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COOLING EFFECT IMPROVEMENT BY DIMENSIONAL MODIFICATION OF ANNULAR FINS IN TWO STAGE RECIPROCATING COMPRESSOR

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ABSTRACT: The Compressor is one of the parts which is used for giving cooling effect in refrigeration and air conditioning systems. For certain people, the Compressor is the essential bit of the refrigeration system and they consider various parts as less supportive. The Compressors are heat exchanger surfaces that move the glow from the substance to be cooled to the refrigerant, in this way removing the glow from the substance. A model to foresee the conduct of fin tube Compressors working with R134a has been created. For displaying the refrigerant stage change, vanishing, or buildup, the warmth move and the weight drop for the two-stage stream must be determined. Subsequently, various relationships, the most suggested ones in the inspected writing, have been examined and looked at. The aftereffects of this correlation are introduced for the dissipation and buildup heat move coefficients and for the Compressor frictional weight drop CFD investigation is finished by shifting liquids like R134A and R407C on all the balance shape plans, for example, rectangular and roundabout blades. The warm investigation led to an Compressor with various materials, for example, Aluminum compound 7475 and copper. The various parameters are obtained from design and model is developed using modeling software Catia to evaluate the results at given operating conditions, analysis is carried out using Ansys fluent. Compressor has great influence on the heat exchangers performance.

I.INTRODUCTION:

Air Conditioner

An Air Conditioner (frequently alluded to as AC) is a home machine, framework, or system intended to dehumidify and remove heat from a territory. The cooling is finished utilizing a straightforward refrigeration cycle. In development, a total arrangement of warming, ventilation and cooling is alluded to as "Air conditioning". Its motivation, in a structure or a car, is to give comfort during either blistering or chilly climate.

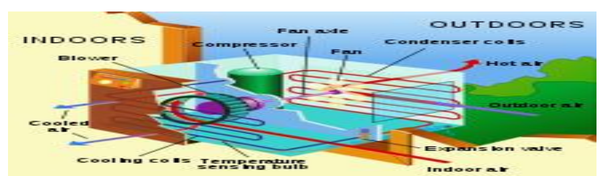

Fig 1.1: A Typical Home Air Conditioning Unit

Air Conditioning System Basics and Theories

Refrigeration Cycle

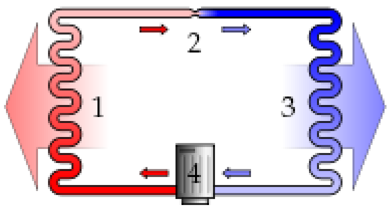

Fig: 1.2 Refrigeration Cycle

A straightforward adapted chart of the refrigeration cycle: 1) Condensing curl, 2) Expansion valve, 3) Compressor loop, 4) Compressor.

In the refrigeration cycle, a warmth siphon moves heat from a lower-temperature heat source into a higher-temperature heat sink. Warmth would normally stream the other way. This is the most widely recognized sort of cooling. A cooler works similarly, as it siphons the warmth out of the inside and into the room where it stands.

This cycle exploits the manner in which stage changes work, where dormant warmth is delivered at a consistent temperature during a fluid/gas stage change, and where shifting the weight of an unadulterated substance likewise differs its buildup/breaking point.

The most well-known refrigeration cycle utilizes an electric engine to drive a blower. In a vehicle, the blower is driven by a belt over a pulley, the belt being driven by the motor's driving rod (like the driving of the pulleys for the alternator, power guiding, and so forth) Regardless of whether in a vehicle or building, both utilize electric fan engines for air flow.

Since vanishing happens when warmth is ingested, and buildup happens when warmth is delivered, climate control systems utilize a blower to cause pressure changes between two compartments, and effectively gather and siphon a refrigerant around. A refrigerant is siphoned into the Compressor curl, situated in the compartment to be cooled, where the low weight makes the refrigerant dissipate into a fume, taking warmth with it. At the contrary side of the cycle is the condenser, which is situated outside of the cooled compartment, where the refrigerant fume is packed and constrained through another warmth trade curl, consolidating the refrigerant into a fluid, consequently dismissing the warmth recently assimilated from the cooled space.

By putting the condenser (where the glow is excused) inside a compartment, and the Compressor (which holds heat) in the including atmosphere, (for instance, outside), or just running a common constrained air frameworks refrigerant the other way, the overall effect is the reverse, and the compartment is warmed. This is normally called a glow siphon, and is good for warming a home to pleasant temperatures (25 °C; 70 °F), regardless, when the outer air is underneath the purpose of cementing of water (0 °C; 32 °F).

II. LITERATURE SURVEY

M. Kazemi et al made an examination to improve the warmth move rate by utilizing longitudinal blades on heat exchanger tubes by contrasting exposed cylinder heat exchanger during stage change. They utilized triple-balance and twofold balance situated at various points on the cylinder surface and contrasted the outcome and exposed cylinder. It is seen that by utilizing triple and twofold blades at an expansion in point of 600 to 1200 for triple balance there is 6 to 22.5 percent decrease in softening time, while for twofold balances at a point decrease from 1500 to 450 lessens the liquefying time by 62 percent regarding the straightforward warmth exchanger, Fig.1 shows triple and twofold balance heat exchanger.

Manish K. Rathod and Jyotirmay Banerjee examined the warmth move Enhancement in shell and cylinder idle warmth stockpiling unit utilizing longitudinal balances. There is increment in the pace of warmth move and The rate decrease in liquefying time because of arrangement of blades is roughly by 50%.Further improvement of warmth move in heat exchanger is completed by utilizing rectangular bantam balances in this analysis .

M.Anishi and B.Kanimozhi made an endeavor to upgrade the warmth move rate by surface change of rectangular blades utilizing various indents fig.3 shows the various kinds of scores shaped on rectangular balances. Warmth move from longitudinal balances with round score, three-sided indent and without score in a flat rectangular channel with uniform warmth transition limit condition at the base surface has been concentrated tentatively. From the examinations the warmth move coefficient was acquired between 10.343 to10.552 for round scored blade, 10.085 to 10.299 for three-sided indented balance and 9.688 to 9.767 for without scored balances, among these three-sided scored balances gives more warmth move co productive for a similar warmth inputs.

Ashish Dixit and Anil Kumar Patel made an exploratory examination on heat move attributes of a plate blade having scores of different arrangements on two wide faces. Cross over furrowed, slanted notched, V-scored, and multi-V-scored balances are utilized in their investigation as appeared in fig.4. They gathered warmth move information by fluctuating Reynolds number from 1500 to 5000, and these outcomes are contrasted and that of a smooth regular blade to check the warmth move execution of adjusted balance.

Shiva Kumar et al mathematically examined the warmth move execution in finned tube heat exchanger by utilizing distinctive blade designs like rectangular, three-sided and illustrative profiles, for consistent mass stream pace of cold liquid and differing hot liquid stream rate rectangular finned tubes indicated a normal improvement of 6.1% over the three-sided and 9.2% over explanatory finned tube. Essentially, For a consistent hot liquid stream rate and changing cold liquid stream rate, it demonstrated an improvement by 2 and 5% over the three-sided tube and illustrative finned tube individually.

Ammar M. Abdulateef dissected tentatively and mathematically by utilizing rectangular and three-sided blades in trio tube heat exchanger by utilizing stage change materials. Two sorts of broadened surfaces were utilized, specifically the longitudinal and three-sided balances in different setup were mathematically and tentatively considered fig.5 shows the two kinds of blades with various game plans. A huge upgrade was noticed utilizing interior, inward outer, and outside three-sided balances at 14%, 16%, and 18% separately, contrasted with longitudinal blades setup. Subsequently, the outside three-sided finned tube has been considered the most effective for the short cementing PCM (630 min). The all out energy delivered for the two sorts of blades were

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looked at. The recreation results were concurred well with the trial results.

Mathanraj tentatively researched the warmth move rate in twofold line heat exchanger by utilizing three-sided balances as appeared in fig.6. They contrasted the test results and plain cylinder heat exchanger the warmth move coefficient for three-sided finned tube is increments roughly by 1.5 occasions that of plain n tube heat exchanger, by utilizing three-sided finned tube heat exchanger the LMTD esteem diminishes from 33.580C to 29.50C, Overall warmth move coefficient (U) increments from 798.901 W/m2 .k to 1137.419 W/m2.k and viability increments from 0.405 to 0.505 when contrasted and plain cylinder heat exchanger.

B. Yu tentatively considered warmth move and weight drop qualities in entrance and completely created districts of three-sided wave like finned tube heat exchanger, they directed the examinations for two cases: one is by obstructing the inward cylinder (no air coursing through it) and the other one is by unblocking the internal container of warmth exchanger (air moving through it). For completely created locale, the outcomes were gotten for Reynolds number scope of 9 x 102 to 3:5 x 103. It has been discovered that the wave-like balances upgrade heat move altogether with the impeded case than unblocked case.

Carles OLIET summarizes the research work carried out by the authors on domestic refrigerator no-frost Compressors. It includes an explanation of the experimental unit that is currently being constructed to test isobutene fin-and-tube Compressors, together with a short description of the numerical tools developed. The first preliminary experimental results using single-phase coolants are then given together with their numerical counterparts. The numerical results are presented in detail in order to both complementing the experimental information obtained, and to show its potential as an analysis and design tool.

III. METHODLOGY ON DESIGN AND ANALYSIS OF COMPRESSOR

3.1 Methodology

- Study the literature review.
- Create the 3D model of Compressor with help of CATIA parametric software.
- Selection of fluids such as R134A and R407C.
- Perform CFD and thermal analysis on the Compressor assembly for thermal loads.

3.2 Problem Description

The main objective of the project is to design and CFD and Thermal analyze an Compressor. In this project is to design using CATIA V5 software and CFD and Thermal analysis is done using Ansys by importing the model.

The principle aphorism of this venture is to plan a 3D model of the disparate balance tube Compressors and study the CFD and properties like warm conduct by utilizing FEA approach. The Compressor is planned with the assistance of 3D demonstrating parametric programming CATIA and discovers the properties with the assistance of ANSYS programming CFD and warm examination.

Our problem involves Body Loads, which act at all point in the body. We will want create a load case that

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is a combination of other loads: after just one solve, we will want to see the stresses separately for the x-direction acceleration, for y-direction acceleration, for z-direction acceleration and for all three acting together (Magnitude).

Main Goals of this Project

1. To develop an analytical geometry model using cad software's (CATIA) with this tool designing 3D-model, 2D-drawing & GA (general assembly) drawing.
2. Importing 3D model (IGES) data in ANSYS software and doing FEA (finite element analysis).
3. Verifying the 3D-model design with standing or not after receiving CFD results, hence updating design concepts.
4. Comparing the results obtain by the analytical model for loading conditions with the results obtain from the Finite element analysis (FEA).
5. Selection Of material to be necessary.
6. To show working component with as per required aspects of heat exchanger pipe

3.3 Introduction to CAD

CAD (Computer Aided Design) is the utilization of program to plan and record an item's plan cycle.

Designing drawing involves the utilization of graphical images, for example, focuses, lines, bends, planes and shapes. Basically, it gives definite portrayal about any part in a graphical structure.

3.4 Introduction to Catia

CATIA is an abbreviation for Computer Aided Three-Dimensional Interactive application. It is the most capable, amazing and profoundly famous CAD for example PC supported plan programming. It is made, created and claimed by Dassault Systems of France. IBM was the main advertiser of CATIA till 2010. In light of its high ease of use, CATIA affirmation is one of the most mainstream and searched after confirmation in market.

<u>2D & 3D MODEL OF FIN TUBE COMPRESSOR</u>

The same CATIA 3D model and 2D drawing model is shown below for reference. Dimensions are taken from. The design of 3D model is done in CATIA software, and then to do test we are using below mentioned software's.

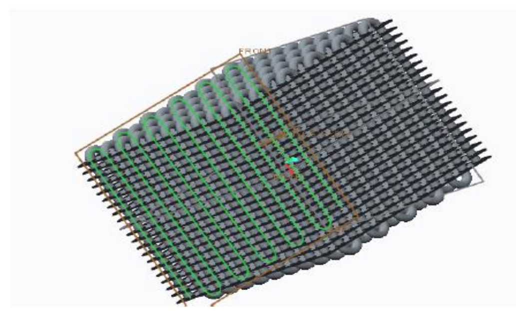

Fig: 3.1 3D MODEL OF COMPRESSOR

The Finned Tube Compressor is designed in the Catia V5 software by both the part modeling and Assembly modeling. This modeling is being done by following steps:

Sketch: It gives the profile, like outer diameter and inner diameter by intended means of line, rectriangle command.

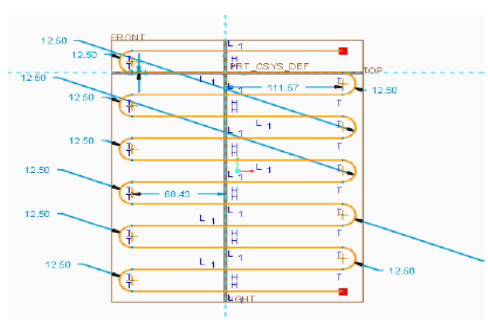

Fig: 3.2 2D MODEL OF COMPRESSOR

It is a line diagram of 2d model fin tube Compressor. It is done by CATIA with parameters.

The below figure is rectangular shaped fin tube Compressor. The outer space of fin tube has rectangular shaped fins. It is done by CATIA Software.

Pad: It gives the required thickness to the component .After the sketch, click on the close workbench icon and then the pad command appears, on clicking on it, the dialog box opens; the required value can be entered.

Pocket: It gives the required pocket / groove / hole to the component .After the sketch, click on the close workbench icon and then the pocket command appears, on clicking on it, the dialog box opens; the required value can be entered.

Applying Material properties: Selection of Component and type of material

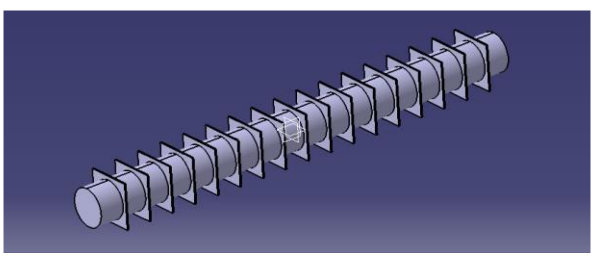

Fig: 3.3 3D Model of rectangular Finned Tube Compressor

The below figure is circular shaped fin tube Compressor. The outer space of fin tube has circular shaped fins. It is done by CATIA Software.

Circular Pattern: This command is used to repeat the profile structure on the total selected workbench. This is the command need to enter the number of profiles are to be repeated on the workbench in the given dialog box.

Measure Inertia: Here we get all the values of the material by which the properties were applied; like Mass, Area, Moment of Inertia, Young's Modulus, etc.

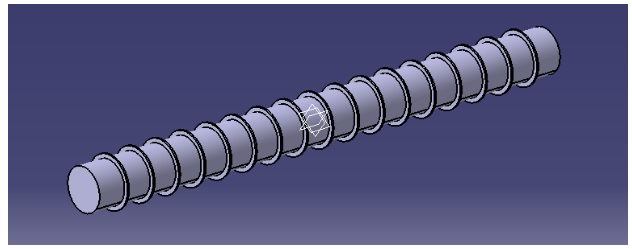

Fig: 3.4 3D Model of circular Finned Tube Compressor

The above figure is hexagonal shaped fin tube Compressor. The outer space of fin tube has hexagonal shaped fins. It is done by CATIA Software.

Manipulate: This command is used to manipulate / turn / rotate the component in any requried direction as per the need / suitable constraints are to be applied on the component.

Multi View: This is the command in which all the views of the component / model can be displayed on the screen at a same time, they can be edited under the workbench.

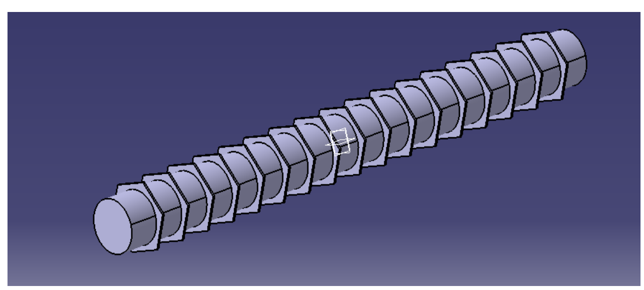

Fig: 3.5 3D Model of hexagonal Finned Tube Compressor

Introduction to FEA

Finite element analysis is a method of solving, typically roughly, certain issues in designing and science. It is utilized chiefly for issues for which no definite arrangement, expressible in some numerical structure, is accessible. Accordingly, it is a mathematical as opposed to an investigative technique. Strategies for this sort are required on the grounds that diagnostic techniques can't adapt to the genuine, convoluted issues that are met with in designing. For instance, designing quality of materials or the numerical hypothesis of versatility can be utilized to ascertain systematically the anxieties and strains in a bowed bar, yet neither one of the wills be effective in discovering what's going on in part of a vehicle suspension framework during cornering.

CFD Methodology

- Import model to ANSYS Design Modeler.
- Develop fluid domain around the fin tube geometry to catch flow physics.
- Generate mesh and make name determination for important faces in the geometry.
- Setup model subtitles in familiar condition.
- Pick the materials (liquid and Aluminum).
- To apply velocity, pressure outlet and cylinder divider temperature as limit conditions.
- Solution initialization.
- Calculate the arrangement by progressively expanding the quantity of cycles while checking the residuals.
- Determine the outcomes through CFD Post-processing.

Tetrahedral element that has a quadratic displacement behavior and is well suited to model irregular meshes (such as produced from various CAD/CAM systems). The element is defined by ten nodes having three degrees of freedom at each node: translations in the nodal x, y, and z directions. The element also has plasticity, creep, swelling, stress stiffening, large deflection, and large strain capabilities.

3D Models of Finned Tube Compressor

The 3d model of circular fin tube Compressor outer space has circular shape fins throughout length of the fin tube.

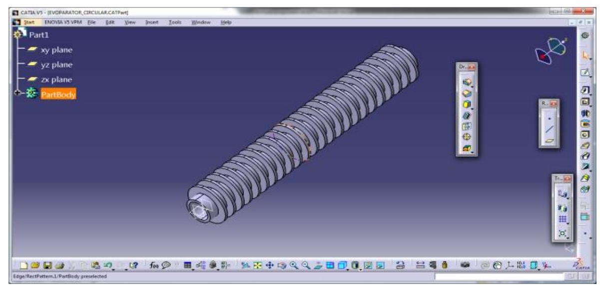

Fig: 3.6 circular finned tube Compressor

The 3d model of rectangular fin tube Compressor outer space has rectangular shape fins throughout length of the fin tube.

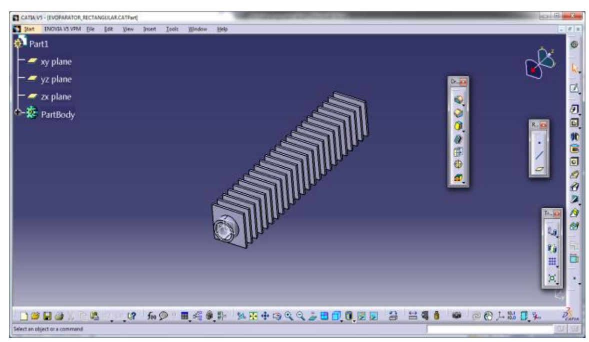

Fig: 3.7 Rectangular finned tube Compressor

CATIA can be customized via application programming interfaces (API). It is a line diagram of 2d model fin tube. The fin length is 600mm, the fin size is 2mm and outer Dia of fin circle is 30 Radius and inner Dia of fin circle is 25 Radius.

3.11 RESULTS AND DISCUSSION

CFD ANALYSIS OF FIN TUBE COMPRESSOR

CASE 1 – CIRCULAR FINS

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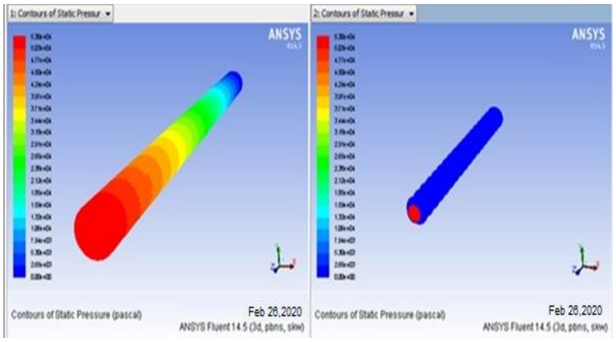

Fig: 3.11Pressure counters

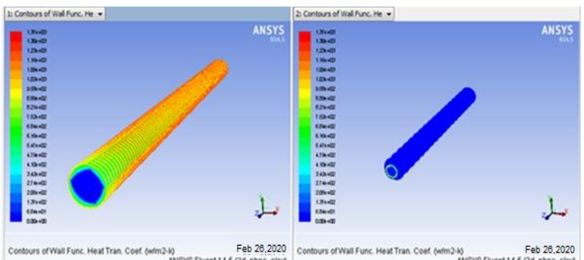

Fig: 3.12 Heat Transfer Coefficients

CASE2 – RECTANGULAR FINS

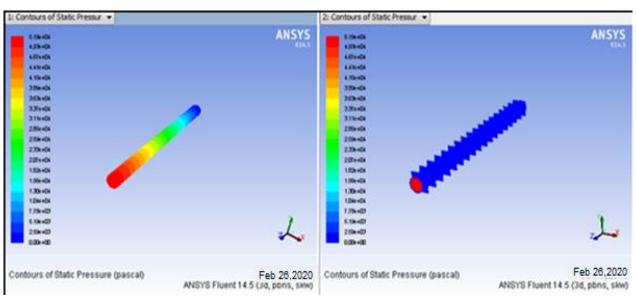

Fig: 3.14 Pressure counters

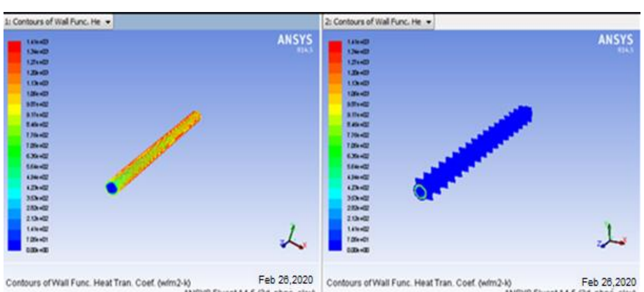

Fig: 3.15 Heat Transfer Coefficients

3.12 THERMAL ANALYSIS OF FIN TUBE COMPRESSOR

CASE 1 – CIRCULAR FINS

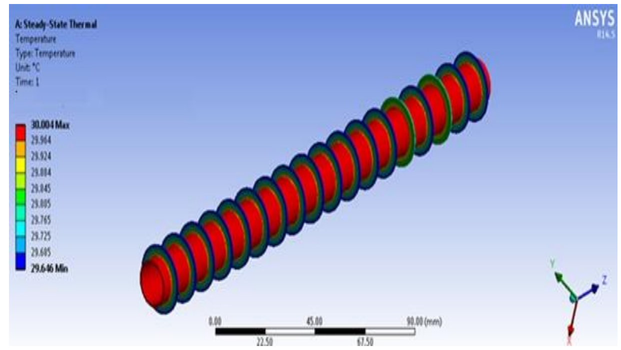

Fig: 3.16 Temperatures

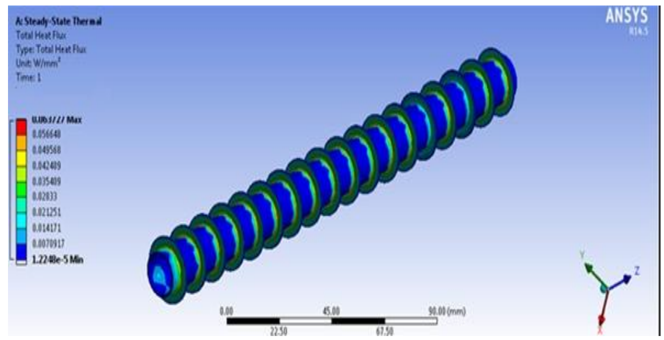

Fig: 3.17 Heat flux

CASE 2 – RECTANGULAR FINS

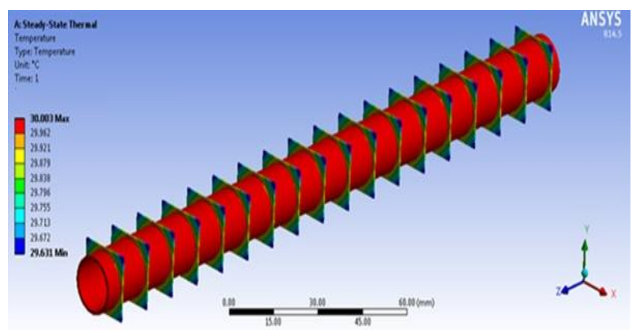

Fig: 3.18 Temperatures

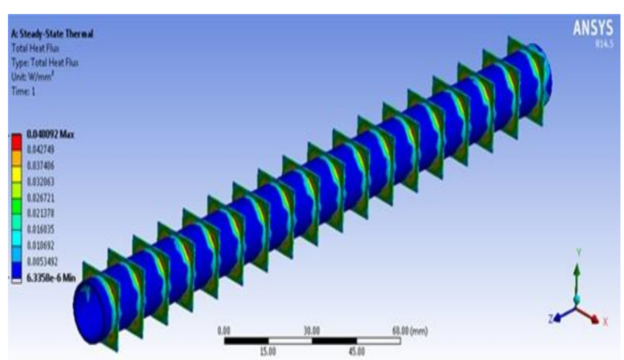

Fig: 3.19 Heat flux

IV.CONCLUSION

In this thesis a highly nonlinear model for the dynamic behavior is considered. A parametric study to investigate the influence of the control parameters on the dynamic response is conducted. The designed the fin tube Compressor with the help of 3D parametric software CATIA. And have done the CFD analysis on the Compressor by varying the fluids R407C and R134A on all design models. By observing the CFD analysis we find out that heat transfer coefficient, heat transfer rate, mass flow rate and pressure and velocity. And also have done thermal analysis to find out the temperature and heat flux by varying the materials on the all models. When come to the fluids while comparing heat transfer rate value of 1.67e+03, the mass flow rate value of 0.000363 and heat transfer coefficient value of 1.9468 are more for R134A and less for R407C at circular fin. The outlet pressure is more for R407C and less for R134A. The velocity is more for R134A and less for 4407C. When come to the thermal analysis results, the heat flux is 0.068739 more at copper with rectangular fin when comparing with the circular fin. So can conclude that the R134A fluid is best for CFD analysis because of the highest values are given at R134A in both circular and rectangular fin tube Compressors. And copper is the better material because of the maximum values are given at circular material in both circular and rectangular fin tube Compressors. The design of the fins of the Compressor mechanism worked flawlessly in analysis as well, all these facts point to the completion of our objective in high esteem.

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