0.011846066
```

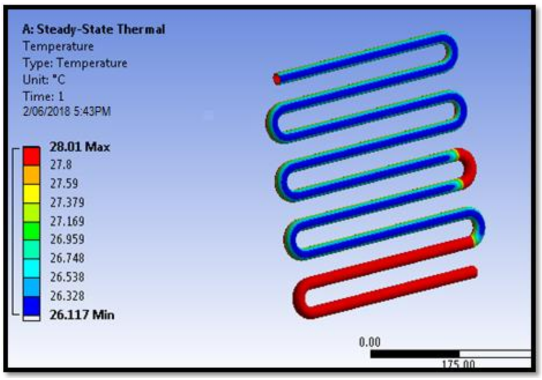
HEAT TRANFER RATE

```
   Total Heat Transfer Rate                            (w)
 -------------------------------- --------------------
                          inlet              -36353.117
                         outlet              -12102.339
                wall-____msbr                48077.563
                ---------------- --------------------
                            Net               -377.89355
```

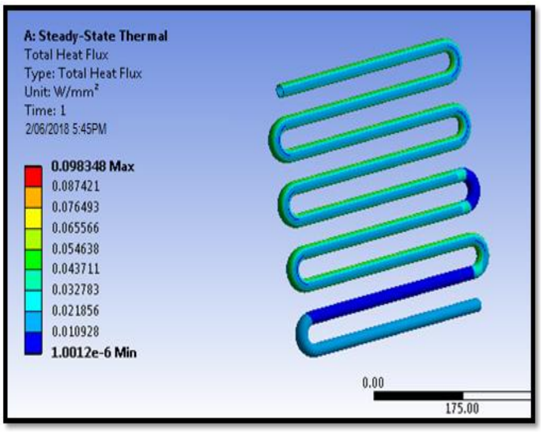
5.2.THERMAL ANALYSIS OF

Material –copper

TEMPERATURE



HEAT FLUX



RESULTS AND DISCUSSIONS

Thermal analysis

Material	Condenser length(mm)	Temperature (k)	Heat flux (w/mm²)
Aluminum alloy	345	28.026	0.068375
	405	28.023	0.073415
	465	28.024	0.069784
	505	28.025	0.069883
Copper	345	28.012	0.092377
	405	28.01	0.098348
	465	28.011	0.093316
	505	28.015	0.093398

Cfd analysis

Condenser length(mm)	Pressure(Pa)	Temperature (K)	Heat transfer coeffiecient(W/mm²k)	Mass flow rate(kg/sec)	Heat transfer rate(w)
345	1.34e+06	3.05e+02	2.01e+04	0.001848208	1033.40
405	1.43e+06	3.05e+02	2.04e+04	0.002087713	564
455	2.15e+06	3.05e+02	1.83e+04	0.01262311	702.95
505	2.16e+06	3.05e+02	2.07e+04	0.011846066	377.89

7. CONCLUSION

In this thesis heat transfer by convection in refrigeration by varying the condenser length are determined by CFD and thermal analysis. The assessment is out on an air-cooled tube condenser of a vapour compression cycle for refrigeration system.

The materials considered for tubes are Copper and Aluminum alloys. The refrigerants varied will be R 12. CFD analysis is done to determine temperature distribution and heat transfer rates.

In cfd analysis, the heat transfer coeffient more at condenser length 505mm.

In thermal analysis , the heat flux is more for copper material at condenser length 405mm.

So we can conclude that the better material is copper.

REFERENCES

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