

Development of Asbestos-Free Brake Pads: Using Lemon Peel Powder

K Ramanathan¹, P Saravanakumar², S Ramkumar³, P Pravin kumar⁴, S.R Surender⁵

U.G. Scholar, Department of Mechanical Engineering, Sriguru Institute Of Technology, Coimbatore,
Tamilnadu, India^{1,2,3,4}

Assistant Professor, Department of Mechanical Engineering, Sriguru Institute Of Technology, Coimbatore,
Tamilnadu, India⁵

ABSTRACT: In this study, the usage of lemon peel powder as one of the composite for asbestos free-brake pad has been studied. The usage of asbestos fibre in brake pad is avoided, as it causes health hazards such as cancer due to its carcinogenic nature. The lemon peels are sun dried at an atmospheric temperature of 32°C for 240 hours and then finely powdered. The percentage of lemon peel powder, aluminium oxide and iron oxide are varied and two samples are made by using hand moulding technique. Epoxy resin is used as the binding material and hardener is mixed with epoxy resin at a ratio of 1:4. The moulding die is made for 30mm diameter and 25mm thickness using mild steel. Both the samples are subjected to hardness test, wear test, water absorption test, oil absorption test and specific gravity test. From the result, it can be seen that the hardness and density of sample 1 is higher than that of sample 2. And the wear loss, oil absorption and water absorption of sample 1 is lower than that of sample 2. The sample 1 with the composition of 40% epoxy resin, 12.5% Al₂O₃, 12.5 % iron oxide, 15% graphite, 10% calcium hydroxide and 10% lemon peel powder has better properties than sample 2. The results clearly shows that lemon peel powder can be effectively used as a replacement for asbestos in brake pad manufacture.

KEYWORDS: Brake pad, Lemon peel powder, Wear loss, Water absorption, Oil absorption, Hardness, Specific gravity.

I. INTRODUCTION

Brake pads are important components of the braking system of most of the vehicles that uses disc brakes. The kinetic energy of the vehicle is converted into thermal energy by the friction produced by brake pads. Asbestos are mainly used in brake pads for its heat resistance but the use of asbestos in brake pads might cause health risk to humans and other living organisms due to its carcinogenic effect when it comes in contact with the dust particles of asbestos. Asbestos has been replaced by palm kernel fibre and the results obtained met the standard requirement for commercial brake performance pad [1]. The material with the highest coefficient of friction will be efficient but will have shorter life due to its high wear rate [1]. Periwinkle shell particles can be used as a replacement material for asbestos in brake pads. Also by decreasing the size of periwinkle shell particles, the compressive strength, hardness and density were found to be increasing. The oil soak, water soak and wear rate were found to be decreasing with the decrease in particle size of periwinkle shell [2]. The use of banana peel particles as a replacement for asbestos has been studied and the results shows that banana peel particles can be used as an effective replacement for asbestos in brake pads. Increasing the wt% of resin causes increase in the compressive strength, hardness and specific gravity of the samples. At the same time, oil soak, water soak and wear rate were found to be decreasing with the increase in the wt% of resin [3]. Banana peel powder can also be used to improve the binding ability of phenolic resin at higher temperature [4]. The wear loss of after market brake pads such as non-asbestos brake pad, ceramic brake pad and semi-metallic brake pads has been studied. The results shows that the non-asbestos brake pad has the highest wear loss and the semi-metallic brake pad has the lowest wear loss [5]. Increasing the lapinus fibre enhances the friction performance, friction fade performance,

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friction fluctuations and friction stability performance. While the increase in wollastonite fibre enhances the wear performance and recovery performance [6].

II. RELATED WORK

Lemon peel particles can be effectively used for replacing asbestos in brake pads. The steps involved are summarized as follows.

1. The lemon peels are sun dried for 240 hours at an atmospheric temperature of 32°C to remove all the moisture content from it. And then it is finely powdered to get fine lemon peel particles.
2. The percentage of aluminium oxide, iron oxide and lemon peel particles are varied to get two samples.
3. The elements are mixed thoroughly as per the composition which is explained in the experimental section and then transferred to the moulding die.
4. Hand moulding technique is used for making the sample brake pads.
5. Density, hardness, wear loss, water absorption and oil absorption of sample 1 &2 are found and the values are tabulated.

III. EXPERIMENTAL PROCEDURE

MATERIAL PREPARATION:

At an atmospheric temperature of 32°C, the lemon peels are sun dried to remove all the moisture content which are present in it. The lemon peels are sun dried for 240 hours for complete removal of moisture content. Then the dried lemon peels are powdered to obtain fine lemon peel particles.

COMPOSITION:

The brake pads are heterogeneous materials and the various elements that are used are aluminium oxide, iron oxide, graphite, calcium hydroxide, lemon peel particles and epoxy resin. By varying the percentage of lemon peel particles, aluminium oxide and iron oxide, two samples are made.

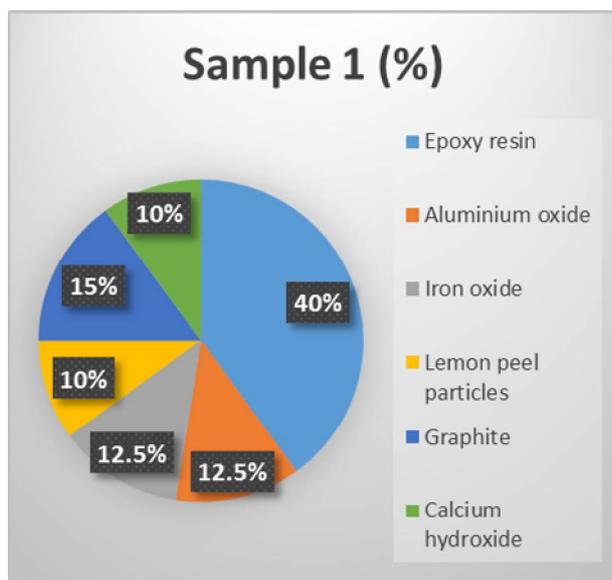


Fig.1- Composition of sample 1

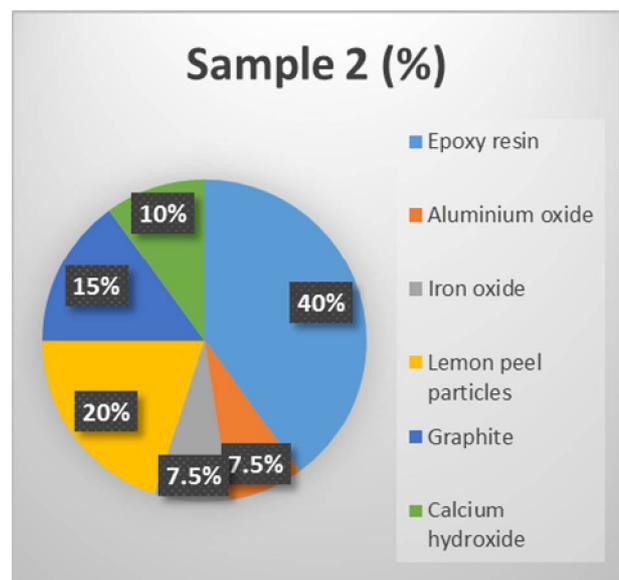


Fig.2- Composition of sample 2

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Figure 1&2 shows the composition of sample 1 & 2 respectively. Epoxy resin is used as binding material. Aluminium oxide is used for wear resistance. Iron oxide is used as abrasive. Graphite is used for enhancing the friction of brake pad.

Calcium hydroxide is used for providing corrosion resistance.

MOULDING:

A 30mm diameter and 25mm thickness moulding die is made with mild steel. According to the above mentioned composition, the elements are mixed together firmly and then transferred to the moulding die. The mould is allowed to cure for 24 hours and then the material is taken out of the die.

TESTING:

The density of two samples are measured by using weighting balance method. The samples are cleaned completely by using a tissue paper to remove any dust particles that might be sticking to it and then weighted by using the weighing machine. Then the density is obtained by using the formulae below,

$$\text{Density} = \frac{\text{Weight}}{\text{Volume}}$$

The hardness test is performed on both samples by following the ASTM D 2583 standard. According to the standard, barcol impressor Model No. 934-1 is used for hardness testing. The test are conducted in a standard laboratory atmosphere of $23 \pm 2^\circ\text{C}$ and $50 \pm 5\%$ relative humidity.

The wear test is performed on both the samples by following ASTM D5963 standard. The tests are carried out at a temperature of $23 \pm 5^\circ\text{C}$. The diameter of the cylindrical drum is 150mm and its length is 500mm. The rotational frequency is 40 ± 1 rpm, equivalent revolution is 84 times and the load applied is 1 kg. The samples are machined to the required dimensions and their initial weight is found using weighing machine. Then the wear test is carried out as per the procedure in the standard and the final weight is found. The difference between the two weights gives the wear loss.

$$\text{Wear loss(g)} = \text{Initial weight(g)} - \text{Final weight(g)}$$

$$\text{Wear loss(\%)} = \frac{\text{Initial weight(g)} - \text{Final weight(g)}}{\text{Initial weight(g)}}$$

Water absorption test is conducted on sample 1 & sample 2 at a room temperature of 26°C . The samples are cleaned with tissue paper to remove the dust particles and then the samples are placed inside oven at 100°C for 1 hour to remove the moisture content in the samples. The initial weight of samples are measured by using weighing method. Then the samples are placed inside a container filled with water. After 24 hours, the samples are taken out of the container and then cleaned with a tissue paper to remove additional water content at the surface. Then the final weight of the samples are measured using weighing method.

$$\text{Water absorption (\%)} = \frac{W_2(\text{g}) - W_1(\text{g})}{W_1(\text{g})}$$

Where, W_1 =Weight of sample before immersion

W_2 =Weight of sample after immersion

Oil absorption test is conducted on both sample 1 & sample 2 at a room temperature of 26°C . The samples are cleaned with tissue paper to remove the dust particles and then the samples are placed inside oven at 100°C for 1 hour to remove the moisture content in the samples. The initial weight of samples are measured by using weighing method. Then the samples are placed inside a container filled with Dot 3 oil. After 24 hours, the samples are taken out of the container and then cleaned with a tissue paper to remove additional oil content at the surface. Then the final weight of the samples are measured using weighing method.

$$\text{Oil absorption (\%)} = \frac{W_2(\text{g}) - W_1(\text{g})}{W_1(\text{g})}$$

Where, W_1 =Weight of sample before immersion

W_2 =Weight of sample after immersion

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IV.RESULTS AND DISCUSSION

DENSITY:

By using weighting balance method, the density of sample 1 is found to be 2.00 g/cm³ and the density of sample 2 is found to be 1.55 g/cm³.

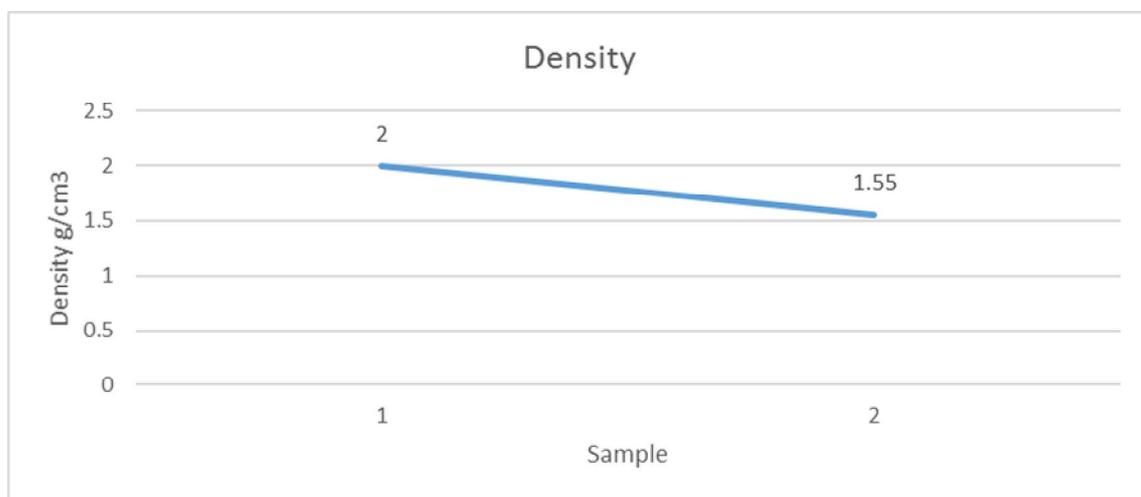


Fig.3- Density of sample 1 & 2

From the figure 3, it can be seen that the density value of sample 2 is less than that of sample 1. As the density value of sample 1 is higher than sample 2, sample 1 is more closely packed than sample 2.

HARDNESS:

The hardness test is performed at three different locations on sample 1 & 2 by using barcol impressor Model No. 934-1. The hardness values obtained at three different locations for sample 1 are 30, 33, 32 and for sample 2 are 25, 27, 27. The average hardness value for sample 1 & 2 are 32 and 26 respectively.

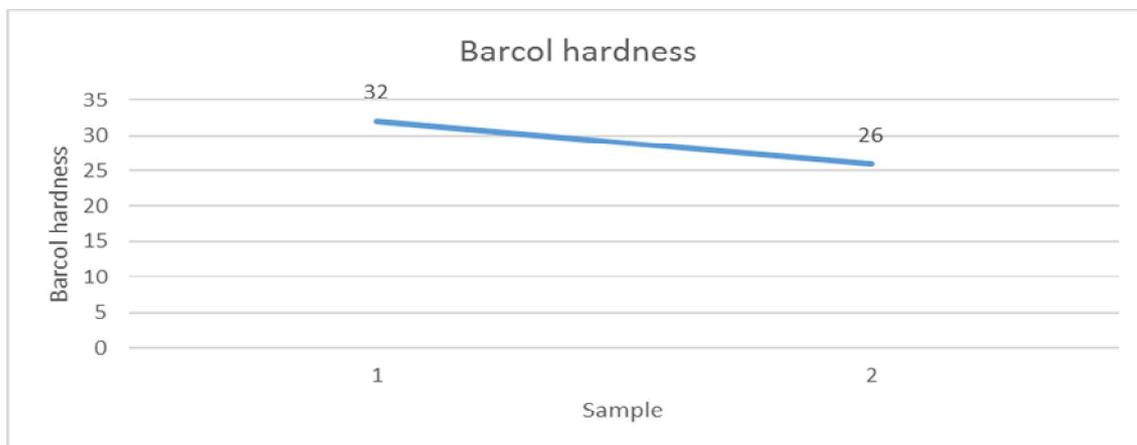


Fig.4- Barcol hardness test value for sample 1 & 2

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From the figure 4, it can be seen that the hardness value of sample 1 is greater than that of sample 2. With the decrease in the wt% of aluminium oxide and iron oxide, the hardness value is also found to be decreasing.

WEAR TEST:

By following the ASTM D5963 standard, the wear test is performed on sample 1 & 2. The initial weight of sample 1 & 2 are 3.8840g and 2.8873g respectively. After performing the wear test, the final weight of sample 1 & 2 are 3.3616 g and 2.3346 g respectively. The wear loss of sample 1 is found to be 0.5224 g and in percentage, it is found to be 13.45%. The wear loss of sample 2 is found to be 0.5527 g and in percentage, it is found to be 19.14%.

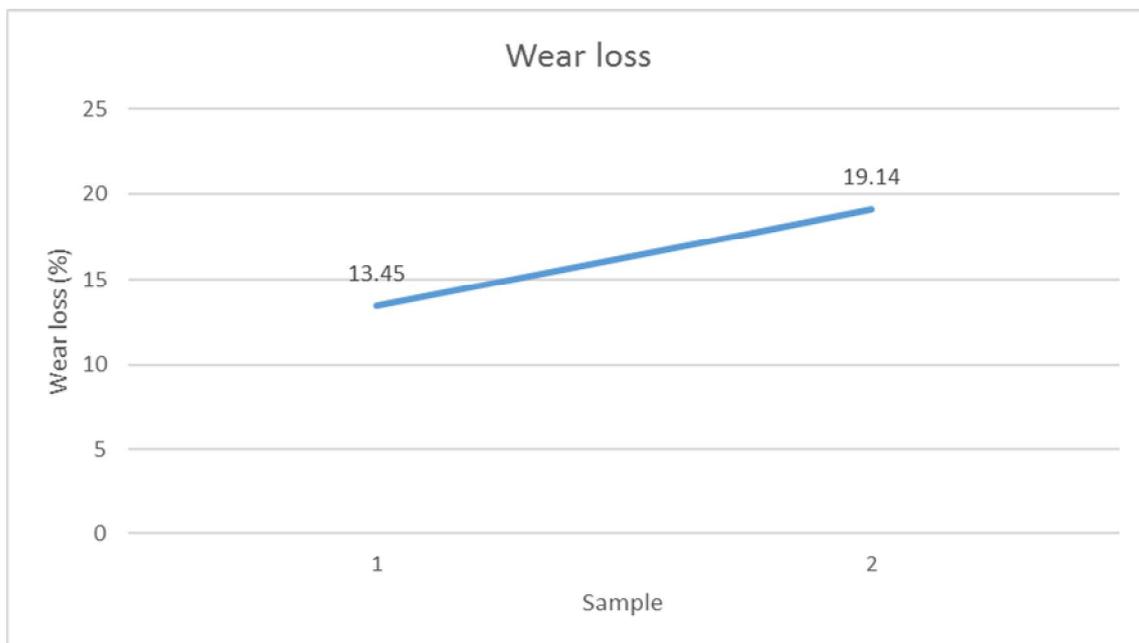


Fig.5- Wear loss for sample 1 & 2

The figure 3 clearly shows that the wear loss of sample 2 is greater than sample 1. Since, the wear loss of sample 1 is less than that of sample 2, the life of sample 1 will be longer than that of sample 2.

WATER AND OIL ABSORPTION TEST:

The water and oil absorption test is performed on sample 1 & 2 and the results are obtained. The water absorption of sample 1 & 2 are 0.96% and 1.38% respectively. The oil absorption of sample 1 & 2 are 0.01% and 0.02% respectively. The water and oil absorption of sample 1 is lower than sample 2 which means sample 1 has better interfacial bonding between particles and resin than sample 2. The close interfacial bonding will reduce the level of porosity and thus reducing the capillary action which causes the material to absorb water and oil.

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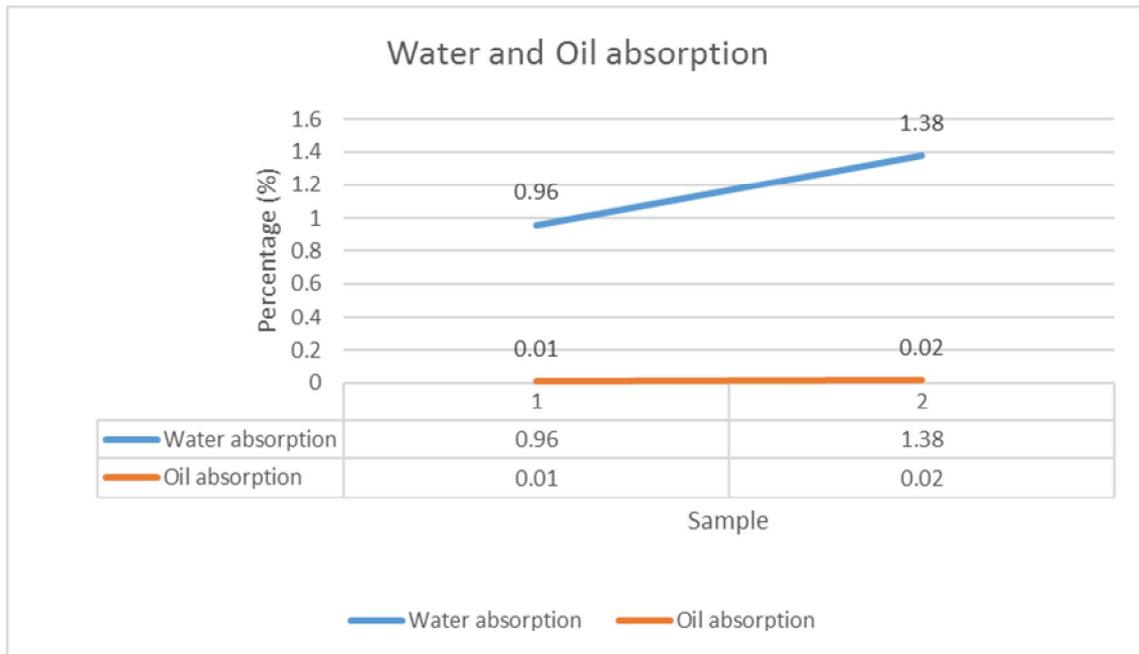


Fig.6- Water and Oil absorption test for sample 1 & 2

From the figure 5, it is clear that water and oil absorption of sample 1 is less than that of sample 2. So the braking performance of sample 1 will be less affected than sample 2 when it comes in with water and oil.

V. CONCLUSION

Brake pads using lemon peels are developed and evaluated. The conclusions are summarized as follows,

1. The hardness and density of sample 1 is higher than that of sample 2 which clearly indicates that the interfacial bonding of sample 1 is better than that of sample 2.
2. The wear loss of sample 1 is less than that of sample 2. So, the life of sample 1 will be longer than sample 2.
3. The water absorption of sample 1 is 0.98 which is very low than sample 2. So, the braking performance of sample 1 will be less affected when it comes in contact with water.
4. The oil absorption of sample 1 is 0.01 which is lower than sample 2. So, the braking performance of sample 1 will be less affected than sample 2 when it comes in contact with oil.
5. Sample 1 with the composition of 40% epoxy resin, 12.5% Al_2O_3 , 12.5 % iron oxide, 15% graphite, 10% calcium hydroxide and 10% lemon peel powder has better properties than sample 2 because of the close interfacial bonding achieved by sample 1.
6. Lemon peel powder can be effectively used as a replacement for asbestos in brake pads.

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