Composite Friction Material For Brake Pad – An Intensive Review

Abstract

The friction pad in brake pad made of asbestos creates harm to environment when the brake is applied. When the number of automotives on road is counted, the pollution contributes to a considerable level in the environment. Hence numerous researches have been carried out with alternative material for friction material of brake pad. There are few investigations with banana peels, palm wastes rock wool, flax fibres etc. Few researches have been done with fibres made with agricultural wastes also. This review paper intensively analyzes the investigations done in this field for a decade. The results have been consolidated and compiled. The conclusion part clearly elaborates the eco-friendly material suggested by researchers to avoid the conventional asbestos material in the brake pad.

Keywords: Brake Pad, Asbestos Material, Eco-Friendly Material

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Introduction

The purpose of braking system in automobiles is to slow down the vehicle or to bring it to halt. This is achieved by the concept of friction generated while friction material in the brake pad contacts in the rotating wheel drum or disc. In earlier days drum braking system alone used in the automobiles, and recent technologies use the disc type of brakes. The manufacturers prefer disc braking as it more effective than drum brake. In both the cases the concept is same, except that the friction material in the brake shoe is exposed to atmosphere in disc braking. While brake is applied the kinetic energy of the vehicle creates heat energy. Hence the pad should absorb the heat without any wear [1]. In general the friction should have a characteristic of high friction coefficient with the brake disc. In earlier days, asbestos material has been used for manufacturing the friction layer of brake pads. Later on many investigations revealed that asbestos caused carcinogenic effects on human health and also pollutes the environment to a considerable level. As the number automotives increase, the polluting effect also increased. Hence the researches have been carried out to replace the conventional friction material with a eco-friendly material which will play the same role as conventional material. Hence the researchers focused their attention on new materials for replacing the asbestos material. Few of the materials tested are agricultural waste, banana peels, palm kernel shells, palm wastes, rock wool, aramid, fibres, etc. A brake pad consists of friction material, fibres, binding material and fillers. These materials are thoroughly blended and friction material for the brake pad is manufactured. This review paper intensively analyses the investigations done by the researchers with various materials which are eco-friendly. Few replacements suggested by the researchers are dolomite for the filler material, agricultural wastes for fibre material etc. At the end of review a consolidated report has been submitted mentioning the various possible eco-friendly replacements instead of asbestos.

Experimental Procdedure For Raw Material Preparation

Preparation of flax fibre

The flax fibres were dried at 80oC for 30 minutes. Sodium hydroxide solution at room temperature for 60 minutes and hydrochloric acid steam for 30 minutes [2]. Singh et al mentioned that aramid fibres and lapinous fibres can be used directly for manufacturing the friction pads [3]. The researchers have also mentioned that there is no necessity for any kind of chemical treatment. A similar method was suggested by Kunal Sinha [4] for the using basalt fibres in formulating the friction material for brake pad.

Preparation of fibre using banana peels

Idris et al [5] dried banana peels and milled at 250 rpm. Further they prepared banana powder and packed in graphite crucible. The powder is then fire treated in a electric resistance furnace at a temperature of 1200o C. The carbonized banana peels ash has been used for manufacturing the friction pad.

Preparation of coconut fibre

Maleque et al [6] have tested four combinations of friction materials using the coconut fibres. The content of coconut fibres were varied by 0, 5, 10, and 15 by volume fraction. The preparation has been done along with friction modifier, abrasive material, binding material and solid lubricant using powder metallurgy technology. The coconut fibre was used as filler material and cleaned using ethanol to remove the foreign matters. The researchers have used the fine powder of grain size ranging from 100 – 200 µm and used for preparing the friction material.

Preparation of Palm kernel fibre

Ikpambese et al [7] fabricated the friction materialwith palm kernel fibre. The researchers collected the palm kernel fibres and suspended them in a solution of sodium hydroxide for one day to remove the unwanted remnant oil and waited for extraction. The fibres washed with clean water to remove the sodium hydroxide particles. The fibres were kept in hot sun for seven days. The dried fibres were then powdered by hammering process and sieved to a size of less than 100 µm aperture.

Fabrication Of Brake Pad Using Composite Material

The materials discussed in previous chapter were treated chemically as well as mechanically to obtain the desired composition. The various ingredients such as filler material, binding material, additives for friction were used in fabricating the composite brake pad. All ingredients were mixed to form a homogeneous mixture and compacted with a pressure of 15 to 17 Mpa using a hydraulic press machine. The product obtained was termed as green body of composite friction material. A hot press machine was used for curing the green body friction material. The temperature and pressure used were 150 oC and 60 ton. The duration of the process was 5 minutes. Then the friction material with brake pad was allowed to cool at room temperature

Literature Review

Gurunath et al [8] have conducted experiments with a newly fabricated resin. The authors have mentioned that phenolics created a problem of evolution of noxious volatiles during the cooling process at room temperature. The researchers have compared the result with the already developed resin which was capable of withstand heat induced. Hence authors have concluded that the composite fabricated by them showed better results when compared to conventional phenolic resin. However, there was change in performance when temperature of the pads exceeded 400o C. Authors have suggested that the newly developed composite would be a better replacement for phenolic resins.

Singh et al [3] tested with hybrid phenolic material composie. Authors have stated that aramid pulp had a characteristic of fibrillation with ingredients. The researchers mentioned that lapinus fibre consisted of metallic silicates. It possessed good dispersion property and reduced the sensitivity to cracking and blistering during post curing. The researchers used NOVLAC type of phenolic resin as binder. The other compositions used were graphite and barites. The experimental result showed that increased lapinus content when aramid content is decreased.

Rusaidi et al [9] experimentally tested the mechanical and wear properties of the palm slag friction material pad. Hydraulic hand press is used to form the composite and curing had been done at a temperature of 150 oC by varying the pressure in the range of 10, 20, 40, and 60 tons of compression loading for 5 minutes. The studies revealed that properties were better when the compression load was 60 tons and the lesser wear rate was reported. Hence the authors have concluded that palm slag would be a better replacement to the fillers in a brake pad composite.

Zhezhen fu et al [2] have developed a brake pad friction composite consisting of plant flax fibre and mineral basalt fibre. Authors have stated that as eco-friendly composite as it is a natural fibre when compared to conventional asbestos. The composite developed by the researchers used wollastonite as reinforcements and natural graphite as lubricant. The researchers have also used zircon as abrasive material and vermiculite and barite as space fillers. The binders sed were toughened phenolic resin. The researchers have used vermiculite as it reduces noise while brake is applied. The composite which was not comprised the flax fibres showed higher friction coefficient than the composites which contained the flax fibre. The researchers have also reported that at elevated temperatures wear resistance found to be increased with the samples containing the flax fibres.

Arnab Ganguly et al [10] conducted experiments with a composite material which consisted of phenolic resin and expoxy resin. The both were being used as toughners to overcome the property of brittleness. Researchers mentioned that the property of brittleness was due to the presence of phenolic resin. To improve the thermal properties cashew nut resin was also additionally added. The Scanning Electron Microscopy (SEM) test had been used for synthesization of the composite. The researchers have conducted wear test, gravimetric analysis etc. The researchers have mentioned that the materials used for preparing the composite were cost effective.

Yun et al [11] carried out experiments to study the tribological characteristics of phenolic resin, postassium titanate whiskers and cashew nut shell liquid. The curing is done by aldehidei in an pad-on-disc model tester. In the experimental work the fibres used were aramid pulp, rock wool and potassium titanate. However, the experiments were carried out to analyze the effects of phenolic resin, potassium titanate exclusively. Authors have reported that average coefficient of friction was found to be decreased when the quantity of potassium titanate was increased. The researchers have concluded that the phenolic resin increased the coefficient of friction, but caused the noise.

Poh wah lee et al [12] conducted experiments on environment friendly friction materials for brake pad. The researchers have attempted to analyze the wear and friction properties of the composite material comprising of synthetic kevlon fibre and phenol resins. The authors have stated that Copper and antimony free composite has been developed. The quantity of phenol resin had been reduced by replacing it with geopolymer materials. The experimental results revealed that modified composite materials showed better performance that cu-sb based material, but with a penalty of increased wear rate.

Table 1 Consolidation Of Literature Review On Composite Friction Materials

S. No.	Title of Paper	Authors	Composite Material	Inference
1	Friction and wear studies on brake-pad materials based on newly developed resin	P V Gurunath J Bijwe	A new form of resin	Increased thermal resistance Variation in performance characteristics at elevated temperature
2	Performance assessment of lapinus–aramid based Brake pad hybrid phenolic composites in friction braking	T Singh A Patnaik	Hybrid phenolic material composite	Good dispersion property and reduced the sensitivity to cracking and blistering during post curing
3	Mechanical Properties and Wear Behavior of Brake Pads Produced from Palm Slag	C M Ruzaidi, H Kamarudin, J B Shamsul, M M A Abdullah Rafiza	Palm slag	Properties were better when the compression load was 60 tons and the lesser wear rate
4	Development of Eco-Friendly Brake Friction Composites Containing Flax Fibers	Zhezhen Fu, Baoting Suo, Rongping Yun, Yimei Lu, Hui Wang, Shicheng Qi,Shengling Jiang Yafei Lu	Plant flax fibre and mineral basalt fibre	Elevated temperatures wear resistance found to be increased with the samples containing the flax fibres
5	Asbestos Free Friction Composition For Brake Linings	Arnab Ganguly Raji George	Phenolic resin and expoxy resin	Composites were cost effective
6	The effect of phenolic resin, potassium titanate, and CNSL on the tribological properties of brake friction materials wear	Yun Cheol Kim Min Hyung Cho Seong Jin Kim Ho Jang	Phenolic resin, Potassium Titanate and CSNL	Phenolic resin increased the coefficient of friction, but caused the noise
7	Friction and wear of Cu-free and Sb-free environmental friendly automotive brake materials	Poh Wah Lee Peter Filip	Synthetic kevlon fibre and phenol resins	Modified composite materials showed better performance that cu-sb based material. Increased wear rate

Table 1 Consolidates The Various Investigations On Composite Friction Materials And Summarizes Its Inference.

Conclusion

The paper analyzed the investigations done by various researchers to find an alternative material for asbestos friction material. The reason for their research was the conventional asbestos material friction pad caused environmental issues and harmed human health. Almost all researchers have proved that performance of composite material is same as that of alternative, where as the wear rate and thermal resistance varied. Especially with the replacement of cu-sb friction material with synthetic kevlon fibre and phenol resin caused more wear rate than conventional one. The research with banana peels dried composite material increased tribological properties, with a penalty of poor shell life on more addition. Investigations are still progressing with agricultural wastes, which was appreciable one. The paper concludes and suggests that the composite material friction pad shall be tested in the vehicle to check its adaptability with road conditions and jerks too, which may give more results. Also, endurance test shall be conducted with all composite friction material as a continual research in this field.

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