"I declare that I have read this report and in my opinion this report is enough from the scope and its quality for the awarded of Bachelor Degree of Mechanical Engineering (Thermal-Fluid)"

Signature :.....................................

Supervisor Name :Dr. Mohd Yusoff Bin Sulaiman

Date :..........15/12/05

MODELLING COMPACT HEAT EXCHANGER SURFACE

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This report submitted to Faculty of Mechanical Engineering in fulfillment of the requirements for the award of the Bachelor of Mechanical Engineering. (Thermo-Fluids)

Faculty of Mechanical Engineering
Kolej Universiti Teknikal Kebangsaan Malaysia

November, 2005

DECLARATION

" I hereby the author, declare that the work in this report entitled "MODELLING COMPACT HEAT EXCHANGER SURFACE" is my own except for quotations and summaries which have been duly acknowledged "

Signature : ....

Author : MOHD FADZIL BIN HASHIM

Date : NOVEMBER 2005

DEDICATION

Dedicated to my beloved parents and my sisters……

For understanding and moral support

throughout the years…….

ACKNOWLEDGEMENT

First of all in the name of Allah, thanks because give me brightness in darkness to completed this *Projek Sarjana Muda* (PSM) and report successfully. There is no regret when go through a thorny road with the guide from The Most Merciful.

In this opportunity, I would like to express my sincere gratitude to my supervisor Dr. Mohd. Yusoff Sulaiman for his invaluable guidance, indispensable help and continuous encouragement throughout the course and the success of this project.

Also, thank you very much to Mechanical Engineering Faculty, KUTKM for full cooperation and contribution towards the completion of my PSM. To lecture En. Mohd Kamal, En. Suhaimi Misha, En.Mohd Azman, and to all my friends especially En. Mohd Ruzaihan Johan, En. Mohd Fakzan, En. Amirul Nizuan Bin Mohd Kasbollah, Abdul Helmyrudin Bin Abd Rahman and Abd Rahman Bin Muhamad thank you for your encouragement and your good ideas.

Finally, to my family, they gave me all the courage, inspiration, motivation, financial aid and love I need in my quest for the success and accomplishment for this project.

ABSTRACT

Compact heat exchanger surface is one equipment for heat transfer, that have a compress surface is compact heat exchanger surface. The thermal resistance at compact heat exchanger depend for air flow tough the fin surface.

The main point of this research is to study the fin surface to increase the efficiency of fin surface for heat transfer to the air. For the purpose the experiment in the Computational Fluid Dynamic (CFD) is using to see and know the real result.

This research must completed by draw fin louvered in the surface of the radiator fin on many dimension and followed by simulation CFD software to find the result.

ABSTRAK

"Compact Heat Exchanger Surface" adalah satu alat permindahan haba yang mempunyai permukaan yang telah dimampatkan didalam satu alat yang dipanggil "compact Heat Exchanger". Pengaruh rintangan haba pada "compact Heat Exchanger" bergantung kepada aliran udara yang bersentuhan dengan permukaan sirip.

Kajian ini bertujuan mengkaji permukaan sirip bagi menambahkan lagi kecekapan sirip untuk memindahkan haba kepada udara. Untuk tujuan ini, ujikaji perlu dilakukan dengan menggunakan "Computational Fluid Dynamic (CFD)" bagi melihat dengan lebih teliti keputusan yang diperlukan.

Kajian ini perlu melukis "fin-louvered" dalam permukaan sirip radiator dalam pelbagai dimensi and buat simulasi di dalam CFD software untuk mendapatkan keputusan.

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Name Of Symbol	Symbol
Louver Angle	θ
Fin Pitch	F_p
Louver Pitch	L_p
Inlet Face Velocity	U_{in}
Fin Thickness to Louver Pitch	t/L_p
Channel depth to Louver Pitch	d/ L_p
Inlet Face Velocity	U_{in}
Outlet Face Velocity	U_{out}
density kg/m^3	ρ
velocity m/s	V
Area m^2	A
pressure N/m2	P
acceleration due to gravity m/s2	g
elevation above datum. M	Z
Surface Temperature of the Wall (Each Louvers).	T_W
Air Temperature	T_{AIR}
Reynolds Number	Re
Temperature (Kelvin)	K
Percentage	%

CHAPTER 1

INTRODUCTION

In the manufacturing process, have a many type of compact heat exchanger. That is use for heat transfer from system to air for decrease or increase the temperature of the system depend on the purpose for example automotive, heating and conditioning. For the automotive system, radiator will use to decrease the temperature.

In the part of radiation there is some part with have their own function. One of the part is fin where it is important part in the radiator system. The function of fin in radiator is to free the heat which was trap in the air. At the surface of the fin, there is a louvered which the function is to add some efficient for the fin to get free the heat.

In this thesis, the writer should make a design and make a research on the efficiency of the louvered.

To use the Computational Fluid Dynamics (CFD), to create and design the model of a heat transfer surface according to exact geometrical values. To simulate the air flow and heat transfer behavior through these surfaces. To identify the characteristic of these flow patterns.

1.1 Project Title

"Modeling Compact Heat Exchanger Surface". To model heat exchanger surface and simulate air flow through these surfaces using Computational Fluid Dynamics (CFD) software package.

1.2 Objective

1. To develop air flow and heat transfer, character or pattern in heat exchangers.
2. Use suitable Computational Fluid Dynamics (CFD) software package to model actual geometries of heat exchanger surface.
3. To compare numerical prediction with published experimental data.

1.3 Scope of Project

Scope project is to survey of Computational Fluid Dynamics (CFD) software package viable. Use an viable available Computational Fluid Dynamics (CFD) software package to model actual geometries of heat exchanger surfaces and simulate air and heat flow over these surfaces. Compare data with existing predictions.

1.4 Problem of Statement

1. To study flow or heat transfer trough surfaces.
2. Determine heat exchanger performance and characteristic.
3. Accumulate automotive performance data for better design.

1.5 Problem Analysis

In this project, to study flow or heat transfer trough surfaces, Computational Fluid Dynamics (CFD) software package must to use for determine heat exchanger performance and characteristic.

Accumulate automotive radiator, check the surface and dimensions the surface. After that design in the Computational Fluid Dynamics (CFD) software package and run in the simulation for the performance data checking. Compare result with existing predictions.

CHAPTER 2

LITERATURE REVIEW

Understanding the mechanisms that difference heat transfer in a louvered fin heat exchanger provides the potential for reducing the heat exchanger's size and surface design. This reduction in size can clearly benefit many industries, including automotive, heating, and air conditioning. A Thole (2003) Because more than 85% of the total thermal resistance in a typical air-cooled heat exchanger occurs on the air side, the performance of compact heat exchangers depends highly on the heat transfer occurring on the air side. Compact heat exchangers are usually characterized by a large heat transfer surface per unit of volume.

Louvered fins, rather than continuous fins, are commonly used in compact heat exchangers to break up boundary growth along the fins and increase the air side heat transfer surface area. The increase in surface area results because of the fin thickness that is exposed as a result of the louvers being stamped out of the fins. Typical geometry for a louvered fin heat exchanger used in the trucking industry as a truck radiator from A.Tole (2003).

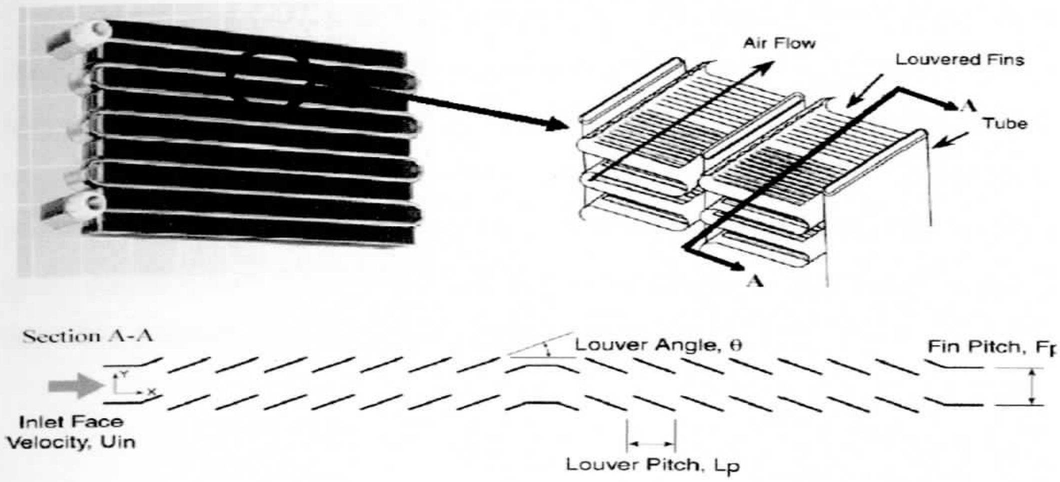

Figure 2.1 : Typical geometry for a louvered fin heat exchanger used in the trucking industry as a truck radiator from A. Tole (2003)

The design compact heat exchanger geometry comprised of louvered fins, where air passes along. The studies was to understand the fundamental radiator affecting the heat transfer along the louvered surfaces in this complicated flow and thermal field. The current study explores the local heat transfer characteristics of louvered fin arrays to determine how geometry and Reynolds numbers affect the heat transfer performance.

The majority of the data currently available for compact heat exchangers focuses on the heat exchanger as an entire system. As such, these heat exchangers are characterized using the Number of Transfer Units. As previously mentioned, the current study focuses on the local heat transfer on louver surfaces. Although most of the published data is for heat exchanger tests using Computational Fluid Dynamics (CFD) software package. To design of a compact heat exchanger, strategies must be proposed to reduce the air side resistance. However, before any strategies to augment the air side heat transfer can be proposed, a thorough insight of the current mechanisms that govern air side heat transfer is required.

Marthinuss (2002), in there research is Air Cooled Compact Heat Exchanger Design For Electronics Cooling explain the plate fins surface In the engineering study, have are many type of the fins and the function. Types of fin depend for function and the suitability. There are many factors to consider in the selection of fins style and geometry. This approach produces a design that works, but is hardly optimized for any of the considerations involved in designing the compact heat exchanger. Figure below show five common plate fin type and the critical fin dimensions.

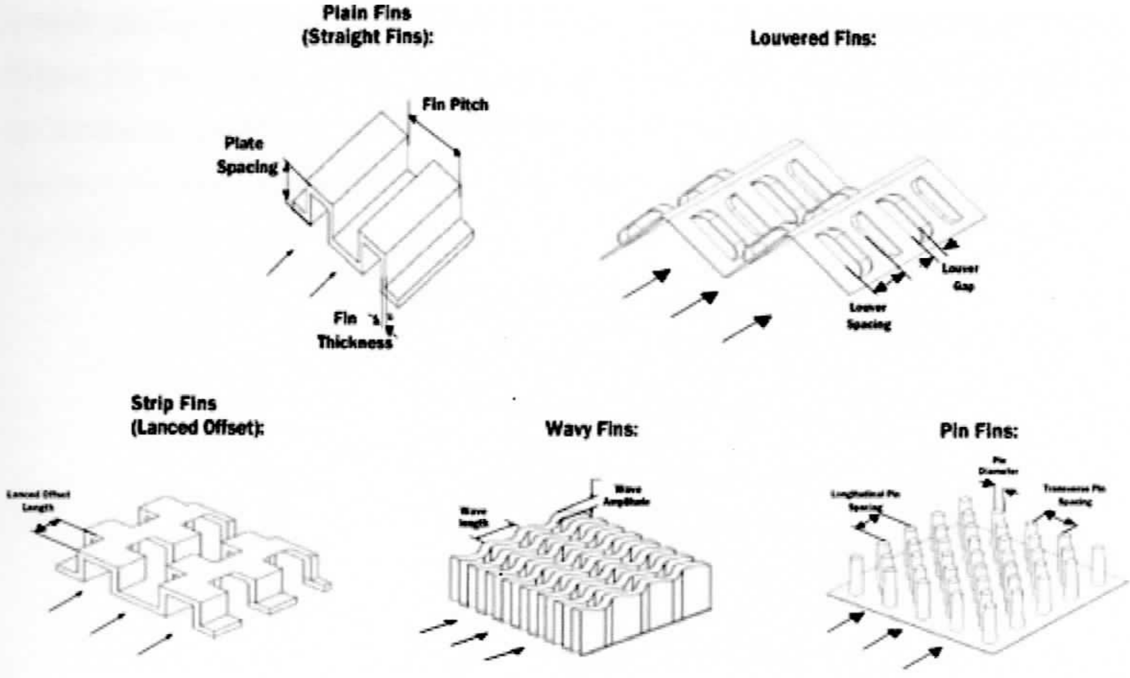

Figure 2.2: Plate Fins Types from Kays & London,(1964)

The heat transfer and pressure drop by picking off the j-Colburn factor and friction factor at the proper Reynolds number for a certain configuration, but it is unknown whether the proper design was chosen from a size and efficiency standpoint. The first thing the thermal engineer needs to do is prioritize the design factors. Pressure drop, heat transfer, size, weight and cost must be placed in order of importance. Hence, figures of merit were developed in an effort to compare the different fin configurations.

Size is generally an important factor in the heat exchanger design. If size is the overall driving design factor then a good figure of merit is heat transfer per unit height. Figure 2.3 provides a comparison if size or height is the critical factor in the heat exchanger design. From a purely standpoint, pin fin offer the smallest design for the best heat transfer while straight fins are the most inefficient from a heat transfer and smallest size constraint.

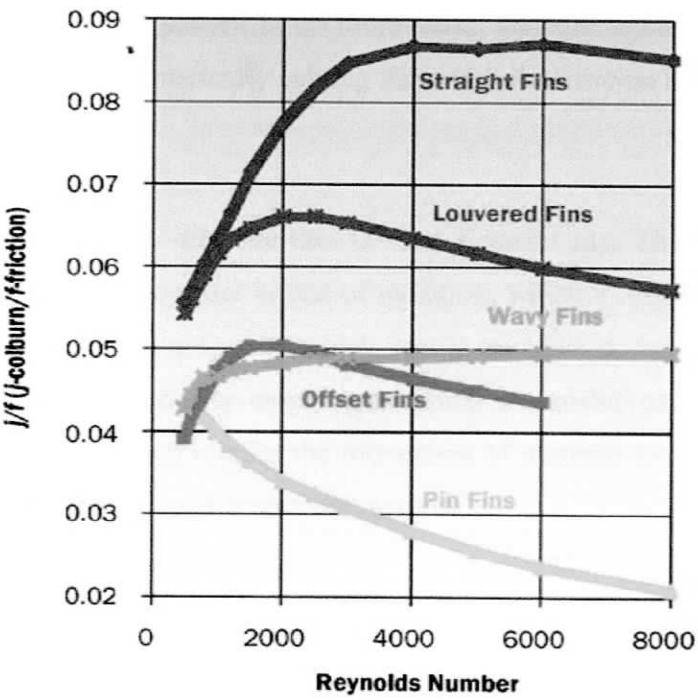

Figure 2.3: Heat transfer/pressure drop FOM from Kays & London (1964)

Stephan et al (2002). Approximately 85% of the total thermal resistance occurs on the air side of the heat exchanger. The results of the experimental study showed that the hot thermal wakes formed at the entrance louver have an adverse effect on the heat transfer of downstream louvers. Measuring the adiabatic wall temperature of the louvers in the array showed the effect of these thermal wakes. The experimental study showed that the optimal louver geometry was Reynolds number dependent.

Perrotin, et al (2003) in there research is Fin efficiency calculation in enhanced fin and tube heat exchangers in dry conditions, explain for the evaluation of the finned surface performance or for the determination of the air-side heat transfer coefficient from experimental data. High efficiency heat exchangers use enhanced fin geometry (louvered and slit fins) for which the fin efficiency could be overestimated by usual formulations and more precisely equivalent circular fin and conventional 1-D sector methods. Because the slits (or louvers) alter the conduction path through the fin, the assumption of radial heat flow pattern is no more valid, and the actual fin efficiency could only be determined by numerically solving the multi-dimensional heat conduction equation.

Modtech (1999) in there Wet site title is Heat Transfer say, The third and last form of heat transfer we shall consider is that of radiation, which in this context means light (visible or not). This is the means by which heat is transferred, for example, from the sun to the earth through mostly empty space-such a transfer cannot occur via convection nor conduction, which require the movement of material from one place to another or the collisions of molecules within the material.

2.1 Review The Latest Research Using CFD.

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Vega et al (2002), in there research Simulation of compact heat exchangers using global regression and soft computing is explain the dissertation investigates enhancement in accuracy of heat rate predictions in compact fin-tube heat exchangers. These include the idealized assumptions in the procedure by which correlations are found, the data compression that occurs through the correlation process, and the multiplicity of solutions for a proposed correlating function obtained using local regression. In there conclusion of the steady state performance of plate fin-tube compact heat exchangers. Two types of techniques have been used. The first encompasses global optimization methods that are used to find the parameters of a given functional form. The second is a adaptive function itself which belongs to the soft computing methodology.