A STUDY ON THE EFFECT OF COCONUT FIBER TO POLYPROPYLENE (PP) AS A FRICTION MATERIAL

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SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Structure & Material)"

Signature: .....

Supervisor: .....

Date: .....

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This report is submitted in partial of requirement for the Bachelor Degree of Mechanical Engineering (Structure & Material)

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DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged."

Signature: .....

Author: .....

Date: .....

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ABSTRACT

The use of asbestos in friction material has been banned due to potential hazard to human. Nowadays, researchers have been striving to find sustainable and environmentally friendly materials for new friction material. This research is meant to study the effect of coconut fiber on mechanical and tribological properties of polypropylene (PP) as friction materials. A composite specimen from combination of coconut fiber and polypropylene (PP) is fabricated with different percentage composition ratio of materials and its effect to mechanical and tribological properties was investigated. The percentage composition ratio of material was found not affect the mechanical properties but slightly affect the tribological properties. This is due to the composition ratio of coconut fiber and polypropylene (PP) is commonly not mixing well during the fabrication process for the physical form of specimens. Then, for hardness properties indicated that this is due to the structure of the composite specimen which is contain lots of hole, void or empty space inside and for density properties indicated that this is due to its highest density which is also come from the fabrication process. Friction properties indicated that this is due to the facts that specimen A is the highest percentage contains of coconut fiber among the others with 25% coconut fiber constituent.

ABSTRAK

Penggunaan asbestos dalam bahan geseran telah diharamkan berikutan potensi bahaya kepada manusia. Pada masa kini, penyelidik telah berusaha untuk mencari bahan-bahan yang mampan dan mesra alam untuk bahan geseran baru. Kajian ini bertujuan untuk mengkaji kesan serat kelapa pada sifat mekanikal dan tribologikal polipropilena (PP) sebagai bahan geseran. Satu sampel komposit daripada kombinasi serat kelapa dan polipropilena (PP) adalah direka dengan nisbah komposisi peratusan yang berbeza bahan dan kesannya kepada sifat-sifat mekanikal dan tribologikal dikaji. Nisbah komposisi peratusan bahan didapati tidak memberi kesan kepada sifat mekanikal tetapi sedikit memberi kesan kepada ciri-ciri tribologikal. Ini adalah kerana nisbah komposisi serat kelapa dan polipropilena (PP) biasanya tidak bergaul dengan baik semasa proses fabrikasi untuk bentuk fizikal spesimen. Kemudian, untuk sifat kekerasan menunjukkan bahawa ini adalah disebabkan oleh struktur spesimen komposit yang mengandungi banyak lubang, rongga atau ruang kosong di dalam dan untuk sifat ketumpatan menunjukkan bahawa ini adalah disebabkan oleh kepadatan tertinggi yang juga datang dari proses fabrikasi. Sifat geseran menunjukkan bahawa ini adalah disebabkan oleh fakta bahawa spesimen A adalah peratusan tertinggi mengandungi serat kelapa diantara spesimen lain dengan mengandungi 25% serat kelapa.

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LIST OF SYMBOLS

F	=	Force, N
μ	=	Coefficient of friction
N	=	Normal force, N
ρ	=	Density of composite material, g/cm^3
W_a	=	Weight of the specimen when hung in the air, kg
W_w	=	Weight of the partly immersed wire holding the specimen, kg
ρ_{water}	=	Density of the distilled water at testing temperature, g/cm^3
W_b	=	Weight of the specimen when immersed fully in distilled water, along with the partly immersed wire holding the specimen, kg

LIST OF ABBREVIATION

NUM.	TITLE
PP	Polypropylene
PE	Polyethylene
PS	Polystyrene
PA	Polyamide
PVC	Polyvinylchloride
PMC	Polymer Matrix Composite
FRP	Fiber-Reinforced Plastic
PEEK	Polyetheretherketone
PPS	Polyphenylene Sulfide
ASTM	American Society for Testing and Materials

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CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, friction materials play an important role in industries especially for automotive, aircraft and aerospace, railroad and heavy machine manufacturing. Friction material can be categorizes as a diverse material which is made up from few elements and each element has its own function. Theoretically, friction materials are used in system that requires specific contact influence between two or more parts. Typical example for friction materials are brake and clutch system, transmissions, and certain household items. Earlier researchers have concluded that there is no simple correlation between friction and wear properties of a friction material with the physical and mechanical properties (Tanaka *et al.* 1973). Therefore, each new formulation developed needs to be subjected to a series of test to evaluate its friction and wear properties using brake dynamometer as well as on-road braking performance test to ensure that the brake friction material developed will comply with the minimum requirements of its intended application. The need for effective friction materials is so great that the market for friction products is nearly seven billion dollars per year (Chan and Stachowiak, 2004).

Friction materials are heterogeneous materials and are composed of a few elements. Each element has its own function such as to improve friction property at low and high temperature, increase strength and rigidity, prolong life, reduce porosity and reduce noise. Changes in element types or weight percentage of the elements in the formulation may change the physical, mechanical and chemical properties of the brake friction materials to be developed (Jaafar *et al.* 2012). Some of the substances used as friction materials are paper, elastomeric, graphitic and sintered metals. A wide variety of other materials are also used, such as ceramics,

advanced fibers and different metal alloys. Common usage, asbestos was actually widely used as a friction material until its usage was banned (Chan and Stachowiak, 2004). The proper selection of friction materials depends on the application, namely the speeds encountered, the temperatures involved and the performance requirements. The ideal friction materials should possess various desirable properties such as resistance to heat, water and oil, has low water rate, high thermal stability and exhibits low noise. However, it is practically impossible to have all these desired properties. Therefore, some requirements have to be compromised in order to achieve some other requirements.

In general, each formulation of friction material has its own unique frictional behaviors and wear-resistance characteristics. For example, sintered metal materials are well-suited to heavy duty applications, like aircraft braking system and industrial machinery clutches. Differently, paper is used as a friction material in many automobiles and light trucks, although the "paper" used in these system is not the paper that we used in daily life. It consists of a cotton or cellulose fiber and phenolic resin mixture, which is later bonded to a steel backing plate (Lu, 2006). Friction materials used for clutches and brakes are attached to more standard components made from cast iron and other similar materials. Like paper friction materials, these clutch and brake friction providers are commonly made of woven, molded or sintered materials composed of a diverse range of substances including fibers, metal particles and bonding materials.

Natural reinforcing materials can be obtained at low cost and low levels of energy using local manpower and technology. Utilization of natural fiber as a part of substances in friction material is one of particular interest to view the mechanical and tribological properties changes when fiber existence. Coconut fiber obtained from coconut husk, belonging to the family of palm fibers, is agricultural waste products obtained in the processing of coconut oil, and commonly available in large quantities in the tropical regions of world, most especially in Asia, Africa and Southern America (Yalley and Kwan, 2003). The resulting composite material should have acceptable heat conductivity and the capability to withstand high-temperatures and be impervious to moisture.

1.2 Objective

The overall aims of this study are:

1) To study the effect of coconut fiber on mechanical properties of polypropylene (PP)
2) To study the effect of coconut fiber on tribological properties of polypropylene (PP)

1.3 Problem Statement

Nowadays, friction materials are very important in engineering field especially in aircraft and aerospace, automotive, railroad, heavy machine manufacturing and defense industry. Friction materials require a friction stability, durability and minimization of noise. Generally, friction materials consist of several materials blended with polymer to improve its tribological properties. Polypropylene (PP) is a material typically used for high temperature application. Since friction materials deal with high temperature operation, polypropylene (PP) application as friction materials is considered fit to the tribological application.

1.4 Scope

Based on the objectives mentioned above, the study is focusing to be more specific, in order to give a clearer view on the crucial points. This research is focusing in study the effect of coconut fiber to mechanical and tribological properties of polypropylene (PP). However, effect of fiber orientation is beyond this project. The scopes including in this study are:

1) Literature study
2) Manufacturing the sample, starting from mixing the polymers to shape the specimen
3) Analysis of mechanical and tribological properties of polypropylene (PP) in the presence of the fiber
4) Statistical analysis on coconut fiber effect to mechanical and tribological properties of polypropylene (PP)

CHAPTER 2

LITERATURE REVIEW

2.1 Friction Material

A characteristic of friction material is a multi component polymer matrix composite whose formulation is generally developed by experimental studies. The friction cooficient should be moderately high, but most significantly must be durable during the braking process. It should have a stable level, independance of temperature, humidity, age, degree of wear and corrosion, existence of dirt and water spray from the road (Filip *et al.* 2002). Frictional braking system must be designed in such a way that a constant coofficient of friction is maintained over a wide range of stressing coonditions (Severin *et al.* 1995). Although the effect of wear to the friction material is unavoidable, but it should be minimize as much as possible. For automotive and other industrial applications, polymer matrix composites (PMC) are used as pads and cast iron or steel disc as counterparts. The performance of the brake system is mainly controlled by the composition and microstructure of the pad material. Industrial pads usually contain a large number of different constituents like ceramic particles and fibers, minerals, metallic chips, solid lubricants and elastomers in a matrix material such as phenolic resin. Three of the key requirements in developing composites and other advanced materials for the friction material is the generation of a good understanding of the relationships between composition and structure, the application of this understanding to develop a material with the desired properties and understand the new materials failure mechanism (Pasto *et al.* 1999). Figure 2.1 show the friction material inside a brake system while Figure 2.2 show friction maerial inside a clutch system.

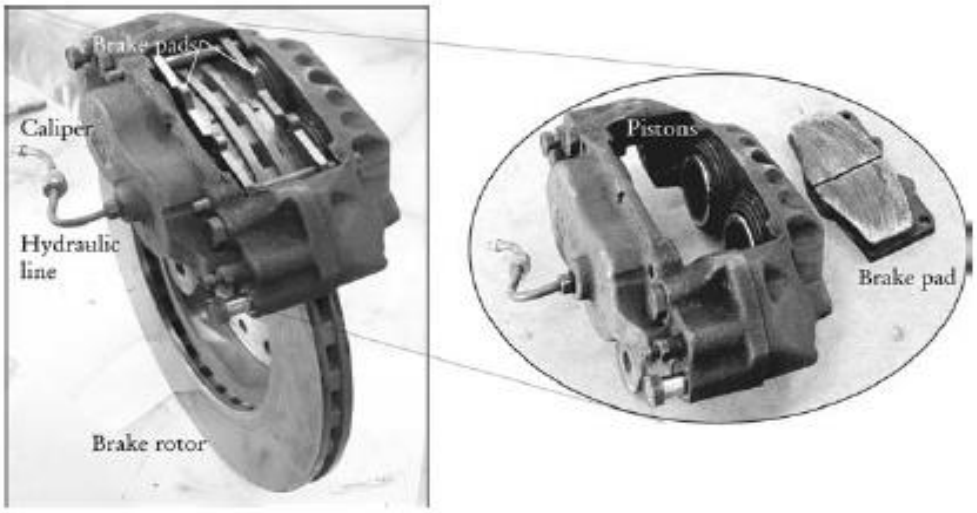

Figure 2.1: Friction material inside the braking system (brake pad)
(Source: Chan and Stachowiak, (2004))

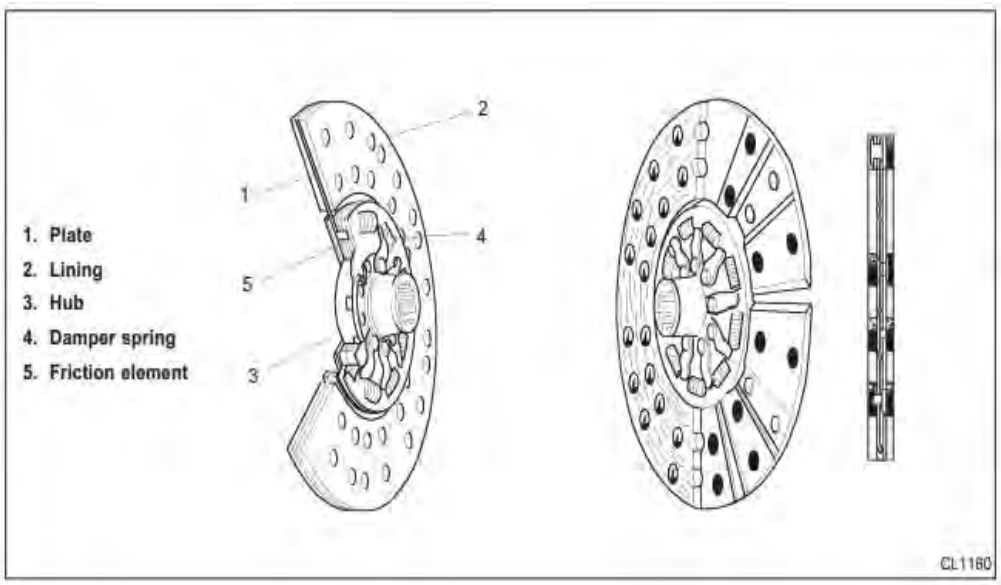

Figure 2.2: Friction material inside the clutch system
(Source: Chan and Stachowiak, (2004))

2.2 Composite

Composite material is a material that formed by combining two or more materials to obtained a unique combination of properties. Early 1960s, introduction of polymeric-based composites attract the attention of industries although this composite materials have been utilized and commercialized for solving many technological problems for a long time. In addition, polymer composites have been

used in a wide range of industrial applications like aeronautic, naval, construction, sporting goods, home appliances and furniture. They have been on the market for over fifty years, and have generally been used to replace materials such as wood, aluminum and steel. Their advantages over traditional materials include greater mechanical strength, lighter weight, better dimensional stability, higher dielectric strength and corrosion resistance, and flexibility to improve the design (Etcheverry and Barbosa, 2012). The major advantage of these composites that help them enter into such a variety of markets is their high specific property, which is greater than that of metals and ceramics. Despite that, the perfect well-bonded interphases between the matrix and reinforcement remain as a critical issue in this kind of material. This factor is critical with thermoplastic material such as polyethylene (PE), polypropylene (PP), polystyrene (PS), polyamide (PA) and polyvinylchloride (PVC). With advantages of many times better performance compared to all materials, composite materials have the potential to replace steel and aluminum which is widely used nowadays. Replacing steel components with composite components can save 60 to 80% in component weight, and 20 to 50% weight by replacing aluminum parts (Mazumdar 2001).

However, there are others composite material which are different from being stated before such as wood, minerals, plastic co-polymers and metal alloys. From the nature, the concept of composites is discovered such as wood, which is a composite of cellulose fibers in matrix of natural glue called lignin. Primary concept of a composite is that they must consist of matrix materials. Typically, composite material is formed by reinforcing fibers in a matrix resin. The reinforcements can be fibers, particulates or whiskers and the matrix materials can be metals, plastic or ceramic. In this case, the reinforcing fibers or fabric function to supply strength and stiffness to the composites, while the matrix contributes rigidity and environmental resistance (Mazumdar 2001). There are several type forms of reinforcing fibers such as short chopped fibers, long continuous fibers, woven fabric and each configuration results in different properties. Mostly, continuous fibers or long fibers are used for structural applications and short fibers are recommended for nonstructural applications. In form of technique used, short fibers utilize injection and compression molding while continuous fibers utilize filament winding, pultrusion and roll wrapping. A working definition for a composite is “a material that contains a