Performance Analysis of Thermal Characteristics of Transient Heat Transfer through Finite Fins of Various Shape of Notches

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***Abstract*-The present article investigate the analysis of transient heat conduction through fins. Fins re the extend surface used for enhancing the dissipation of heat transfer rate and different geometrical fins are used as per requirement its accessibility depends. Fins are extensively used in that heat exchanging device in automobile radiators industrial sector, power plant newer technology like fuel cells. Earlier work under steady state conduction heat been carried out extensively. Transient heat conduction analysis for this is being considered for simplify heat transfer queries. Transient closed from solution had been derived earlier by various researchers. As proper heat dissipation results in saving of power of lesser changes over heating problems, perforation on made the fins. Perforated fin improves heat transfer rate collate to solid fin by varying different parameter like shape of performance For the purpose of contrast and optimizations, notch of different aspect ratio a single plate have also been analysis in a lengthwise short array where the single plate have also chimney flow pattern of present, the central portion of fin flat becomes futile due the fact that, the heated air comes in its contact. In the present study the fin of different geometries are modify by deposing the central fin portion by cutting a triangular, rectangular and un-notch fins. This articals present a performance analysis of the thermal characteristics of Transient heat transfer for finite finite fins and various shape of notches on single plate for that an experimental setup is developing and also shows a comparison between the experimental result obtained by using ANSYS software.**

***Keywords*- Transient heat transfer, Notch, Optimization, conduction, ANSYS.**

I. INTRODUCTION

Fins are the extended surface used for enhancing the dissipation of heat transfer rate The transient response of the fins industrial sectors. Work under steady state conduction had been carried out extensively. Transient heat conduction analysis for the fin is being considered for simplifying heat transfer queries. Transient closed form solution had been derived earlier by various researches.

Extend surface is used specially to enchace the heat transfer rate between a solids adjoining fluid. Such an extended surface is termed a fins. In a conventional heat exchanger heat is transferred from one fluid to another through a metallic wall. The rate of a heat transfer is directly proportional to the extend of the wall surface the heat transfer coefficient and to the temperature different between one fluid and the adjacent surface. If thin strips [fins] of metals are attached to the basic surface, extending into one fluid, the total surface for heat transfer is thereby increased. The use of fins in one side of wall separating two his important in a wide range of engineering devices, automobilese at exchange fluid is exploited most if the thermal resistivity a greatest . in such a case the fin serve the purpose of artificially increasing the surface trasmittance. Thus, fin find numerous application in electrical apparatus in which in generated heat must be efficiently dissipated, in specialized installations of a single and double pipe heat exchange on cylinders of air cooled internal combustion engines. Recently, finned surface are widely used in compact heat exchanger that are used in many application such as air conditioner aircrafts, chemical processing plant etc.. finned surfaces are also used in cooling electronic components. Generally in transient heat transfer on horizontal fin array single chimney flow pattern the air enters from sideways and gets heated as it moves inwards [towards center of the fin channel] as the temperature of the air increases air rises up due to decreases in density. Hence, no air comes in contact with the central bottom portions of fin channel. This creates a stagnation zone near the central bottom portion of fin channel. To overcomes this difficulty some portion of fin is removed near the stagnation zone near to increase HTC. The notches are provide in various size and shapes on single plate and are added at the place where fresh air comes in contact with fin surface.

The general disposition of fin on the base surface is usually either longitudinal [straight fins] on circumferential [radial fins] fins may also be disposed in the form of continuous spiral on the base surface on in the form of continuous spiral on the base form of individual rods as pin –fins or spines.

The cross section shape of the extend surface in a plane normal to the base surface is to be referred to as the profile of the fin or spine. Different fin profiles considered in the present study are shown in fig.

Disposition fin on the base surface result in increase of the total surface area of the heat transfer. It might base expected that the rate of heat transfer per unit of the base surface area would increase in direct proportion. However, the average surface temperature of this strips [fins], by virtue of temperature gradient through them, tends to decrease approaching the temperature different is decreased and the net increase of heat transfer would not be in direct proportion to the increase of the surface area and n that would b be considerably less direct proportion to increases of the surface area and may be anticipated on the basis of the increase of area alone . The ratio of the actual heat transfer from the fin surface to that would transfer if the whole fin surface were at the same temperature as the base is commonly called as the fin effiency.

II. LITERATURE REVIEW

“Exact Solution for Transient Heat Conduction through long Fin ISSN 2278-361X Volume 4, number 1 [2013], pp.1-9[1]

This work emphasized on the analysis of transient heat conduction through fins. The exact local and mean temperature distribution had been generated by numerical technique method. Exact solution is given for a transient temperature influx- base fin with the method of green’s function [GF] in the form of infinite series for three different tip condition. The time of convergence is improved by replacing the series part. For the long fin case, exact fin solution is presented in graphical from. Programmed solution is determined for analysis of exact fin theory. Dimensionless temperature distribution is also presented for exact fin theory.

Analysis of Thermal Characteristics of Transient Heat Conduction Through Long and Comparison with Exact Fin Theory Quasi Steady Theory;-Arun kumar Sao, Dr. Yamuna Prasad Banjare [ISSN 2250-2459, ISO 9001; 2008 Certified journal , volume 4, Issue 11, November 2014.];-[2]

The paper work incorporated the analysis of transient heat conduction through long fin and comparison with theory base on it termed as ‘exact fin theory’ &’quasi steady theory’ at different location of fin at different parameters. The work under steady state conduction had been carried out extensively. Transient heat conduction analysis for the fin being considered for simplifying heat transfer queries .transient close from solution had been derived earlier by various researches .The exact local and mean temperature mean distribution had been numerical technique method. time of convergence is improved by replace the series part from required equation.

Heat transfer improvement of a wet fin under transient response with unique design arrangement aspect. Balaram kundu, Rajan das Pramod A. Wankhede, Kwan –soo Lee. 23 august 2018[3]

A unique design arrangement longitudinal and pin fins involving surface dehumidification is proposed for improving the fin’s heat transfer enhancement under transient operating condition. The new design arrangement involved dual primary fin surface. For the present analysis, the assessment of Fourier and non-fourier effect is made, and a closed from solution methodology involving separation of variables is adopted to evaluated the fin performance. the proposed closed from methodology for the non -Fourier heat transfer effect in the fin as well- validated with the corresponding numerical solution obtained under finite differencing framework. Furthermore, for a dry surface condition, the validation of the present non-Fourier model is done with the pertinent result available in the literature.

Establishment of non-Fourier Heat conduction model for an accurate transient thermal response in wet fins. Pramod A. Wakhede, Balaram Kundu 17 may 2018[4]

In this work, transient heat transfer response of wet fin is carried out using both of non –Fourier heat conduction models. The separation of variables is used to established the actual transient thermal response. The present analysis has been focused and generalized for both longitudinal and pin fin under isothermal and convective base condition. During the analysis the instantaneous efficiency has been introduced with both Fourier and non – Fourier heat conduction model in fins operating under dehumidifying condition .The analysis show a significant deviation in temperature response with the non-Fourier heat conduction as compared with that of the Fourier model. The effect of different design variable and fin surface condition is reported

Study Heat Transfer through a Two –Dimensional Rectangular Straight Fin; Raseelo J. Moitsheki and Atish Rowjee ; 14 february 2011.[5]

Exact solution for model describing heat transfer in a two – dimensional rectangular fin are constructed. Thermal conductivity, internal energy generation functions and heat transfer coefficient are assumed to be depends on temperature. We apply the Kirchoff transformation on the governing equation. Exact solution satisfying the realistic boundary condition is constructed for the resulting linear equation. Symmetry analysis is carried out to classify the internal heat generation function, and some reduction is performed. Furthermore, the effects of physical parameters such as extension factor [the purely geometric fin parameter] and Biot number on temperature are analyzed. Heat flux and fin efficiency are studied.

III. NEED OF INVESTIGATION

1. For optimum heat transfer rate determine dimensions of the notch.
2. To study influence of base ratio to The height of rectangular and triangular notch on the heat transfer
3. To calculate minimum material for maximum heat transfer
4. To analyze the effect for different materials.

5. To study spacing of the fins.

IV. EXPERIMENTAL WORK

Experimentation is done on different notches in fin like Unnotch, Rectangular notch and triangular notch of Aluminum material of thickness 3mm is used also M.S. material of same thickness used for the experimentation to check and calculate transient heat transfer. Following are the experimental setup with different fins with notches.

Figure 4.1. Experimental Setup with Base Plate

Figure 4.1 shows that experimental setup with Aluminum Base plate, thermocouple, ammeter, voltage regulator, and temperature indicator, dimmer, heating coil and bricks as an insulating material.

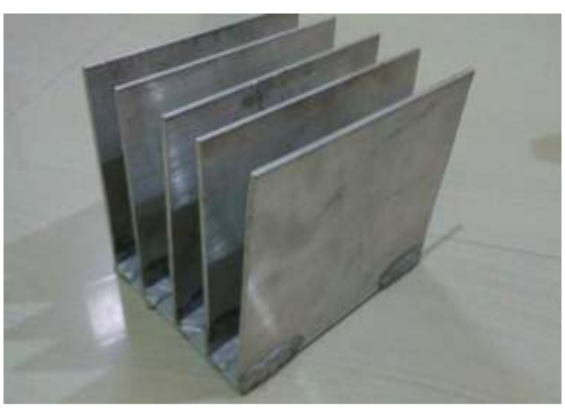


Figure 4.2. Unnotch Fins

Figure 4.3. Rectangular Triangular Notches with Different Material

Figure 4.3 shows that setup of aluminum base plate which is mounted with set of six fins with triangular notch and rectangular respectively. Similarly shows that setup of Mild steel base plate which is mounted with set of six fins with rectangular and triangular notches respectively.

Figure 4.4. Experimental Setup of Un-Notch fins of Aluminium and M.Son different watt.

Figure 4.5. Experimental Setup of Rectangular and Triangular Notch fins of Aluminium and M.S on different watt

V. CALCULATION BY ANALYTICAL METHOD

The Heat transfer rate can be calculated by using numerical relation are as inder:

1) Find Average Temperature of Fins(T_f):

$$T_f = \frac{T_1 + T_2 + T_3 + T_4 + T_5}{5}$$

Where,
$T_1, T_2, T_3, T_4\ and T_5\ are\ the\ temperature\ of\ tip\ of\ fins\ in$°C

2) To find Temperature of whole Body (T_{body}):

$$T_{body} = \frac{T_f + T_b}{2}$$

Where, T_b is the temperature of base plate in°C

3) To Find Temperature solution for fin i.e Caetesian coordinate, we should solve the Laplace's equation with boundary and initial conditions

$$\frac{\partial^2 T}{\partial x^2} = \frac{1}{\alpha}\frac{\partial T}{\partial t}$$

So, one can write

$$\frac{\partial^2 \theta}{\partial x^2} = \frac{\partial \theta}{\partial \tau}$$

4) To find Dimensionless distance X = $\frac{x}{L}$

5) To find Biot Number (Bi) = $\frac{hL}{k}$

6) To find Fourier Number (τ) = $\frac{\alpha t}{L^2}$

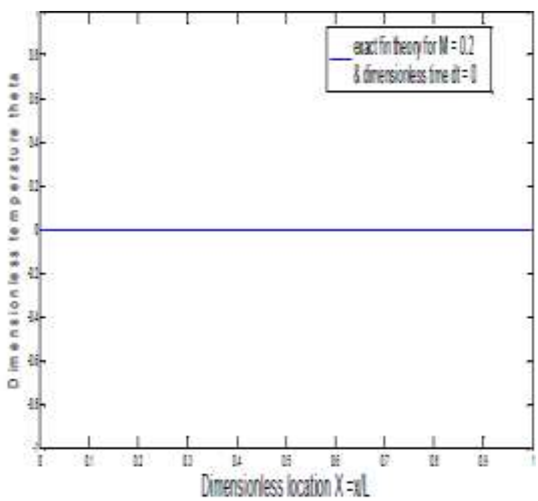
7) To find $\theta = \sum_{n=1}^{\infty} A_n \, e^{-\lambda^2 \tau} \cos(\lambda_n X)$

8) To find out heat transfer coefficient Type equation here.

Q= hA $[T_\infty - T(t)]$

Where, h= Heat transfer coefficient, W/m^2 k

VI. RESULT



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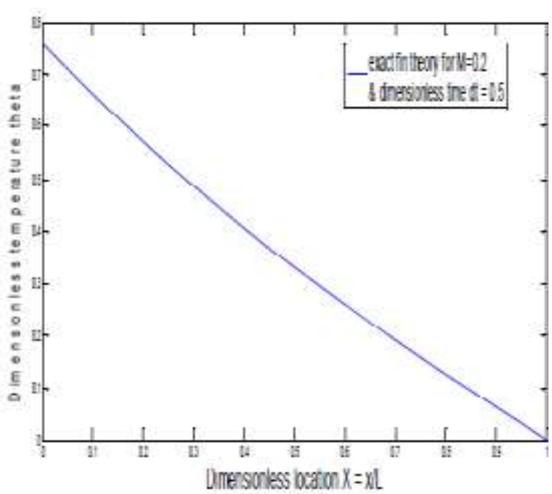

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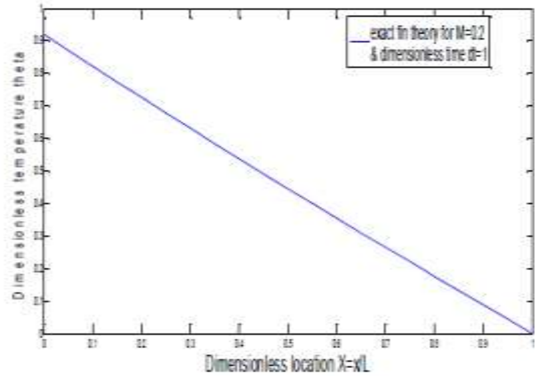

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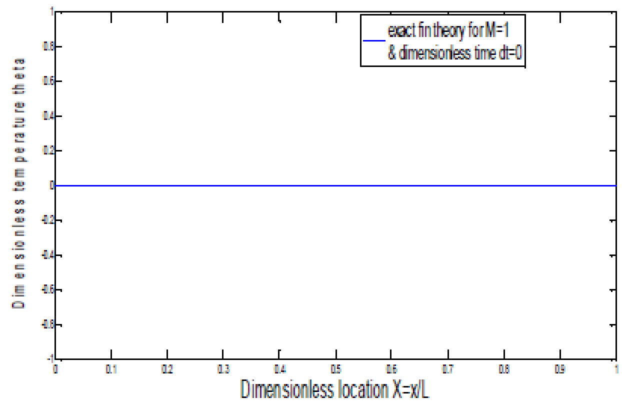

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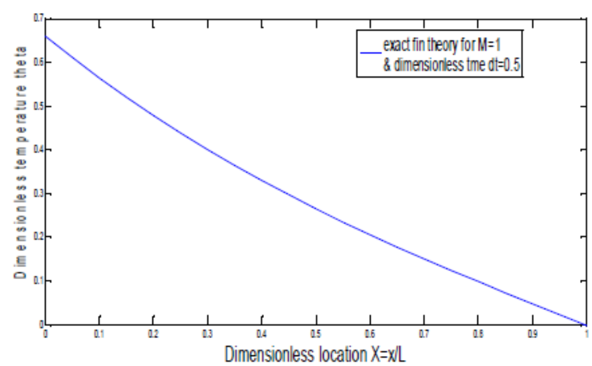

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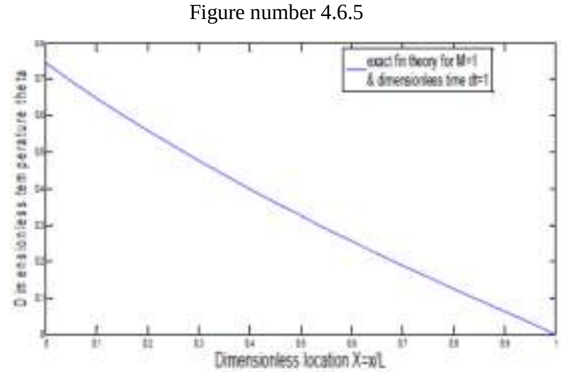

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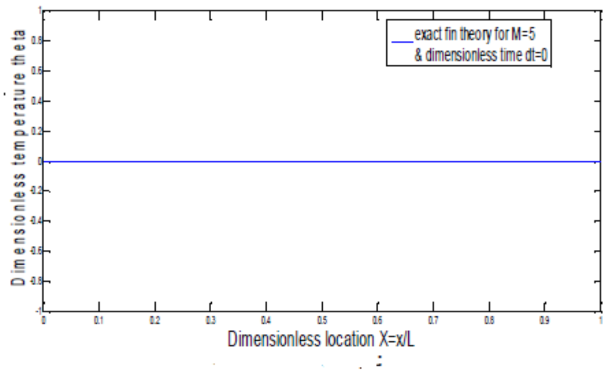

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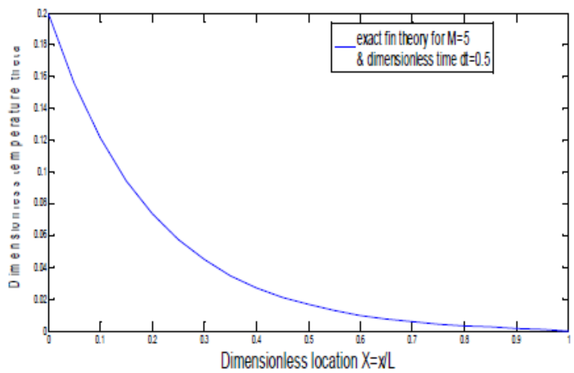

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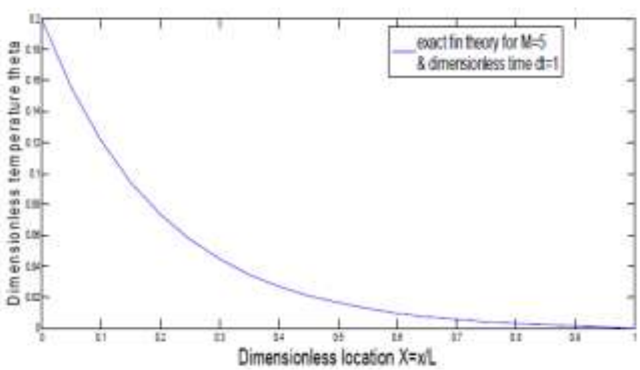

Figure number 4.6.9

Graphical results for the exact fin theory are as follows.Fig.4.6.1 to 4.6.3 shows the temperature distribution curve for exact fin theory, taking M = 0.2 & τ =0, 0.5 & 1. Curve does not change much for large dimensionless time when M is small. Temperature decreases when location changes from zero to one. Base temperature increases as the time increases.

Fig 4.6.4 to 4.6.6 shows the temperature distribution curve for exact fin theory, taking M = 1 & τ = 0, 0.5 & 1. Curve shows that the base temperature increases with increase in time. For low value of M temperature distribution curve remains same

Fig. 4.6.7 to 4.6.9 shows the temperature distribution curve for exact fintheory, taking M = 5 & τ = 0, 0.5 & 1. Curve attains steady state for large value of M.Curve does not change much for large dimensionless time. For the exact fin theory, temperature was computed in the range as: [0 <x=L < 1 and 0 < αt/L2< 1] for fin parameter values M = 0.2, 1.0 and 5.

VII. CONCLUSION

Following points are taken after experimentation and analytical comparison as under;

- Form various paper it has been revealed that fins can be used effectively to enhance the heat transfer rate.
- The performance of heat transfer fins can be analyzed effectively by commercially available ANSYS software.
- The heat transfer coefficient is highest of Aluminium as compared to M.S is 8.1W/m^{2}K with heater input of 200 watt for the set of triangular fins with notch and heat transfer coefficient is highest 8.3W/m^{2}K with heater input of 200 watt for the set of rectangular fins with notch. This has been taken from the experimental analysis done.
- Due to increase in the size of perforation, the friction factor slightly increases.
- Heat transfer enhancement depends on number of perforation, size and shape of perforation, thickness of perforated fin and thermal conductivity of fin material. The above methodology of experimental work and computational analysis with analytical calculation can be used further for different types of notches and fins
- The temperature distribution for long fin has been taken into account for exact fin theory. Complicated exact transient solutions can be simplified for temperature distribution analysis through Greens function method. Convergence of the solution can be improved by replacing the series steady term with non- series finite steady term. A unique solution is produced containing non dimensionless parameter for long fin case Larger value of M increases the transient response of fin.

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