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Heat Transfer Enhancement Using Pin Fin Apparatus

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ABSTRACT

The main aim of this is to improve the heat transfer characteristics and to investigate the performance of fin efficiency by using fins of different materials in pin fin apparatus. The investigation will also be done by varying materials and fin shape. 3D model of the pin fin apparatus will be done in Catia. CFD analysis will be done in Ansys to determine heat transfer characteristics Heat Transfer Coefficient, Heat Transfer rate by varying materials and fin shape.

INTRODUCTION

In the study of heat transfer, fins are surfaces that extend from an object to increase the rate of heat transfer to or from the environment by increasing convection. The amount of conduction, convection, or radiation of an object determines the amount of heat it transfers. Increasing the temperature gradient between the object and the environment, increasing the convection heat transfer coefficient, or increasing the surface area of the object increases the heat transfer. Sometimes it is not feasible or economical to change the first two options. Thus, adding a fin to an object increases the surface area and can sometimes be an economical solution to heat transfer problems

Advantages

Engineers tasked with designing modern electronics face a number of issues. Expectations are for more functionality, more power, and more components in ever-smaller packages but also with quick turnaround for production and staying within tight budget parameters.

Thermal management is a critical aspect of the design process and, as demand for component-density and miniaturization continues to increase, engineers need cooling solutions that fit into small spaces, will not cause project cost overruns, and will provide the best heat transfer possible for today's modern, processors.

Heat sinks and convection cooling remain the go-to solutions for most systems and high-efficiency Pin Fin heat sinks are designed to meet the requirements of modern electronics cooling with little extra cost added. In particular, the pin fin heat sink geometry is designed to provide increased surface area for heat transfer, low thermal resistance from base to fins at high airflow (200-plus LFM), and work in environments where the direction of airflow is ambiguous.

GEOMETRICAL MODELLING OF FINS

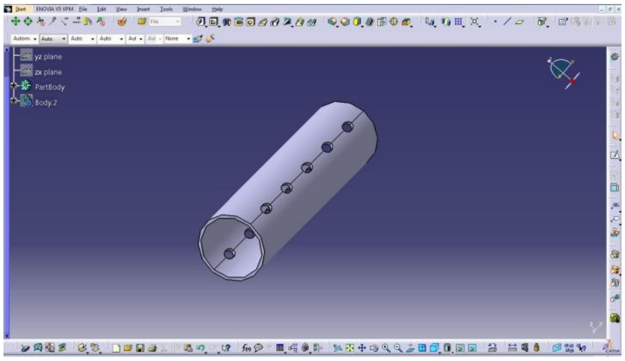

Fig Fin with elliptical hole

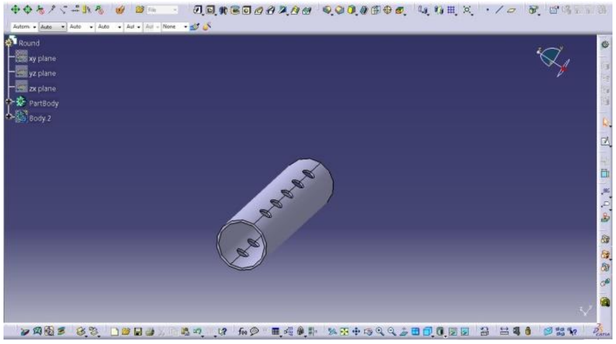

Fig Fin with circular hole

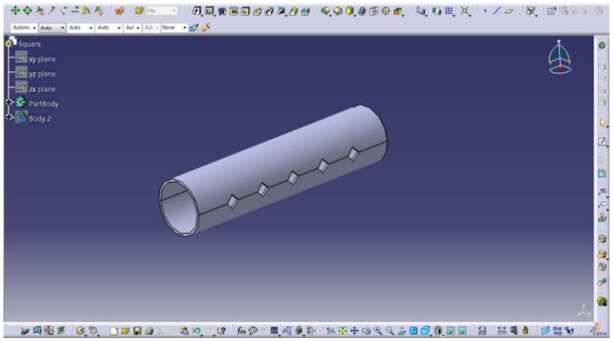

Fig Fin with square hole (45˚)

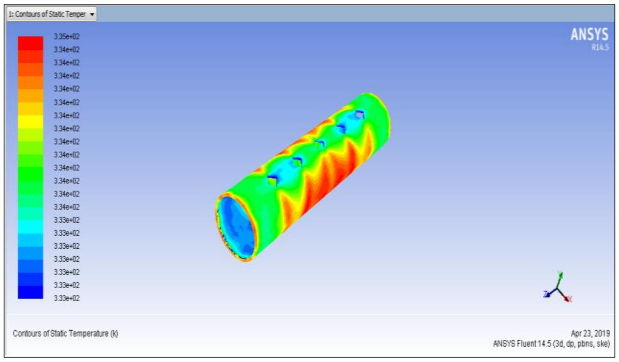

Fig Temperature distribution of 45˚ square holed fin

Total Heat Transfer Rate	(w)
inlet	24.415867
outlet	-24.488445
Net	-0.072578249

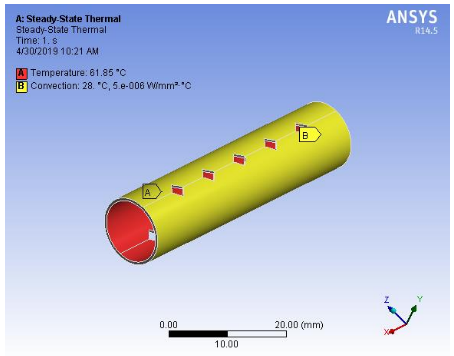

Fig Input of square hole

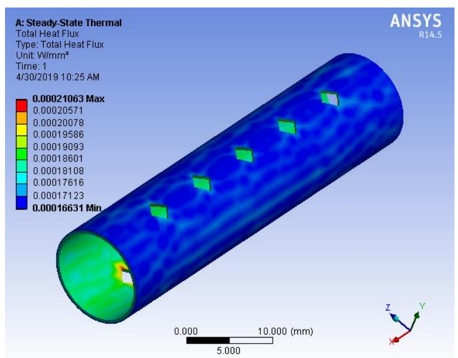

Fig Heat flux of sqaure hole fin.

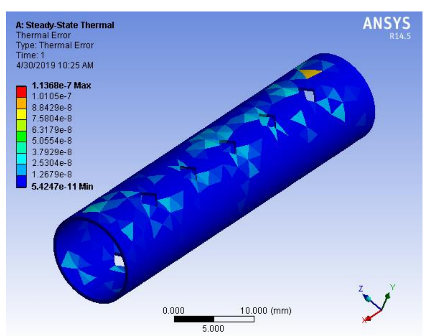

Fig Result of thermal error

EXPERIMENTAL SETUP

An Aluminium fin (7075) of circular cross section in fitted across a long rectangular duct. The other end of the duct is connected to the suction side of a blower and the air flows past the fin perpendicular to the axis. One end of the fin projects outside the duct and is heated by a heater.

Fig Schematic Diagram of the Experimental System

Temperature at seven points along the length of the fin .The air flow rate is measured by an orifice meter fitted on the delivery side of the blower. The apparatus consists of a pin-fin placed inside an open duct the other end of the duct to connected to suction side of a blower the delivery side of a blower is taken on through on orifice meter to atmosphere, the air flow rate can be varied by the blower speed regular and can be measured on the u tube manometer connected to one end of the pin fin. The panel of the apparatus consists of voltmeter, ammeter and digital temperature indicator, heat regulator in it.

BLOWER

The blower used to operates on 1 HP motor and for forced convection. The apparatus consists of a pin-fin placed inside an open duct the other end of the duct to connected to suction side of a blower the delivery side of a blower is taken on through on orifice meter to atmosphere, the air flow rate can be varied by the blower speed regular and can be measured on the u tube manometer connected to one end of the pin fin

Fig Blower

Heater: The heater used is a nichrome wire heater of 50 mm diameter and 50 mm length. One end of the fin projects outside the duct and is heated by a heater of 50 volts and 0.42 amps current and taking Temperature at points along the length of the fin.

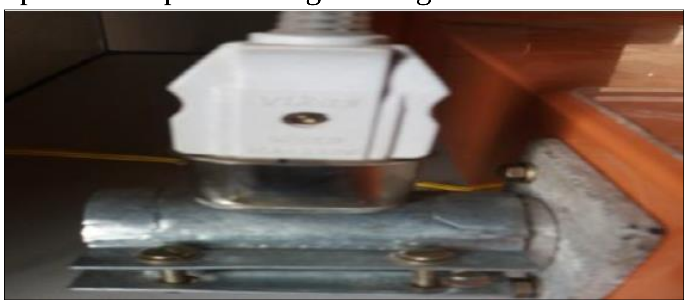

Fig Heater

Temperature Indicator: Here panel gives temperatures at different points of pin fin from T_1 to T_4 with help of thermocouples.

Fig Circular holed fins

Hole diameter 3.13mm
Length of fin 50mm

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Fig Square holed fins

Hole diameter 2.13mm

Length of fin 50mm

Fig Elliptical holed fins

Hole diameter 3.13mm
Length of fin 50mm

EXPERIMENTAL RESULTS

Table Readings for square fin

Material	V	A	T_1 °c	T_2°c	T_3°c	T_4°c	T_∞	T_a	Q (W)
Aluminum	50	0.50	49	47	45	39	27	45	0.661
Brass	50	0.50	51	46	43	41	27	45.25	0.80
Cooper	50	0.50	53	48	44	41	27	46.25	0.610

Table Readings for circular fin results

Material	VOLTS	Amps	T_1	T_2	T_3	T_4	T_∞	T_a	Q

			°c	°c	°c	°c			(w)
Aluminum	50	0.50	49	46	42	38	27	43.75	0.736
Brass	50	0.50	51	49	45	42	27	46.75	0.684
Cooper	50	0.50	52	48	45	41	27	46.5	0.871

Table Readings for elliptical fin results

Material	V	A	T_1 °c	T_2 °c	T_3 °c	T_4 °c	T_∞ °c	T_a °c	Q (w)
Aluminum	50	0.50	47	44	40	37	27	42	0.792
Brass	50	0.50	49	44	41	38	27	43	0.741
Cooper	50	0.50	51	47	42	37	27	44.25	1.27

Table Results for square fin

Material	Nusselt Number	Heat transfer coefficient(w/m²-k)	Efficiency (η)
Aluminum	10.11	23.25	92.1%
Brass	9.96	22.68	84.8%
Copper	10.96	23.95	95.8%

Table Results for circular fin

Material	Nusselt Number	Heat transfer Coefficient (w/m²-k)	Efficiency (η)
Aluminum	10.25	23.33	93.4%
Brass	10.02	22.29	85.21%
Copper	11.07	24.51	96.5%

Table Results for elliptical fin

Material	Nusselt no	Heat transfer rate(w/m²-k)	Efficiency (η)
Aluminum	10.73	24.89	95.1%
Brass	10.12	23.02	87.6%
Copper	11.33	25.77	97.7%

CONCLUSIONS

In this we have considered three different profiled fins like square, circle and elliptical holed fin using three materials like, al – 7075, brass and cooper. Here we have done CFD analysis and the to find out the best output and even the experimental is done on the apparatus to find the best result.

- As here in the comparasion of the graphical results we can clearly observe that the elliptical profile has obtained the best results in all terms .
- But here if we compare with the materials the cooper has obtained the best than the remaining materials like aluminuma nd brass. So as if we veify according to the cost and

life we can even suggest the aluminum material as it also obtained the better output results.

- From the experimental analysis in this project the enhancement of heat transfer of fin for different materials is analyzed and it can be improved.
- Fin efficiencies of materials are 95.1% 87.6% 97.7% are achieved. And among these materials from the analysis that copper has high thermal conductivity than brass and aluminum.

REFERNCES

1. WilkinsJ.E.,Jr.,"MinimizingtheMassofThinRadiatingFins",J.AerospaceScience,Vol.27, 1960, 145-146.
2. S.SunilKumarandS.P.Venkateshan,"OptimizedTubularRadiatorwithAnnularFinsonaNon-IsothermalBase,Int. J.
3. Heat and Fluid Flow", Vol.15, 399-409, 1994.
4. R.L. Webb, Principles of EnhancedHeat Transfer, John Wiley&Sons,New York, 1994.
5. F.Incropera,D. DeWitt,Introduction to Heat Transfer.
6. Antonio Acosta , Antonio campo "Approximate analytic temperature distribution and efficiency for annularfins ofuniform thickness",May2008
7. Prasanta ku. Das "Heat conduction through heat exchanger tubes of non-circular crosssection", Journal of Heattransfer vol .130,January2008.
8. B.Kundu,P.K.Das,Performanceanalysisandoptimizationofellipticfinscircumscribinga circulartube,International journal of Heat andMass Transfer 50 (2007)173-180.
9. Kundu.B,Das.P.KPerformanceanalysisandoptimizationofstraighttaperfinswithvariableheat transfer coefficient",May2002.
10. Chine-Nan lin, Jiin-yuh jang "Atwo dimensional fin efficiencyanalysis of combined heat&masstransferinellipticfins".internationaljournalofheatandmasstransfer45(2002.)3839-3847.