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INVESTIGATIONAL AND CFD ANALYSIS OF HEAT TRANSFER RATE IN MULTI AIR JET IMPINGEMENT OVER A FLAT PLATE AND RECTANGULAR-FIN HEAT SINK

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ABSTRACT

In this paper reports the results of analysis of heat transfer performance of in compression air jet impinging of heated surface over a flat plate & Rectangular-fin heat sink. To impersonate the computer processor of flat plate and Rectangular-fin dimensions are 40mm*40mm*10mm and pin height is 6cm and fin thickness is 2mm and L/t ratios are 5,10, 15respectively.By using this simulation in Ansys fluent software to perform the turbulent jet impingement on a surface. The bottom surface of the plate is providing constant heat flux and top surface of the plate is cooled by an impingement jet of air. It has two equations are used k-w model and shear stress transport to handle the turbulent jet. The result of flat plate heat sink is compare the Experimental and simulation is higher at 0.89% of investigational to contrast numerical and Nusselt is higher at 3.36% of numerical to evaluate the investigational and heat transfer coefficient is higher at 4.58% of numerical to compare the tentative and result of pin fin heat sink is compare the investigational and numerical is higher at 0.24% of trial to judge against the numerical and Nusselt number is higher at0.72% of numerical to evaluate the tentative and heat transfer coefficient is higher at 0.89% of numerical to compare the trial. The effect of L/t ratios

of jet impingement over a flat plate and rectangular fin heat sink on the heat transfer performance of the heated surface of investigate.

1. Introduction

In the present state of affairs of the many trends setting innovation, utilization of Electronic has clad to be much inevitable. Consequently, there has been a standardized increment in heat wasted rate from electronic segments throughout the previous number of decades. Improvement to boot prompted additional fascinating power within the segments and there's a formidable increment within the heat spread of electronic segments. Completely different researchers and scientists typically used the thought of affected convection air to expel heat at the surface of the segments. It's important not solely to stay up low temperatures of segments nonetheless to boot keep one's eyes off from downside areas. For the development within the incorporated circuit structure for additional fascinating heat transfer zone is much impossible. Simply answer seems to be advancement of surprising affected convection cooling ways like impingement planes. This strategy appearance appealing since the cooling will be coordinated towards the recent segments and most well-liked position of impingement planes is that it's viable with framework, wherever the electronic half thickness is high. The importance of considering impingement flies in cooling of electronic components within which headways in heat transfer rates depends on the capability to distribute monumental heat transitions with high yielded burden and found out the typical of warmth transfer coefficients. Jet impingement cooling could be a system of warmth transfer by strategies for collision of fluid atoms on to a surface. The occurrence plane is characterized as a high-speed air of cooling fluid affected through a niche or gap that encroaches superficially to be cooled, that outcomes in high heat transfer quantity among the divider and also the fluid. Heat transfer happens thanks to the collision of high speed fluid particles on to the surface. The experimental and numerical studies of the transient heat transfer characteristics of circular air-jet impingement are presented. Circular nozzle has an inner diameter of 6mm and varied from Reynolds number from 14,000 to 53,000. The nozzle exits to target plate varied from 4 to 8.

Ruifeng.d, Qiang.g et al. [1] Outcomes since preliminary and numerical examinations of the transient heat transfer qualities of spherical air-jet impingement is displayed. The spherical nozzle takes Associate in Nursing inward separation crosswise over of half-dozen metric linear unit. The Re is delineate dependent on the nozzle estimation modified from fourteen,000 to 53,000. The non-dimensional Re transfer among the nozzle withdrawal and also the target platter is modified from four to eight. The (local) letter of the alphabet assortment with the time non heritable. The increasing speed of letter of the alphabet (local) backs off because the air impingement continues chilling off. At the 50–80 s districts, the Nu(local) at uncounted radii R/D get the foremost extraordinary purpose then persist for all intents and functions steady

from 80s till the completion of the take a look at. The letter of the alphabet (local) clearly expanded because the Re expanded. The mathematical letter of the alphabet (local) at the stagnation silluminationly expanded and achieved the foremost extreme Markal.B et al. [2] has investigation of, whirling concentric restricted striking wild air planes supply from a completely unique planned nozzle is examined tentatively. Heat transfer qualities and pressure appropriation on the impingement plate ar examined. Tests are directed at numerous nozzle to-plate separations (H/D = zero.5, 1.0, 1.5, 2.0 and 2.5) and flow rates (Q = zero.25, 0.50 and 0.75) for a uniform complete stream rate of one.33*10-3m3s-1(80 L/min). The outcomes demonstrate that the rate of flow proportion improves the consistency of the warmth transfer through the impingement surface and expands the common letter of the alphabet. The native letter of the alphabet diminished once increment H/D Premachandran.B, Sangeeta.K et al. [3] done numerical examinations on cooling of a spherical chamber preserved at a uniform heat transition by a roundabout air jet impingement with a semi-round sunken containment at the bottom of the heated chamber. Four numerous estimations of the nozzle to chamber distance were deliberated. take a look at study was done to accumulate the (local) letter of the alphabet distribution the results uncover that the air restriction gave at the bottom of the chamber mends the letter of the alphabet(local) by regarding pure gold and actual Nu by regarding Revolutionary Organization 17 November. Mathematical examinations stood furthermore finished semi-round air imprisonment by a primary at the bottom. This arrangement stood found to outcome in most extreme increment in Nu (local) by pure gold once contrasted with the outcomes with containment underprivileged of Associate in nursing inaugural. For all Red and H/D esteems with littlest restriction vary, the letter of the alphabet (ave) stood establish to increment due to the imprisonment, with most extreme increment of near Revolutionary Organization 17 November at H/D = sixteen. Ye-zhen, Yongshen et al [4] has investigated Experimental and CFD examinations were directed to inquire concerning the conjugated convective heat transfer sent by solo section of happening planes within a affected frequency with non-uniform beginning cross flow issued from separate openings. The impacts of the cross flow-to-jet ‘Re’ magnitude relation and cross flow openings course of action (inline or stumbled in with relation to the happening plane gaps) on the air impingement practices were examined giving the same absolute cooling atmosphere rate of flow. Specific thought stood waged to seem at the tab-exited jet impingement practices in a very restricted frequency with non-uniform cross flow. The outcomes demonstrate that the chosen excitation on the sweetening of convective heat transfer within the region of impingement space isn't even as the circumstance wherever no underlying cross flow is existing. whereas for the staggered arrangement of cross flow holes, the world scrutiny to the top on the aspect acquired the (avg) letter isn't unbiased by the cross flow however the top on the aspect found the (avg) letter is diminished repetitively with the enlargement of cross flow-to-jet ‘Re’ magnitude relation. Among 3 cross flow-to-jet ‘Re’ vary from zero.5 to a pair of within the modern, the foremost extreme distinction of pinnacle on the

aspect found the letter (avg) among twin distinctive cross flow plans is happened in Rec/Rej= one. Pullarao.M, Balaji.C et al [5] intelligences the when effects of associate degree exploratory examination of fluid flow and warmth transfer completed with quadrilateral flows dispensing perforated nozzles. This can be cultivated by associate degree happening quadrilateral flow on a systematically heated bowl of restricted thickness (5 mm). The medium into account is air. 3 distinctive nozzle arrangements ar used within the examination particularly a solitary nozzle and examine by suggests that of 4 and 9 holes, that are suited within the equal accessible flow path four.6 mm × 4.6 mm. This course of action is comparable to presenting a wire mesh at the exit plane of nozzle. The impacts of flow to-plate separate (2–9) and therefore the mass flow rates of the jet fluid on the warmth transfer rate are contemplated. For the perforated nozzle styles, the centre line rate and disturbance force esteems are dilated by fifty seven and one hundred and fortieth one by one contrasted thereupon of a solitary jet. Selvaraj.P, velusamy.K et al [6] checked out the influence of enlightenment on materials; take a look at coupons ar irradiated in workplaces. Throughout their radiated procedure, these models turn out makeable live of warmth. This heat has to be compelled to be diligently impartial since the models so as to promise reposeful of the models equally on keep the models at a specific temperature throughout the sunshine procedure. To intensification the warmth rate, jet cooling is employed because it provides Brobdingnagian heat transfer constant. to live the warmth transfer physiognomies of air cooling below these circumstances, tests should been passed on out. Electrical Joule heating is grasped to re-sanction enhancing heat in treated steel tests. Spherical spouts ar accustomed create air stream the outcomes expressions that for relative circumstances spherical planes provide higher standard heat transfer constant seem otherwise in relevancy house stream. The simplest traditional heat transfer constant got is 2500 W/m2K. Within the gift examinations the letter exhibits a growing example with the Re. on these lines there's credibleness to revamp the warmth departure by growing the wind current rate. Chan.B et al [7] investigated the warmth transfer attributes of associate degree aluminium lather sink focus to associate degree imposing air flow is researched tentatively, below stationary siphoning force upset. The impacts of dimensionless siphoning power, Re and L/T on the letter are thought of. The result demonstrates that the impact of the happening house on the letter is inapplicable beneath static Re, whereas the letter reductions with L/T beneath fastened siphoning power. Seeable of the exploratory outcomes, {an Associate in letterrsing|AN|associate degree associate} empiric affiliation for anticipating the Nu is planned as a element of the dimensionless siphoning power and L/T. In light-weight of the take a look at consequences, {an Associate in letterrsing|AN|associate degree associate} experimental affiliation for foreseeing the Nu is suggested as a element of the dimensionless siphoning power and L/T. B.K.Friedrich, A.W.Galspell et al [8] has examined heat transfer and fluid flow attributes of a flooded jet impacting on A level shallow plate ar tentatively researched. The operational fluids are air and water. The

impacts of a varied kind of L/T dividing (H/d = zero.1-40) on the letter and pressure droop are measured. The outcomes demonstrate that the letter and pressure are isolated into 3 spaces; locus (I) jet diversion area (H/d < zero.6), space (II) potential centre locus (0.6 < H/d < 7), and space (III) free flow space (7 < H/d < 40). In area I, the standardized stagnation letter and stagnation pressure radically increment with decreasing the L/T dividing since the provided siphoning force increments because the L/T dispersing diminishes. In area II, the impact of the L/T spacing is immaterial on the standardized stagnation letter and pressure since the traditional speed of potential centre is steady. In space III, the standardized stagnation letter and pressure monotonically decline with increasing the L/T spacing owing to a decreasing in flow rate. The stagnation letter and pressure appeared identical pattern despite the very fact that those don't seem to be really coordinated in big selection of L/T arrangement. In light-weight of the exploratory outcomes, new correlation for the standardized stagnation letter what is a lot of, pressure of the happening plane are created as a part of the L/T dispersing alone. Tan Xiao, Zhang Jing et al [9] he tested examination on cooling exhibitions of indispensably emission cooling arrangements with film cooling openings calculated typical to the quality stream is directed. The adiabatic film cooling adequacy what is more, the final cooling adequacy ar calculable on a polycarbonate take a look at plate and a treated plate on an individual basis. Impacts of the carrying proportion (extended from0.6 to 2.4), Multi-opening arrange (inline and stunned), gap to-gap pitch proportion (ran from three to 5) and stream to-target separating proportion (extended from a pair of to 4) on the preserving execution are studied. The activity of additional stream impingement heat transfer on civilizing usually speaking cooling execution is incredibly captivated with the thunderous amount, Multi-gap game arrange and L/T dividing, that seem to be carried on predominant within the circumstances where the film cooling impact disengaging the wall superficial since the new normal is scrawny. Because the agent amount stream rate per unit territory of cooled apparent expands, the gap to-gap pitches can be slowly extended to whole viable usage of exhibit stream impingement. Multi-gap surprised course of action provides overall higher adiabatic film cooling viability than the inline partner. Given the same agent amount stream rate, the agent glaze over the apparent are going to be showed signs of improvement for the discharge cooling style with very little pitches. Laxmikant.D, Mangesh.B et al [10] has done examinations driven for various game plans of varied spherical openings. The information parameters as an example, excitation repeat, (PCR) and axial distance from slant of the warmth sink edge to gap plate keep measured within the examination. The show of the warmth sink with regard to spatial-typical heat transfer constant and warmth block is recorded. although happening on the warmth sink, the foremost extraordinary heat transfer constant got with varied gap made twelve-tone system bigger than a typical solitary gap engineered jet associate degrees on totally different occasions a lot of visible than the contrastive case and therefore the uncovered perfervid surface designed stream sink mix shows an hazy execution thereupon gained with a normal fan-heat sink framework. Heat

restriction of the warmth sink shows degeneration with addition in data ability to try to made stream mechanism. Regardless, such lead is not shown by a friend. The bottom heat restriction of the warmth sink with varied gaps engineered jet is seen to be up to totally different occasions bigger than the thermal interference without charge convection. empiric relationship stay created since preliminary statistics delineating the assortment in heat obstacle as a element {of data of knowledge} management Multiple-opening invented stream in closeness of warmth sink shows associate degree unclear heat execution in examination with a business fan at higher information management. Varied gap created stream demonstrate on various case higher thermal restriction with the free convection.

2. Experimental Set-Up & Procedure

In the schematic diagram of air jet impingement used in the investigational procedure as shown in fig. A blower is used in the flow of air in the ability of 1.5 m^3/min. It is unreliable the speed also. To connect the blower pipe to settling chamber. In the settling chamber the air is flow through the nozzle into the object plate. In the settling chamber arrange the 30.5cm*30.5cm square wooden sheet and 1.5cm thickness of wooden sheet. In this picket sheet we tend to will take every sides 5cm distance mark and vertically thirty. 5cm height glass wall and horizontally 21cm length type an oblong box. During this box prime of the sinking chamber mark three.5cm radius and cut it hole. Within the middle of the picket sheet mark three hole to flow the air into the target plate. In the bottom of the picket sheet we tend to will take same length of prime box to build another box. In the nozzle recess diameter is 10mm radius & outer diameter is 6mm radius and every nozzle to nozzle distance is 2cm in bottom of the picket sheet we tend to will place the metallic element plate at the distance of 5cm, 10cm & 15cm severally. The parameters of flat plate square measure 40mm*40mm length & thickness is 4 mm and another one is pin-fin length is 40mm*40mm and pin height is 6cm and pin thickness is 2mm. We are able to insulate the plate four sides and bottom of the plate is applied the warmth flux and shelter deck of the plate is placed six thermocouples. In these three thermocouples, three thermocouples are placed plate prime it takes the surface temperature and different three thermocouples placed the sides of the glass wall to require the close temperature in this method to run the pin-fin sink additionally. The heat sinks square measure making ready the metallic element material. The experiment procedure to conduct the flat plate we tend to will apply the bottom heat flux within the vary of 45w/m^2 and prime of the sinking chamber to flow the air within the speed of 10m/s and pin-fin sink is additionally same speed 10m/sin the flow of air through blower . We tend to will take the speed readings through the flow of air flowing to the sinking chamber to place the vacuum meter. We can supply the voltage through dimmer stat in this dimmer-stat to supply the power through the heater in the capacity of heater to supply. The capacity dimmer-stat is zero to 270v AC in single phase AC circuit and 3 phase AC is 415v AC. We can apply the voltage in this experiment is 45w/m^2 source is applied to

perform the experiment. It has some heat loss is also done in the experiment. The schematic diagram of the experiment is shown in fig

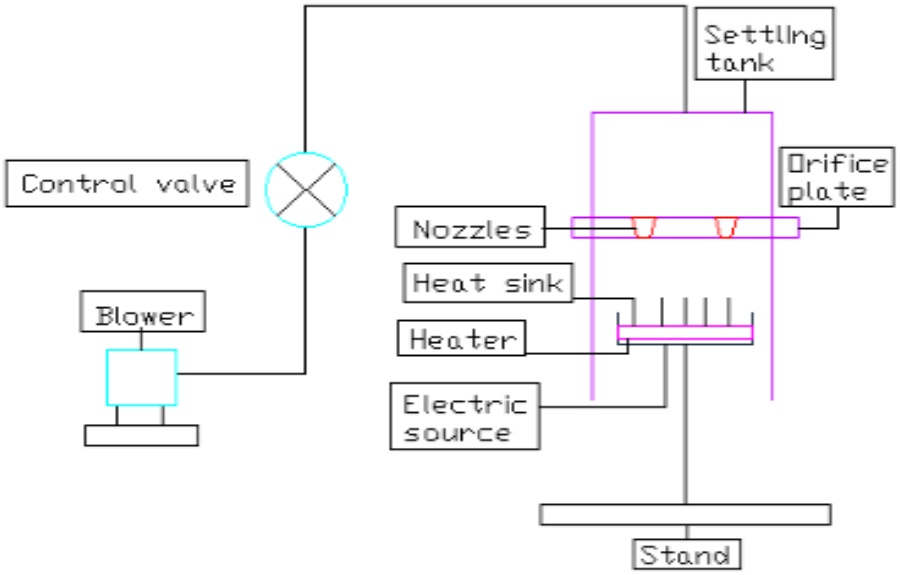

Fig.1 *line diagram of air jet impingement*

Table 1: *Experimental Readings for flat plate Heat Sink*

S.No	Velocity (m/sec)	L/T	Density (Kg/m^3)	Viscosity (m/sec)	Heat transfer coefficient (W/m^2k)	Nusselt Number	Reynolds Number	Thermal Conductivity
1	5.6	5	1.0859	$19.71x10^{-6}$	169.31	47.69	2468.09	0.0284
2		10	1.0787	$19.82x10^{-6}$	148.14	39.2	2438.23	0.02856
3		15	1.0704	$19.94x10^{-6}$	122.6	34.17	2404.91	0.0287
4	5.2	5	1.077	$19.84x10^{-6}$	146.31	41.94	2258.26	0.02859
5		10	1.067	$19.89x10^{-6}$	120.12	33.18	2220.4	0.0288
6		15	1.06	$20.1x10^{-6}$	102.7	28.38	2193.8	0.02896
7	4.8	5	1.0688	$19.99x10^{-6}$	126.98	35.06	2053.12	0.02877
8		10	1.0605	$20.09x10^{-6}$	102.54	28.3	2027.03	0.02894
9		15	1.0532	$20.2x10^{-6}$	96.09	26.14	2002.12	0.0294
10	3.9	5	1.0627	$20.05x10^{-6}$	107.74	29.8	1653.6	0.0289
11		10	1.0522	$20.22x10^{-6}$	92.76	25.5	1623.5	0.0291
12		15	1.046	$20.32x10^{-6}$	85.34	23.2	1606.06	0.0292
13	3.5	5	1.0538	$20.19x10^{-6}$	96.98	26.66	1461.43	0.0291

14		10	1.046	$20.32x10^{-6}$	83.99	23.01	1441.33	0.0292
15		15	1.0388	$20.43x10^{-6}$	77.87	21.18	1423.7	0.0294
16		5	1.04	$20.41x10^{-6}$	79.61	21.66	1059.87	0.0294
17	2.6	10	1.0326	$20.53x10^{-6}$	72.56	19.67	1046.18	0.0295
18		15	1.0251	$20.65x10^{-6}$	66.67	17.95	1032.54	0.0297

Table 2:*Experimental Readings for Rectangular fin Heat Sink*

S.No	Velocity (m/sec)	L/T	Density (Kg/m^3)	Viscosity (m/sec)	Heat transfer coefficient (W/m^2k)	Nusselt Number	Reynolds Number	Thermal Conductivity
1		5	1.125	$19.16*10^{-6}$	918.82	266.23	2865.3	0.0276
2	6.1	10	1.121	$19.2*10^{-6}$	673.6	194.7	2849.2	0.0277
3		15	1.118	$19.25*10^{-6}$	532.1	153.24	2834.2	0.02778
4		5	1.122	$19.2*10^{-6}$	842.1	243.47	2711.5	0.02767
5	5.8	10	1.117	$19.26*10^{-6}$	631.97	182.05	2691	0.02777
6		15	1.112	$19.33*10^{-6}$	421.05	120.9	2669.2	0.02786
7		5	1.1157	$19.29*10^{-6}$	673.68	193.86	2452.3	0.0278
8	5.3	10	1.109	$19.38*10^{-6}$	421.05	120.73	2426.2	0.0279
9		15	1.105	$19.43*10^{-6}$	362.19	103.48	2411.33	0.028
10		5	1.093	$19.6*10^{-6}$	259.1	73.4	1650.65	0.02824
11	3.7	10	1.089	$19.65*10^{-6}$	219.72	62.04	1640.42	0.02833
12		15	1.086	$19.69*10^{-6}$	198.14	55.85	1631.83	0.02838
13		5	1.089	$19.66*10^{-6}$	224.56	63.48	1462.3	0.0283
14	3.3	10	1.085	$19.71*10^{-6}$	198.14	55.81	1453.27	0.0284
15		15	1.083	$19.78*10^{-6}$	171.33	48.09	1445.4	0.0285
16		5	1.088	$19.68*10^{-6}$	215.09	60.8	1282.6	0.0283
17	2.9	10	1.083	$19.75*10^{-6}$	194.36	54.75	1272.1	0.0284
18		15	1.078	$19.83*10^{-6}$	171.33	48.09	1261.3	0.085

Table 5: *Simulation Results for flat plate Heat sink*

L/T	Tmax, K	Tmin, K	Tavg, K	Range, K	% Range	Nu	h(w/m^2-K)
5	373.418	306	339.709	67.418	19.84	128.398	125.915
10	377.112	304	340.556	73.112	21.46	250.921	123.285
15	389.237	304	346.618	85.237	24.59	322.301	107.254

Table 6: Simulation Results for pin-fin Heat sink

L/T	Tmax, K	Tmin, K	Tavg, K	Range, K	% Range	Nu	h(w/m^2-K)
5	329.478	301.635	315.656	27.843	8.82	345.385	319.365
10	331.034	301.713	316.373	29.321	9.26	659.332	305.380
15	342.992	302.388	322.69	40.604	12.58	702.533	220.361

3. Numerical Methodology

A. Geometry

To considered the computational fluid problem under the consideration of the schematic diagram as shown in fig. The cold air enters the room temperature to and uniform velocity U is entering the nozzle comes out through turbulent jet and impinging the heated flat plate and its finite thickness. The plate top side is coming the air & bottom side is applied constant heat flux and other 4 sides insulated. The size of the impinging plate is 75mm*120mm*5mm respectively. The ambient pressure and temperature are 1*10^5 Pa and 300K respectively. The flow of air is incompressible & steady state with constant fluid properties. To neglected the surface radiation & buoyancy.

B. Meshing

When we complete the design modular in ANSYS 2020R. Then we start the meshing option in this option Tetrahedral meshing for fluid domain and Hexahedral meshing for impingement plate. We can give the naming for flow of the air entering and leaving and apply the plate bottom heat flux. Then we apply the fine meshing with 15 inflation layers is adopted.

C. Boundary Conditions

The boundary conditions are applied this problem are shown in fig

1. Velocity inlet: velocity U=5.6, 5.2, 4.8, 3.9, 3.5, 2.6 m/s & uniform Temperature T = 300K.
2. Heat flux: constant heat flux is applied q = 5000w/m^2.
3. Pressure outlet: the flow variable & temperature are corresponding to Zero.
4. Wall: it is an adiabatic condition & No slip.
5. Interface: it is a fluid – solid interface & heat transfer boundary condition is imposed.

D. Numerical Scheme

The 3-Dimesional steady state governing equations of mass, momentum & energy equation flow based on Reynolds number & energy equation is solid

region is solved using the Ansys fluid software. The two equation of turbulence is shear stress & k-w model is acceptability. Pressure and velocity are solved the single algorithms. The three equations are convergence by the continuity, momentum and energy is 1*10^-5, 1*10^-9 & 1*10^-4.

4. Result And Discussion

A. Design Parameter

The jet Reynolds number flow the air above the 2000 is called as turbulent flow jet and it is below the 2000 is called laminar flow jet as shown in equation [1]

Re = ρUd[1]

B. Performance Parameter

Since, in the view of performance of jet impingement cooling at the local temperature range & average heat transfer performance on the heated surface. At that maximum, minimum & average temperature i.e.; Tmax, Tmin & Tavg respectively. From these values distribution of local temperature and its parameter is called as temperature range as shown in equation [2].

TR = $Tmax{-}TminTavg$×100[2]

At this heat transfer performance of impingement jet over a flat plate and pin-fin heat sinks are uniformly distributed. At this distributed to calculate the Range and % Range in the equation of 3 & 4.To also calculate the localized thermal stress and fatigue failure of the component over a flat plate and Rectangular-fin heat sinks to calculate the Nusselt number in the equation of 5.

Range = Tmax-Tmin [3]

% Range = $RangeTavg$×100[4]

Nu = hlk= ($Tavg{-}To$)×lk[5]

C. Effect of jet-to-plate heat sink separation on the impingement cooling performance

The effect of impingement plate variation of L/T values on the temperature distribution over a flat plate heated surface of Aluminium at different L/T ratios is 5, 10, and 15 respectively. It is the evidence of temperature contours that the range of temperature increases when increase the L/T values. When we increase the L/T values the temperature is also increases. In L/T distance is less the heat transfer is low and the L/T distance is increasing the heat transfer is also increases. When the nozzles hit the target plate in that area have low temperature indicated and remaining area have some more heat is having. We can apply the same temperature in all L/T values. The result of Experimental and simulation of Nusselt number, Range of temperature and heat transfer coefficient at different L/T ratio5, 10 and 15 in above tables. The results of the different L/T ratios are 5, 10, 15in maximum temperature indicate the 373.418, 377.112 & 389.237 respectively.

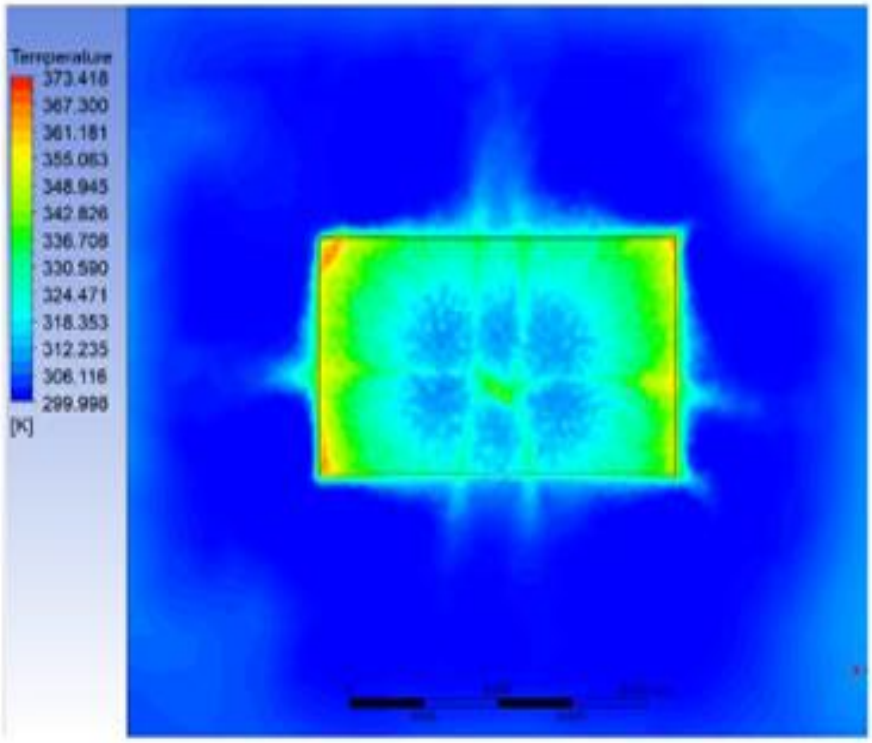

Fig.2 *L/t=5*

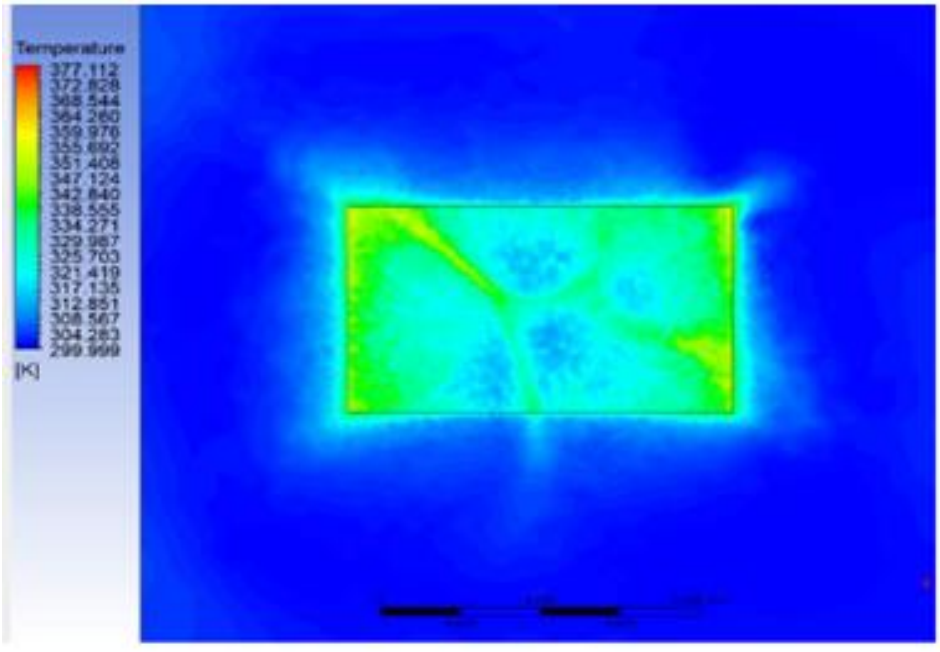

Fig.3 *L/t=10*

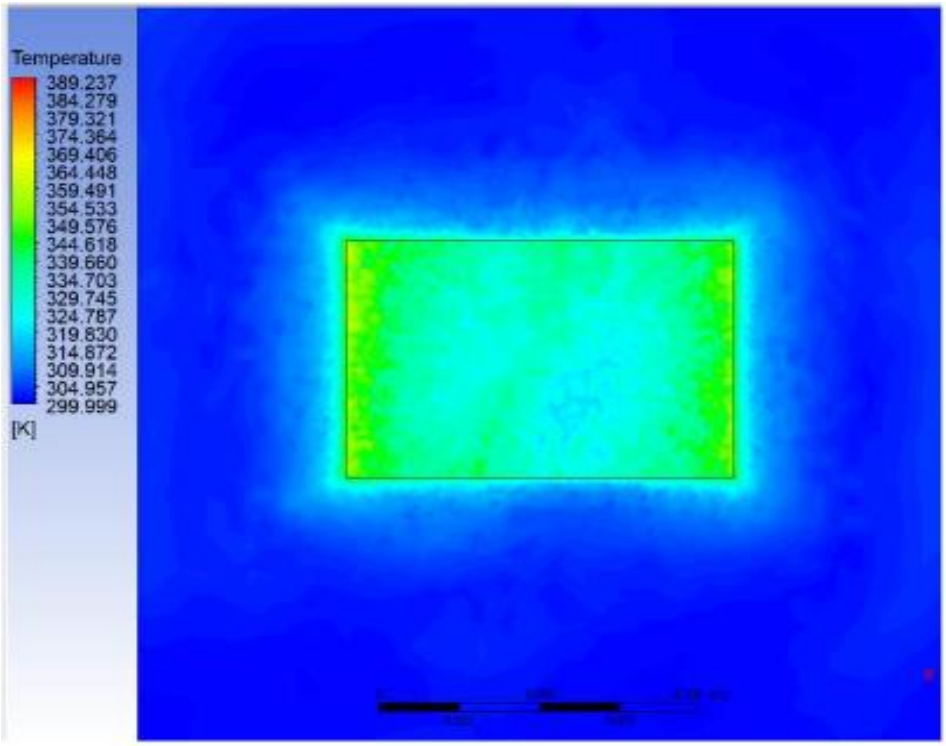

Fig.4 *L/t=15*

D. Effect of jet-to-rectangular fin heat sink separation on the impingement cooling performance

The effect of impingement over a pin-fin heat sink variation of L/T values on the temperature distribution over a pin-fin heated surface of aluminium at different L/T values is 5, 10, and 15 respectively. When we increase the L/T values the temperature is also increases. In L/T distance is less the heat transfer is low and the L/T distance is increasing the heat transfer is also increases. When the nozzles hit the target plate in that area have low temperature indicated and remaining area have some more heat is having. We can apply the same temperature in all L/T values. In this pin -fin heat sink the temperature flow through the bottom of the heat sink to transfer the fin top it takes the sometime it has consider the some length so temperature is low but flat plate it has less length it cover the less time the heat transfer occur the fast and the temperature is more. The results of the different L/T ratios are 5, 10, and 15 in maximum temperature indicate the 329.478, 331.034 & 342.992 respectively. To compare the flat plate and pin-fin heat sink the best heat sink is flat plate to transfer the heat.

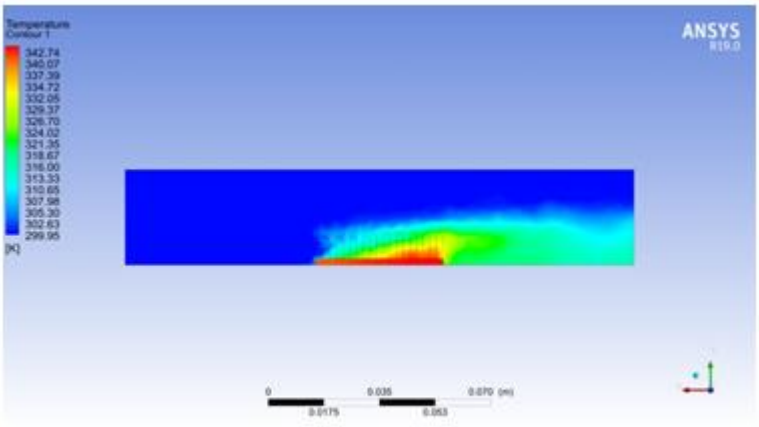

Fig.5 *L/t=5*

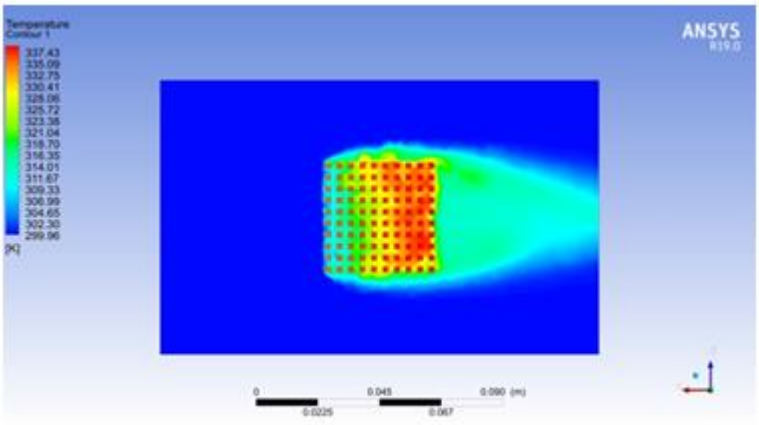

Fig.6 *L/t=10*

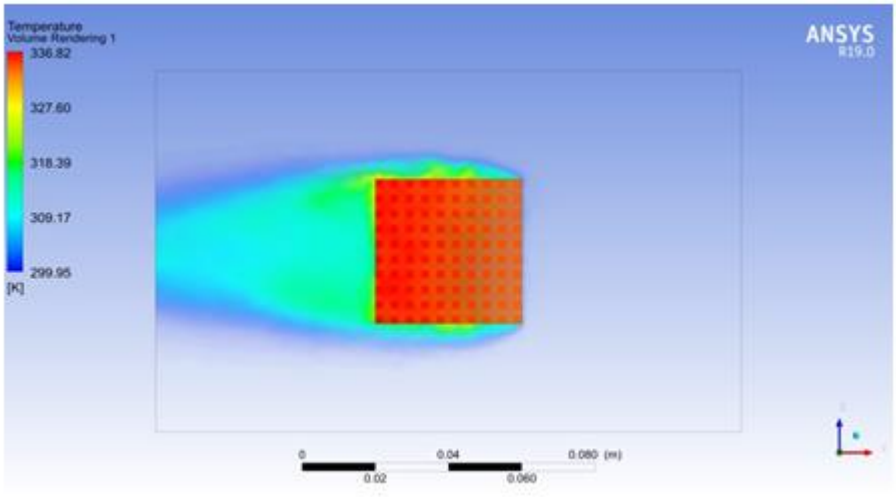

Fig.7 *L/t=15*

E. The graphs between different L/T and Range of temperature, Nusselt number and heat transfer coefficient by flat plate heat sink

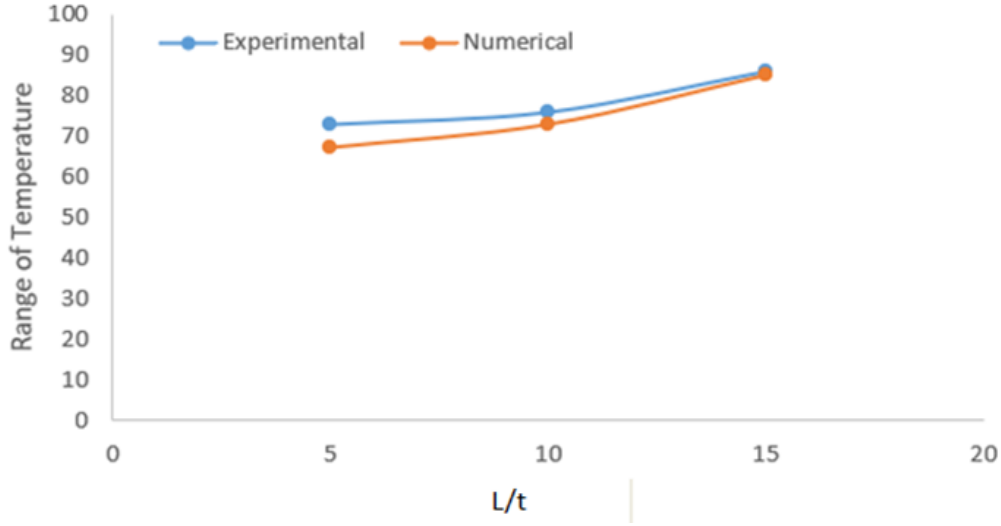

Fig.8*variation of Range of temperature vs L/t ratio on flat plate*

We can observe in this figure 8to vary the different L/t ratios 5, 10, 15 in the Experimental and Numerical values to compare. In this graph the higher values are indicated in the distance of L/t = 15. The Experimental value is 86 & numerical value is 85.237. So, we can conclude the Range of temperature is best for Experimental to compare the numerical.

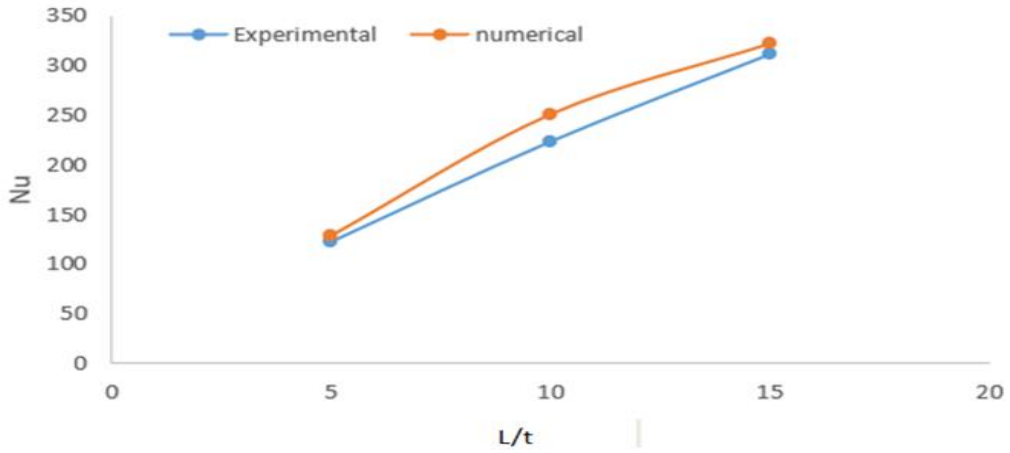

Fig.9 *variation of Nusselt number vs L/t ratio on flat plate*

The flow resistance is the main importance of the heat transfer performance due to minimum pumping the pressure drop for various flow rate of friction factor. we can explain the Nusselt number is higher for numerical value to compare the Experimental value. The numerical value is 322.301 and experimental value is 311.824. Because some leakage for experimental work so the experimental is less than the numerical.

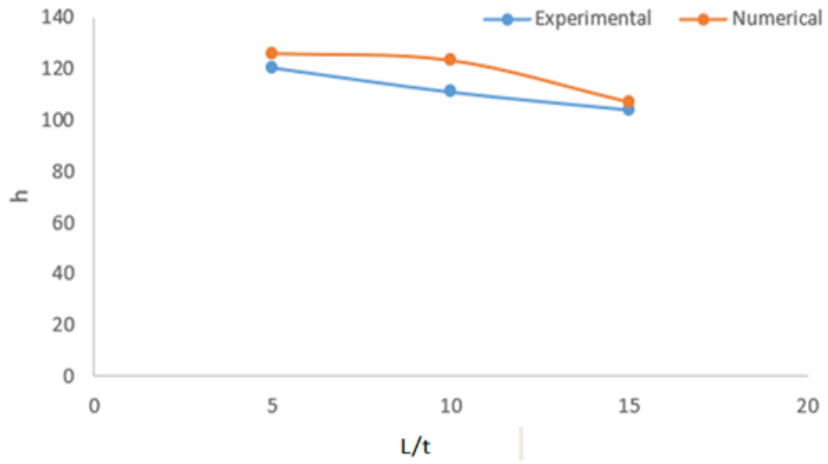

Fig.10 *variation of heat transfer coefficient vs L/t ratio on flat plate*

For this heat transfer coefficient, the performance of Reynolds number for different L/t ratios to flow the incompressible air through the jet to hit the target plate at different L/t ratios in this L/t = 5 is give the best result for numerical. The numerical value is 125.915 to compare the experimental value is 120.481 respectively.

F. The graphs between different L/t and Range of temperature, Nusselt number and heat transfer coefficient by flat plate heat sink.

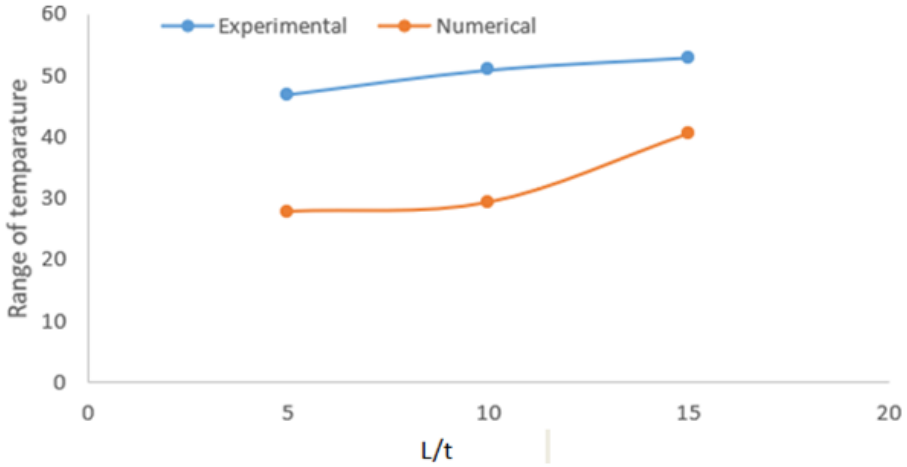

Fig.11 *variation of Range of temperature vs L/t ratio on pin fin*

We can observe in this figure 11 to vary the different L/t ratios 5, 10, 15 in the Experimental and Numerical values to compare. In this graph the higher values are indicated in the distance of L/t = 15. The Experimental value is 53& numerical value is 40.604. So, we can conclude the Range of temperature is best for Experimental to compare the numerical.

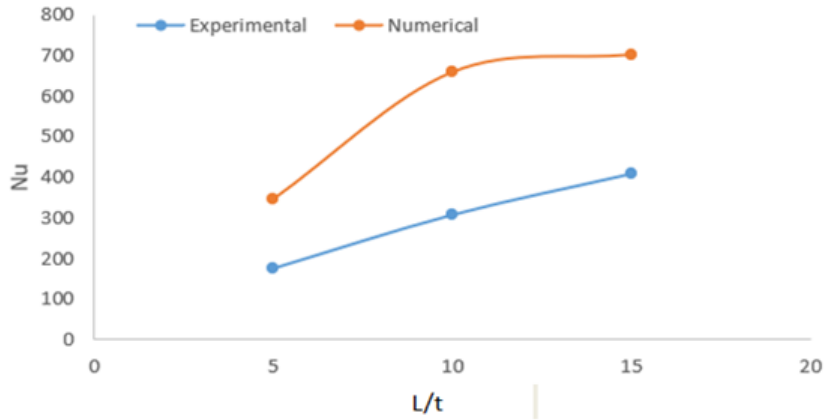

Fig.12 *variation of Nusselt number vs L/t ratio on pin fin*

The flow resistance is the main importance of the heat transfer performance due to minimum pumping the pressure drop for various flow rate of friction factor. we can explain the Nusselt number is higher for numerical value to compare the Experimental value. The numerical value is 702.533 and experimental value is 409.97. Because some leakage for experimental work so the experimental is less than the numerical.

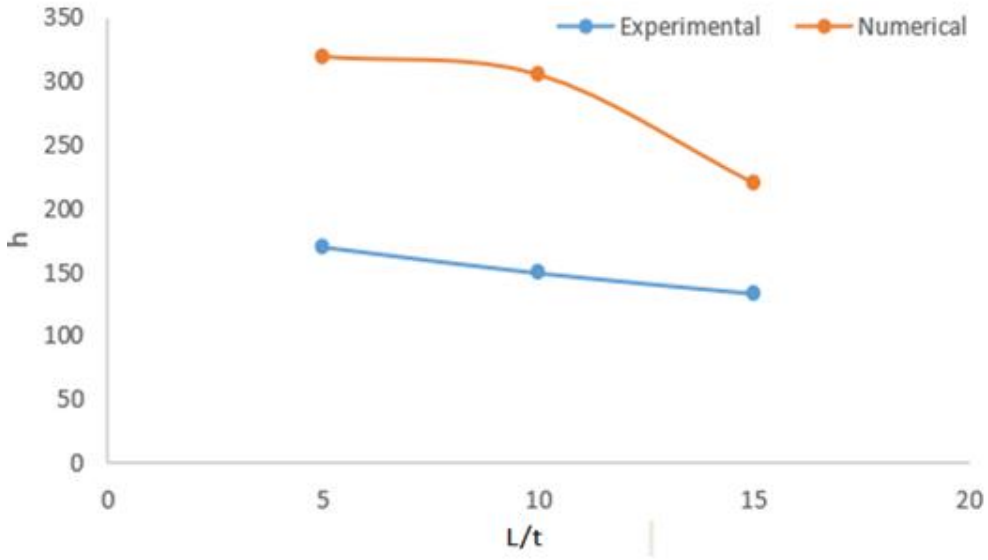

Fig.13 *variation of heat transfer coefficient vs L/t ratio on pin fin*

For this heat transfer coefficient, the performance of Reynolds number for different L/t ratios to flow the incompressible air through the jet to hit the target plate at different L/t ratios in this L/t = 5 is give the best result for numerical. The numerical value is 319.365 to compare the experimental value is 169.48 respectively.

G. The numerical graphs between the different L/t ratios and Range of temperature, Nusselt number, Heat transfer coefficient by compare the flat plate & pin-fin heat sink.

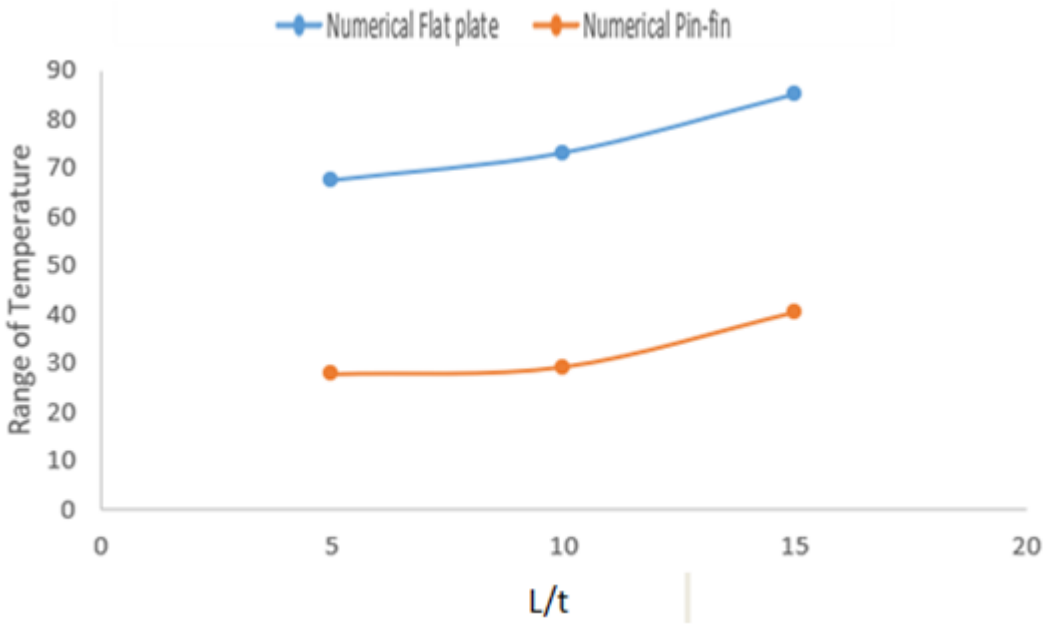

Fig.14 *variation of Range of temperature vs L/t ratio*

In this numerical to vary the Flat plate and pin fin heat sink by different L/t ratio to Range of temperature. In the flat plate easily, the heat distributed but pin fin the heat passes the plate to fin tip take some time but pin fin heat sink gives the best result in this graph the Range of temperature give the best result for flat plate to compare the pin fin heat sink. At the L/t =15 gives the maximum value for flat plate is 85.237 and pin fin is 40.604 respectively.

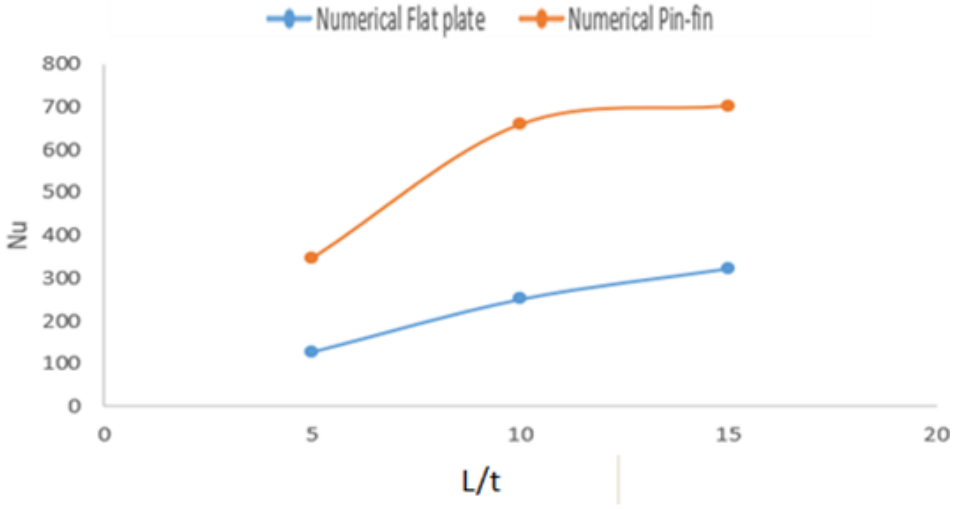

Fig.15 *variation of Nusselt number vs L/t ratio*

In this graph pin fin heat sink give the best to compare the flat plate because the flow of incompressible air through nozzle in the target plate & pin fin heat

sink. At the L/d= 15 is the maximum value to compare the other ratios. In this graph the Nusselt number is higher for pin fin heat sink to compare the flat plate heat sink because the flow of air due to pressure drops of friction factor. In this the Nusselt number for pin fin is 702.533 and flat plate is 322.301 respectively.

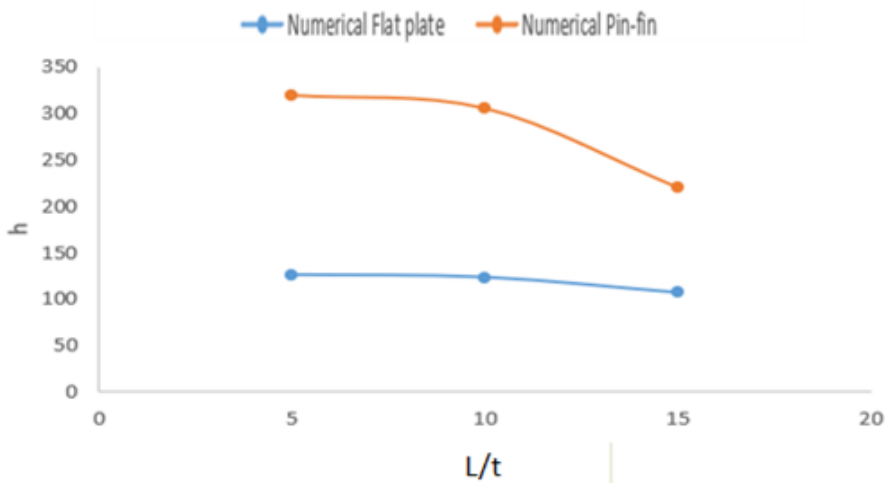

Fig.16 *Variation of heat transfer coefficient vs L/t ratio*

For this heat transfer coefficient, the performance of flat plate and pin fin heat sink. We can observe the L/t = 5 is give best result for pin fin to compare the flat plate heat sink. At this flow of air & Reynolds number through the jet to hit the target plate in this process the more heat transfer rate in the pin fin heat sink to compare the flat plate. The result of pin fin heat sink is 319.365 and flat plate is 125.915 respectively. In this graph the variation of different L/d ratio with Range of temperature, Nusselt number and heat transfer coefficient.

5. Conclusion

An Experimental and numerical investigated on the flow of fluid and heat transfer study on multi air jet impingement over a flat plate and pin fin heat sink. To vary the different L/d ratios in flat plate and rectangular fin heat sink with a constant heat flux over a heated surface. To conclude the study are as follows. The nozzle to the target flat plate and pin fin heat sink spacing by L/t ratio significant of heat transfer on an observed from the graph. Range of temperature is 0.89% and 0.24% is higher at experimental to compare the numerical over a flat plate and pin fin heat sink. Nusselt number is 3.36% and 0.72% is higher at numerical to compare the experimental over a flat plate and pin fin heat sink. Heat transfer coefficient is 4.58% and 0.89% is higher at numerical to compare the experimental over a flat plate and rectangular fin heat sink.

Finally, rectangular fin heat sink is giving the best heat transfer performance to compare the flat plate heat sink

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