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Design and Thermal Analysis of Invertor Enclosure with Fins

T.KeerthiVasan[1], C.Ramesh[2], K.A. HariPrasanth[3],P.Dineshkumar[4], R.Hariprasanth[5]

[1]Department of Mechanical Engineering, M.Kumarasamy College of Engineering, Karur, Tamil Nadu, India.
E-mail: tkeerthivasan91@gmail.com
[2]Department of Mechanical Engineering, M. Kumarasamy College of Engineering, Karur, Tamil Nadu, India.
[3]Department of Mechanical Engineering, M. Kumarasamy College of Engineering, Karur, Tamil Nadu, India.
[4]Department of Mechanical Engineering, M. Kumarasamy College of Engineering, Karur, Tamil Nadu, India.
[5]Department of Mechanical Engineering, M. Kumarasamy College of Engineering, Karur, Tamil Nadu, India.

ABSTRACT

In industrial machinery, heat sinks are used to dissipate excess heat from heat-generating components to the atmosphere. Efforts have been made in recent years to create electronic or mechanical devices that are lighter, smaller, and less expensive. Heat dissipation from the heat sink is a significant concern that many researchers are attempting to resolve. The aim of this work is to implement a heat sink on the enclosure of inverter and improving the heat sink's thermal efficiency and assisting in the understanding of the cooling capacity of their particular heat sink. The various enhancement techniques used for optimizing the thermal design are short fins, longer fins and internal fins. The way in which the heat sinks thermal performance is affected by orientation, shapes, and space between fins and their arrangement are considered in our design. The effective design for implementation is concluded by analyzing the thermal properties of each structures.

KEYWORDSFins, Heat Sink, Thermal Analysis, Graphite Foam, Inverter.

Introduction

In today's world, electricity has a strong grip on the majority of everyday activities, such as the use of electric power for domestic and industrial purposes. Electricity can be produced from a public supply to customers in a variety of ways, including using water, wind, or steam energy to drive a turbine, as well as more recently using generators, solar energy, and nuclear.In India, the power distribution company's supply of electricity to customers is inconsistent. As a result, additional electric power sources such as generators and, more recently, semiconductor power devices such as bipolar transistors, Thyristors, and particularly MOSFETs have been used to produce electric power in the kilowatt range in conjunction with a DC battery. Because of its long lifespan, cost effectiveness, and maintainability, an inverter is a better additional power source for generators and UPS.

Theory of Heat Dissipation

The three methods for dissipating heat from a device are radiation (device), conduction (heat sink), and convection (fan). Heat sinks are used to improve heat dissipation from hot devices in printed circuit board (PCB) designs because heat dissipation between the heat sink and the surrounding air is more effective than between the device and the surrounding air. Because of the low thermal resistance between the heat sink and the air, heat sinks have a high thermal energy transfer efficiency. Thermal resistance is a measurement of a surface's ability to dissipate heat or, in other words, how well heat is transmitted across the boundary between two mediums.

Designing Procedure

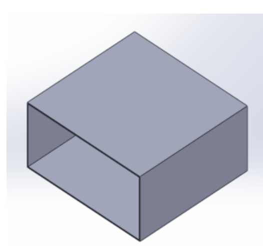

Fig. 1. Existing enclosure design

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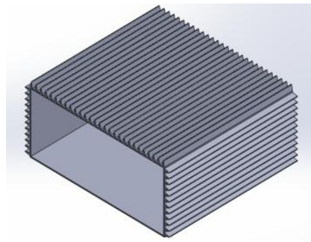

Fig. 2. Enclosure with short fin design

Existing enclosure model is created with reference to standard dimensions using extrude and shell tool as shown in figure 1.The fins created on one of the lateral side is copied on the other side with the help of mirror tool as shown in figure 2

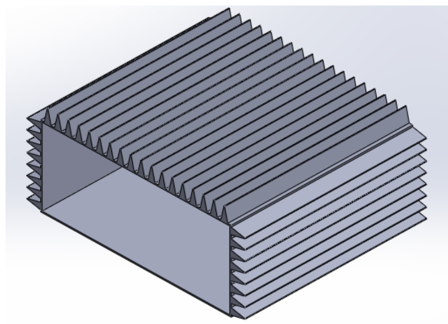

Fig. 3. Enclosure with long fin design

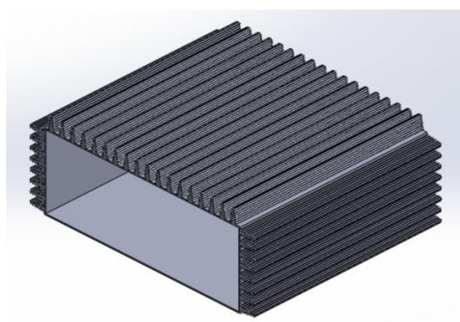

Fig. 4. Enclosure with internal fin design

The dimension of fin is increased and the number of fins is decreased for fins with longer geometry as shown infigure 3.The fins created on one of the lateral side is copied on the other side with the help of mirror tool as shown in figure 4.

Thermal Analysis

The FLOTRAN and Thermal merchandiseassistconstant-country thermal evaluation. A constant-country thermal evaluation calculates the consequences of constant thermal hundreds on a gadget or component. Engineer/analysts frequentlycarry out a constant-countryevaluationearlier than doing a brief thermal evaluation, to assistset uppreliminary conditions. A constant-countryevaluationadditionallymay be the closing step of a brief thermal evaluation, accomplishedin spite of everythingbriefconsequences have diminished.

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Analyzing Procedure

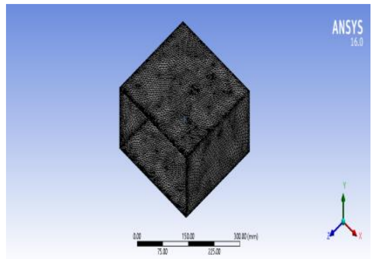

Fig. 5. Meshed view of enclosure

Results of Existing Enclosure

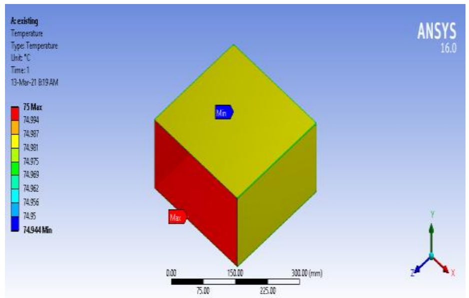

Fig. 6. Temperature distribution

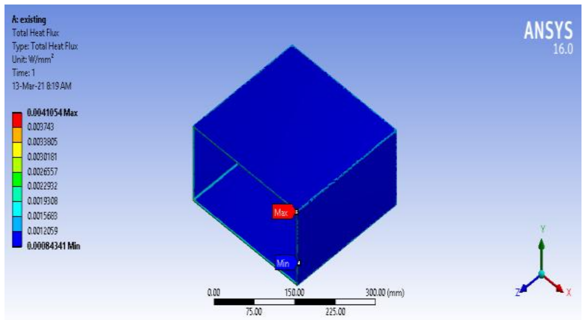

Fig. 7. Total heat flux

Results of Enclosure with Shorter Fins

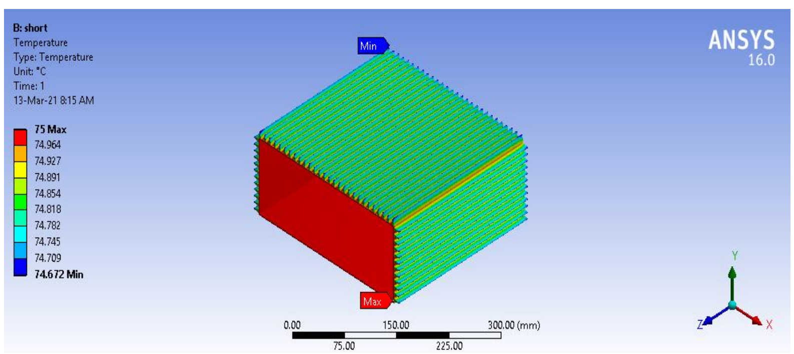

Fig. 8. Temperature distribution

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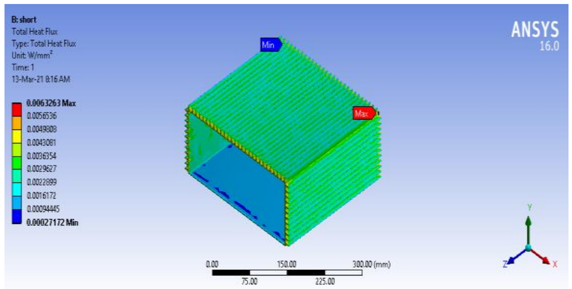

Fig. 9. Total heat flux

Table 1

NODES	**121711**
ELEMENTS	**60204**

Results of Enclosure with Longer Fins

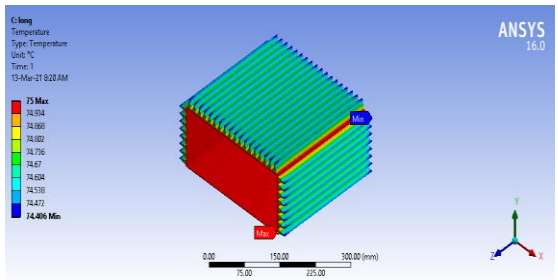

Fig. 10. Temperature distribution

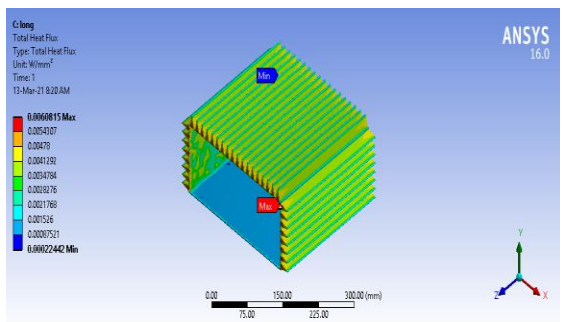

Fig. 11. Total heat flux

Results of Enclosure with Internal Fins

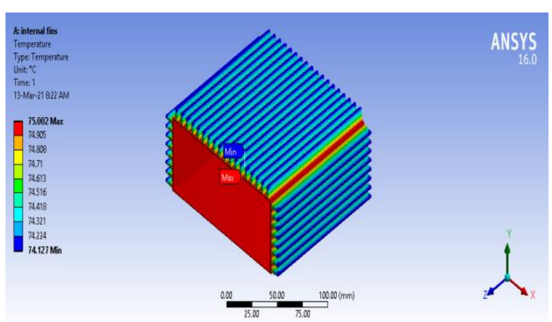

Fig. 12. Temperature distribution

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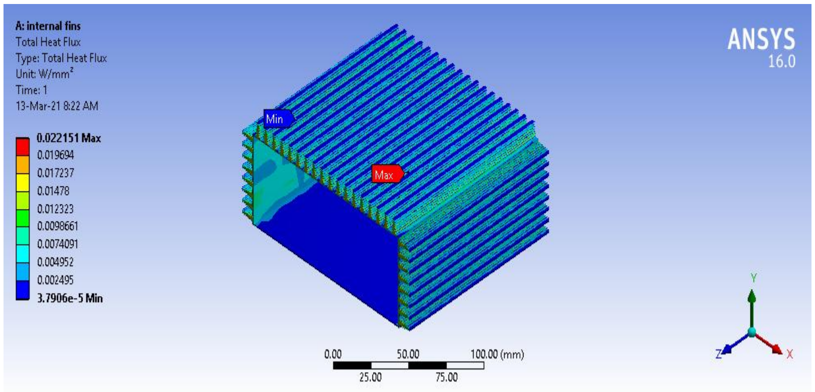

Fig. 13. Total heat flux

Tabulated Result

Table 2. Structural Optimization

Models	Temperature (°C)		Total heat flux(W/MM^2)	
	Min	Max	Min	Max
Existing design	74.94	75	8.43E-4	4.1E-3
Shorter fins	74.67	75	2.71E-4	6.32E-3
Longer fins	74.4	75	2.24E-4	6.08E-3
Internal fins	74.12	75	3.79E-5	2.21E-2

Results of Enclosure

By expanding the stream territory of warmth more cooling get happened, this is a significant idea of our primary improvement. The plain territory of existing nook is given three sorts of balances on its surface, these three balances have various regions. The more limited balances have more modest inclusion zone and its number of dissemination on the nook is most extreme, while then again bigger blades have abundance inclusion region and its number of dispersion on the walled in area is least and the space between the balances additionally get expanded, this makes overabundance air to go into the space and makes the warmth to be scattered to climate. Hence a similar temperature is less in an inside balances, likewise heat motion get expanded when contrasted and other blade model since the abundance heat move is happened in an inner balance model in view of overabundance territory inclusion and furthermore more air flow around the outside of balances.

Graph

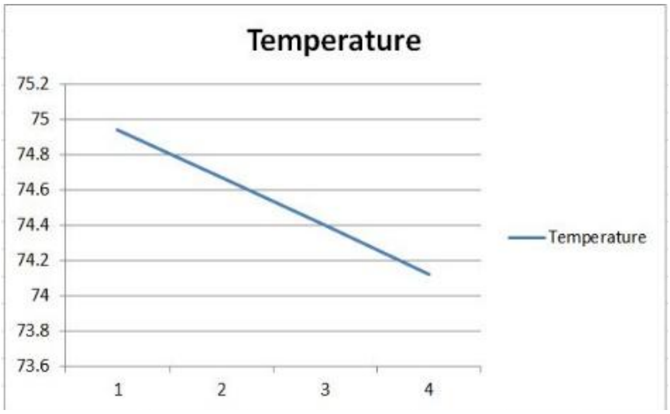

Fig. 14. Temperature graph

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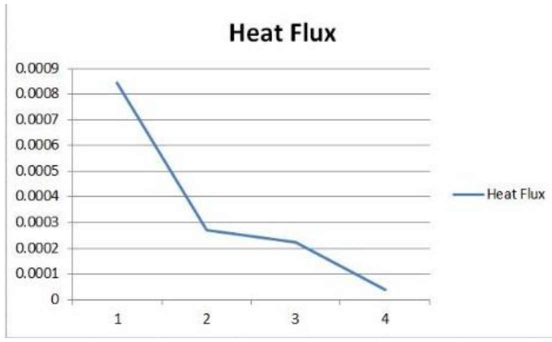

Fig. 15. Heat flux graph

Results of Enclosure with Internal Fins Made of Copper

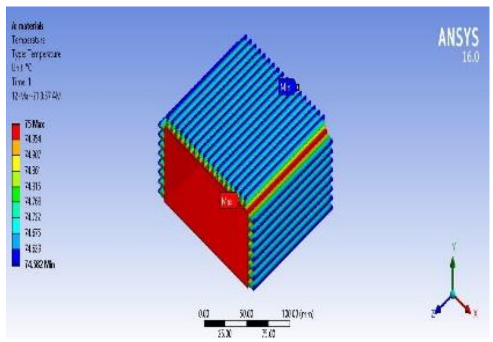

Fig. 16. Temperature distribution

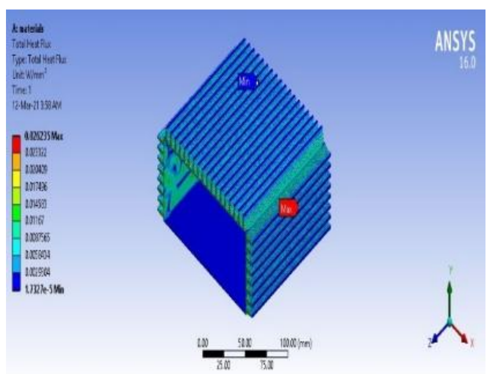

Fig. 17. Total heat flux

Results of Enclosure with Internal Fins Made of Nickel

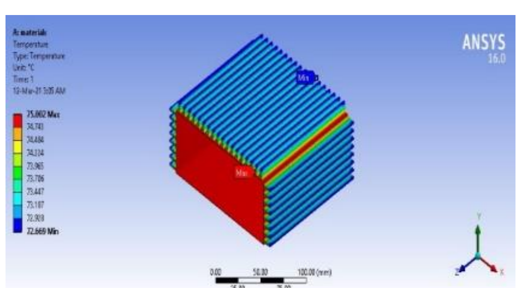

Fig. 18. Temperature distribution

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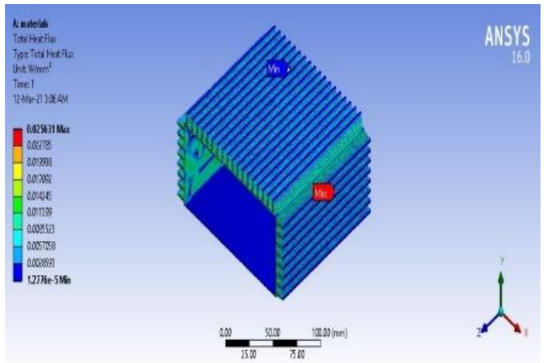

Fig. 19. Total heat flux

Results of Enclosure with Internal Fins Made of Tin

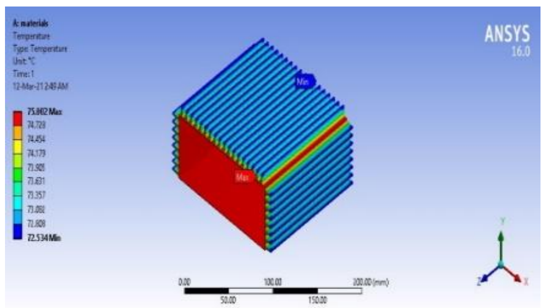

Fig. 20. Temperature distribution

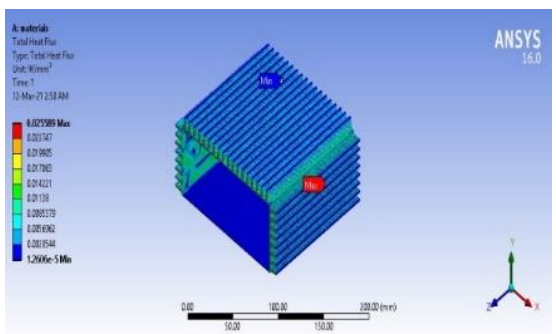

Fig. 21. Total heat flux

Results of Enclosure with Internal Fins Made of Graphite Foam

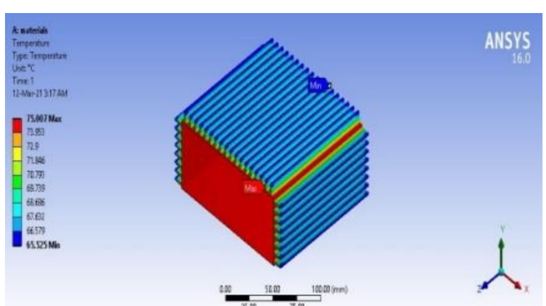

Fig. 22. Temperature distribution

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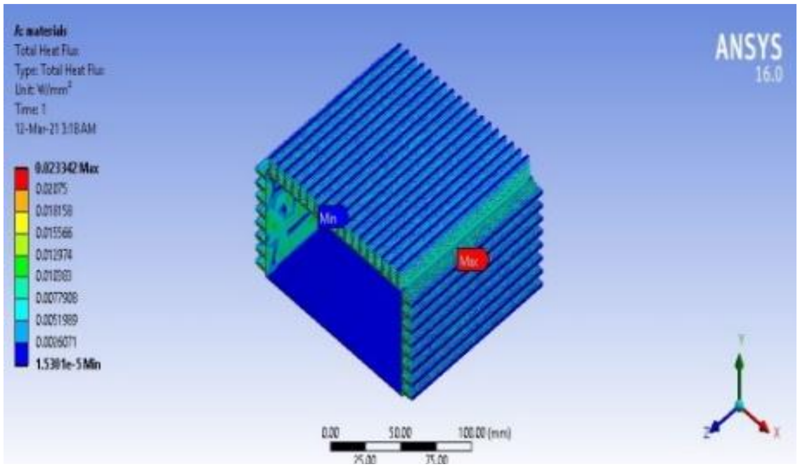

Fig. 23. Total Heat Flux

Tabulated Result

Table 3. Material Optimization

Materials	Temperature (°C)		Total heat flux(W/MM^2)	
	Min	Max	Min	Max
Copper	74.58	75	1.73E-5	2.62E-2
Nickel	72.66	75	1.27E-5	2.56E-2
Tin	72.53	75	1.26E-5	2.55E-2
Graphite foam	62.52	75	1.53E-5	2.33E-2

Results of Internal Fins Enclosure

After checking underlying attributes of warmth sink plan it got cleared that the inner blades fulfills the temperature qualities and to finish the material which is utilized for assembling the warmth sink, abundance warm conductive materials like copper, nickel, tin, graphite froth is utilized and this outcomes are get contrasted and existing aluminum results. Unmistakably when contrasted and any remaining ordinary materials, graphite froth decreases the temperature most extreme, this is a result of its material properties just as its overabundance warm conductive properties, when contrasted and aluminum the warmth motion is additionally in a significant cutoff. Hence the warmth sink made of graphite froth with inward finned structure is a best reasonable for ongoing applications.

Graph

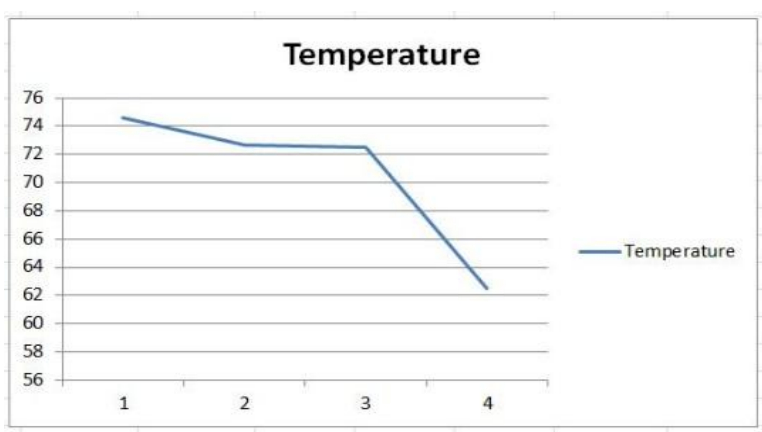

Fig. 24. Temperature

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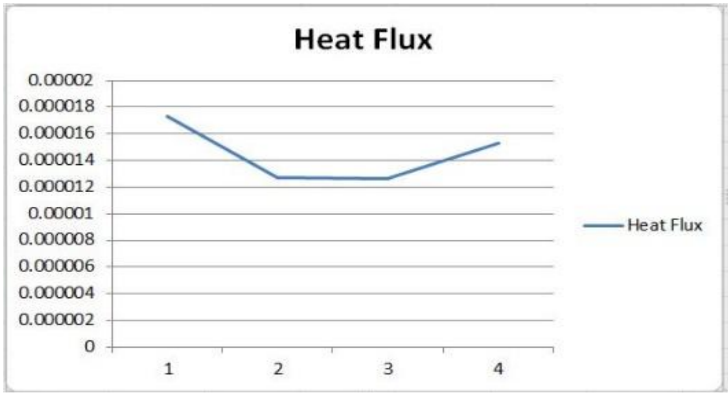

Fig. 25. Heat flux

Conclusion

By giving internal fins on the surface of normal fins will resulting the higher temperature different compared to the existing and normal fins that will affect the temperature distribution of the heat generated at the heat source along the fins. The heat transfer coefficient and temperature distribution for each shape or geometry inference can be analyzed using the data obtained from the experiment. From the obtained results the internal fins are the better geometry suggested for beat heat transfer conditions. This geometry is incorporated with material optimization; upon the results of material optimization it is concluded that the graphite foam is the best suitable material for real time implementation.

References

[1] N.H. Naqiuddin, L.H. Saw, M.C. Yew, F. Yusof, T.C. Ng, Overview of micro-channel design for high heat flux application, *Renew. Sustain. Energy Rev*. 82 (2018) 901–914. doi:10.1016/j.rser.2017.09.110.

[2] C.J. Kroeker, H.M. Soliman, S.J. Ormiston, Threedimensional thermal analysis of heat sinks with circular cooling micro-channels, 47 (2004) 4733–4744. doi:10.1016/j.ijheatmasstransfer.2004.05.028.

[3] D. Yang, Z. Jin, Y. Wang, G. Ding, G. Wang, International Journal of Heat and Mass Transfer Heat removal capacity of laminar coolant flow in a micro channel heat sink with different pin fins, *Int. J. Heat Mass Transf.* 113 (2017) 366–372. doi:10.1016/j.ijheatmasstransfer.2017.05.106.

[4] X. Wang, B. An, L. Lin, D. Lee, Inverse geometric optimization for geometry of nano fluid-cooled microchannel heat sink, *Appl. Therm. Eng.* 55 (2013) 87–94. doi:10.1016/j.applthermaleng.2013.03.010.

[5] S. Romana, S.S. Banu, I. Ali, M.A.M. Iqbal, ScienceDirect, Mater. *Today Proc.* 5 (2018) 5481–5486. doi:10.1016/j.matpr.2017.12.137.

[6] C. Chen, C. Ding, International Journal of Thermal Sciences Study on the thermal behavior and cooling performance of a nano fluid-cooled microchannel heat sink, *Int. J. Therm. Sci.* 50 (2011) 378–384. doi:10.1016/j.ijthermalsci.2010.04.020.

[7] Y.K. Prajapati, M. Pathak, M.K. Khan, Transient heat transfer characteristics of segmented finned microchannels, *Exp. Therm. Fluid Sci.* (2016).

[8] Abdoli, G. Jimenez, G.S. Dulikravich, International Journal of Thermal Sciences Thermo- fluid analysis of micro pin- finarray cooling configurations for high heat fluxes with a hot spot, 90 (2015) 290–297.

[9] J. Li, Z. Shi, 3D numerical optimization of a heat sink base for electronics cooling, 39 (2012) 204–208.

[10] D. Yang, Y. Wang, G. Ding, Z. Jin, J. Zhao, G. Wang, Numerical and experimental analysis of cooling performance of single-phase array microchannel heat sinks with different pin-fin configurations, *Appl. Therm. Eng.*, 112 (2017) 1547–1556. doi:10.1016/j.applthermaleng.2016.08.211.