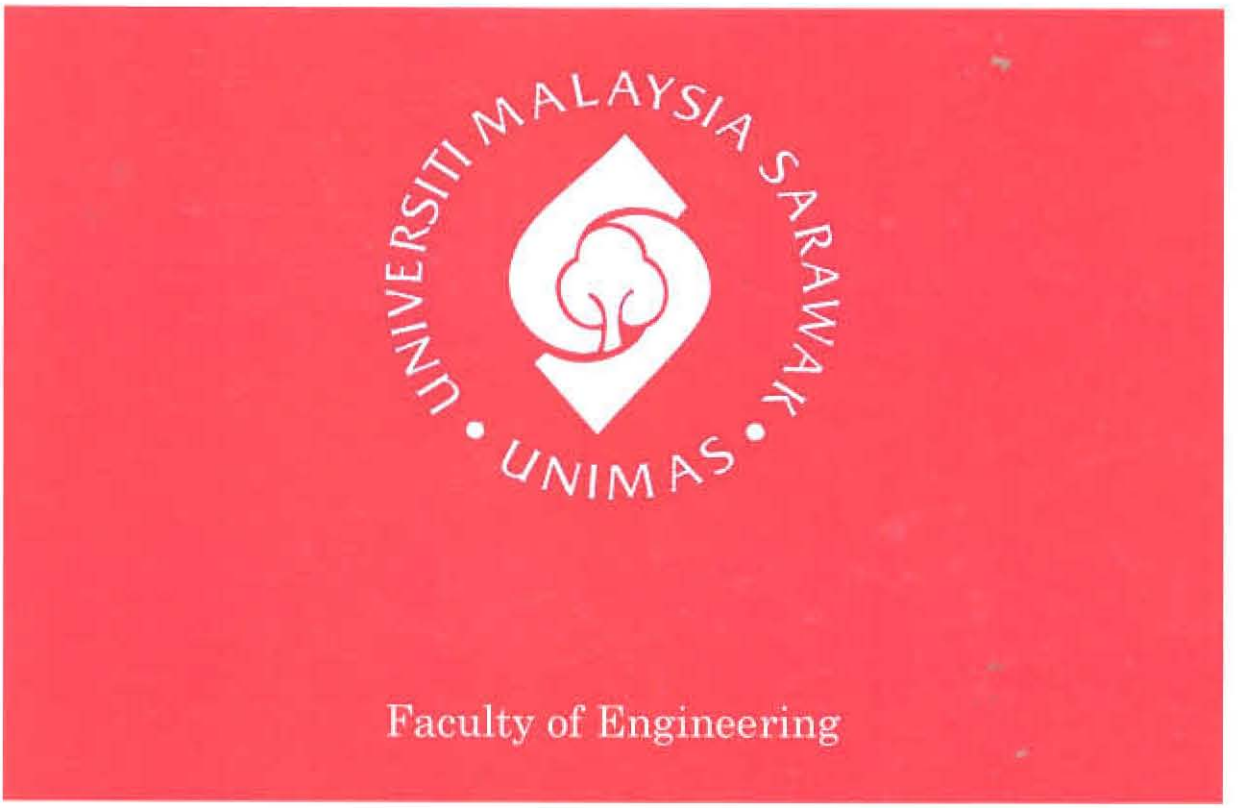

FISH DORSAL INSPIRED SKEW TURNING VANES FOR HVAC SYSTEM

ALIF FALATIN BIN ABDUL LATIF
40493

SUPERVISOR: Ir. Dr. MOHD DANIAL IBRAHIM

Bachelor of Engineering with Honours
(Mechanical and Manufacturing Engineering)
2017

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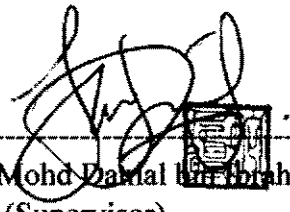

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Final Year Project Report ☑

Masters ☐

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FISH DORSAL INSPIRED SKEW TURNING VANES FOR HVAC SYSTEM

ALIF FALATIN BIN ABDUL LATIF

A dissertation submitted in partial fulfillment
of the requirement of the degree of
Bachelor of Engineering with Honors
(Mechanical and Manufacturing Engineering)

Faculty of Engineering
Universiti Malaysia Sarawak

2017

Alhamdulillah

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ABSTRACT

HVAC stands for Heating, Ventilation and Air Conditioning system which is utilized to supply natural air into a building. The efficiency of the system is around 60 – 75 % and it could reach up to 80% with appropriate installations and design. HVAC have a few problems which happen at the bend of its ducting which create turbulence and create vortex. This problem creates pressure drops brought on by the sudden changes in course due to the bend. To overcome the problem, turning vane was introduced at the bend areas. There are many type of turning vanes accessible in the market. Turning vanes were intended for better flow of the fluids. The turning vanes was design in AutoCAD and simulations was done by AnSys Workbench. The result of the simulations was then analyzed between single turning vane, double turning vanes with 3 proposed turning vanes design and triple turning vanes with 3 proposed turning vanes design. It was found that the proposed triple turning vanes from the first design gave a great result as far as average outlet velocity and turbulence dissipations compared to other designs. The result showed that the best turning vane was the first design of triple vanes with mass flow average of velocity on the outlet of 3.19456 m/s and mass flow average of turbulence eddy dissipation of 1325.16 J/kg.s.

ABSTARK

HVAC bermaksud untuk Pemanasan, Pengudaraan dan sistem pendingin hawa yang digunakan untuk membekalkan udara semula jadi ke dalam bangunan. Kecekapan sistem ini adalah kira-kira 60 - 75% dan ia boleh mencecah sehingga 80% dengan pemasangan dan reakabentuk yang baik. Sistem HVAC mempunyai beberapa masalah terutama di selekoh sesalur yang mewujudkan pergolakan dan vorteks. Masalah ini menghasilkan tekanan titik yang dibawa oleh perubahan secara mendadak ketika melalui selekoh tersebut. Bagi mengatasi masalah ini, *turning vanes* dicadangkan di kawasan selekoh tersebut. Terdapat pelbagai jenis *turning vanes* di pasaran. *Turning vanes* bertujuan untuk membantu aliran udara yang lebih baik. *Turning vanes* direka bentuk menggunakan aplikasi *AutoCAD* dan simulasi telah dilakukan menggunakan aplikasi *Ansys Workbench*. Hasil daripada analisis simulasi diantara single *turning vanes*, *double turning vanes* dengan 3 cadangan rekabentuk dan *triple turning vanes* dengan 3 cadangan rekabentuk. Berdasarkan hasil simulasi yang dijalankan, didapati bahawa *triple vanes* daripada reka bentuk pertama memberikan hasil yang terbaik dengan purata halaju keluar dan *turbulence eddy dissipations* berbanding reka bentuk lain. Hasilnya menunjukkan bahawa *triple vanes* bagi rekabentuk pertama dengan *mass average velocity of outlet* adalah 3,19456 m / s dan *average turbulence eddy dissipations* adalah 1325,16 J / kg.s.

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NOMENCLATURES

p_f	-	Friction losses in terms of total pressure, Pa
f	-	Friction factor, dimensionless
L	-	Duct length, m
D_h	-	Hydraulic diameter, mm
V	-	Velocity, m/s
ρ	-	Density, kg/m^3
ε	-	Material absolute roughness factor, mm
Re	-	Reynolds number
k- ω	-	k-omega
ω	-	Specific dissipation rate
HVAC	-	Heating, ventilating and air conditioning
AHU	-	Air handling unit
VOC	-	Volatile organic compound
CV	-	Constant volume
VAV	-	Variable air volume
SMACNA	-	Sheet metal and air conditioning contractor's national association
ASHRAE	-	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
PVC	-	Poly (vinyl chloride)
fpm	-	Feet per minute
CFD	-	Computational fluid dynamics
CAD	-	Computer aided design

CHAPTER 1

INTRODUCTION

1.1 Impetus of the Project

Heating, ventilation and air conditioning (HVAC) is the technology of indoor and vehicular environmental comfort that provide thermal comfort and acceptable indoor air quality. Air distribution system consist of three segments which are Air Handling Unit (AHU), ventilation and heating system, ventilation and cooling system. Heating, ventilation and air conditioning (HVAC) system is a used to warmth or cool private, business or industries. Air distribution systems are capable to provide fresh air from the natural resources from the inside airborne contaminants, for example, smells from natural resources, unpredictable natural mixes, volatile organic compound (VOC's) comes from inside decorations and chemicals utilized for cleaning. The systems comprise of numerous segments and component will expend energy usage and extensive measure of vitality, the parts and component of the system should be design and installed properly and efficiently. This will reduce unnecessary over design and energy usage. Designers should always specify the highest efficiency fitting possible.

1.2 Background study

There are two types of air distribution systems, constant volume (CV) and variable-air-volume (VAV). Constant volume type, the system will operate with a constant airflow rate (Air Distribution System,2008) but the temperature may be varied and normally used for single-zone and multi zone system.

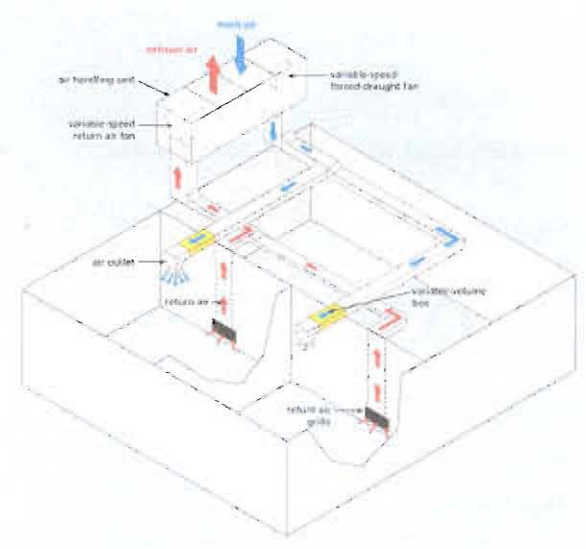

Figure 1: Single zone Variable Air Volume (SZVAV) roof top unit

Single duct system consist ventilation and cooling air-conditioned system in a single ducting but some design there will be separated heating system. Dual-duct system used a single fan to move air for both cooling and heating coils in the air handling unit (AHU) and has separate ducts for hot and cold for the distributing of air. Multi zone unit is where the air supplies to several zones from a centrally located air handling unit (AHU).

Variable-air-volume (VAV) is a system where the temperature is being maintained while the flow of air varied. The benefits are it has accurate temperature control and has lower energy consumption. This system can be applied for both single-zone and multi zone system. For single-zone, the speed of fan varies by the ambient temperature and the set point temperature. The compressor modulates the refrigerant flow and maintain constant supply of air temperature and give more accurate temperature control.

1.3 Type of Ducting System

There are five types of supply and return duct systems in HVAC systems. The types of duct systems are as follows:

i. Radial system

Radial duct system consists of central supply plenum with several numbers of single branch duct arranged in radial pattern. The single branch duct is designed and sized which can supply two or more outlets. Radial system can be used for up flow, downflow or horizontal air handlers.

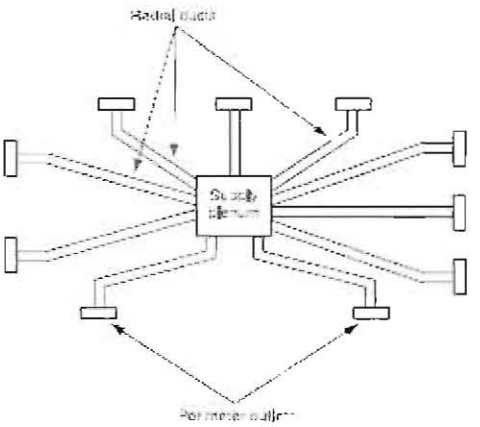

Figure 2 : Radial duct system

ii. Extended plenum system

Extended plenum duct system has one or two box alike pieces of ductwork extending from the main plenum at the indoor unit. It has the same dimension of main ducting. The supply outlet ducting is tapped into the extended plenum that is being feed by the branch.

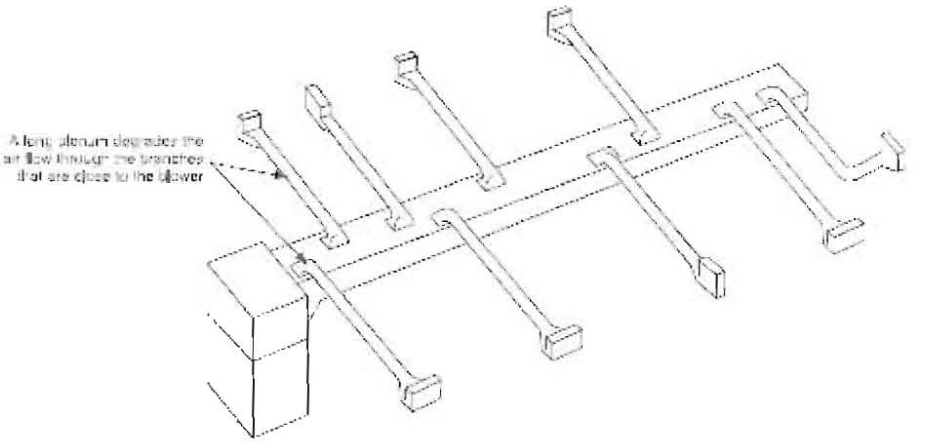

Figure 3: Extended Plenum duct system

iii. Reducing plenum system

Reducing plenum duct system reduced the main ducting so that the air velocity loss will regain and the air flow improved. This type duct system is common in HVAC as it is easy to fabricate and install.

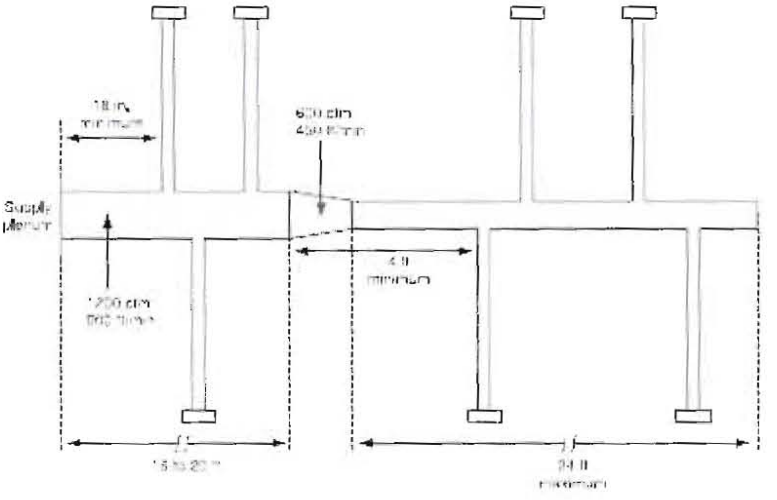

Figure 4: Reducing Plenum duct system

iv. Reducing trunk system

Reducing trunk duct system minimized the ducting sizes after the main and branches outlet. It can maintain the air velocity even the reductions of air flow due to the supplied at each branch. Each of the trunks would have different cross-sectional area.

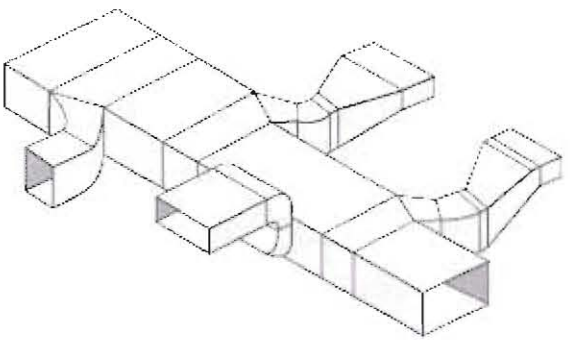

Figure 5: Trunk reduced duct system

v. Perimeter loop system

This system is applicable to the building that is constructed by using concrete slab on grade. It can perform better compare to radial duct system but it also has a weakness which it would cost more to design and installations.

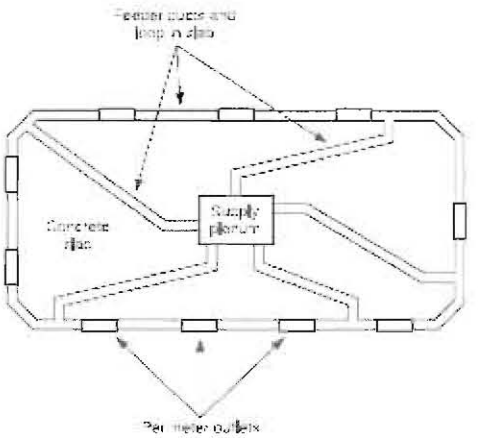

Figure 6: Perimeter loop duct system

Every HVAC ducting system should consider the return air ducting but it is generally ignored or less critical considerations by engineers which creates defect on the circulations of the HVAC systems overall.

The most commonly materials used as the ducting are sheets metal, rigid fiber glass duct board and flexible duct board and flexible non-metallic ducting which each material has its own advantage and disadvantage in term of price, installations and performance.

Figure 7: Squared metal sheet insulated fiber glass ducting board installations roof top unit