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Literature Review On Of Pin Fin And Plate Fin Surfaces

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Abstract
Today, the extended surfaces have shown remarkable progress in the field of heat transfer, and still, an extensive research is going on them, globally. In this regard, the present research work is also devoted to the study of available literature on pin fin and plate fin surfaces. The research paper, acknowledges the summaries of selected contributions in the research, investigates the gaps in existing research and concludes with the objectives of the proposed research.

1. Introduction

According to Freegah et al. (2020), thermal performance improvement through design optimization of heat sinks has also gained a considerable attention in recent years. Ganesh and Prakash conducted research in the year 2019 to determine that all engineering systems in use produce heat. The system will malfunction because of overheating of the components if this heat is not frequently eliminated. Therefore, the heat from the system is removed using extended surface or fin (Ganesh and Prakash, 2019). Likewise, Shitole et al. (2018) explained that convection is the mechanism of heat transfer between a surface and a fluid above it in the year 2018. How it relates to the convection concept. There are primarily two ways to improve the rate of heat transmission: either by increasing the surface area or the convective heat transfer coefficient. The installation of a pump or fan, or the replacement of the current one with a larger one, may be necessary to increase heat transfer coefficient, however this method may or may not be feasible. Furthermore, it might not be enough. The option is to add fins composed of highly conductive materials, such as aluminum, to the surface to enhance the surface area. In actuality, finned surfaces like this are frequently employed to improve heat transmission, and they frequently multiply the rate of heat transfer from a surface by several times. Considering above mentioned facts, the present research work is based on the acknowledgement of summaries of contributions of researchers in the field of plate fins and pin fins, and concludes with the investigated gaps in the research and objectives of a new research.

2. Contributions of Researchers in the field of Heat Transfer

Following are the contributions of researchers in the field of pin fin heat transfer and plate fin

heat transfer.

In the year of 2020, the research work of Buyruk and Karabulut uses a conjugated heat transfer approach to evaluate numerically the heat transfer improvement and pressure drop in plate fin heat exchangers due to zigzag and inner zigzag-outer zigzag rectangular fins 4 mm high. Rectangular fins are mounted on a flat plate channel Buyruk and Karabulut (2020).

In the year of 2019, Ganesh and Prakash investigated that all engineering systems under operations generates heat. If this heat is not removed periodically the system will fail due to overheating of components. Hence, extended surface or fin is used to remove the heat from the system. (Ganesh and Prakash, 2019).

In the year of 2018, Sharma et al. investigated an experimental study is based on an investigation of temperature field inside the fin and analyzing with the use of finite element method. The whole experiment involves selection of appropriate materials and the geometries to get the best possible results. The main emphasis of the present work was to find out the best suitable geometry for the fins. Afterwards materials selected for the experiment by carefully reviewing the literature reviews (Sharma et al., 2018).

In the year of 2018, Venkateshwaran and Mural investigated that heat transfer through radiating pin fins is determining factor on performance of heat dissipation in space or low air pressure applications of hot bodies. The recent research papers shows the need and importance of a detailed review of the literature to identify the potential areas and possibilities of further research on the efficiency and effectiveness studies of pin fins (Venkateshwaran and Mural, 2018).

In the year of 2018, Gnanasekaran and Balaji proposed a solution methodology for an inverse estimation of boundary conditions from the knowledge of transient temperature data. A forward model based on prevalent time-dependent heat conduction fin equation is solved using a fully implicit finite volume method (Gnanasekaran and Balaji, 2018).

In the year of 2018, Saravanan et al. reported that cooling of miniature size electronic components has become a challenge for designer in the development of integrated circuits. Micro pin fin heat sink and Micro channel pin fin heat sink are thermal management techniques for effective cooling. The paper presents comparison of fluid flow and heat transfer characteristics for micro pin fin heat sink and micro channel pin fin heat sink with unfinned micro channel heat sink (Saravanan et al, 2018).

In the year of 2018, Avhad et al. reported that Aluminum material mostly use in automobile and air craft system. In IC engine aluminum is base component as heat transfer and cool engine. In this experimental analysis of heat transfer rate of aluminum rod with changing tapered angles and

changing cross section area. Also there is comparison of heat transfer between natural convection and forced convection. Here we can find tapered angle of jib which is very effective for heat transfer rate. Final results are compared by thermal analysis. (Avhad et al, 2018).

In the year of 2018, Kumar and Sahu reported that transient thermal analyses were performed for actual and proposed design of engine cylinder in order to optimize geometrical parameters and enhanced heat transfer from the IC engine. In the present work transient thermal analysis is performed on actual design and also on two different geometrical designs at ambient temperature 30^{o}C (Kumar and Sahu, 2018).

In the year of 2018, Tijani and Jaffri investigated thermal characteristic of solid and perforated pin-fins heat sink is numerically and experimentally investigated.. Basically, the focus in this study is more on increasing thermal performance of the traditional solid heat sink and study the effect of perforation on fins of the heat sink (Tijani and Jaffri, 2018).

In the year of 2018, Sangaj et al. performed a study to give an overview of the fins and description of recent improvement of fin geometries that increase the heat transfer rate (Sangraj et al, 2018).

In the year of 2018, Yadav and Pandey reported thermal analysis of triangular shaped fins for different parametric conditions. The problem is analyzed numerically using an FEM solver. The comparison shows an acceptable agreement (Yadav and Pandey, 2018).

In the year of 2017, Ali performed experimental analysis for both solid and hollow with and without perforation threaded pin fin with inline arrangement are analyzed and thermo physical properties of Reynolds no, Nusselts no, heat transfer coefficient, heat transfer, efficiency of fin obtained by experimental investigation. Increasing temperature the Reynolds no is found to decrease with heat transfer coefficient also decreased (Ali, 2017)

In the year of 2017, Dange and Deshmukh presented an experimental analysis of heat transfer variation and its enhancement of the cylindrical, staggered pin fin heat sink under constant heat flux condition. In the analysis, a pin fin is fabricated from heat sink cylindrical aluminium (Aluminium-Magnesium-Silicon Alloy) material with diameter 10 mm (Dange and Deshmukh, 2017).

In the year of 2017, Kaviyarasu and Saravanan performed an experimental analysis in which aluminum 6063 rod for three various surface roughness has been fabricated and tested for the heat transfer coefficient and for heat transfer rate. Comparing the smooth surfaced rod, rough surfaced aluminium 6063 rod is having the high heat transfer co efficient and Heat transfer rate (Kaviyarasu and Saravanan, 2017).

In the year of 2017, Kumar and Choudhary performed an experimental analysis whose purpose 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. Here the system follows forced convection as the mode of heat transfer and it is the principle used in it. This procedure followed for the fin of different materials, Reynolds number, Nusselt number is calculated and heat transfer coefficient and fin efficiencies are analyzed. From the experimental analysis in this project the enhancement of heat transfer of fin for different materials is analyzed and we can conclude that

- As Reynolds Number increases, the efficiency of pin fin decreases.
- Heat transfer coefficient for Brass fin is more than others.
- Nusselt Number remains almost same for all materials fin.
- As Reynolds Number decreases, heat transfer coefficient also decreases for all materials fin.
- As heat transfer coefficient decreases, Efficiency increases for all materials fin.
- While material wise Copper is the most efficient material.

In the year of 2017, Yenkar et al. performed a research work in which experimental approach was applied to study the heat transfer characteristics over a flat surface equipped with hollow cylindrical cross-sectional pin fins in a rectangular channel under forced convection (Yenkar et al, 2017).

In the similar manner, in the year of 2017 Reddy et al. reported that rapid development in manufacturing technology and consumer demands has driven the electronic technology towards increasing the functionality and compactness of the components (Reddy et al, 2017).

The research work mad by Gowda and Yadav in the year 2017, reviews pin fin heat sinks of different cross- sections, low density versus high density pin configurations and more factors in figuring out what is required for an application (Gowda and Yadav, 2017).

The main objective of experimental study made by Gaikwad et al. in the year 2017 is to quantify and compare the forced convection and natural convection heat transfer enhancement of pin fin using different metals and to study the thermal performance of pin fin (Gaikwad et al, 2017).

In the year of 2017, Agilan and Rajaparthiban reported that Aluminium reinforced silicon carbide particle composite possess improved operational potential for critical structural components due to its attractive properties when compared to monolithic materials (Agilan and Rajaparthiban, 2017).

The research work of Jasim and Söylemez, in the year of 2017 presented the inclined perforating as a new approach to improve the performance of the pin fin (Jasim and Söylemez, 2017).

In the year of 2016, Rasel conducted a research work in which heat transfer in a rectangular body

embedded with circular fins cooled by forced convection was numerically investigated (Rasel, 2016).

As reported by Pande and Siras, in the year of 2016, in pin-fin heat sinks, the staggered arrangement of fins has lesser thermal resistance as compared to the inline arrangement of fins. The surface coatings on the fin surfaces could play critical role in enhancing heat transfer rate from fins (Pande and Siras, 2016).

In the research work of Soni, made in the year 2016, results are evaluated on basis of total heat dissipation under fixed volume condition. In the present study, thermal performances of plate-fin and pin-fin and elliptical fin heat sinks were compared for the fixed base plate dimensions and fin height under fixed volume condition (Soni, 2016).

In the year of 2015, Roshi et al. carried out a study to analysis the thermal performance of various arrangement of circular and square type of pin fin heat sink using COMSOL multi physics software. Based on the simulation the various pin fin models with different arrangement have been analyzed to see the thermal performance of the heat sink (Roshi et al, 2015).

3.1 Noteworthy Contributions in the Field of Proposed Work

Table 3.1 shows the noteworthy contributions of different researchers in the field of proposed work, as follows:

Table 3.1: Noteworthy Contributions of Researchers in the Field of Proposed Work

S. No	Researcher (Year)	Research Contribution
1.	Buyruk and Karabulut (2020)	Analysis of plate heat exchangers with different fin types
2.	Ganesh and Prakash (2019)	Following are the contributions of the researchers: (a) As the air velocity increases the rate of heat transfer increases. (b) The heat transfer rate is significantly influenced by geometry of perforations. (c) Using of Square perforations of 12 mm reduces the weight by the 23.6% compare to solid fins.
3.	Sharma et al (2018)	Heat dissipation from the rectangular geometry and best material for fins is copper.

4.	Venkateshwaran and Mural (2018)	The vital performance factor to consider should be area of contact to the atmosphere and the material characteristics with respect to effectiveness of the Radiating Pin fins.
5.	Gnanasekaran and Balaji (2018)	Deviations in results tend to increase with increase in time interval due to increased accumulation of noise.
6.	Saravanan and Umesh (2018)	The research work provides a comparison of fluid flow and heat transfer characteristics for micro pin fin heat sink and micro channel pin fin heat sink with unpinned micro channel heat sink.
7.	Avhad et al. (2018)	The research work provides comparison of Al with existing materials.
8.	Kumar and Sahu (2018)	Transient thermal analysis of different fin geometries and their comparison.
9.	Sangaj et al. (2018)	Comparison of fins of different materials and geometries is made.
10.	Yadav and Pandey (2017)	Thermal analysis of triangular shaped fins for different parametric conditions was accomplished.
11.	Ali (2017)	Thermal properties of solid and hollow fins with and without perforations are evaluated.
12.	Dange and Deshmukh (2017)	Experimental analysis of heat transfer variation and its enhancement of the cylindrical, staggered pin fin heat sink under constant heat flux condition
13.	Kaviyarasu and Saravanan (2017)	Aluminum 6063 rod for three various surface roughness was fabricated and tested for the heat transfer coefficient and heat transfer rate.
14.	Kumar and Choudhary (2017)	Investigations on Reynold's and Nusselt's number on fin materials and characteristics.
15.	Ambesange et al. (2017)	Analysis of heat transfer from dimple pin fin of circular cross section.

16.	Yenkar et al. (2017)	Analysis of heat transfer characteristics over a flat surface equipped with hollow cylindrical cross-sectional pin fins in a rectangular channel under forced convection.
17.	Reddy et al. (2017)	The design of heat sink device is predicated upon optimizing the opposite demands of maximizing thermal dissipation rate.
18.	Gowda and Yadav (2017)	The research work reviews pin fin heat sinks of different cross- sections, low density versus high density pin configurations and more factors in figuring out what is required for an application.
19.	Gaikwad et al. (2017)	Quantification and comparison of forced convection and natural convection heat transfer enhancement of pin fin using different metals and to study the thermal performance of pin fin
20.	Agilan and Rajaparthiban (2017)	Aluminium reinforced silicon carbide particle composite possess improved operational potential for critical structural components due to its attractive properties when compared to monolithic materials.
21.	Jasim and Söylemez (2017)	The researchers introduced inclined perforating as a new approach to improve the performance of the pin fin.
22.	Rasel (2016)	Results of the research work shows that as the velocity increases, the heat transfer rate from the base increases and from the fin decreases.
23.	Gowreesh and Veeresh (2016)	In the research work, thermal Analysis is performed for various perforated fin extensions with varied diameter.

24.	Pande and Siras (2016)	In pin-fin heat sinks, the staggered arrangement of fins has lesser thermal resistance as compared to the inline arrangement of fins. The surface coatings on the fin surfaces could play critical role in enhancing heat transfer rate from fins.
25.	Soni (2016)	Elliptical fins can be a replacement for pin fins.

3. Gaps in the Research and Objectives of Propose Research

The present chapter focuses on the gaps in the research and objectives of the proposed research, the details of which are presented as follows.

3.1 Gaps in the Research

Following points represent gaps in the research:

a) A limited research is available in the literature which focuses on comparative analysis of plate finsand pin fins; and

b) There is very limited research available which focuses on different combinations of different finparameters and comparison among them.

And on the basis of above mentioned research gaps, the topic of research has been presented asfollows:

Study and Analysis of Pin Fin and Plate Fin under different Working Conditions

3.2 Objectives of the Proposed Research

Following points research objectives of proposed research work:

a) Evaluation of different thermal properties of fins under different working conditions;
b) Ranking of different combinations of fins.

4. Conclusion

The world of fins is very vast and progressing continuously, due to their unmatched competitiveness. In this regard, the present research should be helpful for industrialists and researchers, who want to have a deep dive in the ocean of fins.

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