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Performance & Thermal Analysis of Heat Sink with Fins of Different Configuration Using CFD

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Abstract- The objective of this paper is to present a best possible Heat Sink for efficient cooling of electronic devices. This paper deals with the comparative study of heat sink having fins of various profiles namely rectangle, Trapezoidal, rectangle Interrupted, Square, circular inline and staggered, as heat sinks are the commonly used devices for enhancing heat transfer in electronic components. In this work, a new concept for cooling the electronic components using the Aluminium alloy heat sink is proposed.
The selection of an optimal heat sink depends on a number of geometric parameters such as fin length, fin thickness, number of fins, base plate thickness, space between fins, fin shape or profile and material etc. Therefore for an optimal heat sink design, initial studies on the fluid flow and heat transfer characteristics of standard continuous heat sinks of different designs have been carried through CFD simulations. CFD analysis is conducted in order to establish effect of geometrical fin parameters for natural convection heat transfer on different fin arrays.

In our analysis, Computational Fluid Dynamics was developed on Ansys Workbench 14.0. The governing equations are solved by adopting a control volume-based finite-Volume method with a power-law scheme on an orthogonal non-uniform staggered grid. The coupling of the velocity and the pressure terms of momentum equations are solved by the Computational Fluid Dynamics.

Heat transfer taken in natural air and aluminum 6063 as a pin fin material. To study of thermal performance of different pin fin and get the value of thermal resistance, surface Nusselt number, pressure drop and heat transfer coefficient and predict the minimum value of temperature distribution along fin for the heat sink of the different fin profile at different velocities and constant heat input 15W and air inlet temperature is taken as 295 K. The purpose of this study is to examine the effects of the configurations of the different pin-fins design.
The results show that the Circular Pin of 7 mm diameter with 18 mm fin spacing and 36 no. of fins heat sink at 12 m/s wind velocity has better unnaturally performance because of max Nusselt number 2242 and minimum value of maximum temperature is 318 K and heat transfer coefficient 28.367 W/M^2K and thermal resistance 1.566 lower than the other type of fin heat sink and other cases.
It is observed from the results that optimum cooling is achieved by the heat sink design which contains Circular pin fins. These heat sink designs promises to keep electronic circuits cooler than standard heat sinks and reduction in cost due to reduction in material.

Index Terms- Heat Sink, Computational Fluid Dynamics, Natural convection, Thermal resistance, Surface Nusselt number, Pressure drop, Heat transfer coefficient.

1. Introduction:-

HEAT sinks are devices that enhance heat dissipation from a hot surface, usually the case of a heat generating component, to a cooler ambient, usually air. [10] For the following discussions, air is assumed to be the cooling fluid. **Heat sink** is a passive heat exchanger that cools a device by dissipating heat into the surrounding medium.
The heat sink is a very important component in cooling design. It increases the component surface area significantly while usually increasing the heat transfer coefficient as well. Thus, the total resistance from the component junction to the surroundings is reduced significantly, which in turn reduces the junction temperature within a device. [3]

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The primary purpose of a heat sink is to maintain the device temperature below the maximum allowable

1.1 Applications of Heat Sinks

Heat sinks are now supplied around the world and are used in a wide range of applications covering audio, electronic cooling, industrial control, telecommunications, defence and more.
Heat sinks are widely used in various industrial applications to cool electronic, power electronic, telecommunications, and automotive components. Those components might be either high-power semiconductor devices, e.g., diodes, thyristors, or integrated circuits,
e.g., audio amplifiers, microcontrollers and microprocessors. More precisely, the passive cooling heat sinks are widely used in CPU cooling, audio amplifiers and power LED cooling. More precisely, the passive cooling heat sinks are widely used in CPU cooling, audio amplifiers and power LED cooling.

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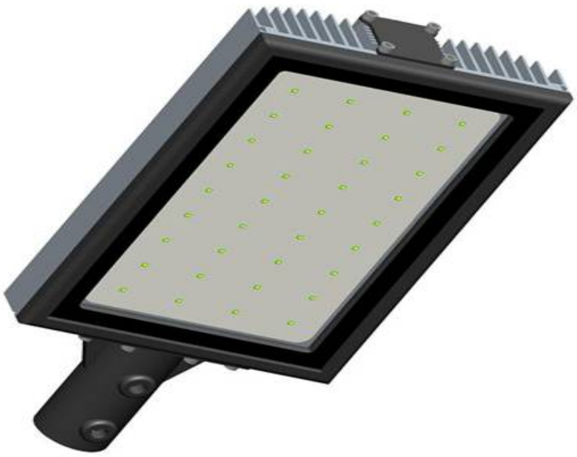

Fig. 1. LED Light using Heat Sink

2. Objective of Work

- To design & optimize the heat sink of the different fin profile for given heat input.
- To predict velocity, Pressure and temperature profiles for heat input applied on the base of the heat sink.
- To predict the optimum value for fin width, fin spacing, no. of fins & fin height, in fin arrays for maximum heat transfer rate.

3. Preparation of the CAD Model

The designs of heat Sink with rectangular fins, Trapezoidal fins, Interrupted Fins, Square pin fin, Circular Pin Fins with inline Staggered arrangements is done in Auto CAD 2012 in IGES format. A flat platform of 150 X 150 X 2.5 mm [9] is common in all designs. Trapezoidal shape fins is made with a draft angle of 1° on either side. Fin height for all models is 50mm. The important geometric variables considered are Fin width, Fin spacing, no. of fins & fin height, base thickness.

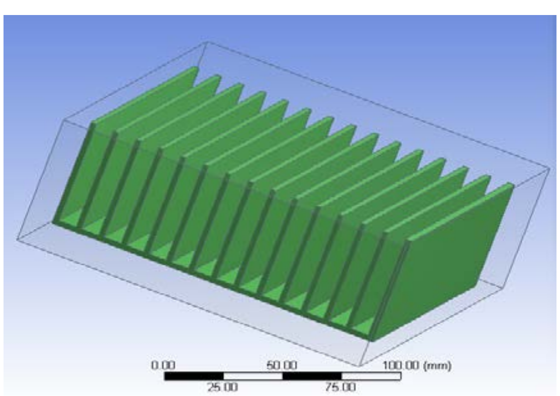

Fig. 2. Rectangular Plate Heat Sink

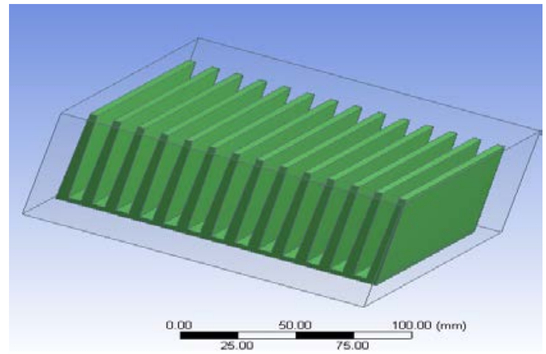

Fig. 3. Trapezoidal Heat Sink

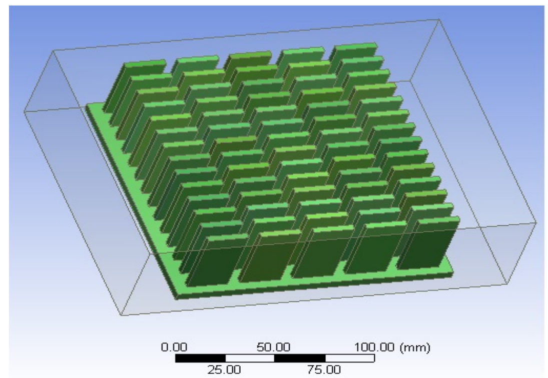

Fig. 4. Rectangular Interrupted Heat Sink

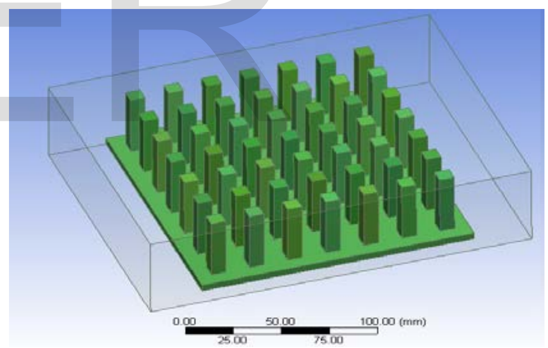

Fig. 5. Square Pin Fin Heat Sink

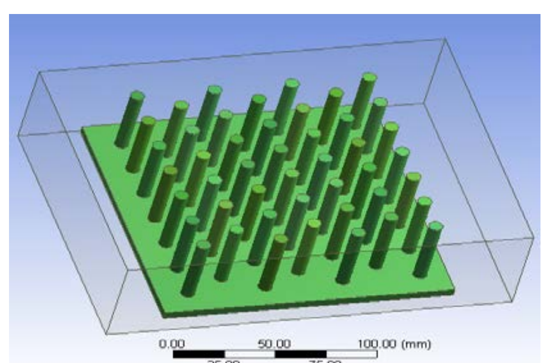

Fig. 6. Circular Staggered Heat Sink

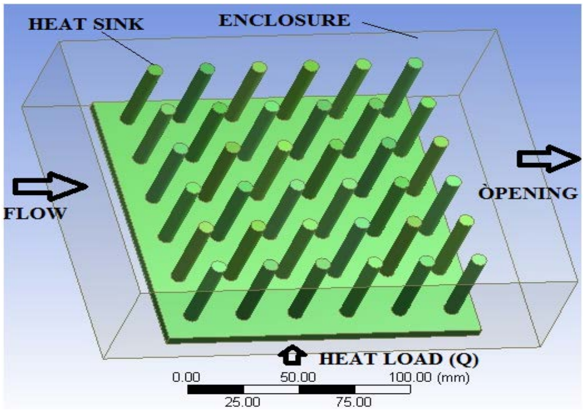

Fig. 7. Circular Inline Heat Sink Computational Model

4. Material Selected for Heat Sink

Aluminium alloy 6063 is a medium strength alloy commonly referred to as an architectural alloy. It is normally used in intricate extrusions. It has a good surface finish, high corrosion resistance, is readily suited to welding and can be easily anodized. Provide good extrudability.

5. CFD Modeling

Computational Fluid Dynamics (CFD) is a branch of fluid mechanics that uses numerical analysis and algorithms to solve and analyze problems that involve fluid flows.
Certain assumptions are made for the ease of solving the models and those assumptions are given below.
1) The fins are with adiabatic tip & the airflow is normal to the axis of fins.
2) The fluid, air is assumed to be incompressible throughout the process.
3) Air properties are taken at film temperature.
4) The flow is steady, laminar.
5) There are no heat sources within the fin itself.
6) The radiation heat transfer is negligible.
7) The temperature at the base of the fin is uniform.
8) The heat flow in the fin and its temperatures remain constant with time.

5.1 Meshing of the Domain [12]

The second part of pre-processing is the mesh generation. After the model is imported to Ansys workbench it is then launched in the meshing module for the mesh generation Coarse, medium, and fine mesh types are available. Mesh is the key component of a high quality solution. In our problem CFD Tetrahedral mesher is used.

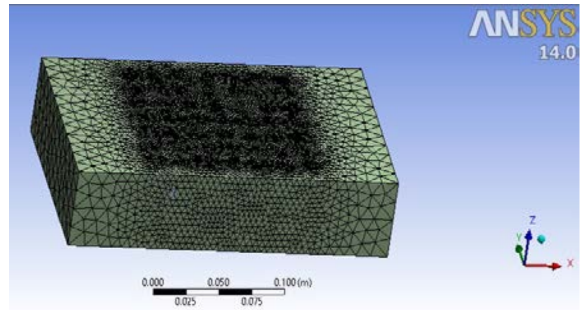

Fig. 8. Meshing of Whole domain

5.2 Boundary Conditions

- In this analysis the blocks are modeled and only heat sink is modeled as solid domain with heat source of 15W. In this case heat sink material considered as aluminum 6063. The analysis is done at atmospheric temperature of 295K.

Boundary conditions [10] are entered as follows:

- Base plate: - Heat Load of 15W & Aluminium alloy properties are assigned.
- Base top(wall): Base top is receiving heat from the chip, so heat flux is applied on the base top
- Fin bottom, Front face, Left, Right, Rear face (Walls): Heat transfer to surrounding atmosphere by convection. Inlet (velocity inlet): Air enters into the Heat sink with 5, 10 & 12m/s [11] in given direction according to the geometry.
- Outlet (Pressure Outlet): After passing through the heat sink air enters into atmosphere, so at outlet atmospheric pressure is assumed.
- After applying the above boundary conditions. Simulation is performed under steady state conditions till the convergence is reached.

5.3 Governing Equations [12]

Heat transfer are based upon the principles of conservation of mass, momentum, and energy. All the thermodynamics property i.e. (P-V-T) is assumed to constant. The continuity, momentum and energy equation are written below. Navier– stokes equations x-y and z direction momentum, and energy equations together with the equation of state.

Governing Equation are solved by CFD [11] - [12]

Law of Conservation of Mass

$$\frac{\partial \rho}{\partial t} + \nabla.(\rho \vec{V}) = 0$$

Momentum Equation

X- Momentum

$$\frac{\partial(\rho u)}{\partial t} + \nabla.(\rho u \vec{V}) = -\frac{\partial p}{\partial x} + \frac{\partial \tau_{xx}}{\partial x} + \frac{\partial \tau_{yx}}{\partial y} + \frac{\partial \tau_{zx}}{\partial z} + S_{Mx}$$

Y- Momentum

$$\frac{\partial(\rho v)}{\partial t}+\nabla.(\rho v\vec{V})=-\frac{\partial p}{\partial y}+\frac{\partial \tau_{xy}}{\partial x}+\frac{\partial \tau_{yy}}{\partial y}+\frac{\partial \tau_{zy}}{\partial z}+S_{My}$$

Z- Momentum

$$\frac{\partial(\rho w)}{\partial t}+\nabla.(\rho w\vec{V})=-\frac{\partial p}{\partial z}+\frac{\partial \tau_{xz}}{\partial x}+\frac{\partial \tau_{yz}}{\partial y}.$$

Energy Equation:

$$\frac{\partial(\rho h_0)}{\partial t}+\nabla.(\rho h_0\vec{V})=-p\nabla.\vec{V}+\nabla.(k\nabla T)+\Phi+S_h$$

Equation of State:

$$p=\rho RT$$

5.4 Material Properties

Properties	Air	Aluminium Alloy 6063
Density (kg/m³)	1.1965	2719
Sp. Heat (Cp) (J/kgK)	1006.43	871
Thermal Conductivity (W/mK)	0.026	202.4

Table. 1

6. Thermal Analysis Procedure

The thermal resistance of the heat sink, R_{th}, is calculated by-

$$R_{th}=\Delta T/Q \qquad (1)$$

The temperature difference is calculated by CFD simulations.

The heat transfer per unit surface through convection was first described by Newton and the relation is known as the Newton's Law of Cooling and calculated by

$$Q = h_c A \Delta T \qquad (2)$$

$$h_c = Q/ A \Delta T$$

ΔT Is taken as temperatures difference between highest temperature at the base of the fins and ambient temperatures and Q is heat dissipation power used in the

Where

Q = heat transferred per unit time (W)

A = heat transfer area of the surface (m^2)

h_c= convective heat transfer coefficient of the process (W/m^2K) or $W/(m^{2}$-°C)

ΔT = temperature difference between the surface and the bulk fluid (K or °C)

7. NOMENCLATURE

L =	Height of a fin (mm)
w =	Width of a fin (mm)
S =	Spacingof a fin (mm)
U =	Velocity of air (m/s)
C_p =	Specific Heat (J/kgK)
μ =	absolute viscosity of fluid (kg/ms)
ν =	kinematic viscosity of fluid (m^2/s)
ϱ=	fluid density (kg/m^3)
P =	Pressure (N/mm^2)
Nu=	Nusselt Number
ΔP =	pressure drop across the heat sink (Pa)
h =	Heat transfer coefficient (W/m^2K)
K=	Thermal conductivity (W/mK)
Q =	Heat Load (W)
T =	Temperature, (K)
R =	Thermal Resistance, (K/W)
V =	Volume, (m^3)
A=	Surface Area (m^2)

8. Result & Discussions

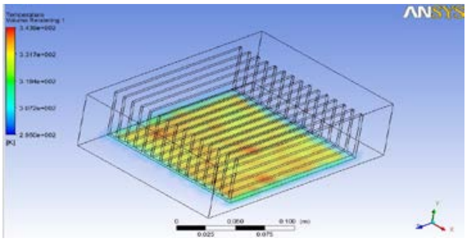

Fig. 9. Contour of minimum temperature distribution for case no. 9 in Rectangular heat sink at 12 m/s velocity

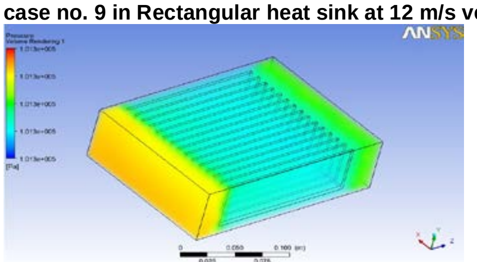

Fig. 10. Contour of minimum pressure distribution for case no. 7 in Rectangular heat sink at 5 m/s velocity

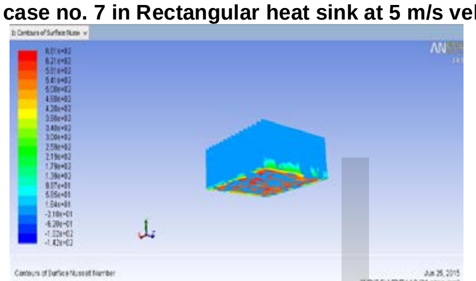

Fig. 11. Contour of Maximum Surface Nusselt Number for case no. 9 in Rectangular Heat Sink at 12 m/s velocity

Case No.	Fin Width (mm)	No. of Fins	Velocity (m/s)	Base Temperature (K)	R_{th} (K/W)	Nu	Pressure Drop Pa	h (W/m^{2}K)
1	3	15	5	352.2	3.8	597	31	11.6
2	3	15	10	349	3.59	610	120	12.3
3	3	15	12	348	3.53	700	179	12.6
4	3	16	5	347.4	3.49	670	35	12.7
5	3	16	10	343.1	3.21	682	134	13.8
6	3	16	12	342.1	3.14	684	194	14.1
7	2.5	15	5	347.7	3.52	629	27	12.6
8	2.5	15	10	345	3.32	654	111	13.3
9	2.5	15	12	343.9	3.26	661	148	13.6
10	2.5	14	5	345.6	3.4	616	28	13.2
11	2.5	14	10	342.6	3.172	627	106	14
12	2.5	14	12	342.2	3.145	629	151	14.1
13	3.5	15	5	344.7	3.31	634	38	13.4
14	3.5	15	10	341.7	3.125	639	149	14.2
15	3.5	15	12	341	3.07	640	211	14.5
16	4	13	5	346	3.4	605	37	13.1
17	4	13	10	343.2	3.212	612	141	13.8
18	4	13	12	342.5	3.167	615	203	14

Table 2. Variation in Computation Result of Rectangular fin profiles at different fin width at velocity 5, 10 & 12 m/s

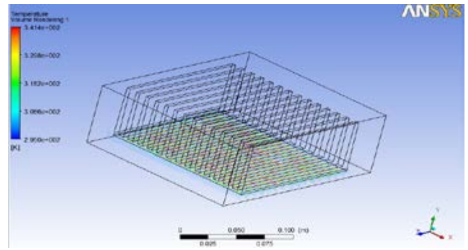

Fig. 12. Contour of minimum temperature distribution for case no. 21 in Trapezoidal heat sink at 12 m/s velocity

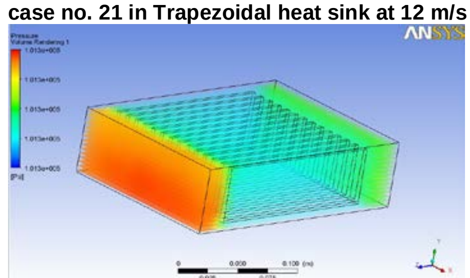

Fig. 13. Contour of minimum pressure distribution for case no. 19 in Trapezoidal heat sink at 5 m/s velocity

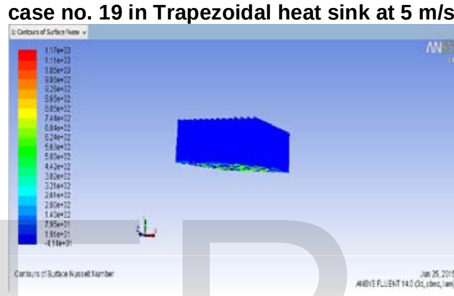

Fig. 14. Contour of Maximum Surface Nusselt Number for case no. 21 in Trapezoidal Heat Sink at 12 m/s velocity

Case No.	Fin Width (mm)	No. of Fins	Velocity (m/s)	Base Temperature (K)	R_{th} (K/W)	Nu	Pressure Drop (Pa)	h (W/m^{2}K)
1	2.5	15	5	344.2	3.29	637	32	13.5
2	2.5	15	10	342.4	3.17	647	121	14
3	2.5	15	12	342.1	3.15	648	175	14.1
4	2.5	16	5	341	3.07	609	35	14.5
5	2.5	16	10	339.2	2.95	624	135	15.1
6	2.5	16	12	339	2.93	628	192	15.2
7	3	15	5	341.7	3.11	649	42	14.3
8	3	15	10	339.7	2.98	655	160	14.9
9	d3	15	12	339.5	2.97	656	230	15
10	3	16	5	342.1	3.15	604	42	14.1
11	3	16	10	341.6	3.11	612	161	14.3
12	3	16	12	341.6	3.11	614	230	14.3
13	3	14	5	343.2	3.22	636	34	13.8
14	3	14	10	341.1	3.08	643	134	14.4
15	3	14	12	340.9	3.06	644	191	14.5
16	3.5	15	5	341.6	3.11	659	47	14.3
17	3.5	15	10	340.8	3.06	671	180	14.5
18	3.5	15	12	340.7	3.05	673	257	14.6
19	3.5	14	5	342.8	3.19	1099	44	13.9
20	3.5	14	10	341.6	3.11	1157	172	14.3
21	3.5	14	12	341.4	3.1	1168	245	14.3

Table 3. Variation in Computation Result of Trapezoidal fin profile at different fin width at velocity 5, 10 & 12 m/s

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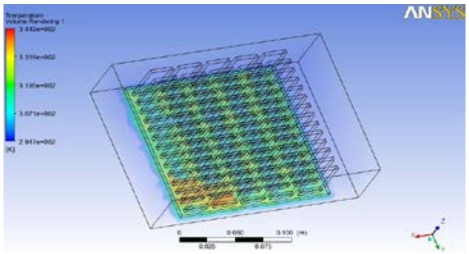

Fig. 15. Contour of minimum temperature distribution for case no. 21 in Interrupted rectangular heat sink with 12 m/s velocity

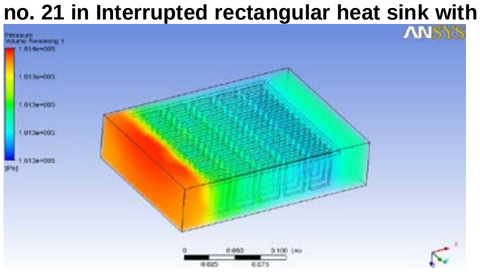

Fig. 16. Contour of minimum pressure distribution for case no. 19 in Interrupted Rectangular heat sink at 5 m/s velocity

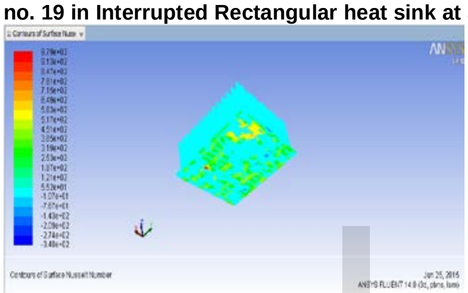

Fig. 17. Contour of Maximum Surface Nusselt Number for case no. 21 Interrupted in Rectangular Heat Sink at 12 m/s velocity

Case No.	Fin Width (mm)	No. of Fins	Velocity (m/s)	Base Temperature (K)	R_{th} (K/W)	Nu	Pressure Drop (Pa)	h (W/m^2 K)
1	3	42	5	348.4	3.57	555	46	12.4
2	3	42	10	346.5	3.44	568	176	12.9
3	3	42	12	346	3.41	571	256	13
4	3	39	5	354	3.96	622	34	11.2
5	3	39	10	352.7	3.88	638	138	11.4
6	3	39	12	350.4	3.74	642	197	11.9
7	3	36	5	360.9	4.41	622	35	10.1
8	3	36	10	360.4	4.38	640	138	10.1
9	3	36	12	360.4	4.37	644	198	10.2
10	2.5	39	5	356.5	4.12	612	31	10.8
11	2.5	39	10	351.5	3.82	626	122	11.6
12	2.5	39	12	350.4	3.76	629	177	11.8
13	2.5	52	5	355.6	4.07	928	28	10.9
14	2.5	52	10	355.3	4.05	1005	111	11
15	2.5	52	12	354.8	4.02	1020	159	11
16	2.5	65	5	351	4	1029	35	11.1
17	2.5	65	10	351.2	3.75	1076	137	11.9
18	2.5	65	12	350.1	3.68	1093	196	12.1
19	3.5	70	5	348.7	3.6	939	51	12.3
20	3.5	70	10	345	3.35	971	204	13.2
21	3.5	70	12	344.2	3.3	979	293	13.5

Table 4. Variation in Computation Result of Interrupted Rectangular fin profiles at different fin width at velocity 5, 10 & 12 m/s

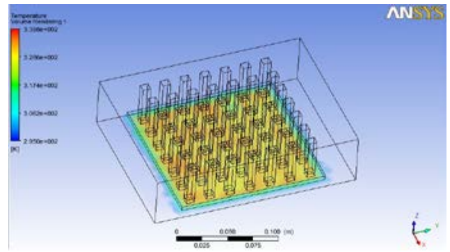

Fig. 18. Contour of minimum temperature distribution for case no.15 in Square pin fin heat sink at 12 m/s velocity

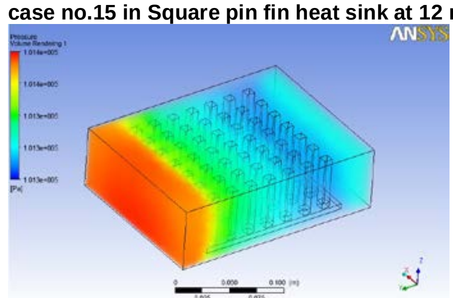

Fig. 19. Contour of minimum pressure distribution for case no. 13 in Square pin fin heat sink at 5 m/s velocity

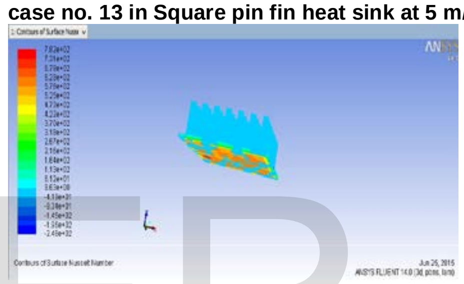

Fig. 20. Contour of Maximum Surface Nusselt Number for case no. 15 Square pin fin Heat Sink at 12 m/s velocity

Case No.	Fin side (mm)	No. of Fins	Velocity (m/s)	Base Temperature (K)	R_{th} (K/W)	Nu	Pressure Drop (Pa)	h (W/m^2 K)
1	9	49	5	341	3.06	605	98	14.5
2	9	49	10	339.6	2.97	622	391	14.9
3	9	49	12	339.4	2.95	626	563	15
4	9	42	5	343.7	3.25	615	91	13.7
5	9	42	10	342.2	3.14	629	364	14.1
6	9	42	12	341.9	3.13	632	524	14.2
7	8	64	5	342.6	3.18	609	113	14
8	8	64	10	341.3	3.08	622	449	14.4
9	8	64	12	341	3.07	625	647	14.5
10	9	64	5	343.6	3.24	605	80	13.7
11	9	64	10	341.6	3.11	637	316	14.3
12	9	64	12	341.4	3.09	644	455	14.4
13	8	49	5	342.2	3.15	759	65	14.1
14	8	49	10	339.9	3	779	260	14.8
15	8	49	12	339.8	2.99	782	375	14.9
16	8	36	5	343.6	3.24	736	68	13.7
17	8	36	10	342.1	3.14	761	272	14.1
18	8	36	12	341.9	3.13	765	391	14.2
19	10	49	5	342	3.14	612	93	14.2
20	10	49	10	339.5	2.97	621	371	15
21	10	49	12	339.2	2.94	624	534	15.1

Table 5. Variation in Computation Result of Square fin profiles at different fin width at velocity 5, 10 & 12 m/s

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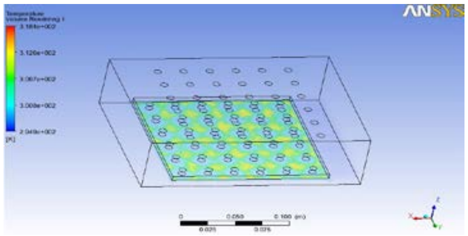


Fig. 21. Contour of minimum temperature distribution for case no.18 in Circular heat sink at 12 m/s velocity

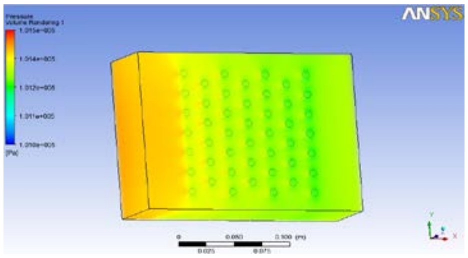


Fig. 22. Contour of minimum Pressure distribution for case no. 16 in Circular pin fin heat sink at 5 m/s velocity

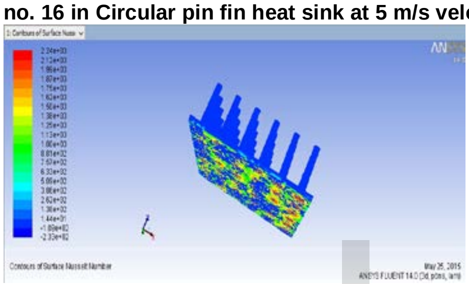


Fig. 23. Contour of Maximum Surface Nusselt Number for case no. 18 in Circular Heat Sink at 12 m/s velocity

Case No.	Fin Dia. (mm)	No. of Fins	Velocity (m/s)	Base Temperature (K)	R_{th} (K/W)	Nu	Pressure Drop (Pa)	h (W/m^{2}K)
1	10	64	5	322.1	1.82	1806	162	24.4
2	10	64	10	321.3	1.76	1863	648	25.3
3	10	64	12	321.2	1.75	1873	944	25.4
4	10	36	5	325	2.02	1431	112	22.1
5	10	36	10	322.5	1.84	1481	445	24.1
6	10	36	12	322	1.81	1494	642	24.6
7	8	36	5	323.5	1.91	1879	88	23.3
8	8	36	10	319	1.61	2039	362	27.6
9	8	36	12	318.5	1.57	2083	525	28.3
10	8	64	5	323	1.88	1527	131	23.6
11	8	64	10	320.3	1.7	1595	528	26.2
12	8	64	12	319.9	1.66	1608	757	26.7
13	8	49	5	322.7	1.86	1957	113	23.9
14	8	49	10	320.1	1.68	2101	445	26.5
15	8	49	12	320	1.67	2134	637	26.6
16	7	36	5	323.4	1.9	2005	78	23.4
17	7	36	10	319.2	1.62	2204	314	27.5
18	7	36	12	318.4	1.57	2242	454	28.4
19	10	49	5	321.4	1.79	1829	142	24.9
20	10	49	10	317.9	1.54	1928	565	28.9
21	10	49	12	317.4	1.5	1945	810	29.6

Table 6. Variation in Computation Result of Circular pin fin profiles at different fin diameter at velocity 5, 10 & 12 m/s

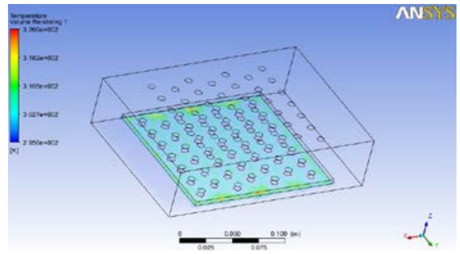


Fig. 24. Contour of minimum temperature distribution for case no. 21 in Circular staggered heat sink at 12 m/s velocity

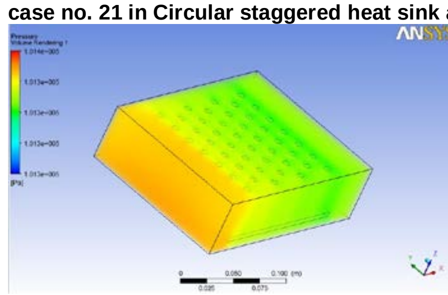


Fig. 25. Contour of minimum Pressure distribution for case no. 19 in Circular Staggered pin fin heat sink at 5 m/s velocity

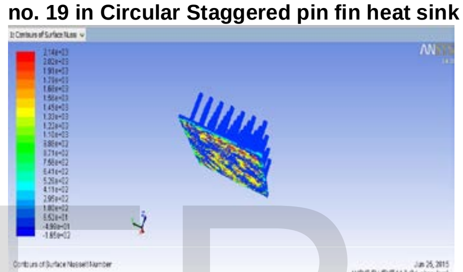


Fig. 26. Contour of Maximum Surface Nusselt Number for case no. 21 in Circular Staggered Heat Sink at 12 m/s velocity

Case No.	Fin Dia. (mm)	No. of Fins	Velocity (m/s)	Base Temperature (K)	R_{th} (K/W)	Nu	Pressure Drop (Pa)	h (W/m^2 K)
1	10	46	5	328.7	2.25	1741	142	19.8
2	10	46	10	327.7	2.2	1866	535	20.2
3	10	46	12	325.3	2	1961	638	22
4	10	60	5	325.7	2.06	1790	144	21.6
5	10	60	10	323.5	1.91	1950	568	23.3
6	10	60	12	323.2	1.88	1988	814	23.6
7	10	33	5	333	2.54	1728	100	17.5
8	10	33	10	330.3	2.36	1867	400	18.9
9	10	33	12	329.8	2.32	1891	575	19.1
10	8	33	5	338.2	2.89	1457	85	15.4
11	8	33	10	336.3	2.76	1569	338	16.1
12	8	33	12	336	2.74	1594	486	16.2
13	8	60	5	338	2.87	1541	109	15.5
14	8	60	10	336.3	2.76	1627	432	16.1
15	8	60	12	336	2.73	1644	600	16.3
16	8	46	5	331.2	2.42	1848	98	18.4
17	8	46	10	329.4	2.29	2007	393	19.4
18	8	46	12	329	2.27	2034	562	19.6
19	7	46	5	329.5	2.3	1964	91	19.3
20	7	46	10	326.5	2.1	2009	368	21.1
21	7	46	12	326	2.06	2137	531	21.5

Table 7. Variation in Computation Result of Circular Staggered pin fin profiles at different fin diameter at velocity 5, 10 & 12 m/s

It is clear from the table 3 that the trapezoidal fin has better performance at the fin width of 3 mm and at this the maximum Nusselt Number is 1168 and minimum thermal resistance is 3.1

It is clear from the table 4 that the Interrupted fin has more temperature than the continuous rectangular fin.

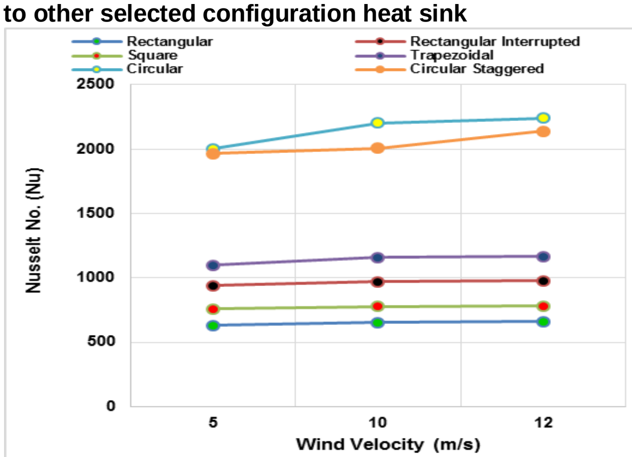
Represent in the table 5 that the case no. 15 has more value of Nusselt number i. e. 782 and minimum thermal resistance of 2.99 than the other configurations.

As it is clear from table 6 that the Circular pin fin heat sink has better performance than the other heat sink profiles. Represent in the table that case no. 18 has maximum Nusselt number of 2242 and minimum thermal resistance of 1.57 which is very low as compare to other profiles and geometries.

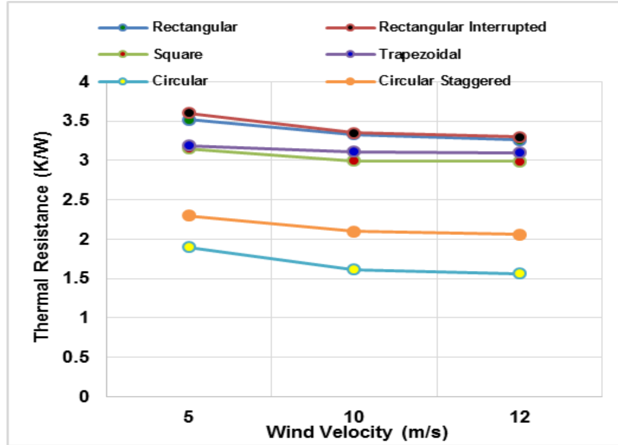
Represent the total volume of selected fin profile from different shapes & Configurations

Case No.	Fin profile	Fin width/Fin Diameter (mm)	Fin spacing (mm)	No. of Fins	Volume (mm^3)
7	Rectangular	2.5	8	15	281250
19	Trapezoidal	3.5	7.634	14	275373
13	Square	8	13	49	156800
19	Interrupted Rectangular	7	22	70	269500
16	Circular Inline	7	18	36	69272.11
19	Circular Staggered	7	43	46	88514.37

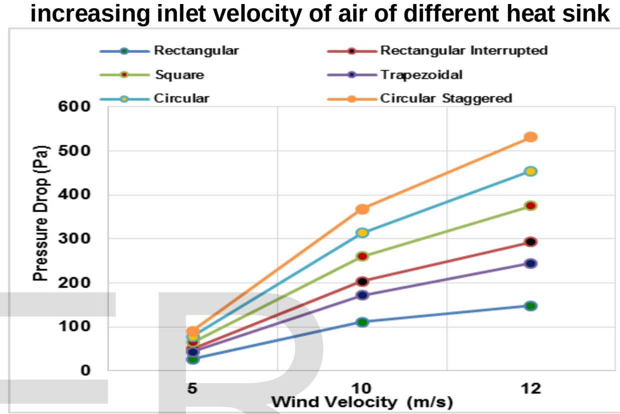
Table 8. It represent from the table that the total volume of the selected circular fin heat sink is minimum as compare to other selected configuration heat sink



Graph. 1. Represent the variation in Nusselt number with increase in velocity of inlet air.



Graph. 2. Represent decrease in thermal resistance with increasing inlet velocity of air of different heat sink



Graph. 3. Represent the Pressure drop of different profile heat sink with inlet velocity of the air.

Conclusion

The overall performance of the six different heat sinks with different shaped pin-fin structures was studied in this paper for different velocities varying from 5, 10 & 12 m/s. The paper presents simulation and thermal analysis of different shape fins heat sink for an electronic system cooled by natural convection.

To find out best heat sink designs, the fin profiles were investigated for enhancing the heat dissipation rate and some thermal improvements as well as space reduction and material savings were attained. Improvements on heat sink designs are possible by the use of CFD. Eventually it is possible to finish up with a new heat sink design which has better thermal performance and uses less material.

The selected material for heat sink is aluminum 6063 because of its high thermal conductivity and it's lightweight.

As we have discussed in results above the thermal resistivity, Nusselt number, heat transfer coefficient, Pressure drop, we are here to conclude that maximum pressure drop is in of 944 Pascals and minimum pressure drop 27 Pascal that is and also we have seen with Maximum thermal resistance is 4.41 in and minimum thermal resistance is 1.5

From computational result it is clear that circular pin fin with 7 mm fin dia. and 18 mm fin spacing has better performance than the other one and the maximum temperature obtained is 318 K at 12 m/s lower than other cases.

It is conclude from graph 1 that the Nusselt number is increasing by increasing velocity and Nusselt number is maximum for circular pin fin design.

Also conclude from graph 2 that the thermal resistance is decreasing by increasing velocity and thermal resistance is minimum for circular pin fin design.

Also represent from graph 3 that the pressure drop is increasing by increasing velocity and pressure drop is more for circular staggered heat sink and minimum in case of rectangular heat sink design.

It represent that the total volume of selected fin profile from different configurations is minimum i. e. 69272.11 mm^3 in case of circular pin fin design.

Acknowledgement

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References

[1] Kumbhar D.G.,Dr. N K Sane, Chavan S.T., "Finite Element Analysis and Experimental Study of Convective Heat Transfer Augmentation from Horizontal Rectangular Fin by Triangular Perforations," International Conference on Advances in Mechanical Engineering, SV National Institute of Technology, Surat - 395 007, Gujarat, India, August 3-5, 2009.

[2] Jafar Mahmoudi and Jussi Vaarno, "Copper Heat Sink Design A Practical Application of Mathematical Modelling," Outokumpu Fabrication Technologies, R&D, Vasteras, Sweden.

[3] Monoj Baruah, Anupam Dewan and P. Mahanta, "Performance of Elliptical Pin Fin Heat Exchanger with Three Elliptical Perforations," Department of Mechanical Engineering, Indian Institute of Technology Guwahati, Guwahati – 781039, INDIA, CFD Letters Vol. 3 (2) – June 2011.

[4] Suabsakul Gururatana and Xianchang Lit, "Study of a Small Scale Heat Sink with Interrupted and Staggered Elliptic Fins," Canadian Journal on Mechanical Sciences & Engineering Vol. 3 No. 2, February 2012.

[5] Yu Xiaoling, Wang Qianlong, Feng Quanke, "Experimental research on the heat transfer and Flow Performance of a Composite Heat Sink," School of Energy and Power Engineering, Xian Jiaotong University, China.

[6] Lakshmi Anusha , S.Murali , P.Srinivas Rao , P. Padmavathi, " CFD Analysis of Splayed Pin Fin Heat Sink using Advanced Composite materials," International Journal of Current Engineering and Technology E-ISSN 2277 – 4106, P-ISSN 2347 – 5161.

[7] Fariborz Forghan, Donald Goldthwaite, Matthew Ulinski and Hameed Metghalchi, " Experimental and Theoretical Investigation of Thermal Performance of Heat Sinks,'' Mechanical, Industrial and Manufacturing Engineering Department Northeastern University, Boston, MA 02115, USA.

[8] R.Mohan and Dr.P.Govindarajan, "Thermal Analysis of CPU with variable Heat Sink Base Plate Thickness using CFD,'' International Journal of the Computer, the Internet and Management, Vol. 18 No.1 (January-April, 2010), pp 27-36.

[9] Vinay Pal, "Modelling and thermal analysis of heat sink with scales on fins cooled by natural convection,'' International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308.

[10] Jeevaraj S, "Numerical Investigation on Heat Sink by Computational Fluid Dynamics (CFD),'' International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308.

[11] Arularasan R. and Velraj R. ," CFD Analysis in a Heat Sink for cooling of electronic devices,'' International Journal of The Computer, the Internet and Management Vol. 16.No.3 (September-December, 2008) pp 1-11.

[12] Ambeprasad.S.Kushwaha, Prof. Ravindra Kirar," Comparative Study of Rectangular, Trapezoidal and Parabolic Shaped Finned Heat sink'', IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684 Volume 5, Issue 6 (Mar. - Apr. 2013), PP 01-07.

[13] Frank Kreith, Raj M. Manglik, Mark S. Bohn, A text book of, "Principles of Heat Transfer", Cengage Publications, pp: 279.