International Journal of Recent Research and Review, Vol. XVI, Issue 1, March 2023
ISSN 2277 – 8322

HEAT TRANSFER THROUGH FINS

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***Abstract*— This review paper focuses on the topic of heat transfer through fins, which is an important aspect of heat transfer in many engineering applications. The paper begins by discussing the various types of fins, including rectangular, triangular, circular, and helical fins, and their unique characteristics. The factors that affect heat transfer through fins are then explored, including the geometry of the fin, material properties, fluid properties, and fin spacing. Fins are used in many applications, such as radiators, heat exchangers, and electronic cooling systems, to increase the heat transfer rate by increasing the surface area available for heat transfer. In this review paper, we will discuss the various aspects of heat transfer through fins. Overall, this paper provides a comprehensive overview of heat transfer through fins, which can be a useful resource for researchers and engineers in the field of heat transfer.**

I. INTRODUCTION

The thermal energy exchange through fins is a broadly studied and important topic in the field of heat transfer. Fins are utilized in numerous engineering practices to increases the rate of thermal energy exchange from an open area. Fins can be used in various applications, such as radiators, heat exchangers, and electronic cooling systems. The transfer of heat through fins is essential for the design of many industrial and consumer products such as radiators, heat exchangers, and electronic devices. Fins come in various shapes and sizes and are classified based on their geometry. Some commonly used fin shapes include rectangular, triangular, circular, and helical fins. The selection of fin geometry depends on the utilization and required rate of heat transfer. Rectangular fins are the simplest and most widely used fins, while triangular fins are used when space is limited. Circular fins are preferred in applications with radial fluid flow, and helical fins are used in applications where the fluid flow is axial.

The heat transfer rate through fins is influenced by various factors, such as the geometry of the fin, material properties, fluid properties, and fin spacing. The geometry of the fin determines its surface area and its ability to transfer heat. The heat conducting properties of the material of fin is an important factor as it determines how quickly heat can be conducted through the fin. The fluid properties, such as temperature, velocity, and viscosity, also play an important role in determining the rate of heat transfer. Finally, the spacing between the fins affects the rate of heat transfer as it determines the amount of fluid that comes in contact with the surface. In this review paper, we will provide a detailed overview of heat transfer through fins. The paper will cover the various types of fins, their characteristics, and the factors that affect heat transfer through fins. This paper aims to be a useful resource for researchers and engineers in the field of heat transfer and will provide a framework for optimizing fin design for specific applications.

II. HEAT TRANSFER MECHANISMS

Heat transfer through fins occurs through three mechanisms: conduction, convection, and radiation. Conduction is the transfer of heat through a solid material. Convection is the transfer of heat through a fluid medium. Radiation is the transfer of heat through electromagnetic waves.

2.1 Conduction: Conduction is the dominant mode of heat transfer in fins. The temperature gradient across the fin causes heat to flow from the hot end to the cold end of the fin. The rate of heat transfer through conduction depends on the thermal conductivity of the fin material.

2.2 Convection: Convection is the mode of heat transfer that occurs when a fluid medium is in contact with the surface of the fin. The fluid absorbs heat from the fin surface and carries it away. The rate of heat transfer through convection depends on the properties of the fluid medium, such as its velocity, density, and viscosity.

2.3 Radiation: Radiation is the mode of heat transfer that occurs when electromagnetic waves are emitted from the surface of the fin. The rate of heat transfer through radiation depends on the temperature of the fin surface and its emissivity.

III. TYPES OF FINS

Different types of fins, including flat plate fins, pin fins, and annular fins, can be used in various engineering applications based on their geometry and performance requirements. Flat plate fins are easy to manufacture and are widely used in electronic cooling due to their compact shape. Pin fins provide higher surface area, leading to improved heat transfer, while annular fins offer high efficiency in heat dissipation for high-temperature applications. Analytical and numerical methods, like lumped system method, finite element method and computational fluid dynamics method, are utilized to predict the thermal energy exchange rate through fins.

These methods help to understand the relation between the input parameters, such as fin geometry, material properties, and fluid flow characteristics. The entropy generation method and the Taguchi method are used for the optimization of the fins' geometry and material properties, leading to improved performance in heat dissipation. Experimental methods, such as wind tunnel testing, are used to validate the prediction obtained from numerical and analytical methods. The experimental validation of the proposed numerical and analytical methods helps to improve their accuracy, leading to more optimized and efficient fin designs.

Fins can be classified into various types based on their geometry. Some common types of fins are rectangular, triangular, circular, and helical fins.

3.1 Rectangular fins: rectangular fins are the simplest type of fin and are commonly used in engineering applications. These fins are easy to manufacture and commonly utilized in several areas. Rectangular fin has a uniform cross-section along their length.

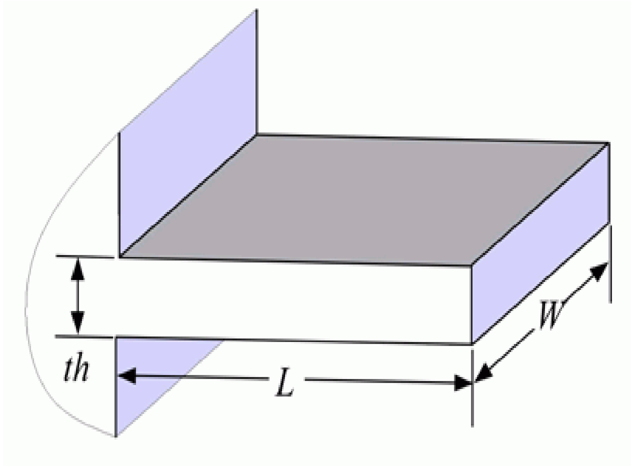

Fig. 1 Rectangular fin

3.2 Triangular fins: Triangular fins have a triangular cross-section and are commonly used in applications where the available space for the fin is limited. Triangular fins provide surface area for heat transfer compared to rectangular fins.

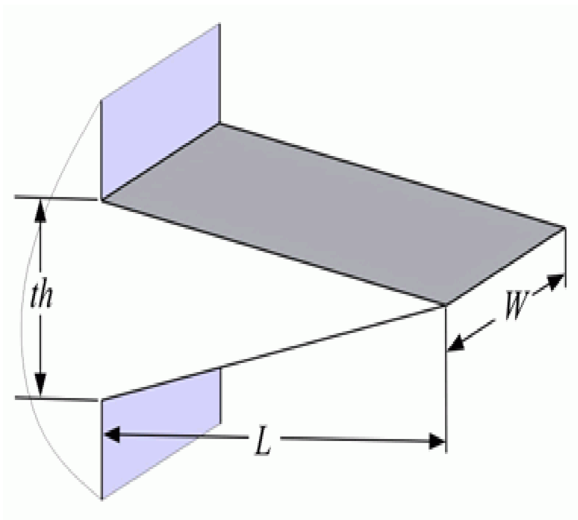

Fig. 2 Triangular fin

3.3 Circular fins: Circular fins have a circular cross-section and are commonly used in applications where the fluid flow is radial. These fins provide a higher rate of heat transfer.

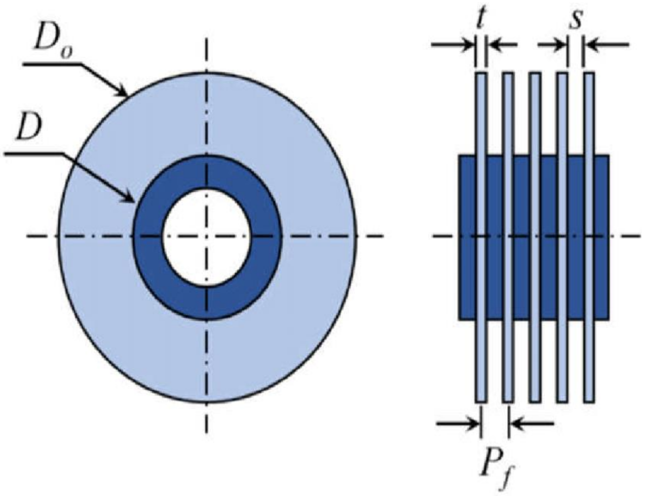

Fig. 3 Circular fin

3.4 Helical fins: Helical fins have a spiral shape and are commonly used in applications where the fluid flow is axial. Helical fins provide a higher rate of heat transfer unlike rectangular fins and circular fins.

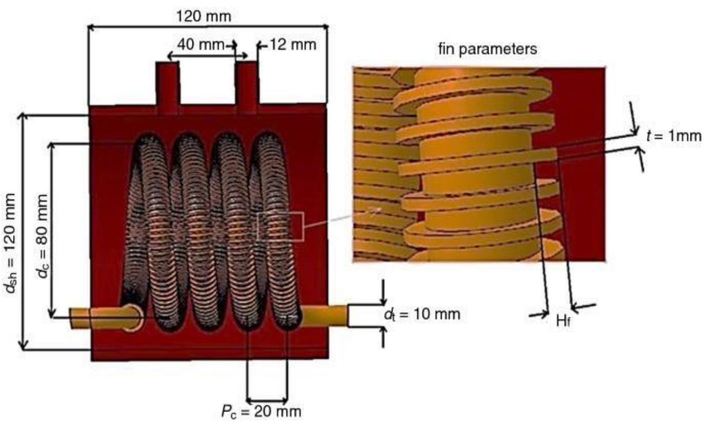

Fig. 4 Helical fin

IV. EFFICIENCY, EFFECTIVENESS AND FACTOR AFFECTING HEAT TRANSFER

There are several factors on which the rate of heat transfer depends, some of the important factors are discussed below-

Fin geometry: The geometry of the fin has a major role in the rate of heat transfer. Fins with a larger surface area provide a higher rate of heat transfer compared to fins with a smaller surface area.

Material properties: The heat conduction of the fin material is an important factor affecting the rate of heat transfer. Fins made of materials with high thermal conductivity provide a higher rate of thermal conduction compared to fins made of materials having low thermal conductivity.

Fluid properties: The exchange of thermal energy through extended surface is also affected by the properties of the fluid flowing over the fin. The fluid velocity, temperature, and viscosity are important factor which affects the rate of exchange of thermal energy.

Fin spacing: The spacing between fins is an important factor affecting the exchange of thermal energy. Fins having smaller spacing provide a higher exchange of thermal energy compared to fins having large spacing.

Efficiency and effectiveness are important parameters to evaluate the potential of fins. The capability of a fin refers to the fraction of the real thermal energy exchange rate through the fin to the rate of greatest possible value of thermal energy exchange through the extended surface. The effectiveness of the extended surface refers to the fraction of the real thermal energy exchange rate done by the extended surface to the theoretical maximum exchange of thermal energy done by the entire surface. Different methods are used to evaluate the efficiency and effectiveness of fins, including analytical, numerical, and experimental approaches. The heat transfer coefficient is a measure of the effectiveness of a fin in transferring heat. The heat transfer coefficient depends on the fin geometry, material properties, fluid properties, and operating conditions.

The heat transfer coefficient can be calculated using various analytical and numerical methods.

Analytical Methods: Analytical methods are used to calculate the heat transfer coefficient for simple fin geometries. The most commonly used analytical method is the fin equation, which relates the heat transfer rate to the temperature gradient across the fin.

Numerical Methods: Numerical methods are used to calculate the heat transfer coefficient for complex fin geometries. The most commonly used numerical method is the finite element method, which discretizes the fin geometry into small elements and solves the heat transfer equation for each element.

V. FUTURE SCOPE OF THE WORK

Further research is needed to optimize fin design for specific applications. Future research should focus on developing efficient and effective fins for different applications. The optimization of fin design can be achieved through numerical simulations, experimental investigations, and optimization techniques. The optimization of fin design can result in improved performance, reduced costs, and increased energy efficiency.

VI. CONCLUSION

Heat transfer through fins is an important topic in the field of heat transfer. These are used in several engineering applications to increase the rate of heat transfer from a surface. In this paper, we discussed the various types of fins, their characteristics, and the factors that affect heat transfer through fins. The selection of fin geometry based on the particular utilization and the desired heat transfer rate. The rate of heat transfer through fins depends on various factors such as fin geometry, material properties, fluid properties, and fin spacing. Further research is required to optimize the design of fins for specific applications.

VII. REFERENCES

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