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WEAR ANALYSIS OF COMPOSITE MATERIAL MADE BY BLENDING OF NATURALLY AVAILABLE COCONUT SHELL POWDER (CSP)

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ABSTRACT

The Aim of the study is to develop a natural, eco-friendly brake pad materials. Coconut shell powder which is one of the naturally available material with outstanding potential in brake pads. Coconut shell powder (CSP) has properties like thermal conductivity, thermal stability, strength etc., which are essential for friction materials. Composite Material for the brake pad was fabricated using Epoxy Resin as binder. Keeping this in view the present work has been under taken to develop a polymer matrix composite (epoxy resin) using coconut shell powder and to study its tribological behaviour, Experiments have been conducted under laboratory condition to assess the frictional wear behaviour of the developed composite. Four different compositions were prepared with varying Al from 0.001, 5, 10 and 15 percent along with binder and grit sizes 0.15,0.40,0.75,0.90 mm. The experiment was conducted by keeping speed, load and time interval constant. From wear considerations, grit size G1(0.15 mm) and % composition of AL powder C4(15%) is the best composite in present investigation.

KEYWORDS: CSP, Epoxy resin, pin on disc machine, wear rate, % composition of Al powder.

INTRODUCTION

A brake pad material plays a vital role in any automotive vehicle so as to slow down the vehicle or to stop the vehicle completely. During the application of brake, friction between brake pads and rotating disc causes to stop the vehicle by converting kinetic energy of the vehicle into heat energy. Therefore the brake pads should quickly absorb heat, should withstand for higher temperatures and should not wear. The brake pad material should maintain a sufficiently high friction coefficient with the brake disc, not decompose or break down in such a way that the friction coefficient with the brake disc is compromised at high temperatures and exhibit a stable and consistent friction coefficient with the brake disc. In past years asbestos is used in brake pads. But asbestos causes carcinogenic effects on human health. It leads to the investigation on new materials particularly agricultural residues or wastes are now emerging as new and inexpensive materials in the brake pads development with commercial viability and environmental acceptability for brake pad which possesses all the required properties. Generally brake pad consists of a composition of binder, fillers, and hardeners. All these constituents are mixed or blended in varying composition and brake pad material is obtained using powder metallurgy technique techniques. Fillers in a brake pad are present for the purpose of improving its manufacturability as well as to reduce the overall the cost of the brake pad. In the present review paper different environment and healthy friendly coconut shell material for asbestos brake pads are provided and their preparation, properties etc. are studied.

LITERATURE REVIEW

Literature review is an assignment which gives idea about previous work done by different authors and from the research paper published by them in different journals gives the data about there research work which are helpful in our project. It gives the guideline or path for progressing our task. Earlier many authors work on same. So we are collecting some usefull information for our project.to analyze wear behavior of composite material following parameters has taken into consideration by reviewing literature review.

In May - October 2014, Rudramurthy, Chandrashekara. K, Ravishankar R, Abhinandan. S.[1] "Evaluation of the Properties of Eco-friendly Brake Pad Using Coconut Shell Powder as an Filler Materials" in IJRMET. This paper had used the CSP as the filler material and other constituients are phenol formaldehyde, epoxy resin and Alumina (Al2O3) as a new brake pad material.

J.O. Agunsoye, S.I. Talabi, S.A. Bello, I.O. Awe[2] "The Effects of *Cocos Nucifera* (Coconut Shell) on the Mechanical and Tribological Properties of Recycled Waste Aluminium Can Composites", in this paper the different sizes of grit are used for checking tribological behavior. The paper shows that addition of CSP improved the wear resistance of recycled aluminium composite. The test was taken on pin on disc equipment. From their analysis they conclude that decrease in filler particles size improved the tensile strength and yield strength of the developed aluminium metal matrix /CSp composite. The hardness of the composite increased with increased additions of the filler within the matrix.

In 2012 Bashar DAN-ASABE, Peter B MADAKSON, Joseph MANJI,[3]" Material Selection and Production of a Cold-Worked Composite Brake Pad" in World J of Engineering and Pure and Applied Sci. This paper entails the selection and production of composite brake pad with varied constituent's composition. Series of tests were conducted that involved tensile, compressive, hardness, impact, wear and corrosion to ascertain composition with the best property as compared to a commercial Honda brake pad (*Enuco*) model widely used in Nigeria. The results shows that higher percentage of grounded coconut shell powder induces brittleness since compositions with lower percentage of it produced higher breaking strength and lower wear rate.

In 2014 F. N. Onyeneke, J. U. Anaele and C. C. Ugwuegbu[4] " Production of Motor Vehicle Brake Pad Using Local Materials (Perriwinkle and Coconut Shell)" in The International Journal Of Engineering And Science (IJES). The production and testing of motor vehicle brake pad using locally available raw materials is presented. The disc brake friction lining with the geometrical specifications of Audi 90 model was produced using palm kernel and coconut shell powder as base materials, araldite and epoxy resin as binder materials and carbon as fibre reinforcement. Aluminum, copper, zinc and cashew nut shell were used as abrasives and rubber dusts from shoe as filler. The commercial asbestos brake pad produced by Ibeto group of Companies served as control.

METHODOLOGY

Materials used

I) Coconut shell particle

Coconut shell particles are used as base material for investigation. Shell particles of different sizes are prepared in grinding machine. Coconut shell filler are potential candidates for the development of new composites because of their high strength and modulus properties. Approximate value of coconut shell density is 1.60 g/cm3.

Figure 1: Coconut shells.

Figure 2: CSP.

Figure 3: Composite pins.

II) Epoxy Resin

Epoxy resin (ER) are one of the most important classes of thermosetting polymers which are widely used as matrices for matrices-reinforced composite materials and as structural adhesives. They are amorphous, highly cross linked polymers and this structure results in these materials possessing various desirable properties such as high tensile strength and modulus, uncomplicated processing, good thermal and chemical resistance, and dimensional stability. The epoxy used is colourless, odourless and completely nontoxic. The Hardener 241/242 MK is used in our experiments. It is a yellowish liquid.

III) Aluminium powder

One of the best known properties of aluminium is that it is light, with a density one third that of steel. Aluminium is an excellent conductor of heat and electricity for heat dissipation. Aluminium reacts with the oxygen in the air to form an extremely thin layer of oxide, this layer is dense and provides excellent corrosion protection. In our experimentation we used powder form of Aluminium.

Sample preparation

The cleaned coconut shells were cut into small pieces by using hammer. These small pieces were grinded into powder form by a using ball milling. The collected powder was then sieved to different four mesh sizes which are 0.10, 0.24, 0.53, 0.75 mm.

The weight percentage of coconut shell powder was mixed with the matrix material consisting of epoxy resin and aluminium powder was added into it as a reinforcement agent. There were four different composition of aluminium powder was used.0.001%, 5%, 10% and 15% were used in the samples.

The mould is prepared from M S bar. 10 mm hole was drilled into the bar which has high surface finish. Then for pressing the material into that mould the steel stud was used for holding the mould bench vice was used.

Initially the correct composition of sample taken as per L16 array. this mixture then mixed uniformly and to make it pin the epoxy resin and hardener was added this mixture then filled into the mould then this mixture was pressed in vice by placing properly. During pressing care should be taken to avoid uneven distribution of the pressure, which may prepare void space in specimen. This pressed mixture was kept in pressed condition for 2 hrs. In this time the mixture had taken shape of the pin type of specimen.

Pin shaped specimen was removed out from mould by using proper method. In this way the pin was ready for experiment.

Pin on disc wear test machine

Figure 4: Pin on disc wear test machine.

A pin-on-disc test apparatus was used to investigate the dry sliding wear characteristics of the composites as per ASTM G99-95 standards. This test method describes a laboratory procedure for determining the wear of materials during sliding using a pin-on-disk apparatus. This equipment works on the dc supply.

Experimental work

The pin was held against the counter face of a rotating disc (Abrasive disc of alumina) with wear track diameter 60 mm. The pin was loaded against the disc through a dead weight loading system. The wear test for all specimens was conducted under the normal loads of 1.5

kg and a sliding velocity of 500 RPM. Wear tests were carried out for a total sliding distance of approximately 37.70 m under similar conditions.

The pin samples were 10 mm in diameter. The surfaces of the disc was cleaned periodically in order to ensure effective contact of fresh and flat surface with the steel disc. The wear rate was calculated from the weight loss technique and expressed in terms of weight of wear loss per unit cycle of revolution.

In the present experiment the parameters such as speed, time and load are kept constant throughout for all the experiments. The experiment was conducted by using orthogonal array of L16. It has two factors and four levels. Grid size and % composition are two factors which are considered.

Table 1: Wear analysis parameter and levels.

Factor \ Level	1	2	3	4
% Composition	C1=0	C2= 5	C3=10	C4=15
Grid size (mm)	G1= 0.10	G2= 0.24	G3= 0.53	G4= 0.75

The pin proportions are as given below. The wear rate was calculated by using formula

$$\text{Wear rate} = \frac{\text{total weight loss of pin in 20 min}}{20\ \text{min} \times 500\ \text{rpm}} \left\{\frac{\text{gm}}{\text{cycle}}\right\}$$

RESULT AND DISCUSSION

Table 2: Pin composition and Result of wear rate.

Pin no.	Grit size and composition of CSP % (gm.)	Composition of Al powder % (gm.)	Binder %(gm.)	Wear rate ×10^-5 (gm./cycle)
1	G1=65% (1.95)	C1=0.001% (0.001)	35% (1.05)	4.2
2	G1=60% (1.80)	C2=05% (0.15)	35% (1.05)	7.2
3	G1=55% (1.65)	C3=10% (0.30)	35% (1.05)	5.6
4	G1=50% (1.50)	C4=15% (0.45)	35% (1.05)	6.1
5	G2=65% (1.95)	C1=00% (0.00)	35% (1.05)	2.6
6	G2=60% (1.80)	C2=05% (0.15)	35% (1.05)	2.9
7	G2=55% (1.65)	C3=10% (0.30)	35% (1.05)	3.9
8	G2=50% (1.50)	C4=15% (0.45)	35% (1.05)	7.9
9	G3=65% (1.95)	C1=00% (0.00)	35% (1.05)	1.9
10	G3=60% (1.80)	C2=05% (0.15)	35% (1.05)	2.3
11	G3=55% (1.65)	C3=10% (0.30)	35% (1.05)	3.0
12	G3=50% (1.50)	C4=15% (0.45)	35% (1.05)	2.3
13	G4=65% (1.95)	C1=00% (0.00)	35% (1.05)	4.1

14	G4=60% (1.80)	C2=05% (0.15)	35% (1.05)	4.1
15	G4=55% (1.65)	C3=10% (0.30)	35% (1.05)	3.6
16	G4=50% (1.50)	C4=15% (0.45)	35% (1.05)	2.5

In above table 2 shows the wear rate for different samples prepared by varying composition and grit sizes.

Taguchi Orthogonal Array Design

Table 3: Analysis of Variance for SN ratios.

Source	**DF**	**Seq SS**	**Adj SS**	**Adj MS**	**F**	**P**
Grit Size	3	119.58	119.58	39.860	4.92	0.027
% Comp of Al	3	15.63	15.63	5.209	0.64	0.606
Residual Error	9	72.86	72.86	8.095		
Total	15	208.06				

Table 4: Response Table for Signal to Noise Ratios; Smaller is better.

Level	**Grit Size**	**% Comp of Al**
1	-15.070	-9.649
2	-11.830	-11.471
3	-7.397	-11.863
4	-10.899	-12.213
Delta	7.674	2.564
Rank	1	2

In wear analysis grit size is important criteria, so the main purpose of analysis of variance (ANOVA) is to find out which design parameters significantly affect the wear rate value.

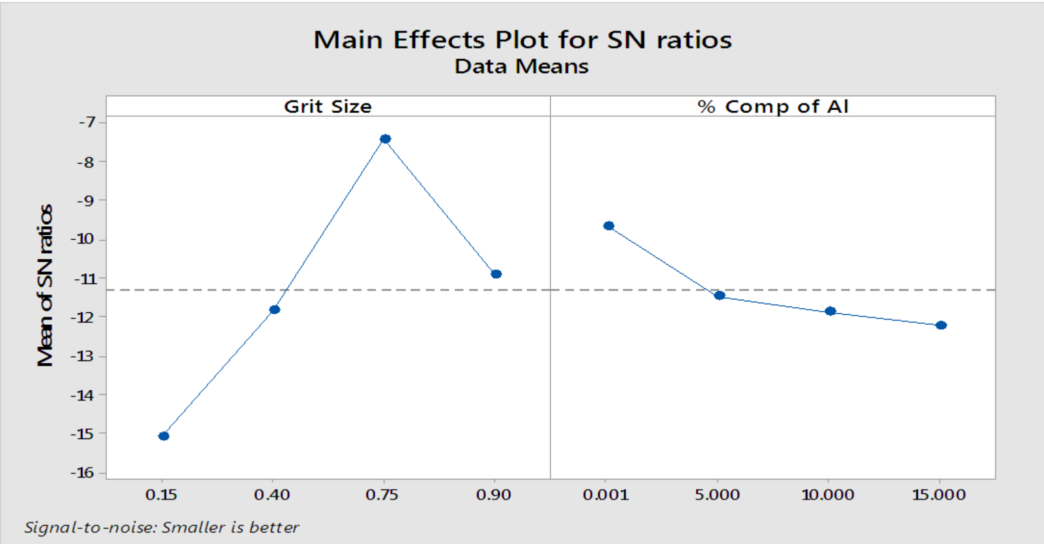

Figure 5: Main Effects Plot for SN ratios.

Above plot shows Main effect plot for S/N ratios in which mean of S/N ratios V/S grit size and %composition of Al. is shown for Signal to Noise ratio: smaller is better.

The plot indicates

1) The S/N ratio vs. grit size gives maximum slope as that of %composition of Al. Hence grit size more affects the response characteristics than %composition. As the plot for S/N ratio vs. %composition of Al. shows significant effect for 0.001 to 5 % but it is nearly horizontal from 5 to 15% that means it has very less significance in response characteristics.
2) For grit size 0.15 mm the S/N ratio is minimum (-15.0705) which satisfies S/N ratio smaller better criteria. Hence it is optimum result for grit size.

Similarly for % composition of Al., 15% Aluminium gives minimum (-12.2131) S/N ratio. Hence it is optimum for % composition.

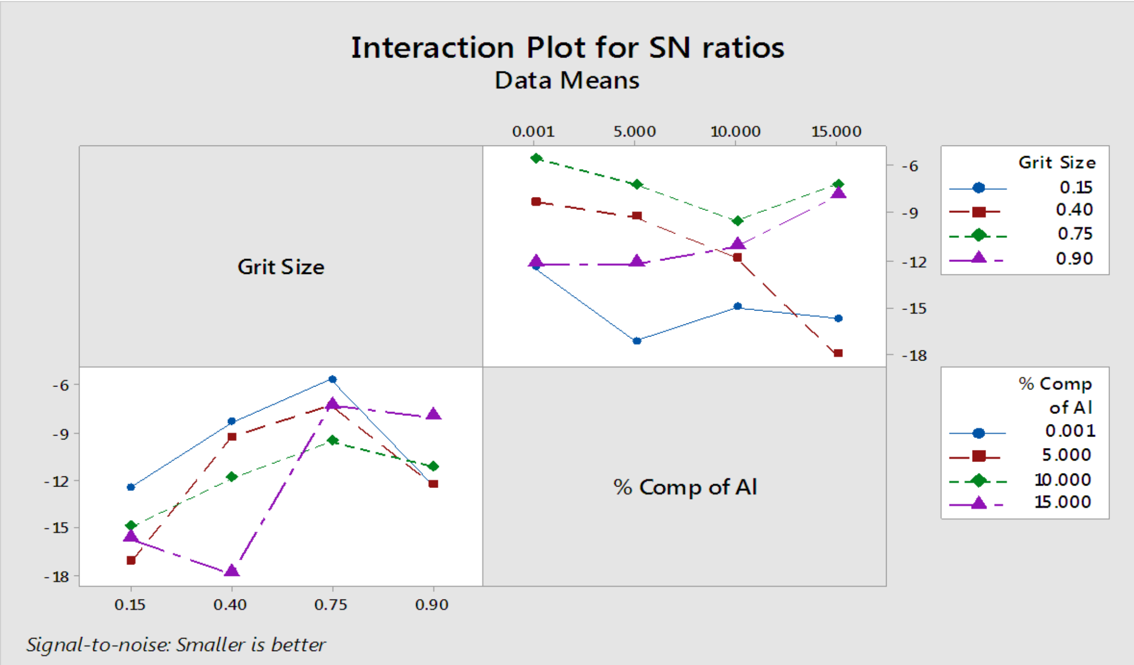

Figure 6: Interaction plot for S/N ratio.

Above plot shows interaction plot for S/N ratio, in which S/N ratio vs. grit size for % composition of Al is shown. It also shows interaction plot for S/N ratio, in which S/N ratio vs. % composition of Al for grit size.

From above graph, we can interpret that the % compositions of Al 0.001, 5 and 10 shows less interaction whereas, 15% shows more interaction which clears that 15% Aluminium has more significant effect on response characteristics. Similarly in S/N ratio vs. % composition of Al for grit size plot; Grit size 0.15 shows more interaction. Hence it has significant effect on response characteristics.

Regression Analysis: Wear rate versus Grit size, %comp

Regression Equation obtained by performing regression analysis,

Wear rate = 5.317 + 0.0880 % Comp of Al - 3.57 Grit Size

Above table shows Regression Analysis: wear rate vs. grit size, % composition of Al ; in which analysis of variance shows that 'p value' for grit size is 0.013 significant at 0.05 α level and the 'p value' for % composition of Al is 0.201 which is greater than 0.05 α level. Hence grit size is more significant parameter for response characteristic. The regression equation for Wear rate is given above.

CONCLUSION

From the results and discussion of this work the following conclusions can be made:

Better result in wear analysis is obtained by using smaller grit size of CSP. As grit size increases wear rate also increases. Increased composition of Al powder in CSP improved the wear rate of composite.

By the analysis of this experiment it is observed that grit size is more significant parameter.

Recycled aluminium cans and coconut shell can be processed and used for the production of useful engineering materials.

Finally by all above research conditions It could be emphatically concluded that, from wear considerations, grit size G1(0.15 mm) and % composition of AL powder C4(15%) is the best composite.

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