REVIEWS ON FINITE ELEMENT ANALYSIS AND FLOW CHARACTERISTICS ON RADIATOR FINS

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***Abstract*— In this study, the three-dimensional fluid flow and heat transfer in a rectangular micro-channel heat sink are analyzed numerically. A numerical code based on the finite difference method is developed to solve. The code is carefully validated by comparing the predictions with analytical solutions and available experimental data. For the micro channel heat sink investigated, it is found that the temperature rise along the flow direction in the solid and fluid regions can be approximated as linear. The highest temperature is encountered at the heated base surface of the heat sink immediately above the channel outlet. Increasing the thermal conductivity of the solid substrate reduces the temperature at the heated base surface of the heat sink, especially near the channel outlet. Although the classical fin analysis method provides a simplified means to modeling heat transfer in micro-channel heat sinks, some key assumptions introduced in the fin method deviate significantly from the real situation, which may compromise the accuracy of this method. The different configured fins were modeled by catia. And thermal and flow characterization will carried by ansys and cfd software.**

***Keywords :* micro-channel heat sinks, Different configured fins, cooling performance.**

I. INTRODUCTION

Automotive engine cooling system takes care of excess heat produced during engine operation. It regulates engine surface temperature for engine optimum efficiency. Most automotive engine cooling systems consist of the radiator, water pump, cooling fan, pressure cap and thermostat. Radiator is the prime component of the system. Radiator is a heat exchanger that removes heat from engine coolant passing through it. Performance of engine cooling system is influenced by factors like air and coolant mass flow rate, air inlet temperature, coolant fluid, fin type, fin pitch, tube type and tube pitch etc. During summer surrounding air is hot i.e. air inlet temperature is more. Maximum power: Engine condition producing maximum power like when vehicle is climbing uphill, maximum heat rejection is required during this condition. To compensate all these factors radiator core size required may be large.

II. LITERATURE REVIEW

P. K. Trivedi, N. B. Vasava [1] illustrated the effect of Tube pitch for best configured radiator for optimum performance. Heat transfer increases as the surface area of the radiator assembly is increased. This leads to change the geometry by modifying the arrangement of tubes in automobile radiator to increase the surface area for better heat transfer. The modification in arrangement of tubes in radiator is carried out by studying the effect of pitch of tube by CFD analysis using CFX. Results Shows that as the pitch of tube is either decreased or increased than optimum pitch of tubes, the heat transfer rate decreases. Pitambar Gadhve and Shambhu Kumar [2] described use of dimple surface to improve forced convection heat transfer. Heat transfer enhancement is based on principle of scrubbing action of cooling fluid inside the dimple. Surface dimples promote turbulent mixing in flow and enhance heat transfer. An experimental set up has been designed and fabricated to study effect of dimpled surface on heat transfer in rectangular duct. Results compared with flat surface tube and found heat transfer enhancement over the later one. C.Oliet, A. Oliva, J. Castro, C.D. Pe´rez-Segarra [3] studied different factors which influence radiator performance. It includes air and coolant flow, fin density and air inlet temperature. It is observed that heat transfer and performance of radiator strongly affected by air and coolant mass flow rate. As air and coolant flow increases cooling capacity also increases.

III. Methodology and Materials

A automobile radiator designed using Catia and analysed with ansys software.

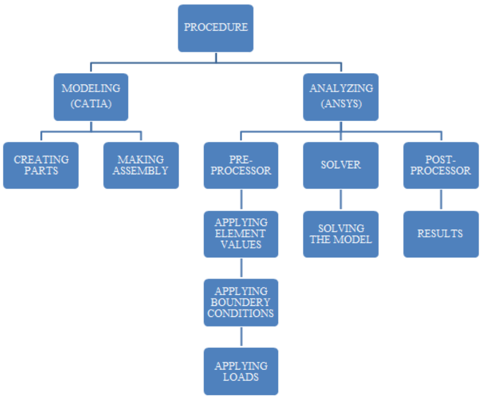


Fig.1 Methodology

CATIA, developed by Dassult systems, France, is a completely re-engineered, next generation family of CAD/CAM/CAE software solution. CATIA serves the basic design task by providing different workbenches.

A. Composites in ansys

Composite materials have been used in structures for a long time. In recent times composite parts have been used extensively in aircraft structures, automobiles, sporting goods, and many consumer products. Composite materials are those containing more than one bonded material, each with different structural properties. The main advantage of composite materials is the potential for a high ratio of stiffness to weight. Composites used for typical engineering applications are advanced fibres or laminated composites, such as fiberglass, glass epoxy, graphite epoxy, and boron epoxy.

B. Modelling composites

Composites are somewhat more difficult to model than an isotropic material such as iron or steel. We need to take special care in defining the properties and orientations of the various layers since each layer may have different orthotropic material properties.

C. Element type used in the project

SOLID45 Element Description: SOLID45 is used for the 3-D modelling of solid structures. The element is defined by eight nodes having three degrees of freedom at each node: translations in the nodal x, y, and z directions. The element has plasticity, creep, swelling, stress stiffening, large deflection, and large strain capabilities.

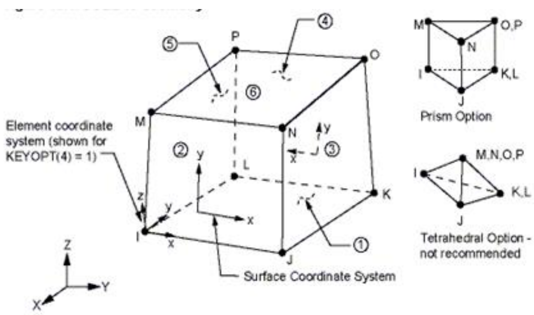


Fig. 2 SOLID45 Geometry

D. Materials

By engineering materials, we mean materials used for manufacturing engineering components in industry. Materials form one of four M’s (Men, Material, Machines and Money) which plays a vital role for the development and flourishment of a country.

The study of engineering materials, namely ferrous and nonferrous metals, metal alloys, non-metals, their grain structure, properties and applications etc. is termed as material science.

1) *Effect of copper:* Symbol**:** (Cu), Atomic mass**:** 63.546 u, Electron configuration**:** [Ar] $3d^{10}4s^{1}$, Atomic number**:** 29, Density**:** 8.96 g/cm³ (Near room temperature) Copper is a good conductor of heat. This means that if you heat one end of a piece of copper, the other end will quickly reach the same temperature. Most metals are pretty good conductors; however, apart from silver, copper is the best. Copper is made from a lattice of ions with free. The ions are vibrating and the electrons can move through the copper (rather like a gas). What happens when one end of the piece of copper gets hotter. The copper ions at the hot end vibrate more. A free electron collides with an ion at the hot end, and gains kinetic energy (it speeds up). It moves to the cold end. It collides with a cold ion, making the previously cold ion vibrate more. This heats up the cold end. In this way, energy is transferred through copper, from hot to cold. Non-metals conducting heat: Compare this with how heat is conducted in a non-metal. The vibrating particles pass on the vibrations to their nearest neighbours. This is much slower. That's why metals are the best conductors – their free electrons can carry the energy along their length.

2) *Effect of Aluminium:* Aluminium or aluminum is a chemical element with symbol Al and atomic number 13. It is a silvery-white, soft, nonmagnetic and ductile material in the boron group. By mass, aluminium makes up about 8% of the earth's crust; it is the third most abundant element after oxygen and silicon and the most abundant metal in the crust, though it is less common in the mantle below. The chief ore of aluminium is bauxite. Aluminium metal is so chemically reactive that native specimens are rare and limited to extreme reducing environments. Instead, it is found combined in over 270 different minerals. Aluminium is remarkable for its low density and its ability to resist corrosion through the phenomenon of passivation. Aluminium and its alloys are vital to the aerospace industry and important in transportation and building industries, such as building facades and window frames. The oxides and sulphates are the most useful compounds of aluminium. Despite its prevalence in the environment, no known form of life uses aluminium salts metabolically, but aluminium is well tolerated by plants and animals

3) *Effect of Aluminium bronze:* Aluminium bronze is a type of bronze in which aluminium is the main alloying metal added to copper, in contrast to standard bronze (copper and tin) or brass (copper and zinc). A variety of aluminium bronzes of differing compositions have found industrial use, with most ranging from 5% to 11% aluminium by weight, the remaining mass being copper; other alloying agents such as iron, nickel, manganese, and silicon are also sometimes added to aluminium bronzes. Aluminium bronzes are most valued for their higher strength and corrosion resistance as compared to other bronze alloys. These alloys are tarnish-resistant and show low rates of corrosion in atmospheric conditions, low oxidation rates at high temperatures, and low reactivity with sulfurous compounds and other exhaust products of combustion. They are also resistant to corrosion in sea water.

   Aluminium bronzes' resistance to corrosion results from the aluminium in the alloys, which reacts with atmospheric oxygen to form a thin, tough surface layer of alumina (aluminium oxide) which acts as a barrier to corrosion of the copper-rich alloy. The addition of tin can improve corrosion resistance.[1] Another notable property of aluminium bronzes are their biostatic effects. The copper component of the alloy prevents colonization by marine organisms including algae, lichens, barnacles, and mussels, and therefore can be preferable to stainless steel or other non-cupric alloys in applications where such colonization would be unwanted. Aluminium bronzes tend to have a golden color.

   Aluminium bronzes are most commonly used in applications where their resistance to corrosion makes them preferable to other engineering materials. These applications include plain bearings and landing gear components on aircraft, guitar strings, valve components, engine components (especially for seagoing ships), underwater fastenings in naval architecture, and ship propellers.[2] Aluminium bronze is also used to fulfill the ATEX directive for Zones 1, 2, 21, and 22. The attractive gold-toned coloration of aluminium bronzes has also led to their use in jewelry.

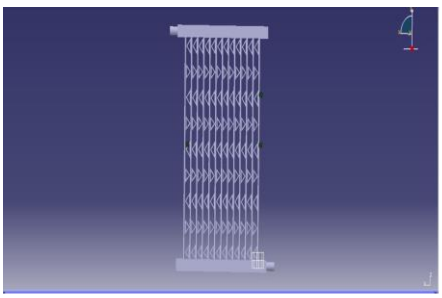


Fig. 3 fin model in catia

IV. ANALYSIS RESULT

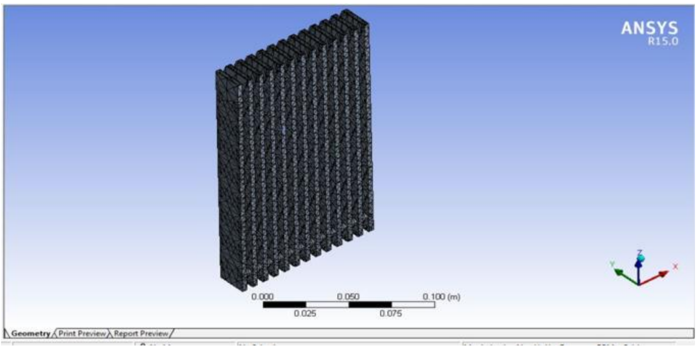


Fig. 4 mesh

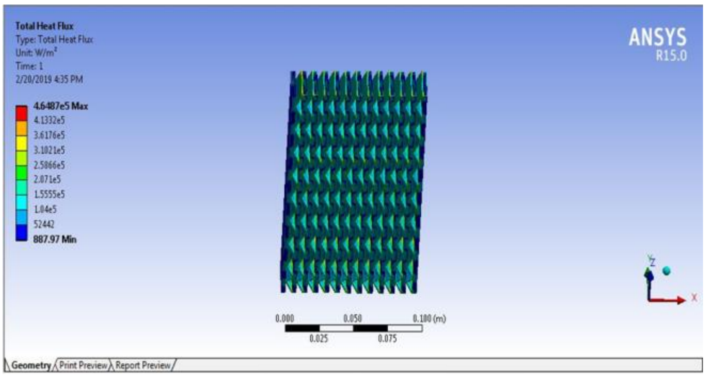


Fig. 5 total heat flux

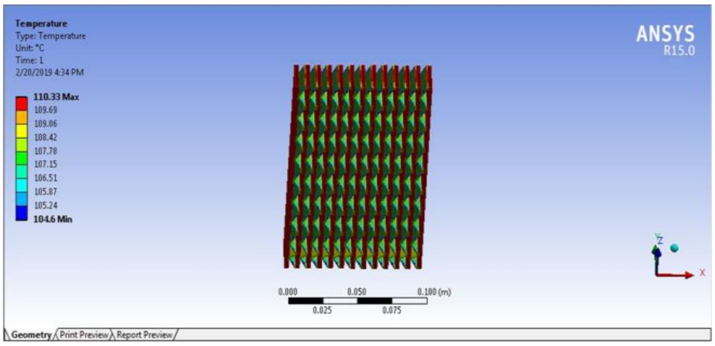


Fig. 6 temperature

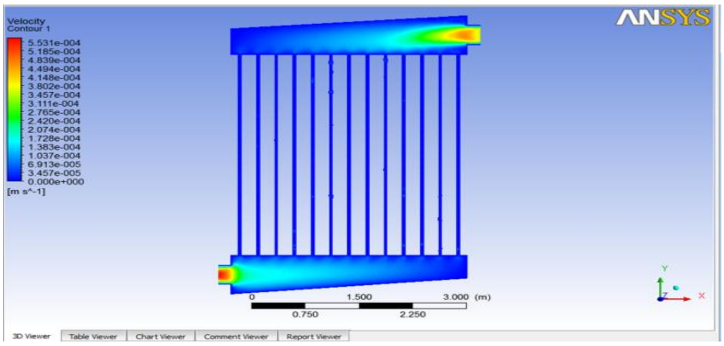


Fig. 7 velocity

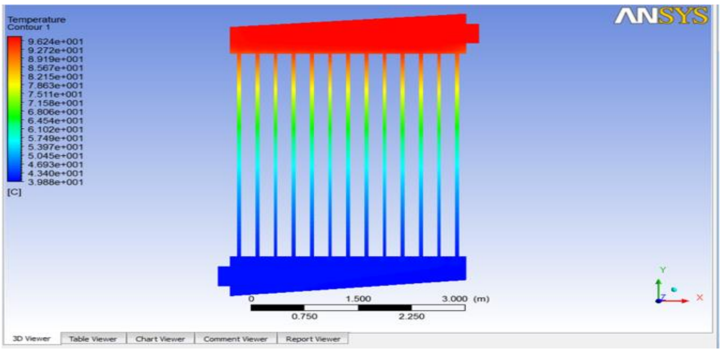


Fig. 8 Temperature distribution

V. COMPARISON GRAPH

TEMPERATURE VARIATION

Aluminium	copper	copper + aluminium
105.2	104.6	105

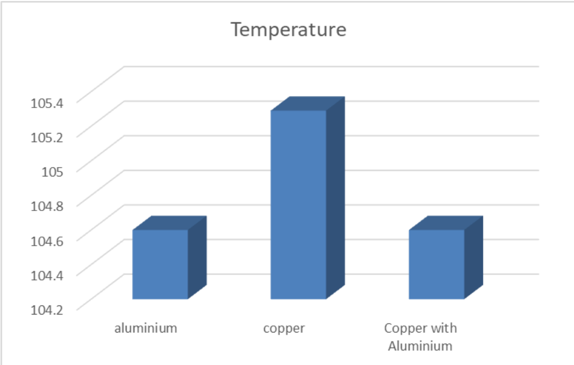
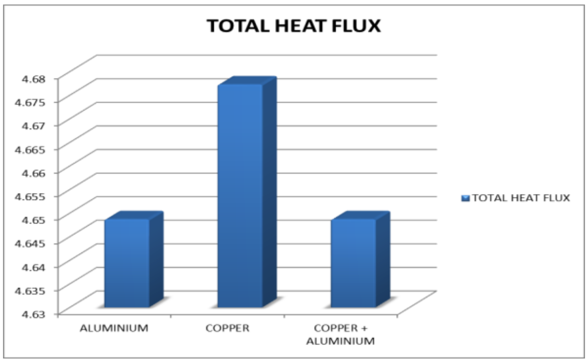


Fig. 9 temperature variation

TOTAL HEAT FLUX

Aluminium	copper	copper + aluminium
4.6487	4.6773	4.6487



VI. CONCLUSION

A set of numerical parametric studies on automotive radiators has been presented in details in this paper, analyzing the influence of those parameters on the full thermal and hydraulic behaviour of the heat exchanger. The first part of the parametric studies has focused on the influence of working conditions on some different designs of geometrical parameters (fin spacing, louver angle) as well as the importance of coolant flow lay-out on the radiator global performance. This work provides a detailed example of the overall behaviour report of an automobile radiator working at a usual range of operating conditions. Significant knowledge-based design conclusions have also been reported. From our experiment's results, we observed that by changing the fin material and shape, we use less material for the radiator but also increase his cooling performance. That means the price will be cheaper and will give our product good competiveness in the market. From the three samples of radiators we made, we choose aluminium bronze because it has the best cooling performance and is the one which uses less material.

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