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Design Optimization of Heat Transfer in Microchip Cooling System

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Abstract: *Thermal Analysis on microchip cooling system with different heat sources like copper and silica, and different varying cross sections of fins are used in this thesis. The main objective of this work is to analyse the heat transfer rate performance of the thermal system i.e. to reduce the maximum temperature and increasing the heat flux of the thermal system with the use of different cross sections of fins without increasing the number of fins. A thermal analysis was performed on microchip cooling system used in computer processors to reduce the Maximum temperature and to increase the heat flux using finite element analysis software. In this study investigation is carried to determine the max temperature and heat flux of the thermal microchip cooling system having rectangular fins and copper source heat generation element. The maximum temperature of the thermal cooling system is 414.715°K for the rectangular fins and copper heat source in microprocessor cooling system.*

The heat flux value maximum for the Octagon type cross section fin and low for the rectangular type cross section fin whereas the triangular type cross section fin gives the better maximum temperature compare to the other cross sections of fins used in the copper source heat generation element in the cooling system.

The triangular cross section fin is good for compare to other cross sections of fins, the max temperature of triangular type fin is 396.252°K, the circular and octagon cross sections fins behaviour is similar in nature in the silicon heat source thermal system. The heat flux is maximum for the octagon type fin compare to others it was gives the good results, the heat flux value is 0.102726, the other fins behaviour very similar in nature in the silicon heat source thermal system.

Keywords: *Maximum Temperature, heat flux, fins, cooling system, ANSYS*

I. INTRODUCTION TO FINS

The study heat transfer fins - extend the surface, which is the object, in order to increase the heat transfer rate of the developer or to enhance the convection. The number of conduction, convection, or the object, which determines and transmits to the rays of heat. The increasing temperature gradient between the object and the environment, issues convection heat transfer coefficient and the heat transfer surface is increased and the increase in area. Sometimes fin cannot change its cost-effective to the first two options.

To create a tractable equation for the heat transfer of a fin, many assumptions need to be made:

- A. Steady state
- B. The constant material properties (independent of temperature)
- C. No internal heat
- D. One-dimensional conductivity
- E. The area of uniform cross-section
- F. Uniform surface area for convection

The fins s are the most frequently used heat exchangers, and vehicles such as radiators, the computer CPU power radiators in the anchorage exchangers, and heat. Even those who are new technologies, such as hydrogen fuel mainstream. He took advantage of the phenomena of nature 38. Rabbits and foxes fins or ears to act, releasing heat flowing through their blood.

II. LITERATURE SURVEY

M. G. Sobamowo [1] The wide range of applications of cooling fins are evident in heat transfer enhancements for various thermal systems and also, for the control and prevention of thermal damages in mechanical and electronic equipment. In this work, nonlinear thermal behaviour of convective-irradiative cooling fin with convective tip and subjected to magnetic field is analyzed using Galerkin finite element method. The numerical solutions are verified by the exact analytical solution of the linearized models using Laplace transforms method. H. Singh, J.S. Crompton*and K.C. Koppenhoefer [2] In this study, the time-dependent fluid flow and thermal interactions have been solved for transient and steady state conditions of the conjugate heat transfer problem between the natural convective flow and heat sinks composed of arrays of pins. M. Bisht, K. S. Mehra [3] in the present study, thermal analysis

of electronic processor is proposed and an effort is made to decrease the maximum temperature in processor by employing straight rectangular fins which aid in rapid heat removal to the surroundings for ensuring the optimal working of the processor. U S Ramakanth, Veeranjanyulu Kodeti, Dr. GVR Seshagiri Rao [4] In this work project, 6065 aluminium alloy structural plate elements are taken what mass uncertainty and rigidity take into account with each free edge condition, important information is observed that only spring plate (SP) and bare mass spring plate (SMBP) The frequency of the five modes is the same. The dynamic behaviour of plates in vibrations was discovered using FEM technique. This shows a good agreement between analyses Methods and finite elements Methods for blank plates under various boundary conditions. U. S. Ramakanth, Putti. Srinivasa Rao [5] presents the research examined the influence of sic and fly ash on the wear behaviour of Aluminium 7075/5 and weight percentage of hybrid complex. Aluminium alloy 7075 strengthened with sic-fly ash were examined. Uppada Rama Kanth, Putti Srinivasa Rao, Mallarapu Gopi Krishna [6] reports that Al-Zn compound supplement / fly ash / Thus, using a device to measure the vortex of casting, while stirring. The carrots are many thermal power plants Industrial waste fly ash, the main service. This article reports on the skill of the Microstructural and mechanical behaviour, zinc aluminum alloy, reinforced with fly ash and silicon carbide (SiC). M. Prashanth Reddy, C. Labesh kumar and T. Vanaja [7] the development of the digital computer and its usage day by day is rapidly increasing. But the reliability of electronic components is getting affected critically by the temperature at which the junction operates. N.Venkatesh, .M. Kedarnath [8] Mechanical housing play critical role in ground electronic devices. It houses Printed Circuit Boards (PCBs) on which high heat dissipating components will be mounted. The complexity associated with this requirement is to dissipate the heat to the ambient through constrained heat path. K a Rajput, A V Kulkarni [9] it is very important to dissipate unwanted heat generated in mechanical devices such as IC engines, radiators, electronic IC's etc. to the atmosphere. Extended surfaces are widely used in many engineering application because of easy in construction, require less space, light weight. A Sathishkumar, MD KathirKaman, S Ponsankar, C Balasuthagar [10] The major automobile component subject to high temperature variation and thermal stress is engine cylinder. Fins are used on the surface of engine cylinder to increase the heat transfer rate. Heat rejection rate in engine cylinder fins can be enhanced by increasing its surface area.

A. Finite Element Analysis of Microchip Cooling Thermal System

The heat source material used in this analysis is copper of thermal conductivity (K 386 W/m²K and fin material used as aluminium with thermal conductivity of 180 W/m²K for cooling the system environment and the entire system is Enclosing in a container is made of a steel with thermal conductivity of 17 W/m²K. Thermal system is keep in steel box. The purpose of attaching the rectangular fins in the thermal systems is reduce the heat generated by the heat source. The convection or film coefficient "h" takes place on the boundaries of the thermal system, the ambient temperature is 20⁰c is maintained, the bottom surface is insulated and the heat generation rate is 1W as shown in fig 3.1. The thermal conductivity of Steel, Aluminium and copper are taken as 17 W/m²K, 180 W/m²K and 386 W/m²K shown in the table 1.1. The purpose of this study is to reduce the heat in the system for this first to find the maximum temperature after that the analysis is carried out using different cross-sections of the fins.

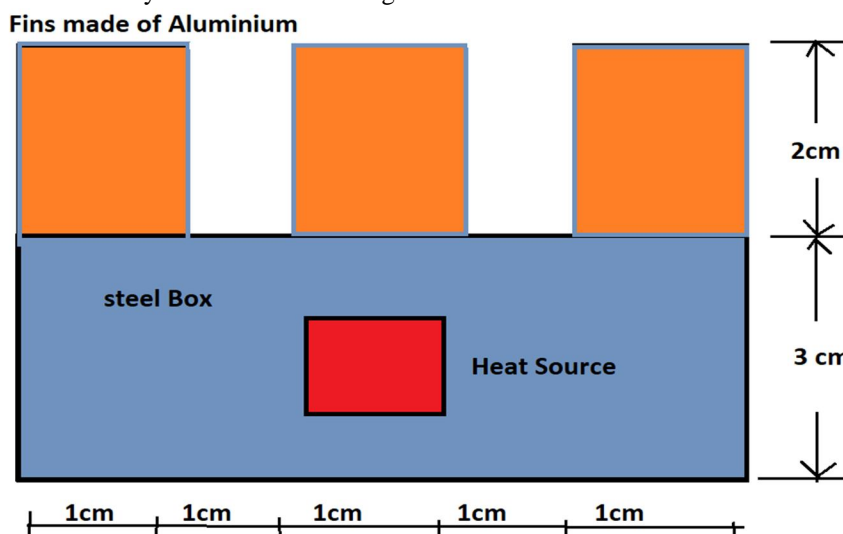


Fig 1.1 Problem formation

The results are found using General post processor command in ANSYS. There are two types of results available in ANSYS software (1) plots (2) list. In plots results display with different colours, the red colour indicate the maximum value and the blue colour indicate minimum value. The list command show the values numerically. The maximum temperature of the thermal cooling system is found using the Fig 1.2 is 414.715 for the rectangular fins and copper heat source in microprocessor cooling system.

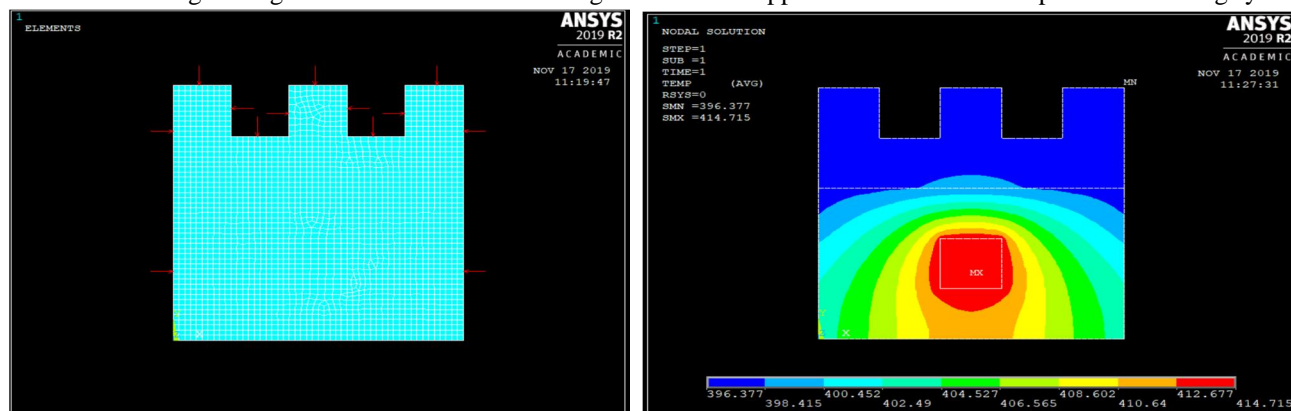


Fig 1.2 Thermal loading acting on the body & the maximum temperature distribution of the thermal system

B. Thermal Analysis on Copper Heat Source Microchip Cooling System under Different Cross Sections of Fins

To reduce the maximum temperature and increasing the heat flux in copper source microchip cooling system different cross sections of the fins are used without adding the number of fins. The following cross sections are used for fins

- 1) Circular, Triangular, & Square
- 2) Pentagon, Octagon, & Hexagon

The convection or film coefficient “h” takes place on the boundaries of the thermal system, the ambient temperature is 20⁰c (20+273=293⁰K) is maintained, the bottom surface is insulated and the heat generation rate is 1W .The thermal conductivity of Steel, Aluminium and copper are taken as 17 W/m⁰K, 180 W/m⁰K and 386 W/m⁰K. The purpose of this study is to reduce the heat in the system for this first to find the maximum temperature after that the analysis is carried out using different cross-sections of the fins. The circular fin was created having radius 5.5mm, the circular fin model thermal system the maximum temperature found that 414.335⁰K and heat flux 0.100476. The triangular fin radius 8.2mm making an angle of side length 291.36, the triangular fin model thermal system the maximum temperature found that 395.594⁰K and heat flux 0.102632. The square fin radius 5.5mm making an angle of side length 263.92, the square fin model thermal system the maximum temperature found that 408.258⁰K and heat flux 0.102672. The hexagon fin radius 5.5mm making an angle of side length 270 the Hexagon fin model thermal system the maximum temperature found that 407.578⁰K and heat flux 0.102646. The pentagon fin model thermal system the maximum temperature found that 408.128⁰K and heat flux 0.103733. The octagon fin radius 5.36 mm making an angle of side length 298.82, the octagon fin model thermal system the maximum temperature found that 409.473⁰K and heat flux 0.103926.

The Table 1.1 and Fig 1.3 to Fig 1.6 represents the heat flux values and maximum temperatures of the different cross sections of fins used in the microprocessor thermal cooling system. The heat flux value maximum for the Octagon type cross section fin and low for the rectangular type cross section fin used in the copper source heat generation element in the cooling system. The triangular type cross section fin gives the better maximum temperature compare to the other cross sections of fins used in the copper source heat generation element in the cooling system.

Table 1.1 shows the heat flux values and Max Temp of different cross sections of fins

| S NO | Heat Flux | S NO | Max Temp |
|-------------|-----------|-------------|----------|
| Octagon | 0.103926 | Triangular | 395.594 |
| Pentagon | 0.103733 | Pentagon | 408.128 |
| square | 0.102672 | square | 408.258 |
| Hexagon | 0.102646 | circular | 414.335 |
| Triangular | 0.102632 | Octagon | 409.473 |
| circular | 0.100476 | Hexagon | 407.578 |
| Rectangular | 0.100432 | Rectangular | 414.715 |

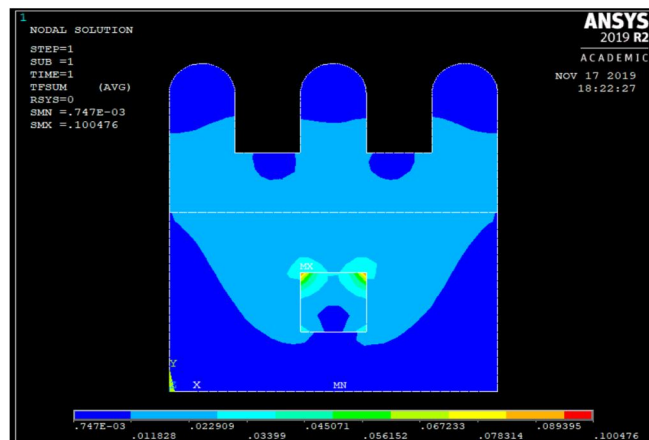
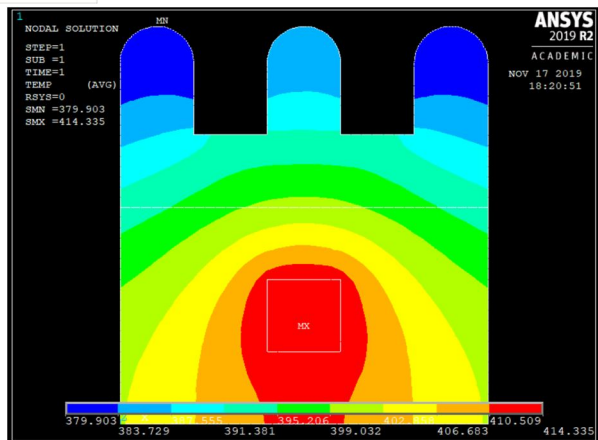


Fig 1.3 Max Temp & Heat Flux of the circular fin model copper heat source thermal system

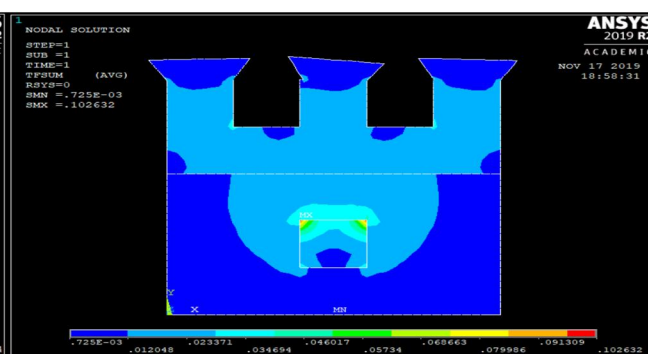
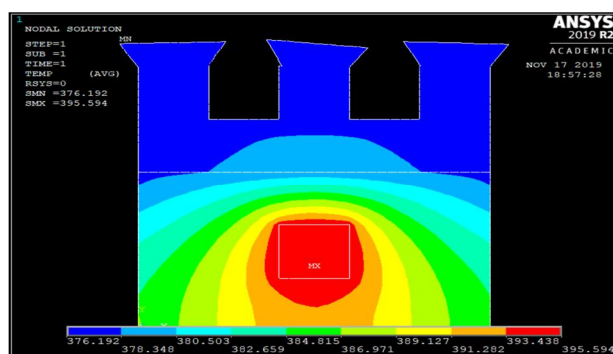


Fig 1.4 Max Temp & Heat Flux of the triangular fin model copper heat source thermal system

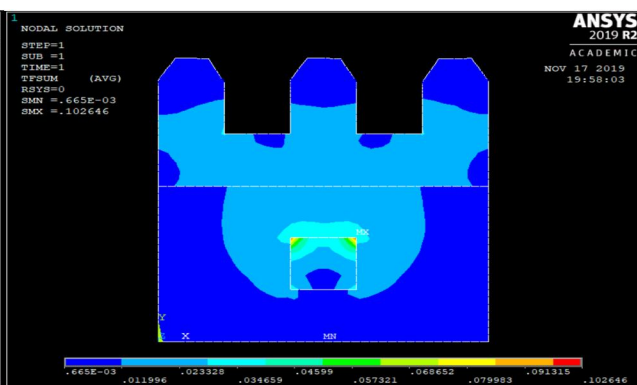
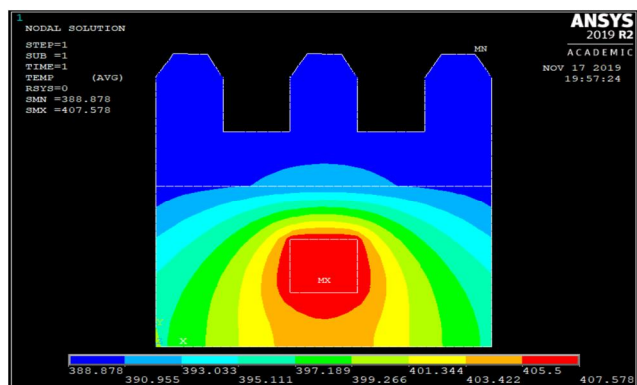


Fig 1.5 Max Temp & Heat Flux of the Hexagonal fin model copper heat source thermal system

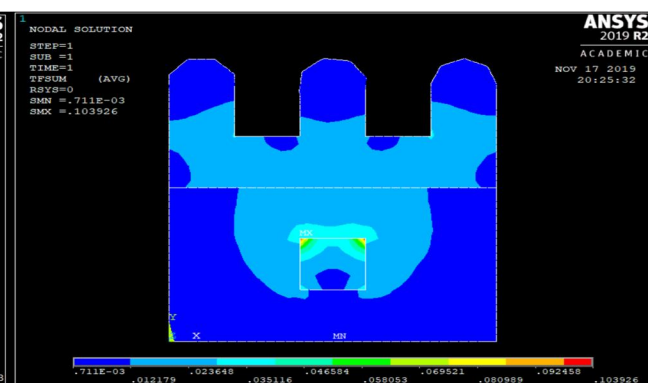
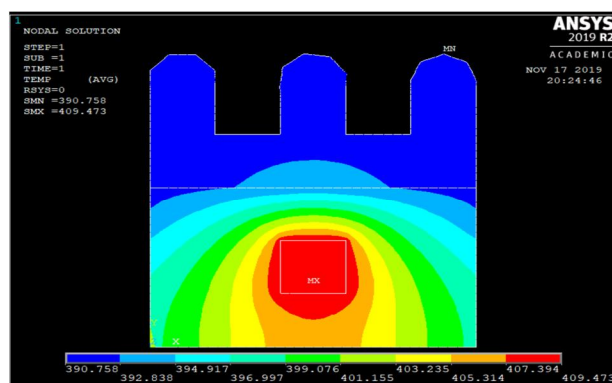


Fig 1.6 Max Temp & Heat Flux of the Octagonal I fin model copper heat source thermal system

C. Thermal Analysis on Silicon Heat Source Microchip Cooling System under Different Cross Sections of Fins

The convection or film coefficient “h” takes place on the boundaries of the thermal system, the ambient temperature is 20°C (20+273=293°K) is maintained, the bottom surface is insulated and the heat generation rate is 1W. The thermal conductivity of Steel, Aluminium and silicon are taken as 17 W/m°K, 180 W/m°K and 130 W/m°K. The purpose of this study is to reduce the heat in the system for this first to find the maximum temperature after that the analysis is carried out using different cross-sections of the fins. Fig 1.7 & Fig 1.8 show the Max temp and Heat flux of Triangular, Pentagon & Octagonal I fin model silicon heat source thermal system

To reduce the maximum temperature and increasing the heat flux in silicon source microchip cooling system different cross sections of the fins are used without adding the number of fins. The circular fin was created having radius 5.5mm, the circular fin model thermal system the maximum temperature found that 407.011°K and heat flux 0.085091. The triangular fin radius 8.57mm making an angle of side length 272.61, the triangular fin model thermal system the maximum temperature found that 396.252°K and heat flux 0.08516.

The square fin radius 5.15mm making an angle of side length 267.77, the square fin model thermal system the maximum temperature found that 409.677°K and heat flux 0.08411. The hexagon fin radius 5.1mm making an angle of side length 297.43, the hexagon fin model thermal system the maximum temperature found that 408.676°K and heat flux 0.08455.

The pentagon fin model radius 5.82mm making an angle of side length 306.16 thermal system the maximum temperature found that 404.64°K and heat flux 0.084882. The octagon fin radius 4.9 mm making an angle of side length 272.78, the octagon fin model thermal system the maximum temperature found that 407.311°K and heat flux 0.102726.

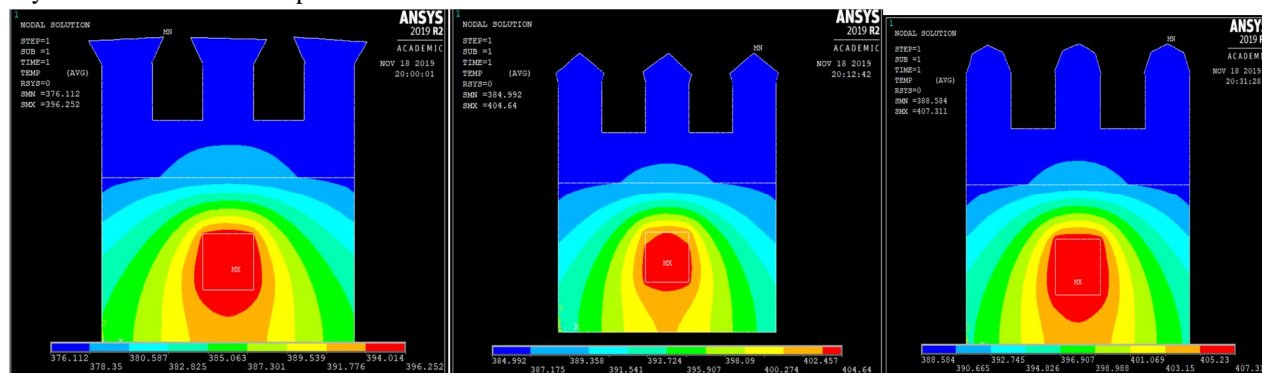


Fig 1.7 Max Temp of the Triangular, Pentagon & Octagonal I fin model silicon heat source thermal system



Fig 1.8 Heat Flux of the Triangular, Pentagon & Octagonal I fin model silicon heat source thermal system

D. Results and Discussions

Thermal Analysis on microchip cooling system with different heat sources like copper and silica, and different varying cross sections of fins are used in this thesis. The main objective of this work is to analyse the heat transfer rate performance of the thermal system i.e. to reduce the maximum temperature and increasing the heat flux of the thermal system with the use of different cross sections of fins without increasing the number of fins.

- 1) **Results of Various Cross Sections Of Fins With Copper Heat Source:** The maximum temperature of the thermal cooling system is 414.715°K for the rectangular fins and copper heat source in microprocessor cooling system. The circular fin model thermal system the maximum temperature found that 414.335°K and heat flux 0.100476. The triangular fin model thermal system the maximum temperature found that 395.594°K and heat flux 0.102632. The square fin model thermal system the maximum temperature found that 408.258°K and heat flux 0.102672. The Hexagon fin model thermal system the maximum temperature found that 407.578°K and heat flux 0.102646. The Pentagon fin model thermal system the maximum temperature found that 408.128°K and heat flux 0.103733. The octagon fin model thermal system the maximum temperature found that 409.473°K and heat flux 0.103926. The Fig 1.9 shows the heat flux value maximum for the Octagon type cross section fin and low for the rectangular type cross section fin used in the copper source heat generation element in the cooling system. The triangular type cross section fin gives the better maximum temperature compare to the other cross sections of fins used in the copper source heat generation element in the cooling system.
- 2) **Results of Various Cross Sections Of Fins With Silicon Heat Source:** Fig 1.10 shows the Max Temp and heat flux versus Various Fin Cross Section of Silicon Heat Source. The triangular cross section fin is good for compare to other cross sections of fins, the max temperature of triangular type fin is 396.252°K , the circular and octagon cross sections fins behaviour is similar in nature. The heat flux is maximum for the octagon type fin compare to others it was gives the good results, the heat flux value is 0.102726, the other fins behaviour very similar in nature.

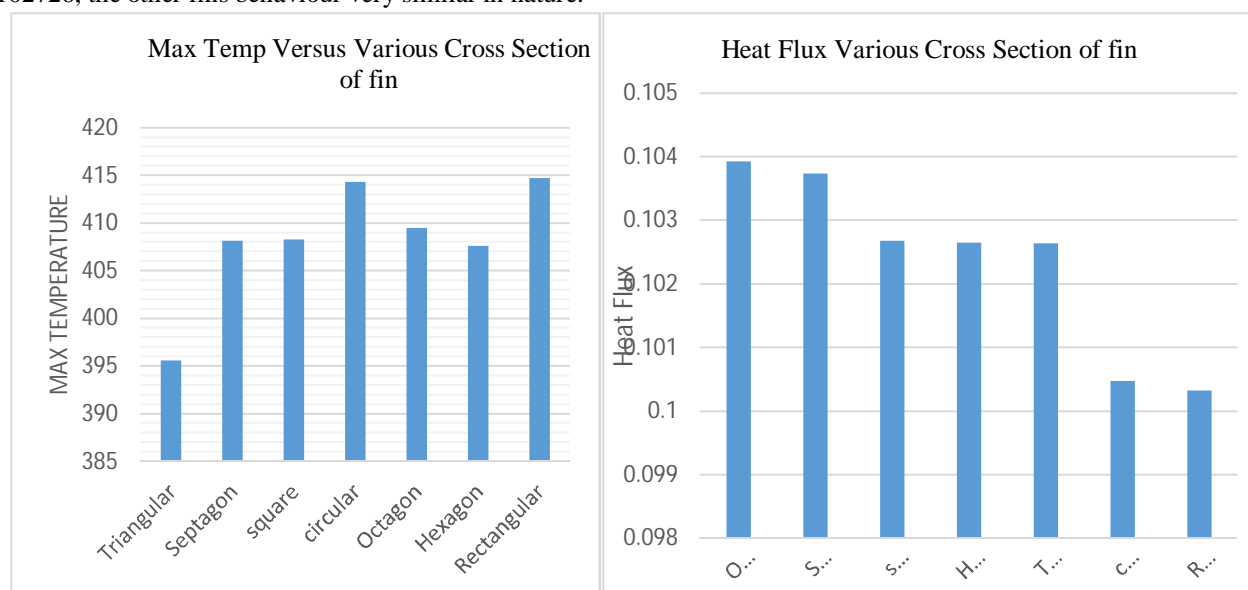


Fig 1.9 Max Temp and Heat Flux Versus Various Cross Section of fin with copper heat source

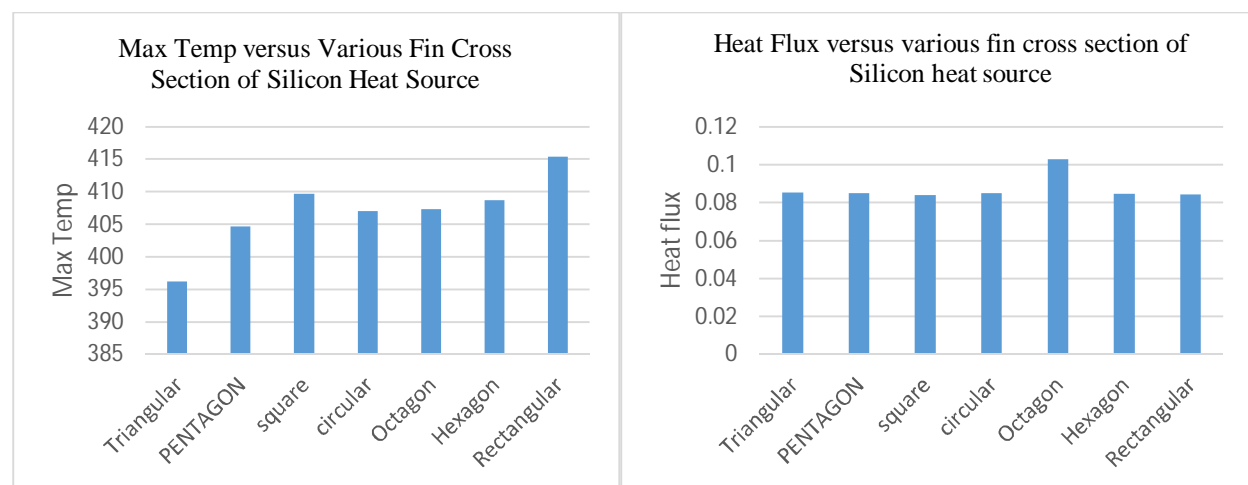


Fig 1.10 Max Temp and Heat Flux Versus Various Cross Section of fin with silicon heat source

- 3) *Copper and silicon heat source Comparison*: Table 1.2 represents the copper, silicon heat source computed data in ANSYS. The triangular fin gives the reduction of temperature compare to other cross section type fins whereas the copper heat source system is better than silicon heat source thermal system. Observed that the rectangular type pin gives the same max temp in copper and silicon heat source. The Heat flux values of all types fins cross section with copper and silicon heat source thermal system. Almost all are gives same heat flux values but in copper heat source the triangular fin gives the good results and in silicon heat source octagon pin gives the better results are observed.

Table 1.2 Copper and silicon heat source Comparison

| Fins Cross section | Max Temp – Copper heat Source | Max Temp – Silicon heat Source | Heat flux - Copper heat Source | Heat flux - silicon heat Source |
|--------------------|----------------------------------|-----------------------------------|-----------------------------------|------------------------------------|
| Triangular | 395.594 | 396.252 | 0.103926 | 0.08516 |
| PENTAGON | 408.128 | 404.64 | 0.103733 | 0.084882 |
| square | 408.258 | 409.677 | 0.102672 | 0.08411 |
| circular | 414.335 | 407.011 | 0.102646 | 0.085091 |
| Octagon | 409.473 | 407.311 | 0.102632 | 0.102726 |
| Hexagon | 407.578 | 408.676 | 0.100476 | 0.08455 |
| Rectangular | 414.715 | 415.391 | 0.100432 | 0.084224 |

III. CONCLUSIONS

- The maximum temperature and heat flux values are determined for different cross sections of fins used in copper and silicon heat source cooling systems.
- The analysis was carried with the help of powerful tool finite element analysis software ANSYS successfully.
- The copper and silicon heat source results are compared and give the best cross section of fin in the thermal system.

IV. FUTURE SCOPE

- Today the composite materials having good properties, the usage of those materials for fins are gives better results.
- Also use composite materials for heat source devices

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