ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Single Phase Micro Channel Heat Sink

Chundru Jagadeesh Pavan Kumar
M.Tech Student
Kakinada Institute of Technology & Science,
Tirupati (V), Divili (M),
East Godavari (Dt), A.P, India.

Mr. V V Rama Krishna
Assistant Professor
Kakinada Institute of Technology & Science,
Tirupati (V), Divili (M),
East Godavari (Dt), A.P, India.

Mr. Annavarapu Venkata Sridhar
Assistant Professor
Kakinada Institute of Technology & Science,
Tirupati (V), Divili (M),
East Godavari (Dt), A.P, India.

ABSTRACT:

Over the last decade, micromachining technology has been increasingly used to develop highly efficient heat sink cooling devices due to advantages such as lower coolant demands and smaller Machine able dimensions. Heat sinks are classified as either single-phase or two-phase according to whether liquid boiling occurs inside of the micro-channels.

In this thesis, two different shapes, rectangular and trapezoidal shape of the micro channel heat sink is analyzed for heat transfer properties, temperature distribution for three different materials Graphene, Aluminum and Silicon, by varying dimensions of the micro channel. Water is taken as the cooling fluid. Modeling is done in Pro/Engineer, Thermal analysis and CFD analysis is done in Ansys.

The boundary conditions for thermal analysis are heat flux, for CFD analysis are heat flux and volumetric flow rate. Three different heat fluxes are considered for analysis.

I. INTRODUCTION

Thermal Energy stands for the vital materialization of all forms of energy. Transfer of heat from one place to other, from one medium to a different and reunion the challenges of accomplishing this transfer under a variety of restrictions have been the objectives of heat transfer research ever as fire was cultivated.

The fundamental Equation of heat transfer by convection is articulated as

$$q = hA (T_s – T_f)$$

INTRODUCTION TO CYLINDER:

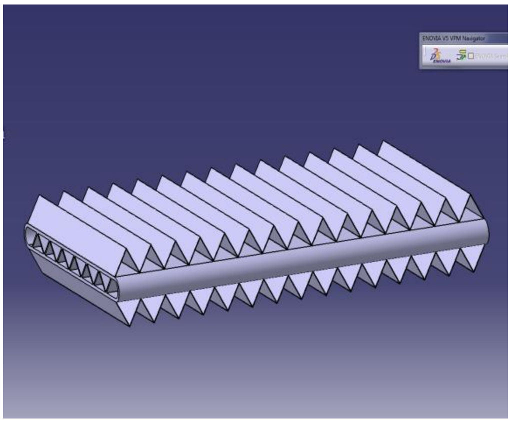
Microchannels know how to be defined as channels whose sizes are less than 1 millimeter and superior than 1 micron.Above 1 millimeter the flow exhibits behavior that is the same as most macroscopic flows. At present, microchannels have trait dimensions anywhere from the submicron level to hundreds of microns. Microchannels can be made-up in many materials — glass, polymers, silicon, metals — using various methods together with surface micromachining, bulk micromachining, molding, embossing, and conventional machining with microcutters.

Micro-channel heat sinks comprise a new cooling technology for the removal of a large quantity of heat from a small area. The heat sink is typically made from a high thermal conductivity solid such as silicon or copper with the micro-channels fabricated into its surfaceby either precision machining or micro-fabrication technology.

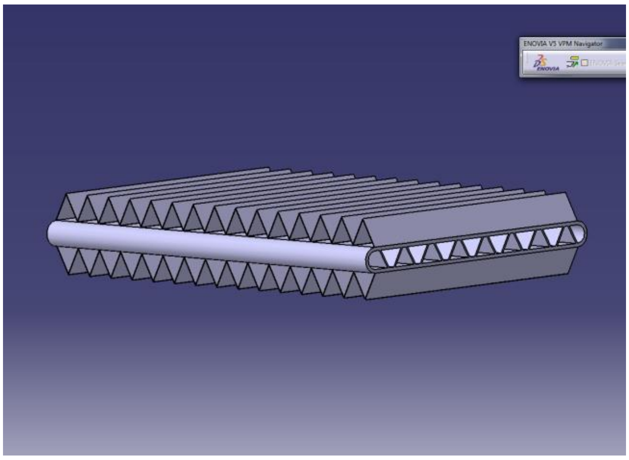
These micro-channels have trait dimensions ranging from 10 to 1000 lm, and serve as flow ways for the cooling liquid. Micro-channel heat sinks unite the attributes of very high surface area to volume ratio, large convective heat transfer coefficient, small mass and volume, and small coolant account.These attributes make these heat sinks very suitable for cooling such devices as high- performance microprocessors, laser diode arrays, radars, and high-energy-laser mirrors.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

DESIGN OF TRIANGULAR MICRO CHANNEL HEAT SINK

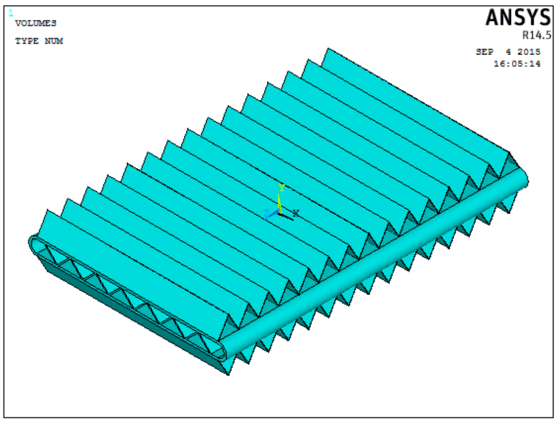


DESIGN OF MODIFIED TREPEZOIDAL MODEL

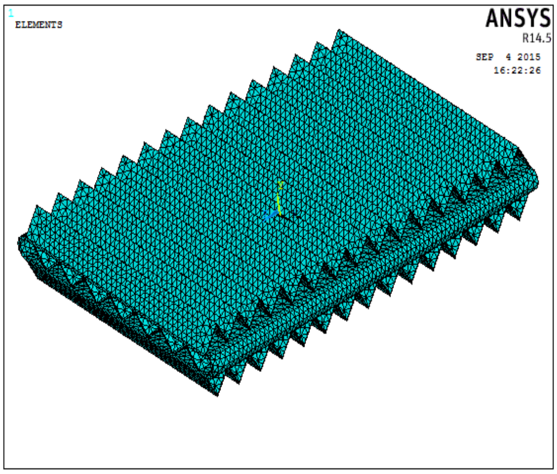


THERMAL ANALYSIS OF MICRO CHANNEL TRIANGULAR USING MATERIAL ALUMINUM NITRIDE

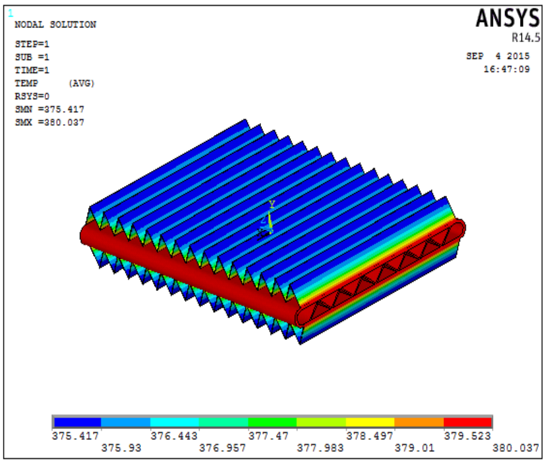
Imported Model



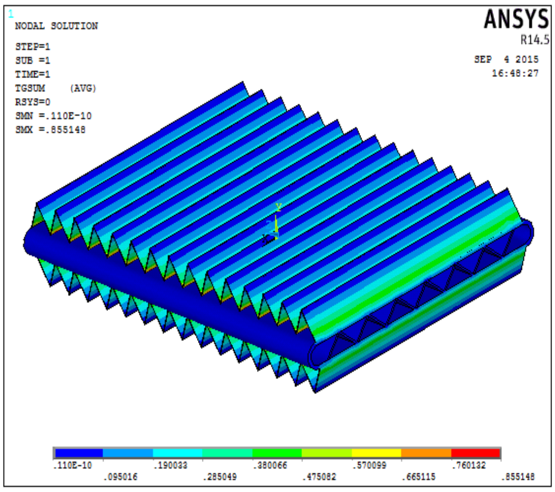
Meshed Model



Nodal Temperature

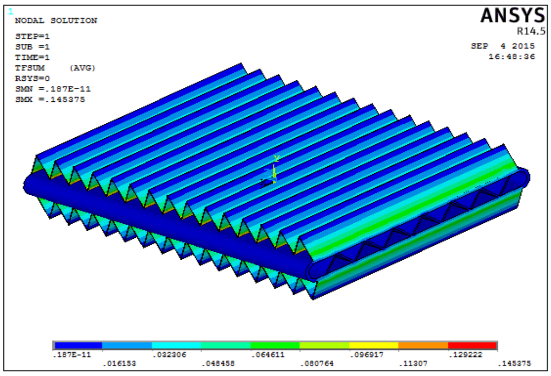


Thermal Gradient



ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Thermal Flux



THERMAL ANALYSIS OF MICRO CHANNEL TRIANGULAR USING MATERIAL BERRYILIUM OXIDE

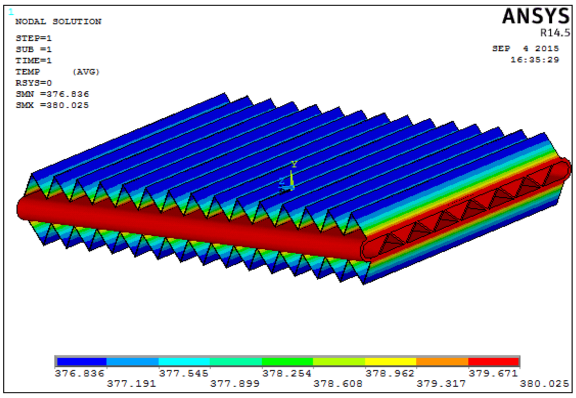
Material Properties:

Thermal conductivity= 0.25 W/mm k

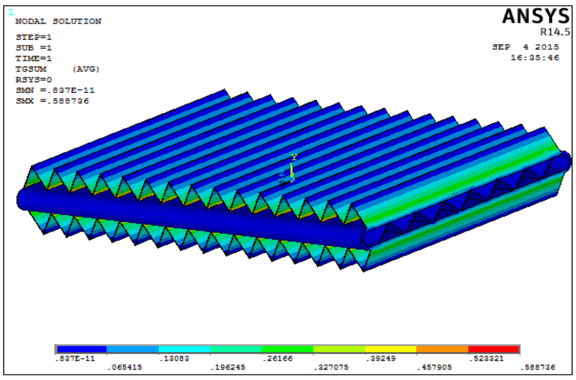
Specific Heat Capacity= 960 J/Kg k

Density=0.0000029

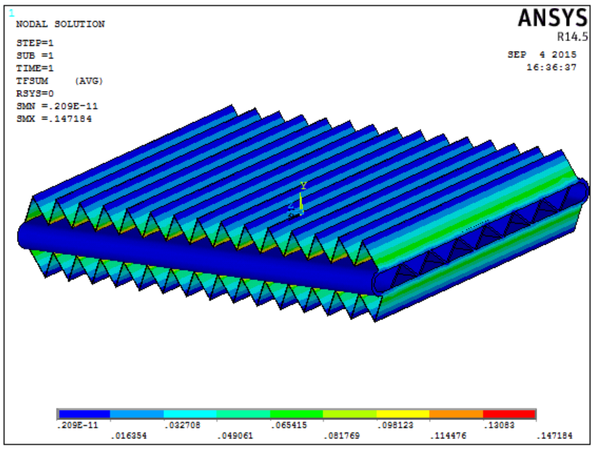
NODAL TEMPERATURE



THERMAL GRADIENT

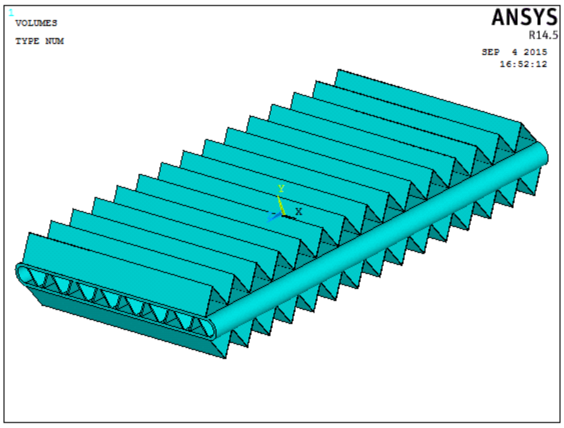


THERMAL FLUX

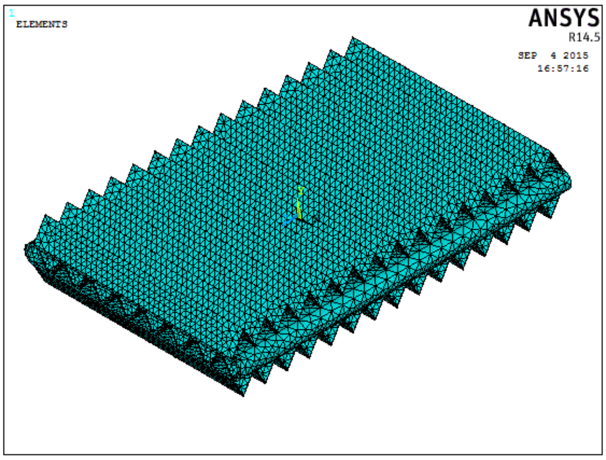


THERMAL ANALYSIS OF MICRO CHANNEL TREPEZOIDAL USING MATERIAL ALUMINUM NITRIDE

IMPORTED MODEL

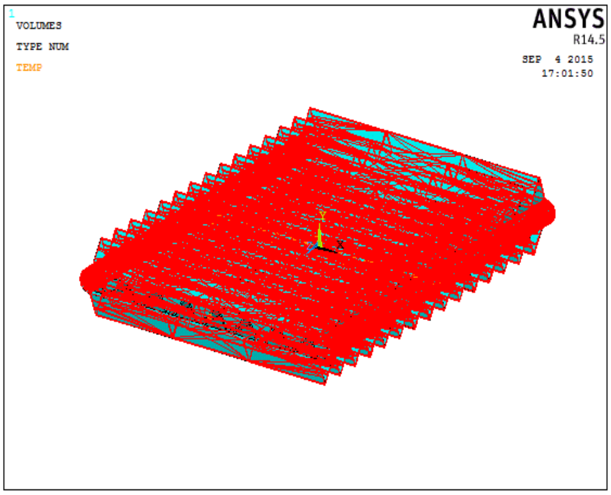


MESHED MODEL

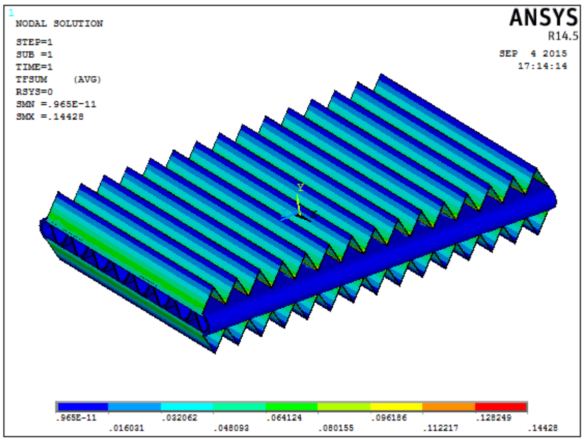


ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

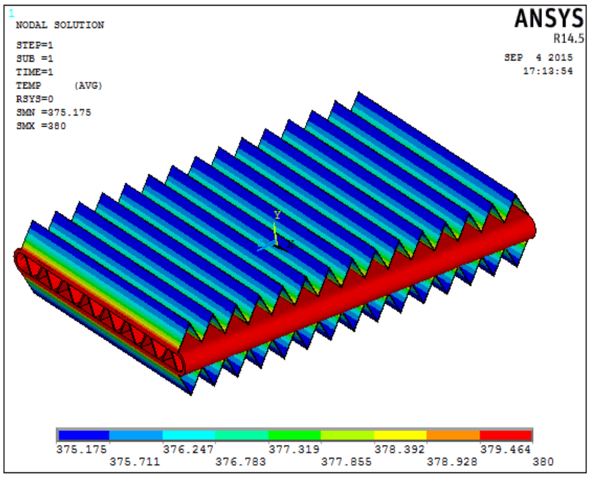
LOADS APPLIED MODEL



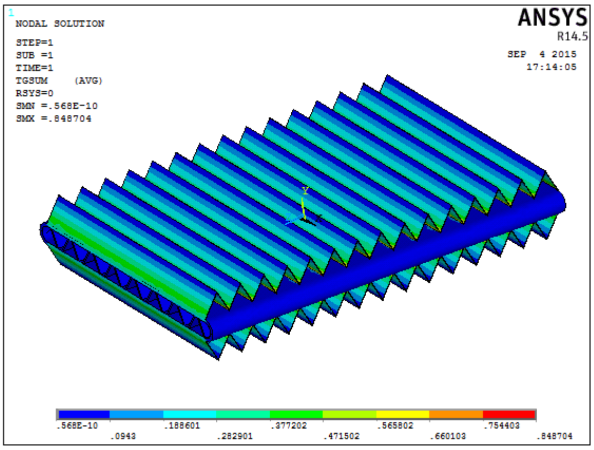
THERMAL FLUX



NODAL TEMPERATURE

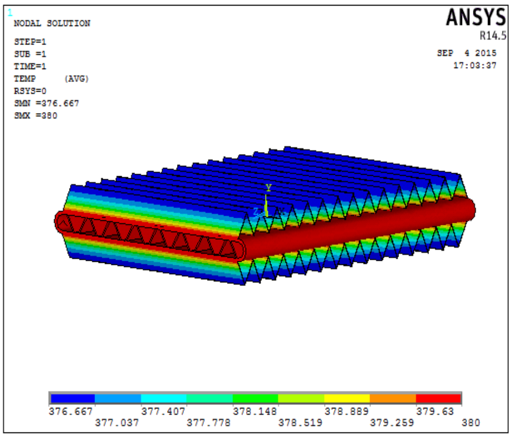


THERMAL GRADIENT

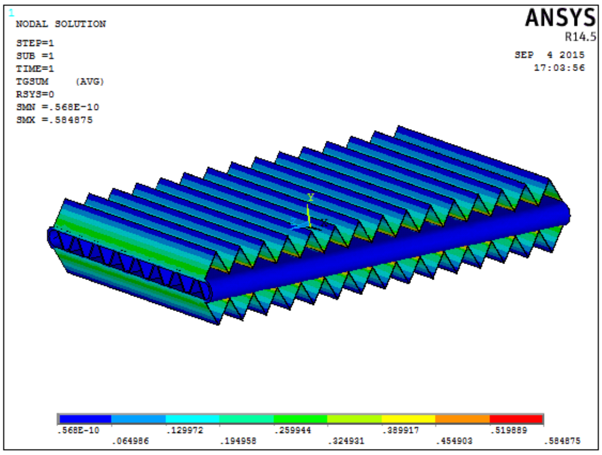


THERMAL ANALYSIS OF MICRO CHANNEL TREPEZOIDAL USING MATERIAL BERRYILIUM OXIDE

NODAL TEMPERATURE

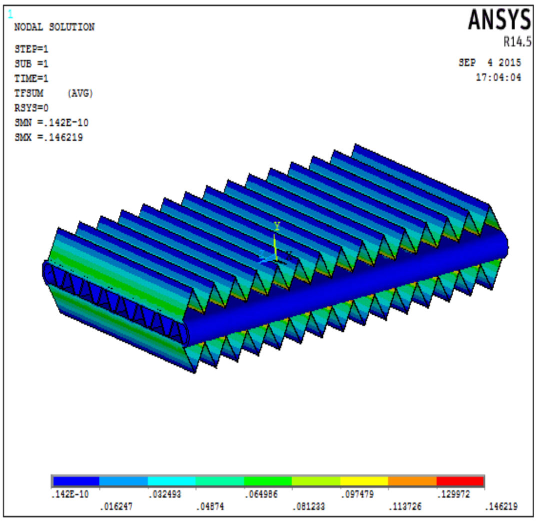


THERMAL GRADIENT



ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

THERMAL FLUX

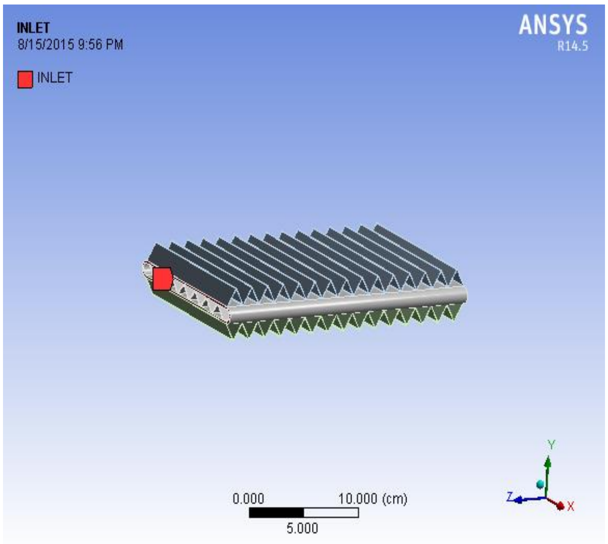


CFD ANALYSIS OF TRIANGULAR MICRO CHANNEL

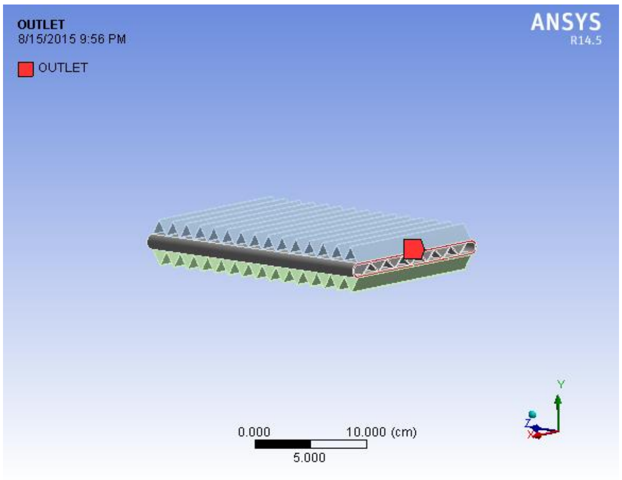
WORKINGFLUID: WATER

WATER PROPERTIES:
DENSITY= 998.2 Kg/M^3
SPEIFIC HEAT= 4182J/Kg K
THERMAL CONDUCTIVITY =0.6W/Mk
Viscosity= 0.001003Kg/m sec

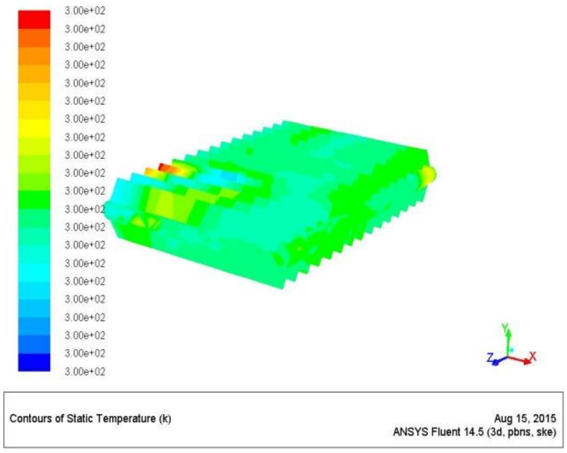
INLET



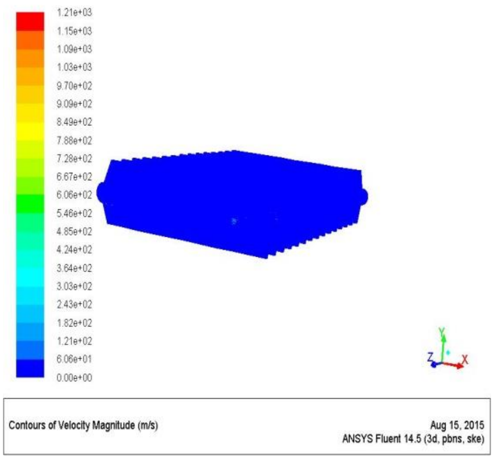
OUTLET



CONTOURRESULTS

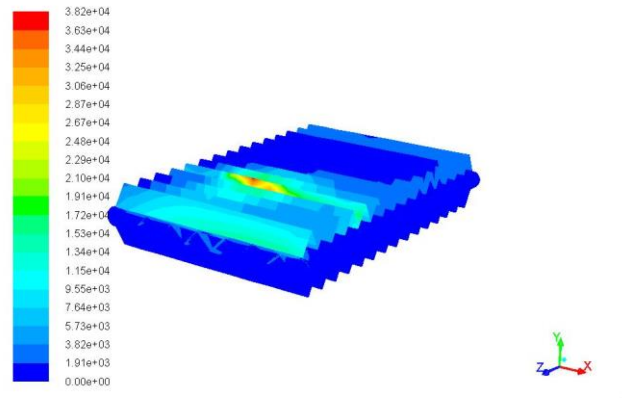


TEMPERATURE



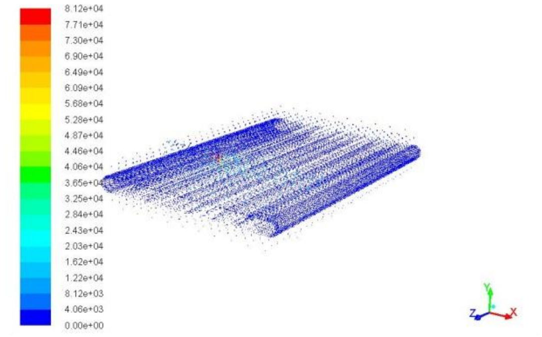
ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

VELOCITY



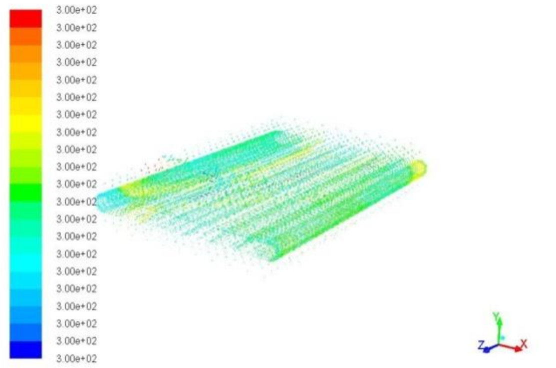
Contours of Wall Shear Stress (pascal) Aug 15, 2015 ANSYS Fluent 14.5 (3d, pbns, ske)

SHEARSTRESS



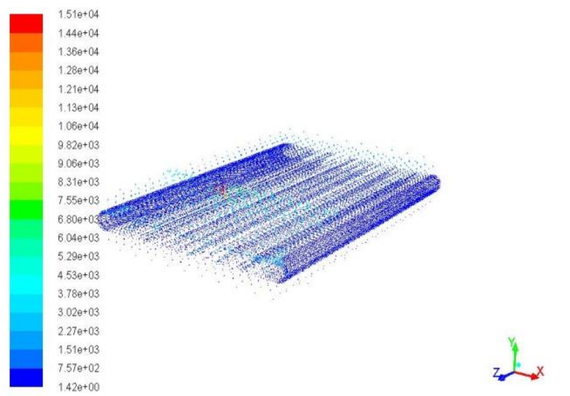
Velocity Vectors Colored By Wall Shear Stress (pascal) Aug 15, 2015 ANSYS Fluent 14.5 (3d, pbns, ske)

VECTORRESULTS TEMPERATURE



Velocity Vectors Colored By Static Temperature (k) Aug 15, 2015 ANSYS Fluent 14.5 (3d, pbns, ske)

VELOCITY



Velocity Vectors Colored By Velocity Magnitude (m/s) Aug 15, 2015 ANSYS Fluent 14.5 (3d, pbns, ske)

"Flux Report"

Mass Flow Rate	(kg/s)
contact_region-src	-0.00030078605
contact_region-trg	0.00030078617
contact_region_2-src	-0.00012657521
contact_region_2-trg	0.00012657524
inlet	0.026383441
interior-14	-0.0004995995
interior-5	0.0058654011
interior-____msbr	-1.2409065
outlet	-0.019388501
wall-12	0
wall-13	0
wall-15	0
wall-16	0
wall-____msbr	0
Net	0.0069949405

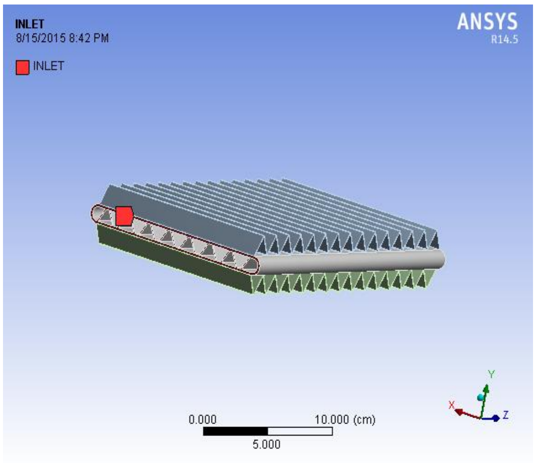
"Flux Report"

Total Heat Transfer Rate	(w)
contact_region-src	0
contact_region-trg	0
contact_region_2-src	0
contact_region_2-trg	0
inlet	49.123207
outlet	-36.099083
wall-12	0
wall-13	0
wall-15	0
wall-16	0
wall-____msbr	0
Net	13.024124

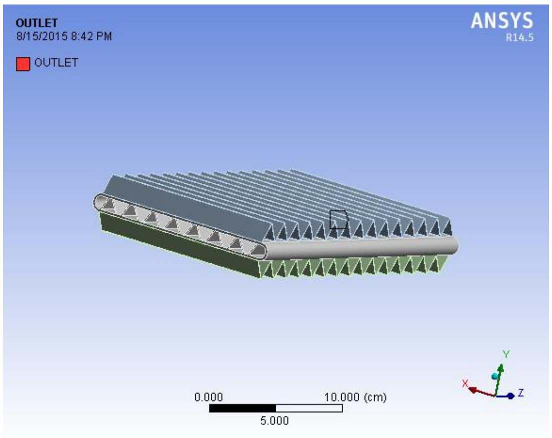
ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

CFD ANALYSIS OF TREPIZOIDAL MICRO CHANNEL

Inlet

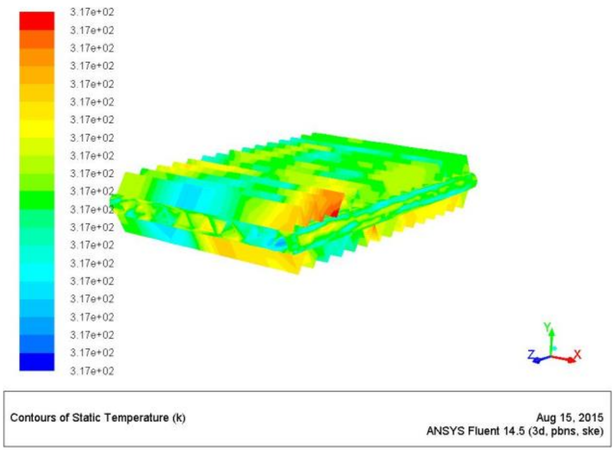


Outlet

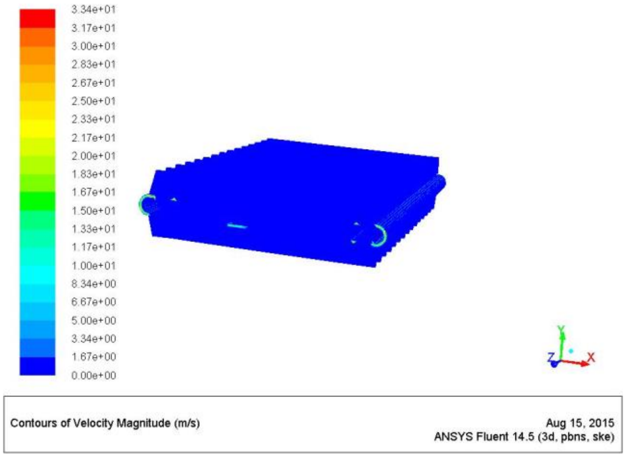


Contour results

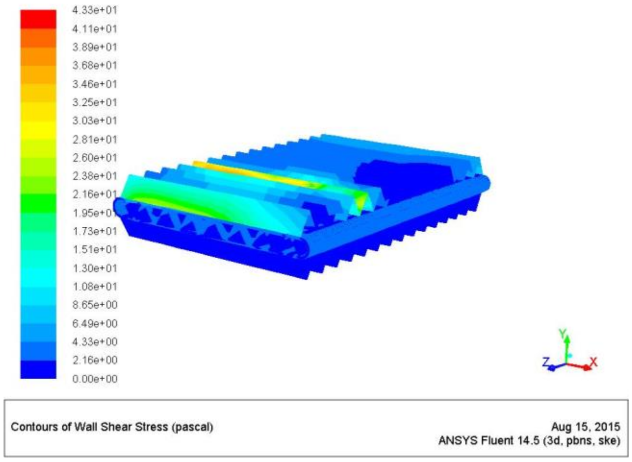
Temperature



Velocity

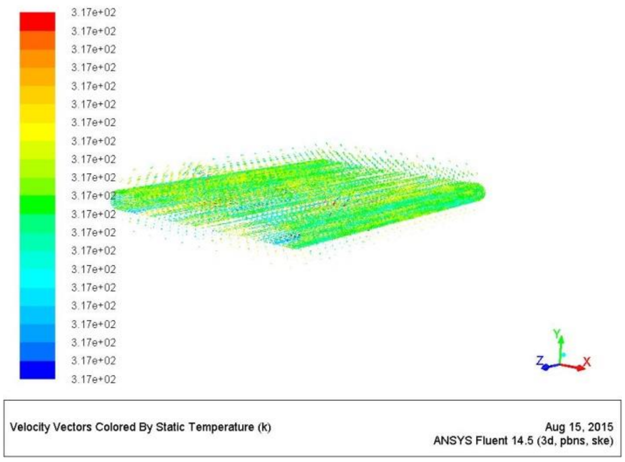


Shear stress



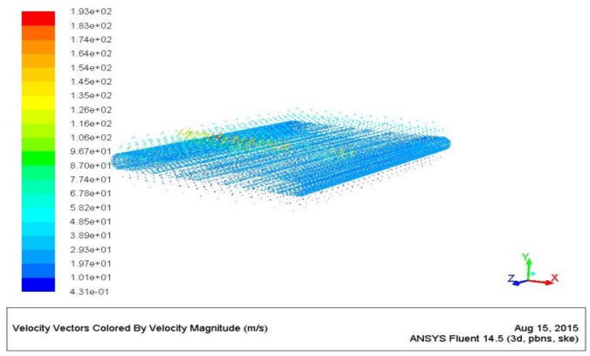
Vector results

Temperature

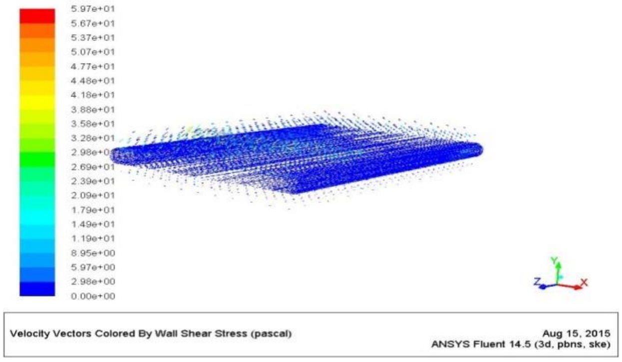


ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Velocity



Shear stress



"Flux Report"

Mass Flow Rate (kg/s)

-------------------------------- --------------------

contact_region-src -6.7321656e-05
contact_region-trg 6.7320128e-05
contact_region_2-src -5.2315132e-05
contact_region_2-trg 5.2315256e-05
inlet 0.026119169
interior-14 -4.7740359e-05
interior-5 -0.00012142477
interior-____msbr 1.375845
outlet -0.026140118
wall-12 0
wall-13 0
wall-15 0
wall-16 0
wall-____msbr 0

---------------- --------------------

Net -2.0950574e-05

"Flux Report"

Total Heat Transfer Rate (w)

-------------------------------- --------------------

contact_region-src 0
contact_region-trg 0
contact_region_2-src 0
contact_region_2-trg 0
inlet 495.51602
outlet -495.61459
wall-12 0
wall-13 0
wall-15 0
wall-16 0
wall-____msbr 0

---------------- --------------------

Net -0.098571777

RESULTS TABLE

MINIMUM TEMPERATURE

	TRIANGULAR	TREPEZOIDAL
ALUMINIUM NITRIDE	375.417	375.175
BERYLLIUM OXIDE	376.836	376.667

THERMALFLUX

	TRIANGULAR		TREPEZOIDAL	
	MINMUM	MAXIMUM	MINMUM	MAXIMUM
ALUMINIUM NITRIDE	1.870E-12	1.4538E-01	9.650E-12	1.4428E-01
BERYLLIUM OXIDE	2.090E-12	1.4718E-01	1.420E-11	1.4622E-01

THERMAL GRADIENT

	TRIANGULAR		TREPEZOIDAL	
	MINMUM	MAXIMUM	MINMUM	MAXIMUM
ALUMINIUM NITRIDE	1.100E-11	8.5515E-01	5.680E-11	8.4870E-01
BERYLLIUM OXIDE	8.37E-12	0.588736	5.68E-11	0.584875

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

CONCLUSION

In this thesis, a Micro channel is designed and modeled in CATIA. The design and parameters are taken from journal paper. The Materials used for micro Channels are Aluminum Nitride and Beryllium Oxide. The Reason why to took these materials is theses are high thermal conductivity, high thermal Gradient and low machining cost and machinability is high and high availability. In this thesis we compare Thermal Flux and Thermal heat transfer rates of those two Micro channels of different cross-sections. Main theme of the Project is to increase the surface area of the Micro Channel so that efficiency of Micro channel increase.

The analytical study is done in ANSYS software for studying the fluid flow and heat transfer in micro channel heat sink using different cross section and different materials, conclusions were made based on the Ansys report: Heat transfer coefficient is best in Trapezoidal section, followed by triangular .

After going through the Ansys reports we conclude that microchannel heat sink with trapezoidal channels made with aluminum nitride will cool the much faster than other models these conclusions are made based on the minimum temperature, minimum thermal flux and maximum thermal gradient.

REFRENCES

1. Co-optimized design of microchannel heat exchangers and thermoelectric generators A. Rezaniaa, , , K. Yazawab, c, L.A. Rosendahla, A. Shakourib, c
2. http://www.sapagroup.com/en/precision-tubing/hvacr/applications/micro-channel-heat-exchangers/
3. http://www.febrava.com.br/__novadocuments/97053?v=635744895647330000
4. https://en.wikipedia.org/wiki/Micro_heat_exchanger
5. Microchannel heat exchangers – present and perspectives traianpopescu 1, mirceamarinescu2 ,horaţiu pop3 gheorghe popescu4 , michelfeidt 5
6. Expanded microchannel heat exchanger: design, fabrication and preliminary experimental test David C. Denkenbergera*, Michael J. Brandemuehlb , Joshua M. Pearcec , and John Zhaib

Author Details

Chundru Jagadeesh Pavan Kumar received the B.Tech degree in mechanical engineering from Regency Institute of Technology, Yanam, Pondicherry University,Pondicherry, India, in May2013 year, and perusing M.Tech in Thermal Engineering from Kakinada Institute of Technology & Science, TIRUPATI(V), DIVILI,P (M),East Godavari (DT) A.P ,India.

Mr.V V Rama Krishna received B.Tech degree in Mechanical Engineering from JNTUH Hyderabad, JNTU, and Andhra Pradesh in 2008 year and received M.Tech in CAD-CAM Engineering from GITE College, Rajahmundry, affiliated to, JNTUK, Andhra Pradesh in 2013 year. Currently he is working as Associate Professor at Kakinada Institute of Technology & Science, TIRUPATI (V), DIVILI. an affiliated Institution, JNTUK, Andhra Pradesh, India.

Mr. Annavarapu Venkata Sridhar received B.Tech degree in –AMIE-Mechanical Engineering from - IEI KOLKATTA .INDIA in 1996 year and received MTech in CAD-CAM Engineering from Jawaharlal Nehru Technological University, Kakinada in 2014 year. Currently he is working as Associate Professor at Kakinada Institute of Technology & Science, TIRUPATI(V), DIVILI., an affiliated Institution, JNTUK, Andhra Pradesh, India.