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Design and Thermal Analysis on Transformer Fin Using CFD

Dwarapudi Sai Balaji[1*], Dwarapudi Ashok[2], Gondesi Gopala Reddy[3], Gandi Upendra[4], Nakka Suneel Kumar[5]

[1,2,3,4]*B.Tech. Student, Department of Mechanical Engineering, Nadimpalli Satyanarayana Raju Institute of Technology, Visakhapatnam, India*
[5]*Assistant Professor, Department of Mechanical Engineering, Nadimpalli Satyanarayana Raju Institute of Technology, Visakhapatnam, India*

Abstract*: The design problem considers minimization of the short circuits and explosions due low heat reduction through fins. The transformer design involves the optimum transfer of heat through fins to minimize the leakage field, short circuits and explosions. While designing the transformer, original dimensions of the transformer should be taken and not consider the before used materials of manufacturing the transformer. The design of transformer involves in considering the two different materials one is alumina 96% and another one is structural steel to get the temperature distribution and temperature changes within the transformer by giving the boundary conditions of transformer including atmospheric temperature. Then compare both the materials with present used material of the transformer using software analysis. Then choosing the best material for better heat reduction (to atmosphere) through the fins (extended surface) of transformer. Generally mild steel is better than the aluminum as it in a strength. The analysis has proved that mild steel has better strength than the aluminum materials. Comparing the mild steel with the aluminum on the transformer for better heat rejection by conducting the steady state thermal analysis, transient analysis. The results of comparing these two different materials on the transformer is that the mild steel has better strength and good temperature capacity for high capacity of transformers than the aluminum. Results based on equivalent stress, static deformation and natural frequencies shows that mild steel transformer performed better in that it has high strength and good temperature bearing capacity and will deflect far less that aluminum. The aluminum materials are assigned to the transformer body and fins will become melts and damaged because aluminum has low strength and low temperature bearing capacity than the mild steel material. So that aluminum is used only for low heat sink or rejection of the fins. Mild steel is better suited for the high temperature holding transformer because mild steel is more rigid. These structural analysis results are gained through experimental work. These structural analysis results are gained through experimental work. These structural analysis results are gained through experimental work.

***Keywords*: Transformer fin.**

1. Introduction

Transformer is a unit which helps in step up and step down the voltage. While doing the operation, transformer core gets heated up to a temperature ranging from 105 degree Celsius to 220 degrees Celsius. Transformer consists fins which helps in transmitting the heat generated inside core to outside atmosphere. If the temperature is increased beyond the mentioned temperature, even in 1 degree rise in temperature also reduces the efficiency by 50%. So, in order to minimize the loses caused to overheating, we are developed a project which can withstand a temperature ranging from 220 degree Celsius to 335 degrees Celsius. In order to get that output we redesigned the fins by changing the material as well as dimensions.

Heat transfer in transformer generally takes place in 3 modes.

1. Conduction
2. Convection
3. Radiation

Conduction: Conduction is a mode of heat transfer in which heat is transferred through direct physical contact between two or more solid bodies. In transformer this mode of heat transfer occurs in transformer core. Heat generated inside the transformer core get transferred to outside atmosphere by means of conduction.

Convection: Convection is also a mode of heat transfer in which heat is transferred within the fluid itself. In transformer this mode of heat transfer occurs within the coolant (mineral oil).

Radiation: Radiation is a special mode of heat transfer in which heat is transferred in form of electromagnetic waves. For this mode of heat transfer does not require any medium. In transformer this phase of heat transfer occurs at transformer fins and air. Heat from transformer fins is dissipated to atmosphere through radiation process.

By redesigning the transformer fins, the area of contact of fins to outside atmospheric air gets increases, due to increase in area of contact to outside atmosphere heat transfer rate increases.

In this design we make use of aluminium as transformer material, so that weight of the transformer gets reduced.

Aluminium has excellent corrosion resistant property and also has good thermal conductivity.

A. Problem Definition

Day by day number of research works are going on thermal stream to proper utilization of thermal energy.

1. Its time to proper utilization of thermal energy, cooling

*Corresponding author: 19nu5a0316@nsrit.edu.in

of hot fluid is important for refrigeration and automobile radiators for that we considered tapered, triangular, rectangular, tube in tube and spiral fins are used and compared the efficiencies and effectiveness of all heat pipes.

2. Heating of cold fluid is important for economizers in boilers, for that we considered tapered, triangular, rectangular, tube in tube and spiral fins are used and compared the efficiencies and effectiveness of all heat pipes.

2. Methodology

1. Design and fabrication of five vertical heat pipes with different fin profiles.
2. Maintain same inlet temperature and corresponding outlet temperature readings are noted.
3. Different mass flow rates are maintained
4. Constant air flow is maintained with the help of fan
5. Different profile fins are fabricated and soldered as obstacles to pipes in perpendicular to its axis
6. LMTD values calculated
7. Effective values are calculated
8. Fin efficiency is calculated

3. Scope

By conducting proper experimentation, and finding suitable fin shape and size will improve the heat exchanger efficiency in different applications.

1. Structural analysis of the transformer tank using Ansys 12.0 software.
2. Numbering Thermal analysis of fins
3. Analysis of Finns
   a. Rectangular fins
   b. At different fin spacing
   c. Circular fins

CATIA:

Pre-processing (CATIA): Designing

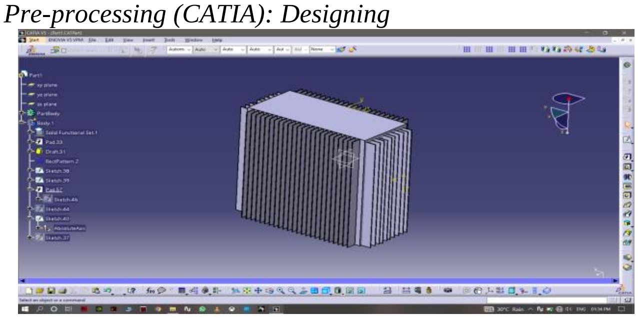

Fig. 1. Designing in Catia

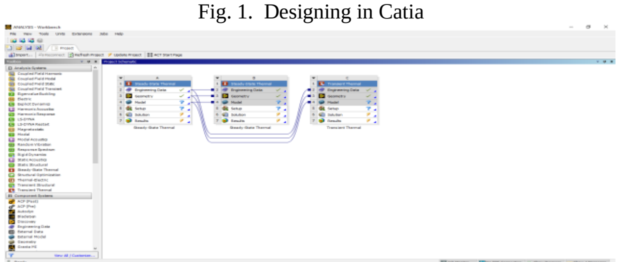

Fig. 2. Importing to Ansys

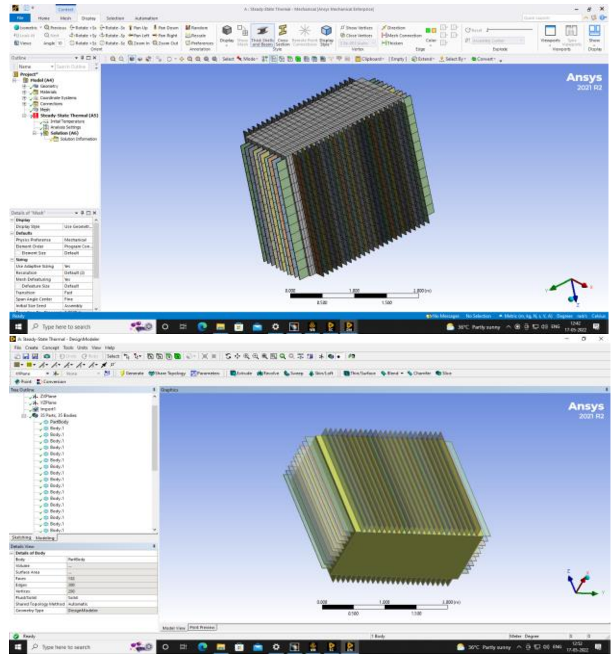

Fig. 3. Meshing and Mapping

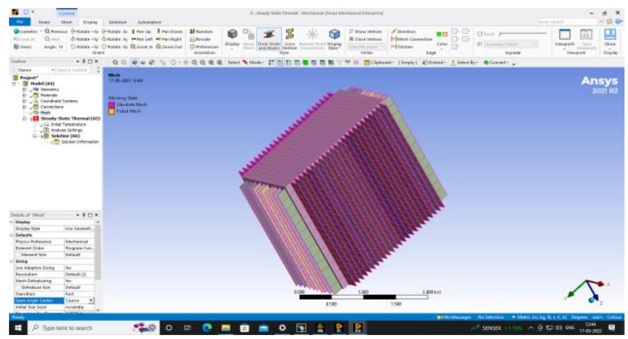

Fig. 4. Ansys mapping

Post-processing (Analysis):

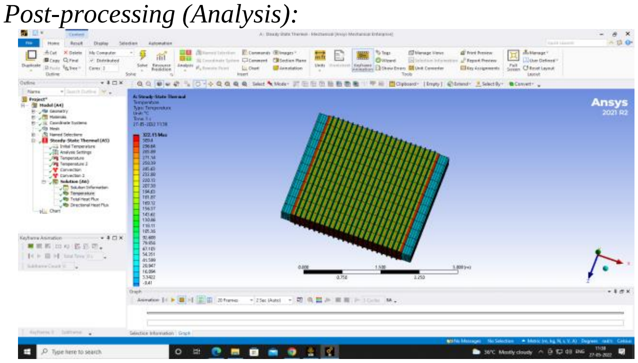

Fig. 5. Temperature

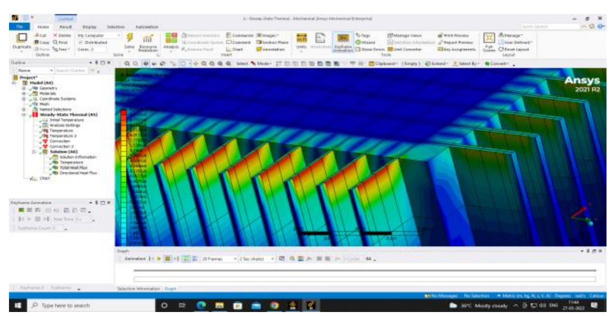

Fig. 6. Total heat flux

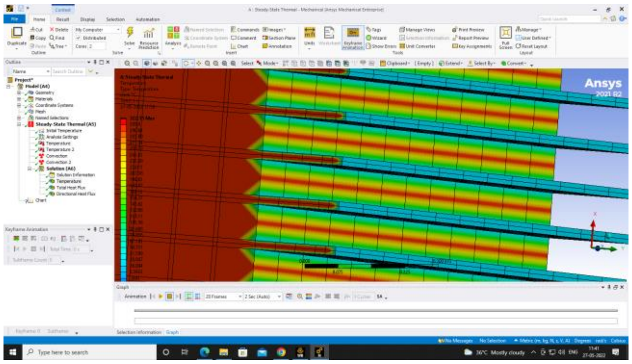

Fig. 7. Directional heat flow

4. Conclusion

This paper presented design and thermal analysis on transformer fin using CFD.

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