Effect of coconut shell powder in brake friction materials

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ABSTRACT - The purpose of this study is to investigate the effects of coconut shell powder in brake friction materials. The specimens are made from four different compositions of aluminum oxide, maleic anhydride, epoxy resin and coconut shell powder. The shore hardness is measured using ASTM D 2240. The density and porosity of a specimen with 25 mm diameter by 14 mm high is estimated using ASTM C 380-79. The applied pressure is 100 kN/cm^2 for 5 minutes at temperature of 80 ^{o}C and cooling time of 15 minutes. Five different sets of specimen are produced with different composition of ingredients. The best result is for specimen C with the Shore hardness, 69.7, porosity of 0.27 % and density of 1.858 g/cm^3.

1. INTRODUCTION

Brake pad plays an important role in safety and performance as it is the most important component in any types of vehicles [1]. Lining materials is the crucial major component in the brake pad and it can be categorized as organic materials, metallic materials and semi materials. Friction materials are composites that consists of binders, fillers, friction modifier and reinforcing fibres. The friction materials can contain asbestos or non-asbestos friction material. However, asbestos has been recognized to be hazardous and the effect of asbestos to human can cause serious diseases [2].

Coconut shell is a wasted product and does not contribute any good value to human except as alternative fuel. Previously, the coconut shell was burnt as a solid water disposal which contributed to CO_2 and methane emissions to environment [3]. Furthermore, the coconut shell waste is renewable, cheap, completely or partially recyclable and biodegradable [4] From the previous study, the coconut shell has better physical properties as well as high compressive strength which depends on the coconut shell composition [5]. From these properties, coconut shell has a potential as an alternative to fibre reinforcement material of friction material non-asbestos brake pad on light weight automobile such as motorcycle.

The objective of this study is to determine the effect of coconut shell powder content as reinforcement materials in brake pad and to study the characteristics of coconut shell powder in brake pad including mechanical properties and physical properties.

2. RESEARCH METHODOLOGY

The specimens were made of four different percentage composition of aluminum oxide, maleic anhydride, epoxy resin and coconut shell powder. Table 2.1 shows the composition of raw materials. This study consisted of shore hardness test, density and porosity percentage and surface structure. The shore hardness was estimated using the Shore Hardness Type D (ASTM D 2240). The apparent density and porosity of a specimen measuring 25 mm in diameter and 14 mm in high was estimated using the Archimedes method (ASTM C 380-79). Figure 2.1 shows the coconut shell powder and Figure 2.2 shows the process of samples. The applied pressure is 100 kN/cm^2, time pressure is 5 minutes, temperature is 80^{o}C and cooling time is 15 minutes.

Table 2.1 Table of composition for the raw materials

Sample	Epoxy resins (%)	Coconut shell powder (%)	Aluminum oxide (%)	Maleic anhydride (%)
A	45	2	53	3
B	45	4	51	3
C	45	6	49	3
D	45	8	47	3
E	45	10	45	3

Figure 2.1 Coconut shell powder

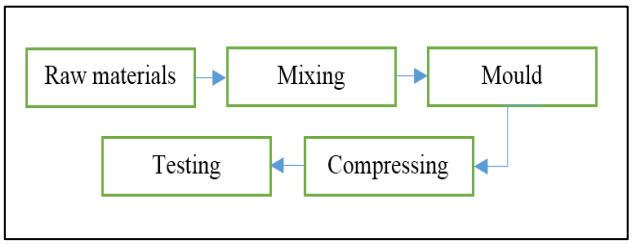

Figure 2.2 Process of Samples

3. RESULTS AND DISCUSSION

3.1 Density and Porosity of Brake Pad Materials

Figure 3.1 shows that when the coconut shell powder is increasing, the density is decreasing with the increasing of porosity. In selecting an optimal friction material, the density of the material should be reasonable

and the porosity should have certain amount to reduce the effect of oil and water on the friction coefficient [5]. Lower porosity will result in higher coefficient and low wear rate due to higher contact areas between the mating surfaces. The aluminum oxide is added to improve the friction coefficient.

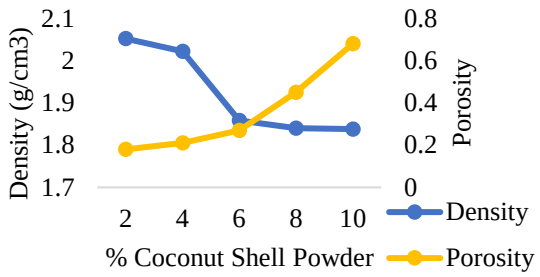

Figure 3.1 Graph of density and porosity vs % of coconut shell powder

3.2 Hardness of Brake Pad Materials

Figure 3.2 shows the hardness is decreasing when the porosity is increasing when content of coconut shell powder is increased. This is due to the high porosity in the sample where it has low content of aluminum oxide. Figure 3.3 shows that the hardness is decreasing when the density is decreased when content of coconut shell powder is increased. In selecting an optimal friction material, the hardness should be average because if the friction material has too high of hardness, it indicates the brittleness. If the friction material has too soft hardness it indicates higher wear and porosity with lower density.

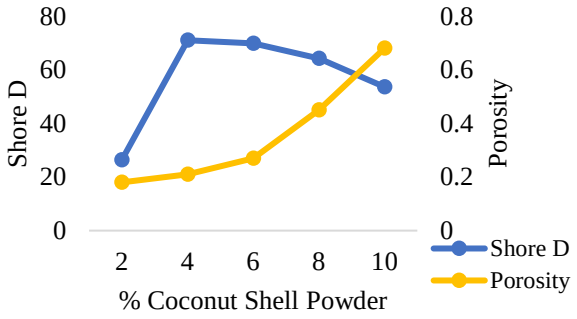

Figure 3.2 Graph of shore 'D' and porosity vs % of coconut shell powder

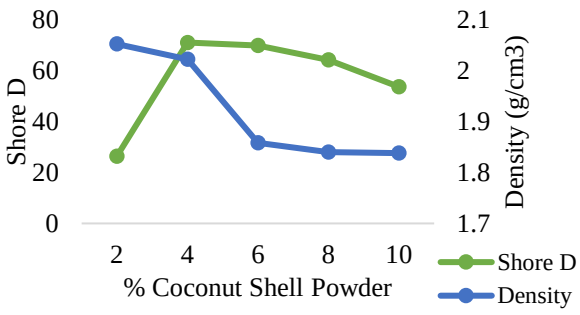

Figure 3.3 Graph of Shore 'D' and density vs % of coconut shell powder

4. SUMMARY

In conclusion, an optimum formulation was achieved for specimen C with an overall content of 49% aluminum oxide, 45% epoxy resin, and 6% coconut shell power with 3 % of maleic anhydride. The hardness of this specimen is 69.7 Shore D, porosity of 0.27 % and the density 1.858 g/cm^3. With these properties, it can give high friction coefficient and low wear rate of friction material. The coconut shell power can be effectively used as a replacement of asbestos in brake pad manufacture.

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