UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INVESTIGATION OF DIFFERENT DUCT MATERIALS EFFECT TO HVAC DUCTING EFFICIENCY

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Mechanical Engineering Technology (Refrigeration and Air Conditioning System) with Honours

by

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I hereby, declared this report entitled "Investigation of Different Duct Materials Effect to HVAC Ducting Efficiency" is the results of my own research except as cited in references

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Refrigeration and air conditioning system) with Honours. The member of the supervisory is as follow

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ABSTRAK

Pemanasan, pengudaraan dan sistem penyaman udara (HVAC) digunakan untuk tujuan penyejukan, mengekalkan kualiti udara dan memberikan keselesaan kepada pengguna. Pada era kini, lembaran logam galvani adalah antara jenis bahan yang biasa digunakan untuk sistem penyaluran udara. Walau bagaimanapun, terdapat banyak permasalahan dan isu yang timbul dari sistem saluran seperti masalah hakisan, beban untuk memasang, kos penyelenggaraan yang tinggi, kos permulaan yang tinggi, masalah bunyi bising, masalah kebocoran dan kurang kecekapan saluran. Reka bentuk sistem salur yang cekap boleh mengurangkan saiz peralatan, lagi menjimatkan kos dan penggantian peralatan. Projek inovasi baru telah menghasilkan sistem saluran menggunakan kain fabrik untuk menyelesaikan masalah tersebut. Saluran fabrik mampu untuk semua jenis penggunaan, keperluan pengudaraan dan juga membantu untuk menyediakan lebih kawalan halaju dan persekitaran yang selesa. Namun begitu, pengedaraan udara bagi kedua-dua saluran adalah berbeza. Kaedah pengagihan udara bagi salur fabric adalah menggunakan penyebaran udara merentasi seluruh permukaan manakala kaedah bagi lembaran logam galvani pula menggunakan kaedah taburan tempat salur udara. Perbezaan dalam cara pengagihan udara telah mendorong saluran fabrik lebih berkesan daripada saluran lembaran logam galvani. Oleh itu kajian ini akan melibatkan kedua-dua jenis saluran penting untuk mengukur kecekapan saluran dengan menggunakan kaedah taburan tempat salur udara. Reka bentuk sistem salur yang cekap boleh mengurangkan saiz peralatan, lagi menjimatkan wang baru atau penggantian peralatan. Bahan saluran yang digunakan adalah fabrik dan lembaran logam galvani. Dengan diameter bagi kedua-dua salur sekitar 12 inci, 1.5 meter panjang saluran dan kelajuan kipas adalah 800 RPM. Peralatan digunakan untuk mengukur semua parameter aadalah seperti anemometer TA465-P, Pitot tiub manometer berbeza Extech HD350, pengukur getaran (AT-2040) dan pengukur tahap bunyi (Multifunction HVAC Meter PCE-EM 882). Proses pengukuran akan dapat dijalankan menggunakan kedua-dua jenis saluran, lembaran logam galvani dan fabrik. Data yang diperoleh akan dibandingkan dan dianalisis menggunakan kaedah teori.

ABSTRACT

Heating, Ventilating and Air Conditioning Systems (HVAC) are applied for cooling purpose, maintaining quality of air and providing human comfort. Nowadays, galvanized sheet material were commonly used for ducting system. However, there are lots of issues from the duct system such as corrosion problem, heavy to install, high cost of maintenance, high initial cost, noise problem, leak problem and less duct efficiency. An efficient duct system designs can reduce equipment size and further saving money for new or replacement equipment. A new innovation project have produced cloth ducting system from fabric material to solve those problems. Fabric duct are able for all kinds of applications, ventilation requirements and also helps to provide a much more controlled velocity and comfortable environment. Recently, the air distribution for both duct are different. Galvanize steel duct is using spot duct air distribution method while fabric duct is using air diffusion across entire surface. Differences in air distribution method may contribute fabric duct to be more efficient than galvanize steel duct. Thus this study will involve both duct material to measure their duct efficiency by using spot cooling air distribution method. The duct material used are fabric and galvanized steel metal. The diameter for both duct are around 10 inch and 1.2 meter of duct length. The device used for measure all the parameters are anemometer TA465-P, Pitot tube differential manometer Extech HD350 vibration device (AT-2040) and sound meter level (Multifunction HVAC Meter PCE-EM 882). The measuring will be carry out for both duct material, galvanized steel and cloth fabric. The data obtain will be compare and analyzed with the theoretically method.

DEDICATION

I dedicate this project to Allah Almighty my creator, my strong pillar, my source of inspiration, wisdom, knowledge and understanding. He has been the source of my strength throughout this program and on His wings only have I soared. I also dedicate this work to my family who has supported me all the way and whose encouragement has made sure that I give it all it takes to finish that which I have started. This project also is especially dedicated to my supervisor, for her willingness to guide me to the success of this project for my degree.

ACKNOWLEDGEMENT

First of all, I would like to express my gratitude to my supervisor Mrs Noor Safreena Binti Hamdan for her mindful supervision and guidance that have guided me in accomplishing this project. Her wide knowledge and experience in this studied area has contributed in making this project succeed. Besides, thanks a lot to my family who have been supporting and giving me endless encouragement, without the spirit and support that I received throughout this path, possibility these projects will not be successfully completed. Finally, I am grateful for having my housemates, supportive classmates and beloved friend as my companion along the way while working on this project. They have given me the greatest support right from the beginning and it has given me the courage to move on when not capable to through more further while completing this project.

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AHU	-	Air Handling Unit
ASHRAE	-	American Society of Heating, Refrigerating and Air-Conditioning
ASTM	-	American Society for Testing and Materials
CFM	-	Cubic Feet per Minute
CEN	-	The European Committee for Standardization
EN	-	European Standard
EUROVENT	-	Europe's Industry Association for Indoor Climate
°F	-	Fahrenheit
HVAC	-	Heating, Ventilation and Air-Conditioning
IAQ	-	Indoor Air Quality
ISO	-	International Standard Organization
MERV	-	Minimum Efficiency Reporting Value
mm	-	Milimeter
m^3/h	-	Meter cube per hour
m/s	-	Meter per second
NAIMA	-	North American Insulation Manufacturers Association
Pa	-	Pascal

CHAPTER 1

INTRODUCTION

1.0 Introduction

The research entitled "Investigation of Different Duct Materials Effect to HVAC Ducting Efficiency". Generally, this chapter provides information about background, problem statement, objectives and scopes of the study.

1.1 Project Background

Air flow problems have overwhelmed the HVAC industry for years. No matter how much money spend on a high-quality HVAC system, the equipment won't work at its best without properly designed and installed ductwork. Discomfort, high energy costs, bad air quality, and increased noise levels were the results of ducts that are not well designed. Heating, Ventilating and Air Conditioning Systems (HVAC) are practically use for cooling purpose, maintaining quality of air and providing thermal comfort for the occupants and condition spaces.

HVAC system is very important and crucial in many industries and laboratories in cold storage and preservation purposes, pre-cooling and pasteurization of milk, in various manufacturing processes in rubber industries, textile industries etc. apart from residential applications. The process that involved are consist of switching or replacing air in any place to provide high quality indoor air, which involves temperature control, oxygen replenishment, and removal of moisture, odours, smoke, heat, dust, etc. from the air. (Lathia & Mistry 2016)

1.1.1 DUCTWORK

HVAC ductwork material includes of galvanized sheet metal, fiberglass board and fabric cloth for conducting air from an air handling unit. According to (Hozemer et al. 2000) ductwork can be divided into four basic types: rectangular duct, spiral duct, fittings, and components. Straight HVAC runs are created using rectangular and spiral (round) duct. Rectangular duct (***Figure 1.1***) comes in standard sizes, metal wall gauge, and where appropriate internal insulation thickness. In other hand, spiral duct (***Figure 1.2***) exist in a standard number of weights and sizes, but it is not insulated. By using separating processes, both rectangular and spiral duct are made machines.

Figure 1.1: *Rectangular Duct*

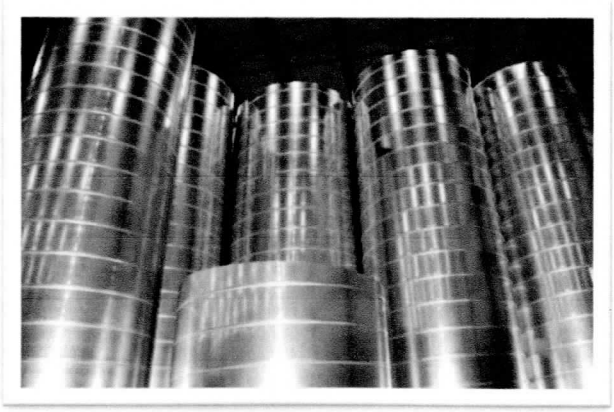

Figure 1.2: *Round Duct*

Nowadays, galvanized sheet material was commonly used for ducting system. However, there is lots of issues from the duct system such as corrosion problem, heavy to install, high cost of maintenance, high initial cost, noise problem, leak problem and less duct efficiency. An efficient duct system designs can reduce equipment size, further saving money for new or replacement equipment. An innovation project has produced cloth ducting system from fabric material to solve those problems. Fabric duct are able for all kinds of applications, ventilation requirements and helps to provide a much more controlled velocity and comfortable environment. (Fontanini et al. 2011)

Thus, the purpose of this research is to identify a best material used for HVAC duct between fabric and galvanized steel. This project involves discovering how the different duct materials affected HVAC ducting efficiency.

1.2 Problem statement

The Galvanized steel metal ducting have a lot of weakness which consist of corrosion problem, high cost of maintenance, high initial cost, heavy to install and less ducting efficiency. This issue contributes some company searching for a new solution to reduce the energy losses and cost in a ducting system. Thus, this research was conducted to study the material of ducting to reduce all the problems faced. Many of occupancies claims that fabric duct is the best solution for the ducting problems. However, there are still no evidence and data that prove the comparison between galvanize steel duct and fabric duct. Recently, the air distribution for both duct are different which are Galvanize steel duct using spot duct air distribution method while fabric duct using air diffusion across entire surface. Differences in air distribution method may contribute fabric duct to be more efficient than galvanize steel duct. Thus this study will involve both duct material to measure their duct efficiency by using both air distribution method (spot cooling and air dispersion across entire surface).

Further steps on how this project is developed as well as the parameter of both materials to be recorded will be discussed in Chapter 3 of this report.

1.3 Objectives

Based on the research title, "Investigation of Different Duct Materials Effect to HVAC Ducting Efficiency", the objectives below are followed.

a) To develop a prototype and connecter for ducting system using galvanized steel metal and fabric.
b) To investigate the effects of different duct materials to the HVAC ducting efficiency which consist of the air flow rate, velocity, sound and vibration using spot cooling and air dispersion across entire surface air distribution method.
c) To compare the ducting efficiency for both duct material system.

1.4 Scope of This Research

The work scope of this research is for the Cooling system. The duct material used are fabric and galvanized steel metal. The diameter for both duct are around 10 inch, 1.2 meter of duct length and the speed of the fan is 800 RPM. The parameter of this project consist of air flow rate, velocity, pressure drop, sound level and vibration level. The device used for measure all the parameters are anemometer TA465-P, Pitot tube differential manometer Extech HD350 vibration device (AT-2040) and sound meter level (Multifunction HVAC Meter PCE-EM 882). The measuring will be carry out for both duct material, galvanized steel and cloth fabric. The data obtain will be compare and analysed with the theoretically method.

1.6 Proposed Solution

The procedure and method for this research are consist of duct sizing, air flow rate test, velocity, vibration test and sound level test. For duct sizing, the measuring includes of the diameter size of duct, efficient length of duct, speed of the fan, relative humidity and temperature supply by the axial fan. The air flow rate test- will measured using Anemometer TA465-P and the pressure drop measured by Pitot Tube Differential Manometer Extech HD350. However, the vibration of the duct system will be measured using the vibration device (AT-2040) and sound test will measure using sound meter level (Multifunction HVAC Meter PCE-EM 882). The measuring will be carry out for both duct material, galvanized steel and cloth fabric. The data will compared to choose the best material for HVAC duct uses.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

In this chapter, reviews of the previous researches project that are related with this project will be discussed. This chapter will discuss about the history and theoretical thing for this project, "Investigation of Different Duct Materials Effect to HVAC Ducting Efficiency". The information will become additional source for the project to improve the understanding of the researches related to the project

2.1 Type of supply duct systems

An air duct is an enclosed channel through which air is transmitted from one place to another. The design of the duct system must follow the required space accessible, allowable noise levels, potential for duct leakage, consequence of duct heat losses or improvements on system performance, thermal and noise insulation, effect of air contaminants on duct materials (corrosion, etc.), fire and smoke control, and pressure losses due to friction and turbulence. (Haines, R.W & Myers, M.E et al. 2010)

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Supply ducts carried air to the spaces that are to be conditioned. Trunk and branch system are the two common supply duct systems for residences because of their adaptability, performance, and economy. Thus, main duct and branch duct will be discussed deeply in this subtopic.

2.1.1 Main trunk ducts

Main trunk duct is a large main supply trunk which connected directly to the air handler unit (AHU) and as a supply duct. The main trunk duct is the central delivery source for conditioned air leaving the plenum. Run outs and smaller branch ducts are connected to the trunk. The figure below shown the same one size main supply in an extended plenum system. (Rebollo et al. 2016). In this application, the main trunk duct is centrally located, with a straight trunk duct portion one group of branch outlets and another straight trunk duct serving a similar group of branch outlets.

The main trunk ducts never exceed 24 feet length of single-size trunk duct. Usually, the furnace will be centrally located with the main trunk line extending in both directions when doing installations. The main trunk duct (***Figure 2.1***) may run above the ceiling or below the floor depends on the climate of the installation. (Swim, W.B. and E.I. Griggs et al. 1995)

***Figure 2.1**: Main trunk duct*