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Morphology and Wear Properties of Palm Ash and PCB Waste Brake Pad

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Abstract. This research was conducted to produce a non asbestos brake pad. The use of asbestos fiber is being avoided due to its carcinogenic nature that might cause health risks. A new brake pad produced by using palm ash and PCB waste to replace asbestos together with metal filler and thermoset resin as a binder. Morphology and wear properties of the brake pad were studied. In this research, there are five different ratio were examine. The result shows the higher palm ash composition has better wear and mechanical properties. Non-asbestos composition shows the wear properties comparable to conventional brake pad.

Keywords: Non-asbestos brake pad, palm ash, PCB waste

1. Introduction

Brake pads are an important part of braking systems for all types of vehicles that are equipped with disc brakes. Brake pads are steel backing plates with friction material bound to the surface facing the brake disk (1). Brake pads convert the kinetic energy of the car to thermal energy by friction. When a brake pad is heated up by coming into contact with either a drum or rotor, it starts to transfer small amounts of friction material to the disc or pad (that is the reason a brake disk has a dull grey). The brake rotor and disk (both now with friction material on), will then "stick" to each other to provide stopping power. The friction of the pad against the disk is however responsible for the majority of stopping power. In disc brake applications, there are usually two brake pads per disc rotor, held in place and actuated by a caliper affixed to a wheel hub or suspension upright(1,2).

The brake pads presently used are generally made from asbestos fiber. Asbestos was widely used in pads for its heat resistance. In spite of its good properties asbestos is being withdrawn from all those application where there is possibility of man consuming or inhaling its dust, because of its carcinogenic nature. Due to this health risks, it is necessary to use alternative material for making non-carcinogenic brake pad (3).

Asbestos has now been replaced by a mix of alternative fibers such as mineral fibers, cellulose, aramid, PAN, chopped glass, steel and copper fibers. This paper present a characteristic of brake pad produced from a mixture of palm ash and PCB waste.

2. Material and Methods

2.1. Development of Brake Pad

Four types of raw material are use including palm ash, PCB waste, phenolic resin and aluminum. Phenolic resin is used as binder in friction materials due to good combination of mechanical properties such as high hardness, compressive strength, moderate thermal resistance, creep resistance and very good wetting capability with most of the ingredients. The high hardness of phenolic resin is attributed to the increased in the hardness during curing process (4,5).

Figure 1 indicates the flow chart of the whole process begins from the raw material process. First of all, raw materials need to be characterized. These include, particle size analysis of the materials, elemental analysis of the powders and materials using Scanning Electron Microscopy (SEM) and energy dispersive Xray (EDX) technique. Microstructure and elemental data on each raw material was compiled for reference during analyzing outcome of brake pad materials formulation. Their shape and length were noted.

The weight percentage used in the brake pad mixtures are presented in Table 1. The mixtures then compacted with the pressure of 122 MPa (approximately 12 tons) using unaxial hydraulic hand press machine. The compacted samples were cured using oven at 150°C for 5 minutes.

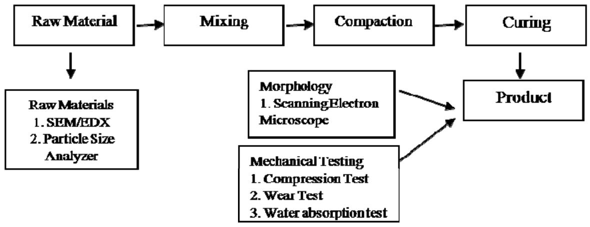


Figure 1: Flow chart of the raw material process

Table 1: Composition of Brake Pad

Composition	Ratio				
	1	2	3	4	5
Palm Ash, %	15	25	35	45	55
PCB, %	55	45	35	25	15
Phenolic, %	20	20	20	20	20
Aluminium, %	10	10	10	10	10

2.2. Testing of Brake Pad

The sample was then undergo several testing such as compression strength test, wear test, water absorption test, Scanning Electron Microscope (SEM), and EDX. The morphology of the surface of brake pad and raw materials were examined by Scanning Electron Microscope (SEM) JEOL JSM- 6460LA.

The water absorption test is done to measure the porosity of the brake pad. Porosity affects resilience and compressibility. Both can affect brake effectiveness (4). The simple porosity test involved each specimen from five ratios soaked for an hour in distilled water. The amount of water absorb for each specimen was determines by measuring the weight difference using electronic balance.

Compression strength of brake pad was measured out using Instron Universal Testing Machine (UTM). The wear test is used to examined various friction materials and brake rotor with regard to their service life if they are exposed to abrasive contact. The test specimen was consistently rubbed against an abrasive paper (silicon carbide paper) of grade 320 and 800 for 1 minute. The weight loss of the specimen was determines by measuring the weight difference.

3. Result and Discussion

3.1. Raw material characteristic

Particle Size Analysis

A wide variety of graphing functions includes trend graphs where outlying values are automatically highlighted. Customizable record pages permit at-a-glance comparison of key particle size parameters, ensuring consistent data management and reporting. A simple, automated data export function enables full integration of particle sizing data with other analytical information. Figure 2-5 shows the trend size for the raw materials. While figure 6 show the trend graph after mixing of all raw materials.

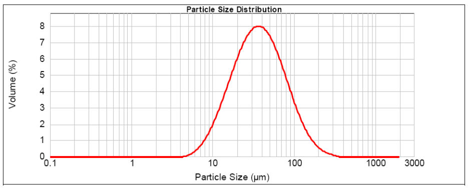


Figure 2: Particle size distribution of aluminum

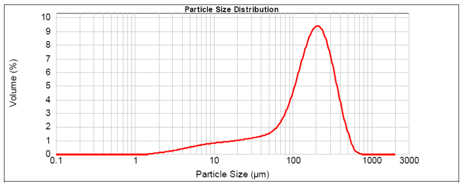


Figure 3: Particle size distribution of palm ash

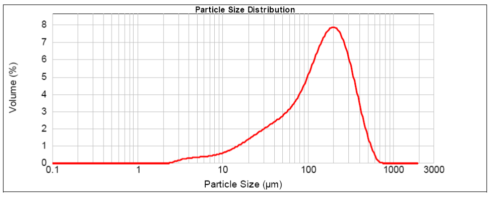


Figure 4: Particle size distribution of PCB

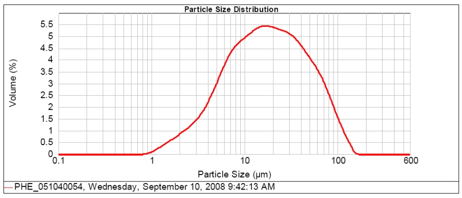


Figure 5: Particle size distribution of phenolic

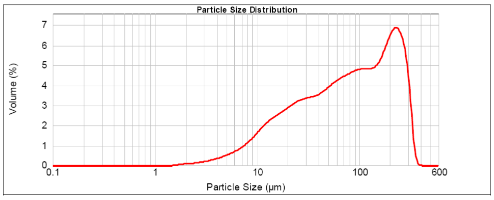
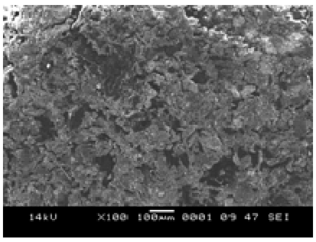


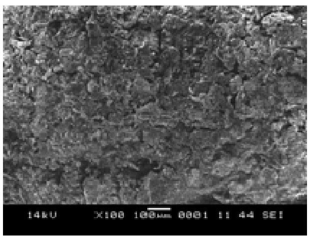
Figure 6: Particle size distribution of the brake pad mixture

Morphology

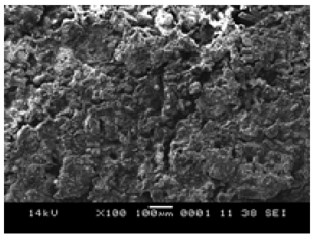
Microstructure of brake pad sample after curing was done by SEM with 100X magnification. Figure 7 (a)-(e) shows the SEM micrograph of brake pad sample with different percentage of palm ash and PCB waste. Overall observation shows the mixture of the brake pad materials is well dispersed even though there are some traces of pores due to the different particle size of each admixture materials. The micrograph indicated more pores are found in ratio 1-3 mixture, compared to the ratio 4 and 5 mixture. It is confirm that the presence of pores is controlled by the content of palm ash. The pores decreased with increasing content of palm ash.



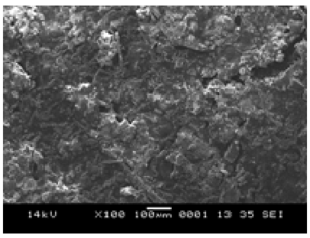
a) Ratio 1



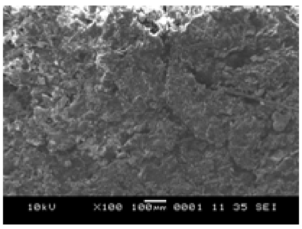
b) Ratio 2



c) Ratio 3



d) Ratio 4



e) Ratio 5

Figure 7: SEM micrograph of brake pad samples with different percentage of palm ash and PCB waste.

3.2. Effect of different composition on the properties

Water Absorption Result

Figure 8 shows the graph for water absorption for different composition of raw materials. From the graph, ratio 1 shows the higher value while ratio 5 shows the lower value of water content. Higher PCB waste content will result in more water absorption because more pores is observed. This result was influenced by porosity and void formed in the brake pad samples. The water absorption decreased when increasing the palm ash content. Theoretically, lower water absorb to the brake pad will result in higher friction coefficient and wear rate due to higher contact areas between the mating surface.

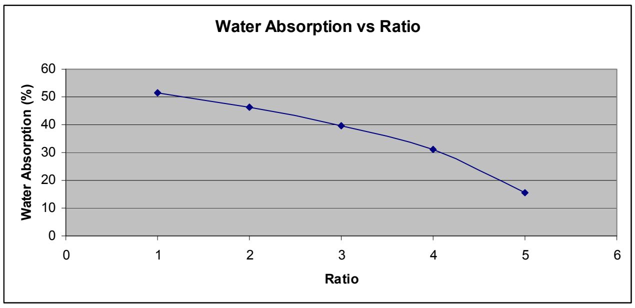


Figure 8: Water Absorption result for different composition

Compression Test Result

Ratio 5 showed the highest compression strength compared to other ratio. This is due to the high composition of palm ash in ratio 5 compared to others (55% palm ash). The less pores and the more compact mixture in ratio 5 shown a significant effect on the compression strength, and more pores in high composition of waste PCB decreased the compression strength of the brake pad.

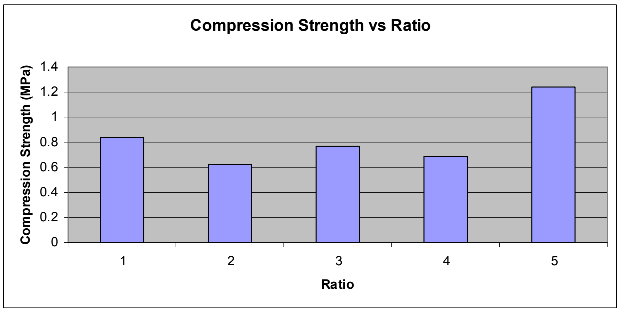


Figure 9: Compression Result for different composition

Wear Test Result

In literature, general trends show that the friction and wear performance do not match each other. If friction behavior is good, wear performance is poor and vise versa. (4). In this case, ratio 3 which contain 35% palm ash, 35% PCB give better wear properties. However, ratio 5 also gives better wear properties. Samples that contain high content of PCB waste (ratio 1 and ratio 2) show the highest weight loss when tested with silicon carbide paper. So, the composition of ratio 1 and ratio 2 is not suitable as a brake pad since it need a high wear resistance. Figure 10 also show the wear result for commercial product of brake pad. From the graph, commercial product has better wear properties. But, since the commercial product is produce using 50-70 ton of load, it can say that the brake pad were produce from ratio 3 and ratio 5 were comparable in term of wear properties.

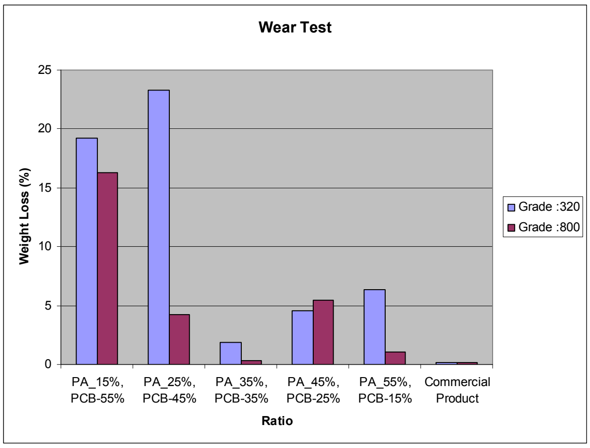


Figure 10: Wear result for different composition

4. Conclusion

As the conclusion, the non-asbestos brake pad (friction materials) can be developed by replacing asbestos fibres with other suitable reinforcement such as palm ash and waste PCB that can reduce the production cost of the product. Compressive strength is increase in increasing the content of palm ash in the composition. The sample with high content of palm ash gives better wear properties and lower water absorption that result in better properties of brake pad in application.

5. References

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