‘I hereby declare that I have read this project report and found its content and form to meet acceptable presentation standards of scholarly work for the award of Bachelor of Mechanical Engineering (Thermal-Fluid)’

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Date :

Optimization of louvered plate angle using CFD method

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A report submitted in partial fulfillment of the

Requirement for the award of the degree of

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DECLARATION

I declare that this project report entitled *"Optimization of louvered plate angle using CFD method"* is the result of my own research except as cited in the references.

Signature : ....
Name : ....
Date : ....

To My beloved mom and dad

for their endless love and support

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ABSTRACT

This studies present the design and an analyze of a louvered plate in heat exchanger and air conditioning usage. Literature review is including the geometry of the louvered plate such as its length, air velocity, pressure outcome and also the louvered plate angle. The air velocity distribution for louvered fin heat exchanger in residential air conditioning installation is not very well documented today because it is difficult to measure accurately. This louvered plate also encouraged the air flow, velocity and pressure. This project is using a Computational Fluid Dynamics simulation to identify the pressure drop and velocity profile of air which will flow through the louvered with changing the louvered plate angle. The simulation that has been use for this project is Computational Fluid Dynamics. Computational Fluid Dynamics software use in this project is FLUENT. This simulation can identify the shape or air flow that is forced to the louvered plate. This method involves the designing process, mesh, solve and analyze. All results will be analyzed directly from this method. The result show the optimal angle is 25° degrees and that result approximately with the previous study.

ABSTRAK

Kajian ini membentangkan reka bentuk dan menganalisis kepingan ram di dalam pengunaan penukar haba dan penyaman udara. Kajian ilmiah yang terhasil ini meliputi geometri kepingan ram seperti panjang kepingan, halaju udara, tekanan yang terhasil serta sudut kepingan ini. Agihan halaju udara untuk kepingan ram pada penukar haba sirip di dalam pemasangan penyaman udara kediaman amat tidak di dokumenkan dengan baik pada hari ini kerana ia sukar untuk diukur dengan tepat Sudut kepingan ram juga mempengaruhi aliran udara, halaju dan tekanan. Projek ini menggunakan Pengiraan Dinamik Bendalir simulasi untuk mengetahui penurunan tekanan dan bentuk halaju yang akan melalui kepingan dengan mengubah sudut kepingan ram itu. Simulasi yang digunakan di dalam projek ini ialah dengan menggunakan kaedah Pengiraan Dinamik Bendalir. Perisian Pengiraan Dinamik Bendalir yang digunakan di dalam projek ini adalah FLUENT.Penggunaan kaedah ini dapat mengetahui bentuk atau aliran udara yang dikenakan pada kepingan ram yang direka. Kaedah ini juga terdiri daripada mereka, jaringan, penyelesaian masalah dan menganalisis. Semua keputusan akan dikaji terus dari kaedah ini. Keputusan menunjukkan sudut 25° adalah sesuai bagi mengoptimum sudut kepingan ram dan keputusannya hampir dengan kajian sebelum ini.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

v	=	velocity, m/s
θ	=	angle
x	=	distance, m
g	=	Gravity
h	=	height
l	=	Length
°	=	Degree
N	=	Newton
P	=	Pressure ,Pa
ϕ	=	Louver angle
L_h	=	Louver thickness
L_l	=	Louver length
L_p	=	Louver pitch
L_h	=	Louver height
F_p	=	Fin pitch
F_d	=	Flow depth

LIST OF ABREVIATION

CFD	Computational Fluid Dynamics
2D	Two – Dimensional
3D	Three – Dimensional

CHAPTER 1

INTRODUCTION

The louvered fin has been used heavily in the automotive and air conditioning industries for the last several decades. 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 mechanisms that control heat transfer in a louvered fin heat exchanger provide the potential for reducing the heat exchanger's size and weight. This reduction in size can clearly benefit many industries, including transportation, heating, and air conditioning.

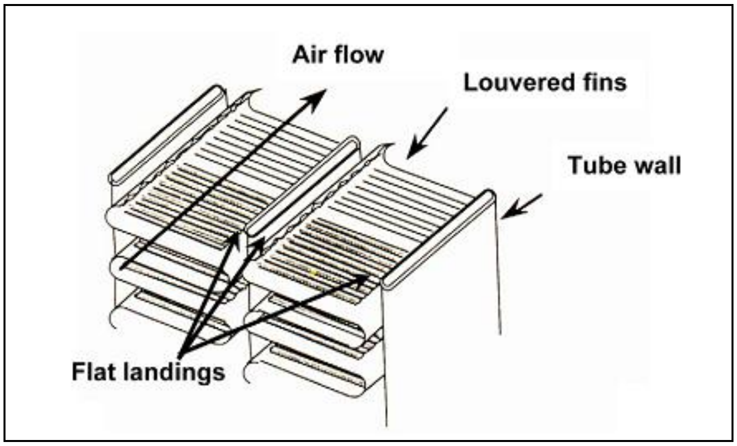


Figure 1.1: Flat-tube heat exchanger (source: Wang et al., 1999)

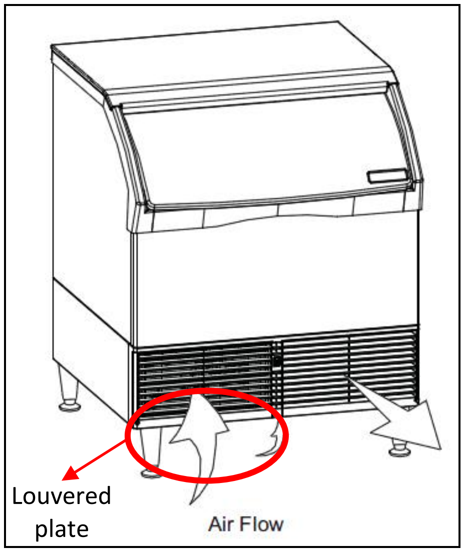


Figure 1.2: Air conditioning product

Types fin always used in the automotive and air conditioning industries can see in Figure 1.3.

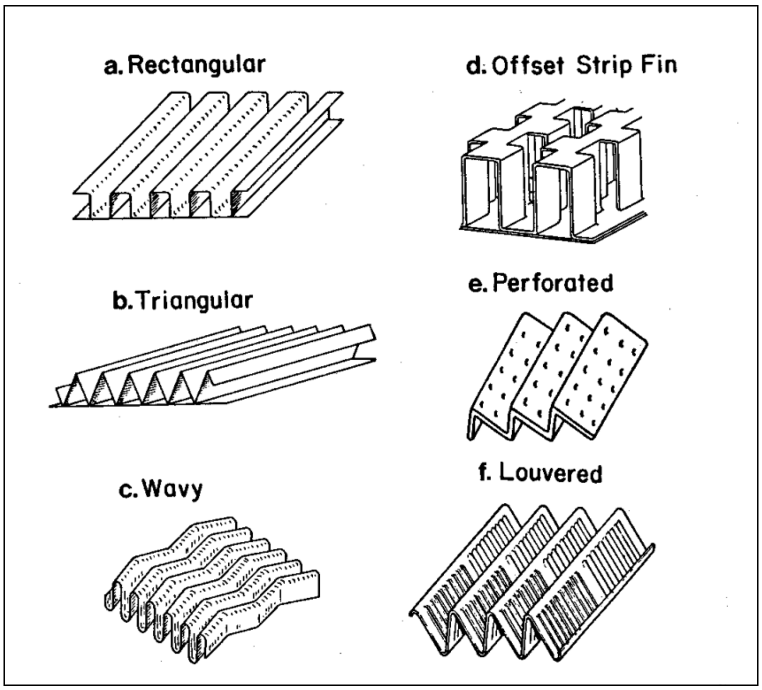


Figure 1.3: Type of fin (Source: Jiehai Zhang, 2004)

1.1 Problem Statement

One particular type of compact heat exchanger for the louvered fin heat exchanger has been used heavily in the automotive and air conditioning industries. Over the last several decades, the majority of the work towards improving louvered fin exchanger efficiency has focused on designing more efficient fins by optimizing fin parameters like louver angle, fin pitch, louver pitch, and louver length. The majority of past research aimed towards improving louvered fin exchanger efficiency and has focused on optimizing various parameters of the louvered fin only.

The air velocity distribution for louvered fin heat exchangers in residential air conditioning installations is not very well documented today because it is difficult to measure accurately. In this study the louvered fin geometry will be determine the angle of louvered plate at different air velocity. In the same time the air velocity and pressure drop is determine with optimization the angle louvered plate using the CFD method. Pressure drop and air velocity results and comparisons of the different louvered angle and solvers are reported and discussed.

1.2 Objective

The objectives for this project are as below:

a. To determine the optimal angle of louvered plate at different air velocity.

b. To determine the air velocity and pressure drop profiles.

1.3 Scope

The scope for this project includes:

a. Literature study on overview of louvered plate design, geometry and CFD modeling and simulation

b. To study the application of CFD method.

c. To construct the CFD louvered plate geometry.

d. To simulate numerically air flow through the louvered plate angle.

e. CFD simulation and predictions.
   - Collect results and data
   - Observe the simulation of air flow

CHAPTER 2

LITERATURE REVIEW

On doing this study, there are some journal that been produce someone on previous time had been referred. The journal was based on their studied and finding on various titles. The previous studied was mostly conduct by grouping or coupled. The content of previous papers is related to this project title. Otherwise all these journals can be helped in completing the project till the objectives of the project can be achieved.

DeJong N.C and Jacobi A.M (2003) had presented a detail study of flow, heat transfer, and pressure drop for louvered fins. Louver-by-louver mass transfer data are acquired for Reynolds number from 130 to 1400. Pressure-drop data are obtained using a low-speed wind tunnel and local flow structured are visualized using dye injection in a water tunnel. Particular attention is placed on the role of vortex shedding in heat transfer enhancement. In contrast to recent studies for similar for. Set-strip arrays, vortex shedding is found to have less impact in louvered fin arrays. Several practical implications for louvered fin design and analysis are discussed.

They found that, the flow through louver arrays is duct-directed at very low Reynolds number; that is, it passes through the duct created by neighboring fins as shown in figure 2.1 (Schematic a louvered fin arrays showing duct and louvered directed flow). At higher Reynolds number, the flow becomes more louver-directed and follows the louvers rather than remaining in the ducts. The flow of the louvers is call flow efficiency.

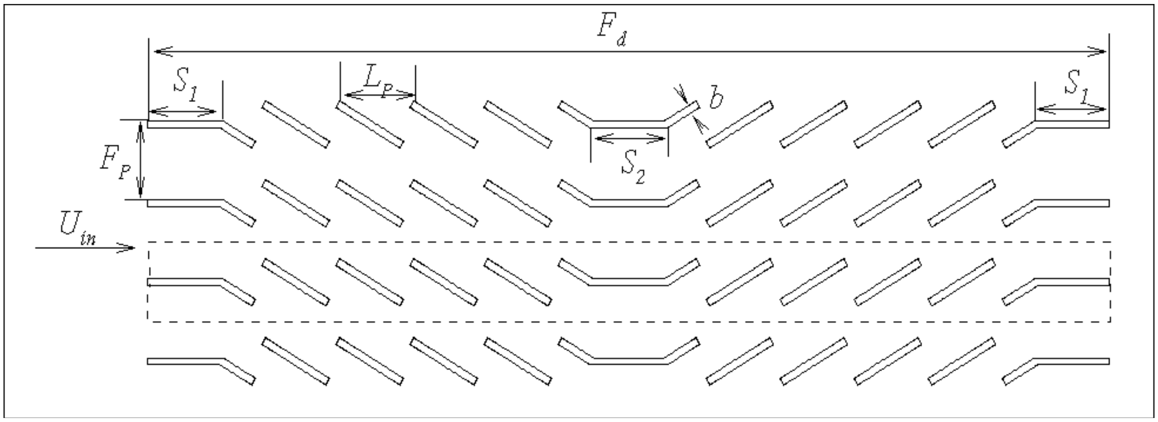


Figure 2.1: Schematic a louvered fin arrays showing duct and louvered directed flow.

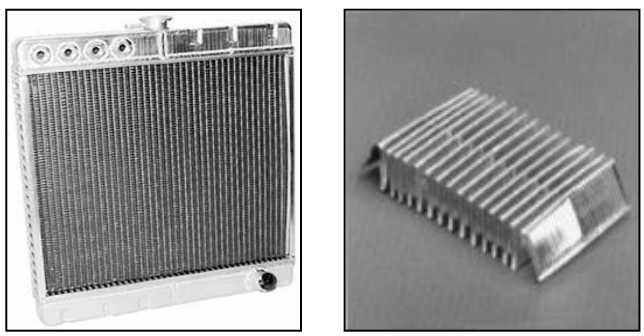
The goal of their paper is to present a more complete experimental description of flow and heat transfer in louvered fin arrays, with a focus on the physics important to thermal-hydraulic performance. A better understanding of flow and heat transfer interaction is possible through complementary experiments that provide louver-by-louver convection data, overall heat transfer, pressure drop, and detailed flow visualization.

Table 2.1: Parameters of sample tested.

θ (degrees)	Ratio of fin pitch to louver pitch,(F_P /L_P)	Number of fins
18	1.09	12
28	1.09	12
22	1.2	15

2.1 Louvered plate geometry

The availability of high-speed production techniques, consequently being less expensive than other interrupted fins, is an additional reason for their wide usage. They are associated with higher heat transfer coefficients than those for offset strip fins. Although the friction factor increase is greater than the heat transfer increase, the heat exchangers can be designed for higher heat transfer and the same pressure drop compared with those with offset strip fins by proper selection of the exchanger frontal area, core depth, and fin density. Louvered fin geometry can be considered as a combination of wavy and strip fin geometry (Figure 2.2).



(a) (b)

Figure 2.2: A flat-tube and louvered fin heat exchanger: a) Heat exchanger, b) Louvered fins (Source: Shah, 1999)

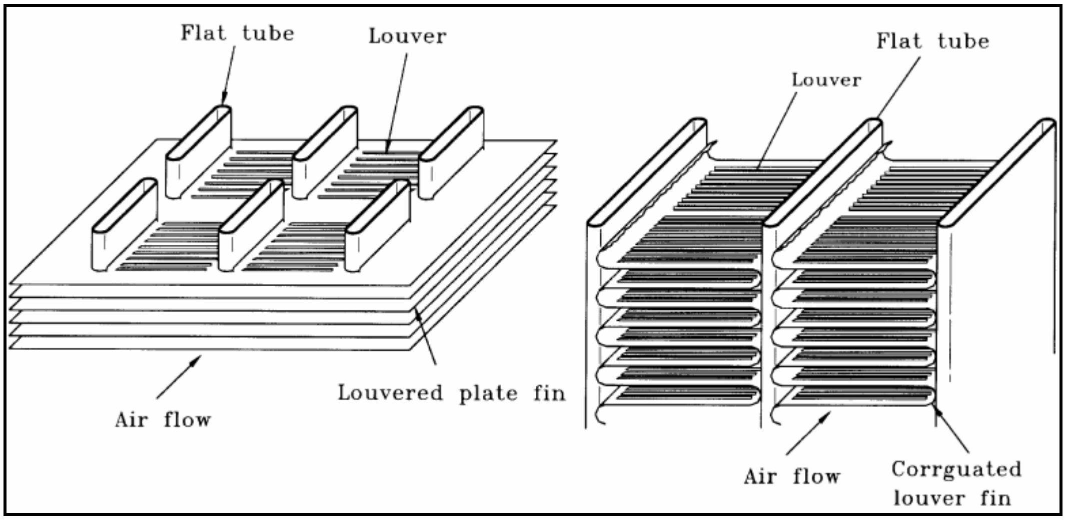
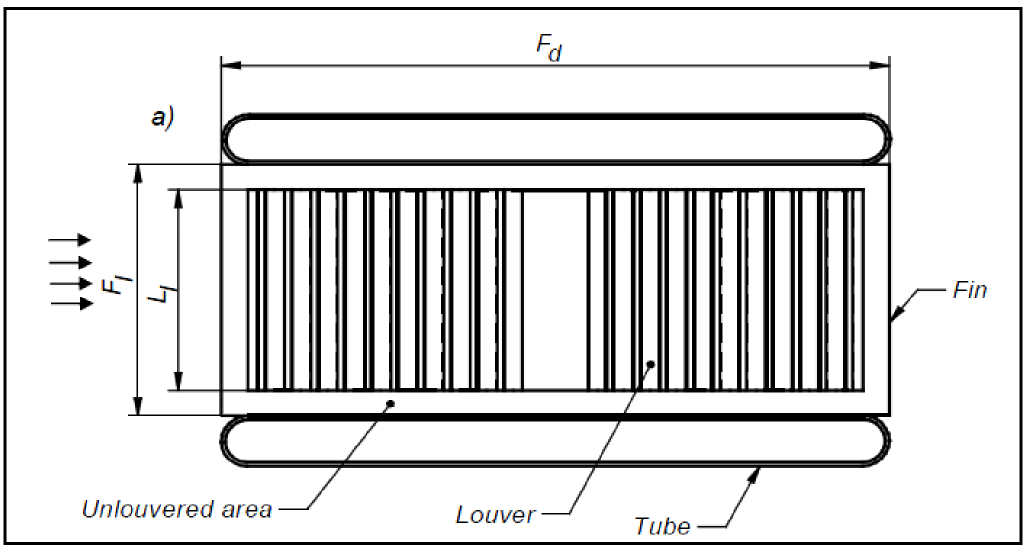


Figure 2.3: Typical louvered fin geometry with two and one flat rows of tubes in the flow direction (source: Wang et al., 1999b)

They are usually brazed, soldered or mechanically expanded to a flat, extruded tube, and formed into serpentine or parallel flow geometry. The louvered fin heat exchanger is built in the form of a combination of louvered fins and a single row of flat tubes with high aspect ratio or multiple rows of tubes with lower aspect ratio. Although not very common, the louvered fin and round tube combination can be encountered in practical applications.

Basic geometrical parameters influencing the heat transfer and pressure drop in a louvered fin configuration are louver pitch L_p, louver angle ϕ, louver height L_h, louver thickness t, louver length L_l, and fin pitch F_p (Figure 2.3).

The fluid dynamic and heat transfer characteristics of louvered fin heat exchangers have been studied intensively by numerous groups perhaps starting with the work of London and Ferguson (1949). One year later, Kays and London (1950b), reported the test results of three different louvered fin geometries. They noted an increase in heat transfer coefficient owing to laminar sub layer interruption but also a friction factor increase. They suggested lower flow velocities in order to keep friction factors of the same order as for plane fins but with substantially higher heat transfer coefficients than those of plain fins. The research performed on actual-sized louvered fin heat exchangers has been related to overall 2 heat transfer and pressure drop performance. Kays and London (1984) gave a compilation of such data for a large number of available heat exchangers at the time. Other studies of actual sized heat exchangers, like the one performed by Achaicha and Cowell (1988), showed performance data for heat exchangers for a wide range of influential parameters such as fin pitch, louver pitch, tube pitch, and louver angle. Although information like this is very valuable, it does not provide any details of the performance determining heat transfer and flow field mechanisms within the exchanger.



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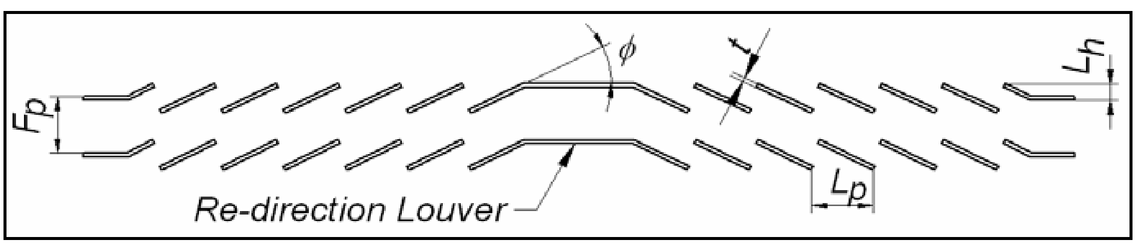

(b)

Figure 2.4: Geometrical parameters of louvered fin: a) Cut in the flow direction, b) Cut normal to the louver fins (Source: Cowell et al., 1995)