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HEAT TRANSFER FROM THE FINNED SURFACE


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A thesis submitted in partial fulfillment of the requirement for the award of the
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Specially dedicated to my family, girl friend, friends and companion

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ABSTRACT

The purpose of this study is to investigate heat transfer characteristics by free convection from extended surface. The project aim to evaluate the corresponding heat loss from finned surface and the parameter for the finned surface that affect the heat transfer characteristic namely height, width, spacing, diameter, thermal conductivity, base and surrounding temperature. Two experiments will be carried out involving plate fin and pin fin experiment. Comparison between the different temperature dissipation along the fins from the plate and pin fins experiment on different parameter has being carried out for this study. Different temperature carries out the different efficiency, heat transfer and heat transfer coefficient. Effect of the Nusselt number and Rayleigh number in heat transfer along the fins are also being carried out in this research.

ABSTRAK

Tujuan bagi kajian ini adalah untuk menyelidik ciri-ciri pemindahan haba daripada permukaan sirip dengan olakan bebas. Kajian ini adalah untuk menilai kehilangan haba daripada permukaan sirip dan parameter permukaan sirip yang mempengaruhi ciri-ciri pemindahan haba seperti ketinggian, ketebalan, ruang antara sirip, diameter, konduktiviti termal, suhu tapak plat dan suhu persekitaran. Dua eksperimen yang akan dilaksanakan adalah eksperimen sirip lurus dan sirip. Perbandingan eksperimen di antara perbezaan suhu mengalir menerusi sirip pada ciri-ciri yang berlainan juga dikaji dalam kajian ini. Perbezaan suhu membawa kepada perbezaan kecekapan, pengaliran haba dan pemalar pemindahan haba. Pengaruh daripada nombor Nusselt dan nombor Rayleigh dalam pengaliran haba permukaan sirip juga dikaji dalam kajian ini.

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LIST OF SYMBOLS

SYMBOL	DEFINITION
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Nomenclature

h	Heat transfer coefficient, $\text{W.m}^{-2}\text{K}^{-1}$
m	mass, kg
R_a	Rayleigh number, $g\beta\Delta TS^3/\nu\alpha^2$
Q	Heat dissipation, W
T	Temperature, $^{\circ}\text{C}$
P_r	Prandtl number
η	Efficiency
L_p	Length of off set strip fin, mm
L_i	Length between inlet boundary and leading edge of (first) fin, mm
L	Length of fin, mm
t	Fin thickness, mm
P	Fin pitch, mm
x	Measure point
μ	Velocity components, m/s
OSF	Off set strip fin
n	L/L_p
W'	Half-gap between fin, mm

G'	Distance between bottom of fin and the bottom well, mm
G	G'/W'
H	Fin Height, mm
D	Diameter of pin fin, mm
t	Thickness of fin for plate and triangle arrays.
S	Horizontal clear spacing in plate and triangle arrays
Sh	Center to center pin fin horizontal spacing, mm
U_f	Average flow velocity between fins, m/s
S	Half-pitch of fins
U_0	Uniform flow velocity, m/s
N_f	Number of fin
P	Pressure, Nm^{-2}
Re_0	Reynolds number ($U_0 s/r$)
C	Clearance gap between the fin tip and the horizontal shroud, mm
S_x	Pin uniform spacing in the stream wise direction, mm
S_z	Pin uniform spacing in the span wise direction, mm
Q	Heat losses, W
A	Area, m^2
\bar{h}	Average 'tube-side convective heat transfer coefficient
\overline{Nu}_{pfin}	$\bar{h} dp/kg$, Particle Nusselt number for finned tube
G	Mass velocity
G_{mf}	Minimum fluidization mass velocity, $kg/hr.m^2$
F_L	Fin length, mm
\bar{D}_p	Average particle diameter, mm
Ω	Heat transfer capacity function
P	Convection losses for parallel plate
u	Convection losses for U-shaped channels
Nu	Nusselt number hd/kfx
Ra	Rayleigh number

Greek

β	Coefficient of volumetric expansion, K^{-1}
ν	Kinematic viscosity, $m^2 \cdot s^{-1}$
θ	Temperature at any location excess over the ambient temperature, K.

Subscripts

A1	Aluminium
Bs	Brass
Ms	Mild steel
avg	Average
max	Maximum
f	Fin
b, base	Fin array base

CHAPTER ONE

INTRODUCTION

The heat extended surface is commonly used to depict an important special case involving heat transfer by conduction within a solid and heat transfer by convection or radiations from the boundaries of the solid.

Although there are many different situations that involve such conduction convection effects, extended surface in term of fin surface are manufactured by extending, welding or wrapping a thin metal sheet on a surface enhance heat transfer from a surface by exposing a larger surface area to convection and radiation.

The application for finned heat transfer normally to the highly integrated electronic device and mechanical equipment such as high performance computers, compact mobile phones, radio, heat exchangers and etc.

1.1 Background of the Problem

Fin is a device that especially for the heat transfers through the surface. Heat transfer through fin surface are most important for making sure the systems or equipment are on safety condition, mean no overheat. Fin parameter condition is an important factor that affects the heat transfer characteristic.

Research about free convention heat transfer from fin arrays has been done by David and James in 1974. The authors have considered the finned surfaces and the base plate to be vertical U-shaped channels and have used a relationship for the Nusselt number for that geometry which has the proper behavior for both very long and very short fins. Therefore, fin length to fin spacing ratios (L/s) at from zero to infinity may be considered.

Research for heat transfer from finned surface has been done by Sujatha and Sobhan in 1996. This research has been carried out on fin array, spacing, height, and material thermal conductivity on a uniformly heated horizontal base. In order to obtain the overall heat transfer coefficients at steady condition.

Finally, fin parameter like fin height, diameter and material should be factors that have to carry out for investigating heat transfer characteristic from finned surface over the fin spacing or fin array in the heat sink system. Several researches about heat transfer characteristic also have been carried out by several authors that will be discussed in the literature review section.

1.2 Statement of the Problem

Finned surface are frequently used as an efficient method of rejecting waste heat from equipment like heat exchanges, computer and so on. Several researches have done by several authors about heat transfer or loss from finned surface. Factors such as fin parameter and other characteristic have affected the heat losses or transfer from finned. This research is carried out to find answers to the following issues:

1. Whether the parameter affects the heat transfer from fin surface? Different material, height and other parameter are used from the experimentally.
2. Which correlations are useful in design and selection of fin arrays? One is based on the base temperature of the fin and the other on the average temperature of the fin.
3. Whether the ambient effect will affect the heat transfer from the fin surface?
4. Whether the Nusselt number and Rayleigh number relationship is considered as a major parameter in finding fin efficiency?

1.3 Purpose of the Research

This research is carried out to investigate heat transfer characteristic from extended surfaces for plate fin and pin fin, with following objectives:

1. To build up the specimen to carry on the heat transfer experiment.
2. To evaluate the corresponding heat losses from finned surface.
3. To evaluate the parameters for the finned surface that affects the heat transfer characteristic.

4. To compare the heat transfer characteristic affect on plate fin and pin fin for the experimental.
5. To define the correlation that is useful in design and selection of fin array.

1.4 Importance of the Research

With rapid progress in electronic and also mechanical system, various types of highly integrated electronic device and equipment produce such as high performance computer, compact mobile phone, radio, heat exchanger and turbine have been developed. Fin heat sink was used to prevent the excessive heat on the system during operation.

So, acknowledgement about characteristic finned surface from heat transfer is very important especially to prevent the heat over the limitation level for equipment such as heat exchanger. Parameter, material arrangement and condition for fin are important factors that affect the heat transfer from finned surface.

Through the experiment, heat transfer from finned surface characteristic can be obtained. Beside that, comparison on the parameter that affect the heat transfer characteristic from plate fin and pin fin also observed through conduct the experiment.