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Testing of Coconut Shell Reinforced Brake PADS

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Abstract:

Asbestos had been used by manufacturers to produce brake pads, but it turned out to be harmful and toxic in nature. So the manufacturers had decided not to manufacture brake pads using Asbestos. It can cause health issues like asbestosis, mesothelioma and lung cancers too. Thus the brake pads can be manufactured using some natural fibres like coconut shell as reinforcement material, along with Graphite which can act as better friction material, Alumina as abrasive material, and, Epoxy resin as a binder. This will make brake pads function well with high friction co-efficient and less wear rate and by using natural waste material as reinforced material, it is good for the environment too. It has its advantages as it makes less noise than metallic brake pads, thus reducing noise pollution. About the tests conducted, various samples were collected by varying the compositions and were tested at various speeds. The wear rate was calculated and, the co-efficient of friction was also investigated. Sample four has given the better result than others. It is observed that, the naturally produced brake pads can be a considerable alternate for Asbestos.

Keywords: Coconut Shell powder, Wear rate, brake pads, Epoxy Resin, compression strength.

I.INTRODUCTION

Composite materials are getting trending nowadays for manufacturing of several materials based upon automobile and aerospace components. Study of Tribology and R&D will be concentrating on the continual growth of natural fibres (i.e. palm kernel, coconut shells etc..).coconut shells are more relatively similar to wood as it consists of cellulose, lignin, pentosans and Ash. domination of bio and agro-based products will contribute the engineering materials in coming times. The main aspect for the usage of natural fibre instead of artificial components is lightweight and good in matrix adhesion of fibres for eco-friendly condition and environmental regulation industries triggered towards natural fibre materials.in current situation, 33billion coconut is harvested throughout the world in that only 1/6 of coconut are used for their fibres[1,2]. for safety purpose and resist of motion at a high or moderate speed of the vehicle or to control any prime movers, the braking system plays a major role in this scenario with help brake pads[3]. Brake pad consists of brake lining when it subjected braking effect it causes high friction and high heat liberation by a material which simultaneously increases the wear rate. Brake pads were made out categorized material like organic, metallic, semi-metallic. moreover, modern brake pad consists of asbestos ceramic, graphite. These material are used due to high resistant wear and reduce heat liberation but the major drawback is asbestos causes a series effect on human health like mesothelioma and asbestos-related lung cancer [4].advantage in natural fibre polymer such as leading high strength, it can be recycled easily and also a

renewable source. Natural fibre enhances the reduction in weight of material than other metallic materials and it will be low in economical wise; in an environmental point of view, natural fibre is more eco-friendly than others[5]. 30% of coconut shell and epoxy or resin polymer matrix tends to form a filled composite of natural fibre. The simultaneously enhance tensile strength and young modulus of material [6]. Concentration on the effect of reduction in wear rate will spontaneously reduce the harmful effect of environment tragedies. More than 50 components are reinforced in their desired category to the material highly efficient brake pad. Multiple components in brake pads are categorized mainly as fibres, Fillers, blinders, frictional reduction agent. However mechanical properties will be influence Brake pads using fibres. Moreover, production cost and machinability of brake pads are improved using filler material. For better optimise performance filler contributes its roll in brake pads [7]. Wear rate and friction properties of brake pad will further growth by addition of blinders[8].in this research, aims to use of waste agro material as utilization of brake pads material, through investigation of this research, strength and friction rate on brake pads are highly efficient when subjected to commercial use of this reinforced composite materials.

II. MATERIALS AND METHODS

A. Materials

Material of reinforcement used here is Coconut shell, obtained from a coconut trader in Chennai from a local industry, whereas, the graphite powder, which is going to act as a friction modifier, is extracted from 1.5 V dry cell batteries and Alumina, which is suited to act as an abrasive material is purchased from a local chemical store in Chennai. And also, Epoxy resin which serves as binder is obtained from a chemical store in Chennai was used jointly with a hardener to give desired property.

B. *Method*

The initial process flow involves preparation of coconut shell and graphite powder by carrying out processes like removing of shell fibres from coconut and washing the obtained shell with soap and detergent, followed by cleaning using a clean dry cloth and drying it in the oven at 150 ^{0}C for nearly 3 hours. After that, crushing the dried coconut shell using mortar and pestle is done and fine grain size of 100 micrometres is obtained. The sieve size of 100 micrometres of Coconut shell was added in varying percentages to Aluminum oxide, Graphite and epoxy resin based on 176 g weight of commercial brake pad. To achieve homogenous steady-state condition for the moulding process, each sample combination is separately dry-mixed using a blender.

Fig . 1 Compression moulding machine

COMPOSITION (%)				
Sample no.	Coconut shell	Aluminium oxide	Graphite	Epoxy resin
S1	10	20	35	35
S2	20	15	30	35
S3	30	10	25	35
S4	40	5	20	35

Table 1: composition variation for different samples

C. Preparation:

Compression moulding machine is used in the production of brake pad samples and a standard method specified [11] is followed. During the process, the sample composition is varied and the process factors like Molding pressure (MP), Molding temperature (MT), Curing time (CT), Heat treatment time (HTT) is kept constant for all samples. Fig 1 shows the moulding machine and Table 2 shows the detailed specification of the machine.

Molding pressure (MP) = 14(MPa)

Capacity = 750 k N

Molding temperature (MT) = 140(^{0}C)

Curing time (CT) = 8(min)

Heat treatment time (HTT) = 1(hr)

The samples, which are in various proportions are manually stirred in the definite composition as referred in Table 1 and are stirred thoroughly and were transferred into the mould for compression moulding. Furthermore, the moulded samples are heated at 150 ^{0}C for particular heat treatment time as shown above.

D. Wear rate:

Wear rate of samples pin on the Disc Wear Testing Machine per the ASTM G-99 standard [9]]. The sample is of cylindrical in shape of size 8mm in diameter and 30mm length were prepared for all compositions of the fibres which is as shown in Fig.2. These tests were carried out at a load of 20N at different speeds. The accompanying condition is utilized to calculate the wear rate [10]. The sliding distance (*D*) and wear rate (*Wr*) were calculated using the following Equations.

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Sliding distance (D) = 2Nπdt

$$Wr = \frac{\text{Loss in weight (wl)}}{\text{Sliding distance (D)}}$$

Where d is the disk diameter

t is the time of exposure of the specimen to abrasion and

N is the radial speed, respectively.

Particulars	Specifications
Max. Day Light	150 mm
No. Of Day Light	2
Platen size	350mm X 350mm
Ram Diameter	200 mm
Heating Capacity	400ºC
Max Pressure	210 bars

Table 2: Hotpress specifications

E. Observations

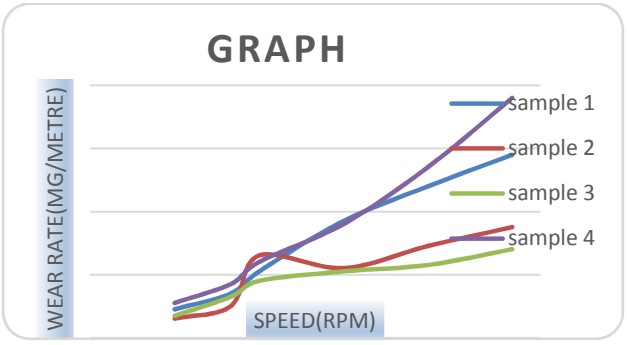

Fig.2. Wear rate comparison of samples

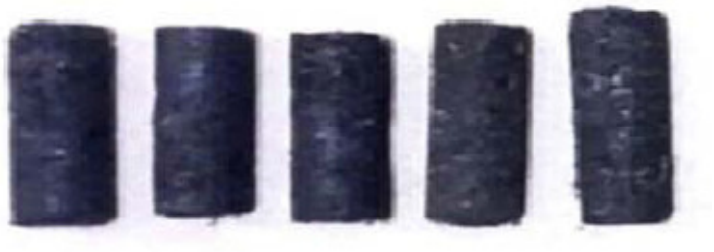

Fig. 3 sample compositions

Speed (rpm)	*SAMPLE WEAR RATE ($mg.m^{-1}$)*			
	Sample 1	*Sample2*	*Sample 3*	*Sample 4*
150	0.9	0.6	0.7	1.1
250	1.4	1	1.3	1.7
300	2.1	1.6	1.8	2.4
450	3.7	2.2	2.1	3.6

Table 3. Wear rate at different speeds of samples

It was observed that as speed increases the wear rate also increases for any sample irrespective of the composition.The reason is the increase in contact pressure between the rotor and brake pads, and this is confirmed [12]. But the wear rate data obtained were different for all formulations, due to different additives and their weight percentages used in their compositions. The following conclusions can be made from the above experimental values. The wear rate was higher in sample 1 and sample 4 since the reinforcement material is low in sample 1 and the amount of abrasive material is less in sample 4. Sample 3 is concluded to be the better composition at high speeds and sample 2 is found to be the better composite to be used at low speeds.

F. Compressive Hardness:

The compressive hardness of the material is the ability to resist against plastic deformation such as scratches, indentation and abrasion. The variation of hardness with speed is determined by using an inertia dynamometer. The hardness determined from the experimentation is the time taken by the brake pad to return to its normal state from maximum stress.

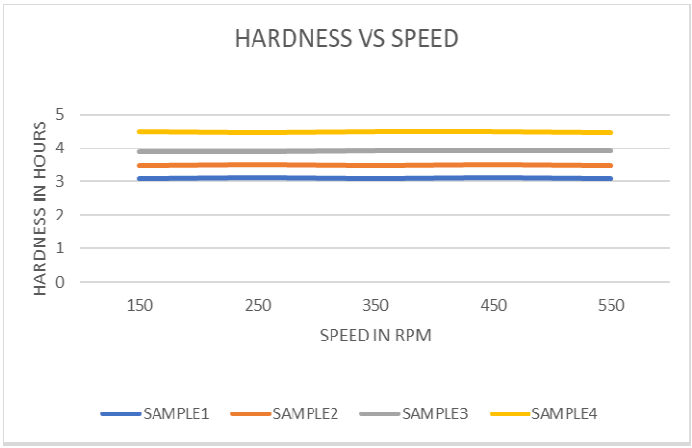

Fig. 4.Hardness vs Speed

Table 4. Compressive Strength of samples

Compressive strength(hours)				
Speed (rpm)	*Sample1*	*Sample2*	*Sample3*	*Sample4*
150	**3.1**	**3.5**	**3.9**	**4.485**
250	**3.11**	**3.52**	**3.9**	**4.484**
350	**3.1**	**3.5**	**3.91**	**4.485**
450	**3.12**	**3.51**	**3.92**	**4.485**

From the observation, it is clear that the time taken to return to the original state for the brake pad is constant and does not change with speed. Although they vary based on the composition of the brake pads

G. Coefficient of friction:

The coefficient of friction is the relation between the normal force acting on the object and the frictional force. The coefficient of friction is given by the formula. The coefficient of friction is an important parameter in braking as it varies with speed [13]. but sometimes this parameter is neglected when considering the performance of brake pads at various speed.

Coefficient of friction				
Rpm	**Sample 1**	**Sample2**	**Sample3**	**Sample4**
150	0.24	0.29	0.36	0.42
250	0.24	0.29	0.36	0.42
350	0. 42	0.29	0.36	0.42
450	0.24	0.29	0.36	0.42

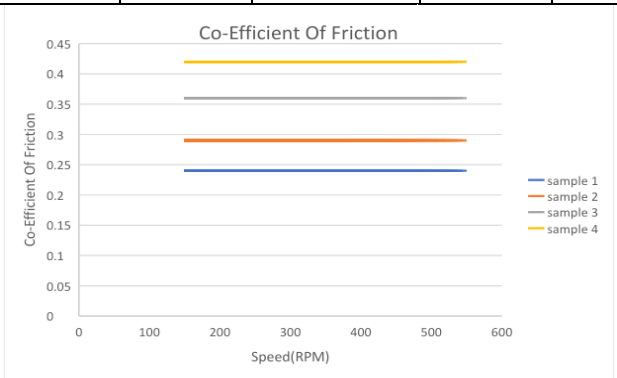

Fig.5. Speed Vs Coefficient of friction

From the graph, it is observed that the coefficient of friction remained constant for various range of speed(RPM).The constant value observed may be due to absence of steel fibres as stated and reported that coefficient of friction will increase if steel fibres are used due adhesion of steel particles or maybe the absence of trapped asperities[14]. In the sliding surface, the composition of the same changes their coefficient of friction also changes due to various properties of the elements and their varying compositions [15]. The highest coefficient of friction was found to be in sample4 and the lowest was observed for sample 1, The sample 2 and 3 had a coefficient of friction between o.3 to 0.35

From the existing literature, it is found that coconut fibres are abundant in nature. The element composition in coconut fibres are as follows;

Compound	**percentage**
Lignin	29.4%
Pentosans	27.7%
Cellulose	26%
Moisture	8%
Solvent extracts	4.2
Uronic hydrides	3.5%
Ash	0.6%

III. Results and discussions:

H. Tribological properties:

The wear rate for sample 1, sample 2, sample 3, sample 4 composites at different fractions of coconut shells at different speed limits are presented in the Table in the observations mentioned above. The wear rate table shows that, as speed increases, the wear rate also increases irrespective of the composition for any samples. The wear results of such composites show that the

trend of graph increases but it decreases for sample 2. It depends on the adhesion properties of graphite, epoxy resin and Aluminum oxide.

I. Mechanical properties:

The compressive Hardness values for all sample composites at different volume fractions is shown in the graph drawn between compressive hardness (Mpa) and speed (RPM) in the observation section.It is observed that the compressive hardness shows a linear deflection with the increase in speed respective for the samples. From the graph, it is concluded that sample 4 is having more hardness value compared to all other samples used.

J. Physical properties:

The values of coefficient of friction for all sample composites at different volume fractions are shown in the graph drawn between the coefficient of friction and speed (RPM). It is observed that sample 4 develops a high coefficient of friction whereas sample 1 shows the very minimal coefficient of friction according to the graph shown in the observation section.

IV.CONCLUSIONS:

The wear rate was higher in sample 1 and sample 4 since the reinforcement material is low in sample 1 and the amount of abrasive material is less in sample 4. Sample 3 is concluded to be the better composition at high speeds and sample 2 is found to be the better composite to be used at low speeds. The coefficient of friction is observed to be very high in sample 4 and to be very low in sample 1. The compressive hardness values are high in sample 4 and are very low in sample 1. It is concluded that sample 4 shows better hardness than all other samples

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