UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF LOW-COST MAGNETIC MOTOR FAN FOR INDIVIDUAL USAGE

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Air conditioning & Refrigerant system) with Honours.

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Refrigeration & Air-Conditioning Systems) (Hons.). The member of the supervisory is as follow:

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ABSTRAK

Keselesaan terma berkait rapat dengan iklim global yang kritikal. Dari situ, sistem HVAC disediakan untuk mencapai keselesaan terma kepada pengguna sedangkan sistem tersebut telah dijelaskan sebagai pengunaan tenaga utama di dalam sesebuah bangunan dengan 57% diikuti dengan lampu dan peralatan yang lain. Oleh itu, kajian ini bertujuan untuk membina sebuah kipas motor magnetik kos rendah untuk kegunaan individu demi mencapai keselesaan terma pengguna, mengurangkan penggunaan tenaga kemudian mengelakkan pencemaran alam sekitar secara serentak. Produk ini telah direka bentuk dengan menggunakan perisian SolidWorks 2013 dan dihasilkan dengan menggunakan serbuk Nylon Polyamide (PA12) melalui Pencetak Laser 3D Selektif. Kipas motor magnetik menggunakan magnet Neodymium untuk menghasilkan daya tolakan yang menjana gerakan berputar kepada motor. Kipas tersebut menghasilkan aliran udara untuk mengurangkan suhu sekitar pengguna yang kritikal. Sebelum itu, eksperimen tolak-tarik untuk magnet telah dijalankan bagi mengenal pasti sama ada daya paksi atau tangen menghasilkan daya kerja yang lebih tinggi melalui pelbagai jarak (0.5 cm hingga 10.0 cm). Selain itu, empat jenis konfigurasi magnet (A, B, C, D) pada rotor dan pemegun motor dibandingkan berdasarkan kelajuan, aliran udara dan masa. Kemudian, semua parameter konfigurasi magnet dibandingkan dengan pengiraan mekanikal pada tork dan kuasanya. Berdasarkan eksperimen tolak-tarik, daya paksi menghasilkan daya kerja yang lebih tinggi dan penggunaan kuasa yang rendah berbanding daya tangen pada jarak 0.5 cm manakala konfigurasi C menunjukkan hasil purata yang lebih tinggi untuk semua parameter yang terlibat. Secara ringkasnya, penggunaan magnet boleh mengurangkan penggunaan kuasa motor disebabkan oleh daya tolakan di antara mereka dan telah dibuktikan melalui eksperimen tolak-tarik dan pengiraan mekanikal pada tork dan kuasa.

ABSTRACT

Thermal comfort significantly associated with the critical global climate. Then, HVAC system is provided to achieve the desired thermal comfort of the consumer while that system is clarified as the major energy uses in a building with 57% followed by lighting and other equipment. So that, this study aims to develop a low-cost magnetic motor fan for individual usage to achieve thermal comfort of the consumer, reduce energy consumption then avoid environmental pollution simultaneously. This product is designed by using SolidWorks 2013 software and fabricated by using Nylon Polyamide (PA12) powder via Selective Laser Sintering (SLS) 3D printer. This magnetic motor fan used Neodymium magnet to produce repulsive force that generated rotating motion to the motor. The fan then produced air flow to reduce the critical ambient temperature of consumer. Before that, push-pull experiment of the permanent magnet is conducted to identify either axial or tangential force is produces higher work generated through a various distance (0.5 cm until 10.0 cm). Furthermore, four different types of magnet configurations (A, B, C, D) on rotor and stator of the motor are compared based on speed, airflow and time. Then, all the parameters of magnet configurations are compared with the mechanical loss calculation on its torque and power. Based on the push-pull experiment, axial force produced higher work generated and low power consumption compared to tangential force in 0.5 cm on its distance while configuration C indicated the higher average result for all parameters involved. In the nutshell, the usage of permanent magnet can reduce the power consumption of the motor due to the repulsive force between them and has been proved through the push-pull experiment and mechanical loss calculation.

DEDICATION

I dedicate my disquisition work to all my family whose words of encouragement support me and even listens to my problems along my project period. I also dedicate this disquisition to my friends and classmates who have always monitor and give idea throughout the process and also helping to complete this project on time without feel any disturbances.

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CHAPTER 1

INTRODUCTION

1.0 Briefing

Thermal comfort significantly depends on satisfaction of human being when there are in thermal environment condition. It plays a vital role to ensure the well-being, safety and work potency perpetually in good shape in our lifestyle (Zhu et al., 2018). There are several instrumentality and systems that may achieves the thermal comfort of humans being. All the instrumentality and systems sometimes exploit electricity to work, and also the long amount of electricity usage will result in the rise of energy consumption and price.

1.1 Project Background

Thermal comfort is the most vital issue that determines the foremost concern of consumer which is overall quality of indoor atmosphere because of their long amount of activity in a building (Zhao, Houchati, & Beitelmal, 2017). It conditions physically related to the building structures, settlement maths, open areas obstacles and surface materials. All these options area associated to the environmental condition that require to be assessed to induce the required thermal comfort (Hirashima & Katzschner, 2016). When the specified thermal comfort is often achieved, the building energy efficiency also will improve at the same time with the operating potency and productivity of the occupants. In the current era of technology, HVAC system plays a major role because the thermal comfort satisfying of consumer based on the climates and building conditions. Moreover, the energy consumption and price is reduced by exploiting the advanced

management of HVAC systems whereas adhering to the thermal comfort desired conditions of consumer (Kampelis et al., 2017). The usage of HVAC systems require power or in others word is electricity. In 2013, the power sector in Asian country has been absolutely suppose typical fossil resources and the obtainable capability knowledge indicated that the foremost proportion of sources is come from fossil fuels as its maximum amount is 88.4% whereas the opposite supply is come from hydropower that is 11.4% (Haiges, Wang, Ghoshray, & Roskilly, 2017). Those resources will result in the environmental pollution like atmospheric phenomenon due to the emission of greenhouse emission (Anderson, Hawkins, & Jones, 2016). Other than that, Malaysia is assessed as one of the countries that contributed to the biggest greenhouse emission contributors in South East Asia after Indonesia and Thailand (Haiges et al., 2017). For that reason, numerous alternatives have to be compelled to be executed to cut back energy consumption and emissions of carbonic acid gas to the atmosphere simultaneously. Proper use of energy will result in the environmental well-being besides cut back the energy consumption on the required thermal comfort of consumer.

1.2 Problem Statement

Nowadays, there are several HVAC systems sold within the market because of the critical global climate change and high demand from consumer to get their required thermal comfort. In Malaysia, HVAC system indicates to the major energy uses in a building with 57%, followed by lighting, lifts, pumps, and other equipment (Saidur, 2009). The installation cost of HVAC systems not only overpriced, but additionally got to be operated for an extended amount of time as working hours in the building sometimes up to 12 hours. From that long amount of operating system, the energy consumption and

electricity can increase dramatically if not be controlled properly. There are several factors that may influence the demand of electricity in Malaysia like population growth, urbanization increasing and growth of economic (Mahlia, Masjuki, & Choudhury, 2002). One of the biggest factor is critical climate change that make the usage of HVAC systems uncontrollable solely for achieved desired thermal comfort of consumer and without conscious, it leads to the increase of energy consumption and cost. Based on that downside, consumers like better to use alternative initiatives like fan, over the HVAC system because of the exceptionally high energy usage gap additionally similarly because the country's economic downswing. So that, this magnetic motor fan is fabricated to reduce the energy consumption of electricity at once, help the consumer to achieve their desired thermal comfort at low cost.

1.3 Proposed Solution

Information above lead to the purposes of this project. This project is designed and fabricated to achieve the desired thermal comfort of consumer. Therefore, the criteria of this project have been set which could reduce energy consumption and cost simultaneously with the desired thermal comfort.

1.4 Objectives

There are several targets to be achieve in this project and all these objectives should be achieved in the end of the project. Therefore, the following below are the objectives that have been considered:

1. To design a magnetic motor fan by using Computer Aided Design software (SolidWorks 2013).
2. To fabricate low cost magnetic motor fan by using Selective Laser Sintering (SLS) 3D printer.
3. To compare the result of four different magnet's configurations based on its performance with mechanical loss calculation (Torque & Power).

1.5 Scope

This project focused on designing and fabricate the magnetic motor fan by using Nylon Polyamide (PA12) powder via Selective Laser Sintering (SLS) 3D printer on 170 ^{0}C of laser temperature. Several limitations have been determined through this project. This product is focused on individual usage same as the conventional portable fan. So that, the size of this product is determined as 250 mm x 180 mm on its length and height. There are four different types of magnet configurations (A, B, C, D) on rotor and stator of the motor that are performed on actual test process and compared based on speed, airflow and time. Then, all the parameters of magnet configurations are compared with the mechanical loss calculation on its torque and power to determine which configuration produce higher work generated and low power consumption.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This literature review is executed to identify the studies which is related to the topic of this project which is magnetic motor fan. The author has found a good representative literature discussing the concept of the magnetic free energy in a motor to create a useful energy that can be used for individual usage. Furthermore, the material selection also can be performed from this literature for example, the types of magnet that can be used for this project. Each of the material for this project is very important to choose, so that the manufacturing processes will be easier with the proper plan and the cost for this project also can be saved in line with the title of this project which is development of low cost magnetic motor fan for individual usage.

2.1 Energy

Any properties which that can be produced or converted to work is called energy (Patil, 2011). In the era of technology nowadays, there have many equipment and electrical appliances used to facilitate our daily work. For example, communities in the past mostly use hand fans to get rid of heat around their body during hot weather. But in the present, communities are more advanced to use electrical fan compared to hand fans due to the difference source of energy used. The energy resources to use the electrical fan is electricity while for the hand fans, the energy to move the fan is manpower that is highly irrelevant to be used in the current flow of modern technology.

2.1.1 Classification of Energy Resources

In this universe, there have many sources of energy that can be recognized such as solar, wind power, nuclear, oil, biomass, hydropower and many more. All this energy resources are fall into two main classification which are renewable and non-renewable energy. In principle, the renewable energy may be remodelled into another kind of energy that may be keep and it also can be remodelled back (Olabi, 2017).The non-renewable energy cannot be stored like renewable energy and it will run out someday if not used properly.

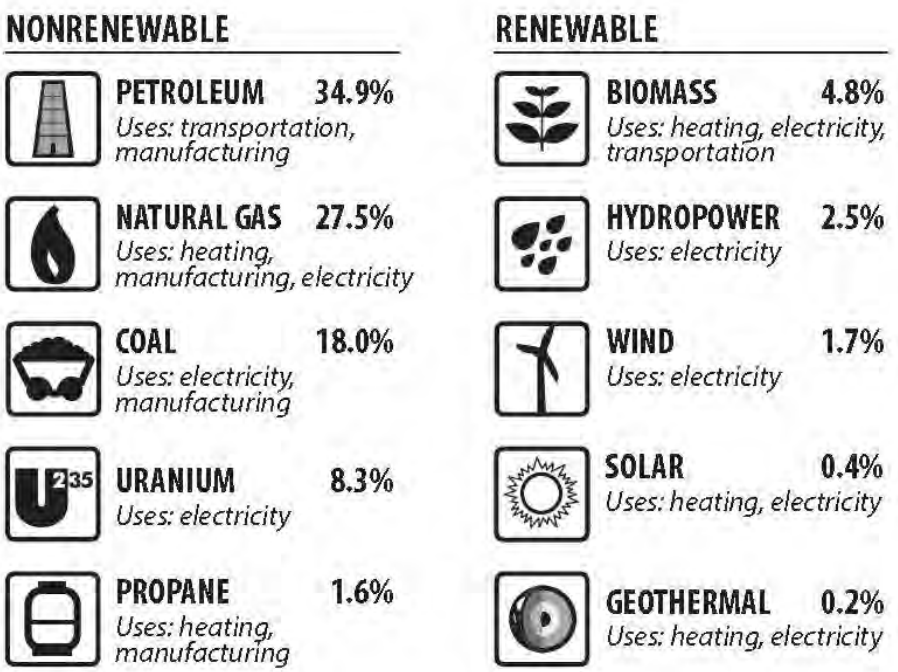

Figure 2.1: U.S energy consumption by source in 2014 (Baumann, Beatty, Constant, Hawk, & Chester, 2016).

In 2014, the investments of renewable energy in developing countries have raised by 12 months to US$ 131.3 billion whereas the investments of developed countries have raised by 3% to 138.9 US$ (Destek & Aslan, 2017). In 2014, the uses of non-renewable sources are higher than renewable sources in Unites State as shown in Figure 2.1. That show an unpleasant situation because the renewable energy is very important to be maintained as a precaution when the world is facing a crisis running out of non-renewable energy in the future. Table 2.1 below show the differences of renewable and non-renewable of energy resources:

Table 2.1: Comparison between energy.

Renewable Energy	Non-renewable Energy
• Sources of energy that can be stored and recycled through biologichemical processes and sustainable practices.	• Sources of energy that can't be refilled once used and sustained promptly.
• Use sustainable practices to reduce environmental pollution and protects Earth's biodiversity.	• Can be restored, but it will take too much time compared to its usage.
• Energy resources: ➢ Solar ➢ Biomass ➢ Hydroelectric ➢ Wind ➢ Geothermal	• Energy resources: ➢ Electricity ➢ Coal ➢ Oil and gas ➢ Power stations