Faculty of Mechanical and Manufacturing Engineering Technology

ECO JUTE - INVESTIGATION OF AN OPTIMAL BICO FIBER AND JUTE BLEND COMPOSITION FOR HVAC (DUCT LINER)

MUHAMAD AFIQ BIN SHAHARANI
B071610963

Bachelor of Mechanical Engineering Technology (Refrigeration and Air-Conditioning Systems) with Honours

2019

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B071610963

930412-14-6761

A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Mechanical Engineering Technology
(Refrigeration and Air-Conditioning Systems) with Honours

FACULTY OF MECHANICAL AND MANUFACTURING ENGINEERING TECHNOLOGY

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2019

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **ECO JUTE-INVESTIGATION OF AN OPTIMAL BICO FIBER AND JUTE BLEND COMPOSITION FOR HVAC (DUCT LINER)**

SESI PENGAJIAN: **2019/2020 Semester 1**

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DEDICATION

To my respected supervisor, Puan Norain Binti Idris

My sincere thanks to Encik Qamar Fairuz Bin Zahmani

and to all my fellow friends.

APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology (FTKMP) as a partial fulfillment of the requirements for the Degree Bachelor of Mechanical Engineering Technology (Refrigeration and Air-Conditioning Systems) with Honours. The member of the supervisory is as follow:

Signature :……

Supervisor Name : **NORAIN BINTI IDRIS**

Date :…….

Signature :……

Co-Supervisor Name : **QAMAR FAIRUZ BIN ZAHMANI**

Date :…….

ABSTRACT

Today, air conditioning system (ACS) is very important for the world, especially in the heating, ventilation and air conditioning (HVAC) industry, which plays a major role in helping the occupant to maintain real-life thermal comfort. ACS are used in many industries such as schools, buildings, factories, homes and hospitals. In addition, ACS help to maintain indoor air quality (IAQ) by controlling the temperature climate and control the air flow to prevent from health problems respiratory such as cough, asthma and lung disease. However, air conditioning system cannot be operated alone, which requires help including ducting for air distribution in order to guarantee ducting system smooth operation. Insulation is an important part of air conditioning, in particular for ducts. Insulation is a material that helps prevent heat loss and should frequent provides a comfortable, healthy, safe and quiet environment in air distribution. Nowdays, the fiberglass insulation is the most common type insulation used for duct liner. Fiberglass has material properties not eco-friendly which is the particles danger when blow into the cooled space. The objectives of this project to prepare the composition of bico fiber and jute blend and to optimize the composition by conducting k-value, r-value and acoustic test as evidence. The first methodology is material selection that bico fiber and jute. On this project, make the three samples which is sample A 70% bico fiber and 30% jute, sample B 30% bico fiber and 70% jute and sample C is 50% bico fiber and 50% jute. The sample will be testing for Thermal conductivity (K-value), Thermal resistivity (R-value) and Acoustic Test for sound absorption. The result on this project is sample A is the best sample with another samples. In conclusions, the sample A can be draw which represents 70% bico fiber and 30% jute, has potential to replace fiberglass duct liner for the HVAC industry with some improvement on the project.

ABSTRAK

Hari ini, sistem penghawa dingin sangat penting bagi dunia, terutamanya dalam industri pemanasan, pengudaraan dan penghawa dingin yang memainkan peranan penting dalam membantu mengekalkan keselesaan terma kepada penghuni. Sistem hawa dingin banyak digunakan dalam industri seperti sekolah, bangunan, kilang, rumah dan hospital. Di samping itu, sistem penghawa dingin dapat membantu mengekalkan kualiti udara dengan mengawal suhu iklim dan mengawal aliran udara untuk mencegah masalah kesihatan penafasan seperti batuk, penyakit asma dan masalah paru-paru. Walau bagaimanapun, sistem penghawa dingin tidak boleh dikendalikan sendiri, ia yang memerlukan bantuan termasuk saluran untuk pengedaran udara untuk menjamin operasi sistem berjalan lancar. Penebat adalah bahagian penting penghawa dingin, khususnya untuk saluran. Penebat adalah bahan yang membantu mencegah kehilangan haba dan harus kerap memberikan persekitaran yang selesa, sihat, selamat dan tenang dalam pengedaran udara. Hari ini, penebat gentian kaca adalah penebat jenis yang paling banyak digunakan untuk saluran. Gentian kaca mempunyai sifat bahan yang tidak mesra alam yang zarahnya berbahaya apabila meniup ke ruang yang disejukkan. Objektif projek ini adalah untuk menyediakan komposisi serat bico dan campuran jutedan untuk mengoptimumkan komposisi dengan menjalankan ujian k-nilai,r-nilai dan akustik sebagai bukti. Metodologi pertama adalah pemilihan bahan ialah serat bico dan jute. Pada projek ini, tiga sampel dihasilkan iaitu sampel A serat bico 70% dan jute 30%, sampel B 30% serat bico dan 70% jute dan sampel C adalah 50% serat bico dan 50% jute. Sampel akan diuji untuk termal (K-nilai), termal rintangan (R-nilai) dan ujian akustik untuk penyerapan bunyi. Keputusan pada projek ini ialah sampel A adalah sampel terbaik antara sampel yang lain. Sebagai kesimpulan, sampel A yang mewakili serat bico 70% dan 30% jute, berpotensi untuk menggantikan pelapik saluran gentian kaca untuk industri HVAC dengan penambahbaikan pada projek.

ACKNOWLEDGEMENTS

First and foremost, I would like to take this opportunity to express my sincere acknowledgement to my supervisor Puan Norain binti Idris from the Faculty of Mechanical and Manufacturing Engineering Technology (FTKMP) Universiti Teknikal Malaysia Melaka (UTeM) for her essential supervision, support and encouragement towards the completion of this thesis. I would also like to express my greatest gratitude to Mr. Qamar Fairuz Bin Zahmani from Faculty of Mechanical and Manufacturing Engineering Technology (FTKMP), co-supervisor of this project for his advice and suggestions in this project. In particular, I would also like to express my deepest gratitude to Mr. Zawawi Ibrahim from the Malaysian Palm Oil Board (MPOB) as the industry supervisor who collaborated in this research. Special thanks for the guidance and support throughout this project. Special thanks to all beloved mother and father for their moral support in completing this degree. Lastly, thank you to everyone who had been to the crucial parts of realization of this project especially my friends.

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LIST OF SYMBOL AND ABBREVIATIONS

ACS	-	Air Conditioning System
UTeM	-	University Technical Malaysia Melaka
FTKMP	-	Faculty of Mechanical and Manufacturing Engineering Technology
EJ	-	Eco Jute
OSHA	-	Occupational Safety and Health Administration
IAQ	-	Indoor Air Quality
HVAC	-	Heating, Ventilation and Air Conditioning
AHU	-	Air Handling Unit
CG	-	Cellular Glass
EPS	-	Expanded Polystyrene
XPS	-	Extruded Polystyrene
MPOB	-	Malaysian Palm Oil Board
K-value	-	Thermal Conductivity
R-value	-	Thermal Resistivity
Wa	-	Absorbed Energy
Wi	-	Incident Sound Energy
ASTM	-	American Society for Testing and Materials
MC	-	Moisture Content
B	-	Bico Fiber
J	-	Jute Blend
R	-	Resistivity
%	-	Percentage
°C	-	Degree Celcius
°F	-	Fahrenheit scale
Ω	-	Omega
Vrms	-	Voltage Root Mean Square
hPa	-	Hector Pascal
w	-	Watts

W/m·k	-	Watts per Meter Kelvin
$W/m^2 \cdot k$	-	Watts per Meter Square Kelvin
mm	-	Millimeter
Hz	-	Hertz
kHz	-	Kilo Hertz
m/s	-	Meter per Second
kg/m^3	-	Kilogram Per Meter Cubic
g	-	Gram
λ	-	Lambda
$\boldsymbol{l}$	-	Thickness of the Material

CHAPTER 1

INTRODUCTION

1.1 Background Study

Energy is the most important resource, while the sustainable concept focuses on community long-term survival. According by (Owusu and Asumadu-sarkodie, 2016) energy and sustainability have become an important aspect and the current issue around the world. Energy source can be classified as renewable energy and non-renewable energy. (Ferluga, 2012) stated renewable energy sources is an energy source that can be easily replenished. In other words, they are finite, and when used, they are actually gone because the reform takes so long. Next, for non-renewable an energy source is cannot be easily replenished (Ferluga, 2012). Renewable energy can be used as a primary source of energy to generate useful energy such as heat or to generate secondary energy sources such as electricity. There are five main common sources of renewable energy, such as solar energy from the sun, wind energy from turbine fans, hydro energy from flowing water, tidal energy from the ocean and plant biomass. (AZoCleantech, n.d.)

Worldwide, biomass is growing rapidly in the agricultural and forestry sectors as the most. The various from biomass are used all over the world for energy generation. (Owusu and Asumadu-sarkodie, 2016) states clean sources of renewable energy are provided by biomass which could improve the environment, the economy and energy security considerably. By researching in biomass technology, more value-added product succeeds from biomass. Biomass is proven to be a source of energy that can produce energy from organic sources such as wood, palm oil, crops and land fill gas.

Jute is a lower-cost, renewable, annually available fiber from organic sources than other natural fiber crops. As regards the suitability of the insulating material, it has a high potential to be used as three types of insulation (thermal, sound and electrical). The lowest fiber crop available on the market in bulk amounts is one of these. With regard to the properties of jute fiber, it has both good characters and unwanted properties. In essence, this type of fiber is like a mesh structure that provides good overall cover, high tensile strength, strength, durability, less breaking elongation, dimensional stability and an ethnic natural color. (Sanjoy Debnath, 2016)

The name of the project is Eco Jute (EJ) for duct liner. The project focuses to study on the composition between bico fiber and jute**.** The flow of this chapter 1 can be referred in Figure 1.

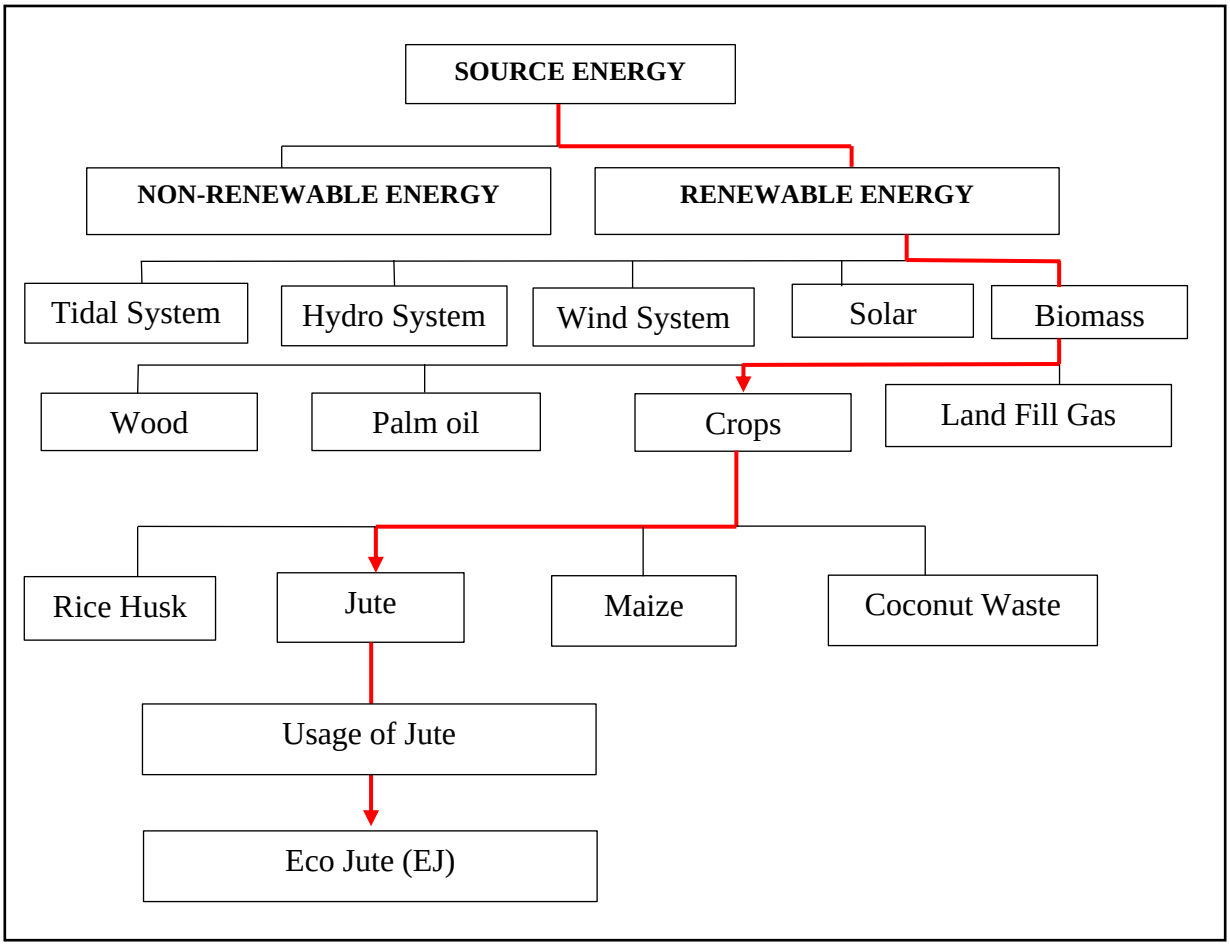

Figure 1.1: The K-chart of Eco Jute

1.2 Problems statement

Insulation is most important to reduce power consumption in ductwork. Fiberglass insulation is the most common type of insulation used for duct liner. Fiberglass has material properties that are not eco-friendly. One of the main disadvantages of fiberglass insulation is that it can be particularly dangerous for humans. When fiberglass insulation installs in ducting, the particles which one cannot see in the naked eye, blow into the cooled space. Fiberglass insulation can cause bad indoor air quality (IAQ) to those who are exposed to it and health effects. The Occupational Safety and Health Administration (OSHA) estimates that 69,000 people with severe headaches and 105,000 people with respiratory problems at work may suffer from poor indoor environmental quality. Therefore, EJ proposal to replace in the air conditioning system as a new duct liner. In the HVAC industry, the characteristic of bico fiber and jute blend as low cost, more durable and more economical is suitable for being new duct liner.

1.3 Objectives

- To prepare the composition of bico fiber and jute-blend.
- To optimize the composition by conducting K-value, R-value and Acoustic test as evidence.

1.4 Scope of study

In order to achieve the above objective, the following scopes have been identifed,

- Determining composition percentage of bico fiber and jute to find the most optimum composition of both materials via K-value, R-value and Acoustic test.
- To compare the Eco Jute K-value and R-value with the conventional duct liner such as fiber glass.

CHAPTER 2

LITERATURE VIEW

2.0 HEATING, VENTILATION AND AIR CONDITIONING SYSTEM

This chapter discusses important heating, ventilation and air conditioning systems (HVAC) in air conditioning systems for insulation ducting, type of insulation duct liner and type of material used for insulation.

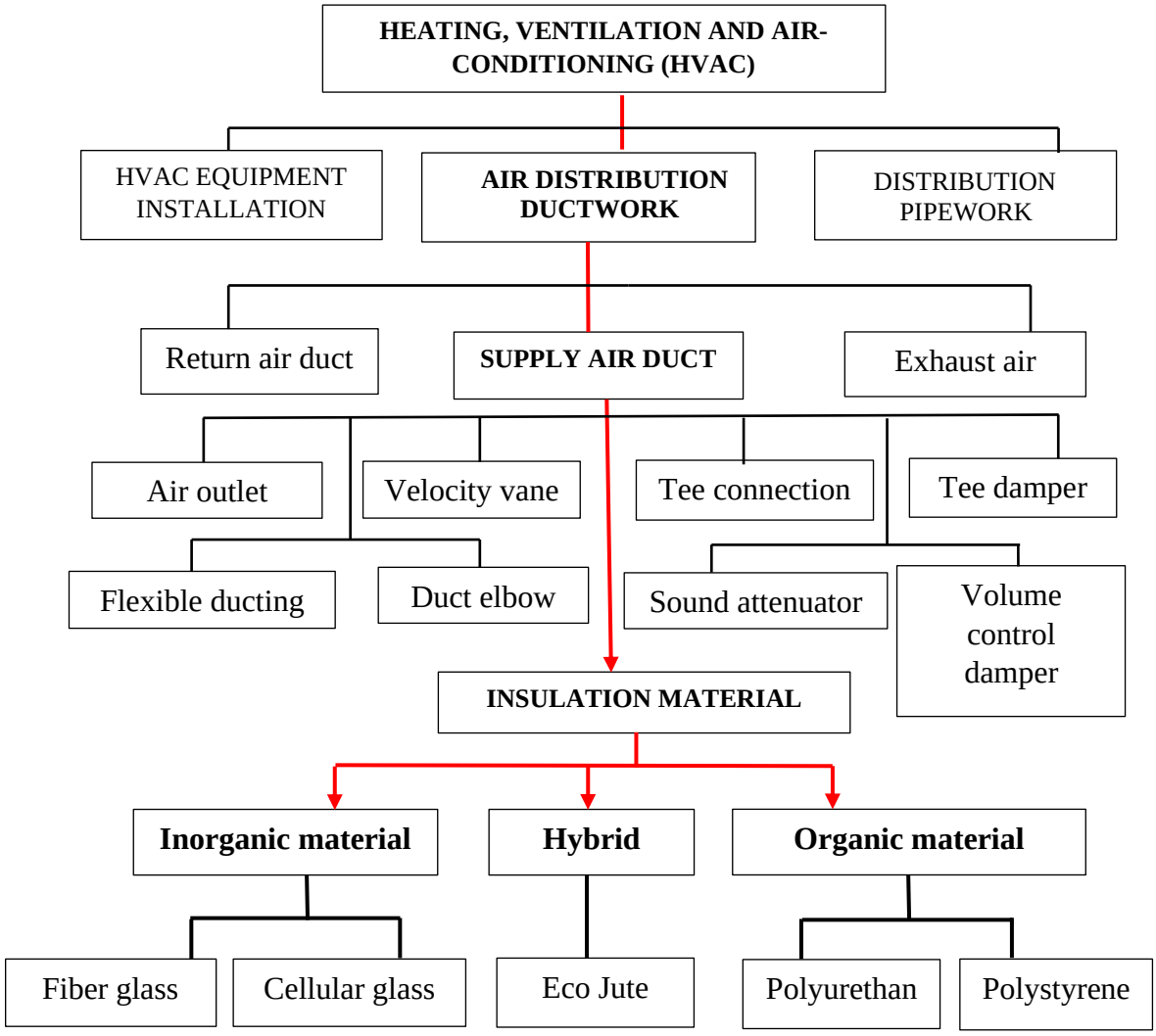

Figure 2.1: The Flowchart of HVAC

Heating, ventilation, and air conditioning (HVAC) system is designed to achieve the environmental requirements of the comfort of occupants and a process. According by (Seyam, 2018), the main mission of HVAC system is to satisfy the thermal comfort of occupants by adjusting and changing the outdoor air conditions to the desired conditions of occupied buildings. This has also been explored in prior studies by (Al-Homoud, 2005), HVAC is the systems that processes combined that performs many functions at the same time. An HVAC system maintains the comfort of occupants in buildings by controlling, humidity, air temperature and air flow. It also uses energy efficiently and controls external air intake and contaminated air exhaust or filtering. It is designed to provide complete air conditioning, including filtering out of dust, odors and freshening outdoor air. Some important factors before installation of HVAC systems include equipment space, noise and vibration, air duct space and building enclosure properties. The equipment must be allocated adequate space because it is generally very large and weighty. The equipment must also be strategically positioned so that it is economically feasible and accessible for maintenance and replacement purposes.

2.1 AIR DISTRIBUTION DUCTWORK

HVAC systems can be classified according to necessary processes and distribution process (Seyam, 2018). For air duct networks, the systems require large spaces. These must serve the interior spaces of the building and connect to the operating equipment, and the air intake and exhaust must be connected to the outside air at appropriate locations. All types of supply and return air ducts, smoke control ducting, pressure air ducts and exhaust air ducts are generally covered by the air distribution ductwork. The ducting accessories include offsets, transformation parts, tee connections, access doors, duct elbows, fire dampers, volume control dampers, branch off parts, sound attenuators, flexible ducting and insulation.(Al-Homoud, 2005)

2.2 SUPPLY AIR DUCT

Supply air ducts can classify the most important thing in the HVAC system. The function of the air supply duct is to bring the cool air into the room. According by (Li et al., 2010), the HVAC system was used to supply fresh air and to remove pollutants caused by the activity of occupants, furniture fittings and decorative materials. The main HVAC component of the supply air duct provided a large inner surface area. The supply and return ducts are designed to maintain a balanced supply of air. In other words, it must have the same amount of air entering and leaving the HVAC system. In cases where pressure difference, they can expect problems with comfort and efficiency. These issues can be caused by poor construction of the duct and obstructed airflow. Therefore, the air supply duct needs to be installed properly, to make every room in building comfortable and achieve satisfaction of people. The example components of supply air duct is damper, elbow, return air, offset, chamber, end cap, round duct, register tee and register boot.

2.3 INSULATION

Insulation in HVAC is a material that helps prevent heat flow and provides a comfortable, healthy, safe and quiet environment in the ducting system (Koegelenberg,2017). Insulation also are used for duct wrap and duct liner. Manufactured insulation materials can slow down heat transfer to or from ducting and can be adapted to many forms. According by (Ron George, 2019) insulation also is manufactured in rigid or flexible sheets, flexible fiber batts, granular fill, or open or closed cell foam. (Ron George, 2019) mentioned, a variety of finishes are used to protect the insulation against physical and environmental damage and to improve the appearance of the insulation. Insulation also contributes to reducing the level of noise, absorbing the system vibrations, and preventing fire spreading. Insulation for ducting can classify two categories as inorganic material and organic material.

2.4 INORGANIC MATERIAL

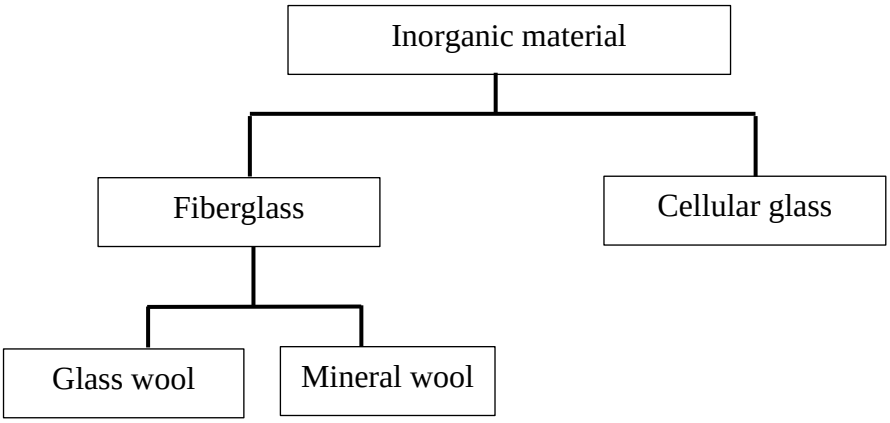

Figure 2.2: Type of Inorganic Material

Inorganic materials may be classified into two famous types. There is insulation of fiberglass and cellular glass. Insulation of fiberglass consists of small diameter fibers which finely divide the air space. Typical inorganic fibers include glass wool and mineral wool. Type insulations are further classified as either wool or textile-based insulations. Textile-based insulations consist of woven and non-woven fibers and yarns.(US. Department of Energy, 2017).

The research by (Sölken, 2008) mention cellular insulation consists of small individual cells that are either interconnected or sealed to form a cellular structure. Cellular insulations are often further classified as either an open cell (cells are interconnected) or a closed cell (cells are sealed from one another). Another research by (US. Department of Energy, 2017) materials with a closed cell content of more than 90 percent are generally considered closed cell materials reflectivity.

2.4.1 FIBERGLASS INSULATION

Fiberglass is one of the most commonly used insulation materials (Thermomaxxx Jackets, 2011). According by (US. Department of Energy, 2017) fiberglass is used in two different blankets (loose fill) and also (batts and rolls) forms of ducting insulation. Loose-filled fiberglass insulation is made of molten glass that

is spun or blown into fibers. Most manufacturers use recycled glass content of 30%–40%. With an insulation blowing machine designed for open-blow or closed-cavity applications, loose-fill insulation must be used (Insulation, 2017). A research by (Khalid, 2017) fiber glass made from thin glass fibers, which is lightweight and cost-effective, making it a practical option for ducting insulation. It is also a product of lower cost that can be installed without the use of expensive equipment.

a) Glass wool

Figure 2.3: Glass wool (Power, 2015a)

Glass wool is an insulating material made of fiber in a wool-like texture arranged with binder. Glass wool is a product of molten glass furnace at a temperature of around 1450 ° C. This process is based on spinning molten glass in high-speed spinning heads, similar to the process used to make cotton candy. During spinning of the glass fiber, a binding agent is injected. Glass wool is produced in rolls or slabs with different thermal and mechanical properties. It may also be produced as a material that can be applied to the surface to be insulated. Applications of glass wool is used for ducting insulation. It should be kept dry at all times during installation of glass wool, as increased moisture content leads to a considerable increase in thermal conductivity. Typical thermal conductivity values for glass wools are 0.040 w/m·k per inch (Power, 2015a). R-value for glass wool is 0.635 w/m²·k per inch.