Analyse Wear Behaviour of Brake Friction Lining Manufactured from Pistachio Shell Composite

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Abstract: The aim of this paper is to analyse wear behaviour of break friction lining manufactured with pistachio shell powder as filler material in place of asbestos. Asbestos replaced because asbestos denunciation is mostly harmful as they cause asbestosis and mesothelioma. Here in this work binder phenolic resin, frictional additives graphite and silica dioxide, reinforcing material copper used and most important pistachio shell powder as filler material in place of asbestos used. Sample manufactured by compressive moulding process. Wear rate of brake friction lining is gradually increases up to 30N load and beyond this load wear rate is higher. Wear behaviour of material also studied with FE-SEM, this shows presence of swallow groves and delaminated surface which are reasons behind increasing wear.

Keywords –Pin on Disc, Composite material, Pistachio shell, Wear, FESEM.

1 INTRODUCTION

Braking system plays crucial role in every automobile. This system consist of either disc brake or drum brake. Kinetic energy of any automobile get converted into heat energy because of friction of metal plate and friction lining of brake these is due to operation of tear and wear at surface. As technology get developed alternative for brake lining also come to market. Both brake have brake shoe with attached friction lining, mostly these are made up of asbestos material. These asbestos exposure is reason behind health hazards decease like asbestosis and mesothelioma (It is rare cancer which is associated with exposure to amphibole asbestos). Due to this health risk, nowadays asbestos is being replaced by non-asbestos friction material. This is the reason behind development of asbestos free material which are used in brake pads and clutches in automobile industry during manufacturing. These additional materials are metals, ceramics, carbon and organic material.

When we use this material to manufacture brake pad have different advantages and disadvantages. Hence more research has been carried out for replacement of asbestos and optimize the performance requirement. By make of utilization of organic waste products we can develop friction material suitable for friction pad in braking. Organic waste is solution to control harmful health disease but also helpful in reducing the dependence on depleting resource. Which are renewable resource and non-renewable resource.

MohamadAlsaadi [1] have studied particle of pistachio shell on microscale. In this work they observed morphology of polyester matrix consist particle of pistachio shell by making use of SEM (Scanning Electron Microscope). They found that good distribution of particles of pistachio at 5% and 10% wt. Adegbola[2] have developed cow bone resin composite for brake lining friction material. They studied cow bone microstructure at 250 µm, 500 µm, 800 µm particle size. They found that as particle size of cow bone goes on decreasing proper bonding take place between particle. Similarly K. W. Liew [3] have studied effect of spraying water on commercial and non-commercial brake pad material. They found that as water spray on brake pads continuously cleaning and removal of debris present at interface.

Natural resources has been used to produce fillers and fibers, including, groundnut, wood flour, rice husk, husk ash, rice straw,cellulose, cotton, and jute. These materials are helpful to improve the mechanical properties of composites, entail low costs, increase impact strength, enhance physical properties and improve other mechanical properties.

Among the agricultural resides, pistachio nut can produced in most places of world so pistachio shell can easily available on large scale. Turkey, Iran, and the USA are largest producer. Among them turkey produces half of total pistachio nut production. Dueto specific whether condition and land requirement for cultivation of pistachio is available in this country.

2 MATERIALAND PROCEDURE

2.1 Materials

The various material used for production of brake lining are shown in Figure 1 below.

Figure 1 PHOTO OF INGREDIENT

Pistachio shell Powder | Phenolic Resin | Copper

Silicon Dioxide | Graphite

Filler used is Pistachio shell. Binder is Phenolic resin (phenol formaldehyde) which has high resistance to various acids, water and solvents. Reinforcing fiber used is Copper which improves thermal conductivity of pads and hence helps in decreasing contact temperatures. Abrasive is Silica (SiO_2), which possess high hardness and lubricant used Graphite have good thermal conductivity and lubrication properties as frictional additives.

2.2 Material Preparation

A 2 kg quantity of pistachio shell taken from shop. Salt is removed by washing and drying pistachio shell under sunlight. In domestic grinding, shells were crushed into powder and then sieved into various sieve sizes of small aperture of 120 microns, 60 microns, 40 microns for 10 minutes. Production of composite consists mixing of material, compaction of material (cold pressing), and sintering (hot pressing) cooling, cooling, post curing and finishing of specimen. All constituent gradients pistachio shell powder, copper, phenolic resin, graphite, silicon dioxide are added together in % of wt. ratio. The combination were properly mixed in domestic mixer for 15 minutes to form homogenous mixture formed. Now this mixture is poured in die. And cold pressed with hydraulic press. Then ring specimen is placed on hot pressed hydraulic machine for sintering temperature range of 150 °C to 160 °C. Finally specimen had taken out and kept for cooling as shown in Figure 2.

Figure 2 MANUFACTURE RING

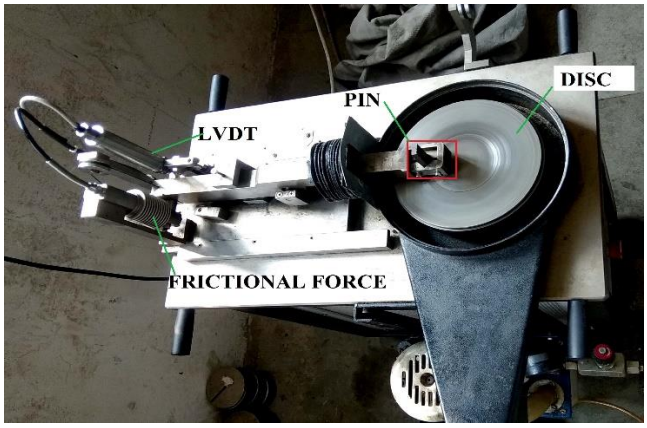
For wear testing purpose, specimen is developed as pin in rectangle size as shown in Figure 3.

Figure 3 FINISHED SPECIMEN

2.3 Wear of Material

TR-20LE, Wear and friction monitor equipment represents a substantial progress in terms of simplicity and convenience of operation, ease in measurement of both wear and friction force parameter. Tribometer is an instrument that measure wear and coefficient of friction and frictional force i.e. tribological properties between two surfaces in contact. The Tribometer can apply normal load up to 200 N and vary speed in 200 RPM to 2000 RPM range. Experimentation test is conducted under dry condition.

Figure 4 MOUNTING OF SPECIMEN ON TRIBOMETER



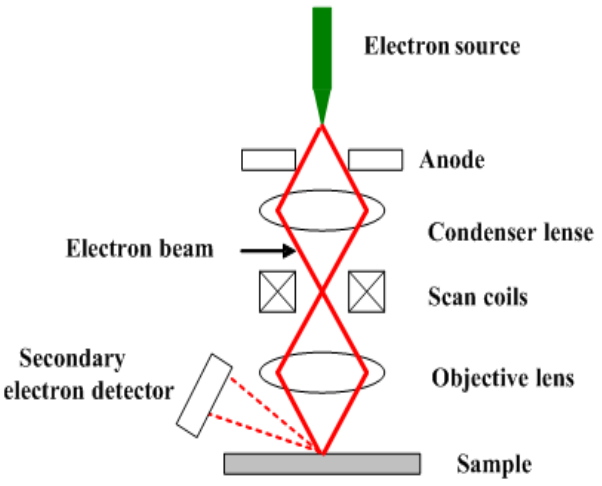
Normal load, Rotational speed and Track diameter parameter are chosen for testing purpose. In this we get wear and friction value directly on controller display and also display on computer screen. These data continuously monitor because of presence on electrical sensor. For wear and friction test disc of material MS manufactured as above pin is used. Pin size is 13 mm and 48 mm length.

2.4 FE-SEM Analysis

A Field Emission Scanning Electron Microscope (FE-SEM) is a type of electron microscope. In these electron is used instead of light. Field emission is source for electron generation. These electron scan surface in zig-zag pattern and produces image of sample. The interaction between atoms of material and electron of FE-SEM produces various signals. These various signal contains information of topography and composition of entire surface or fraction of surface. This technique used to observe very small surface or structure up to 1 nanometre, study the coating on microchips, polymers, DNA material of cells and organelles.

Electron are generated from field emission source and in high electron gradient field. Narrow beam of primary electron are produced within column of high vacuum deflected and focused by lenses. From surface of object, electrons are emitted called secondary electrons. Velocity and angle of these secondary electron are well connected to object surface structure. Detector produce electrical signal from secondary electron signal. This electrical signal amplified and modified on monitor by video scan image.

Figure 6 PRINCIPLE WORKING OF FE-SEM



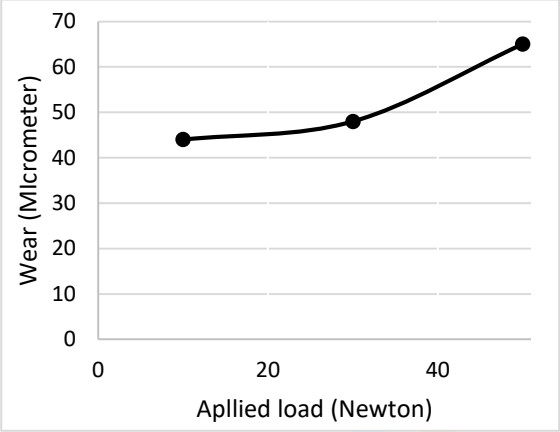
3. RESULT AND DISCUSSION

3.1 WEAR

Effect of Applied Load–

The effect of load applied on the tribological properties of 3 sample is studied. 10 N, 30 N and 50 N loads are used for application at 600 RPM rotational speed and 70 mm track diameter kept constant for study of effect of applied load.

Figure 7 VARIATION WEAR VS LOAD



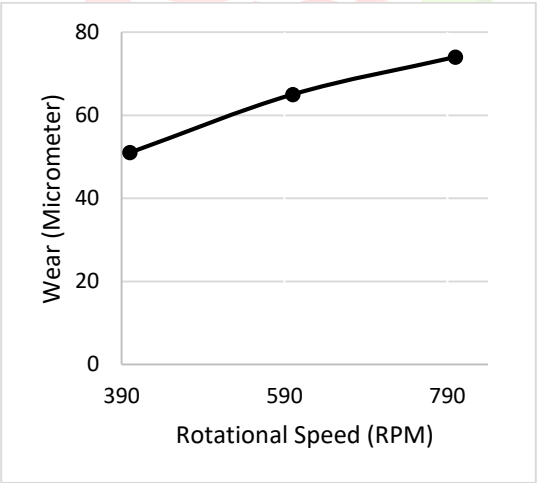
Above graph shows the variation of wear of sample against cast iron disc at applied load 10 N, 30 N and 50 N and 600 RPM rotational speed. It is observed that, initially wear is gradually increases up to 30 N load and beyond this wear increases suddenly and wear is maximum at 50 N applied load.

As load the increased, heat developed at frictional surface is more and strength at surface is decreased and these causes to more wear. Increase in wear causes increase in roughness.

Effect of rotational speed –

The effect of rotational speed on tribological properties of 3 sample was studied. 400 RPM, 600 RPM and 800 RPM rotational speed were used for application, at 50 N load and 70 mm track diameter kept constant for study of effect of rotational speed.

Figure 8 VARIATION WEAR VS SPEED

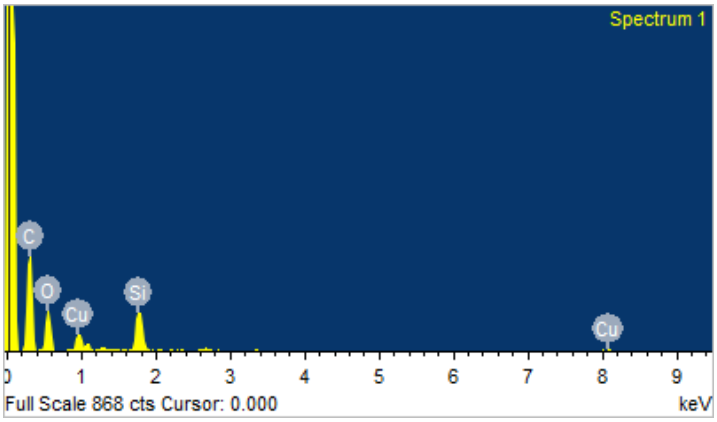


From above graph it is observed that wear is increasing as rotational speed increase. These is because of duration of rotational speed is same in all case but as speed increase rotation completion in circular path increases and this causes increase in length of friction.

3.2 FE-SEM ANALYSIS

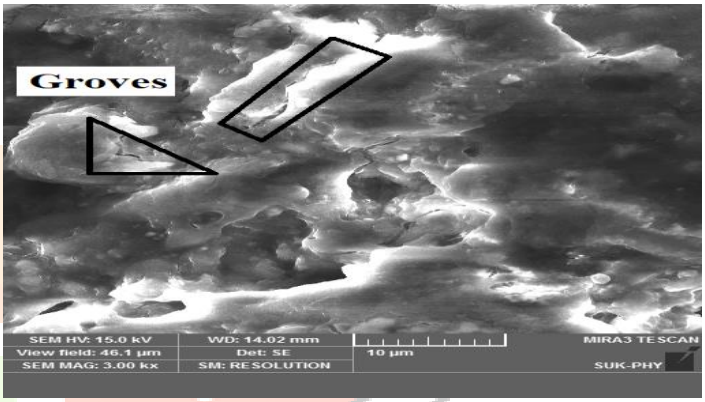
By using FE-SEM machine component present in sample material can be verified. Fig. 5.17 shows Edax pattern of sample containing 25% pistachio shell particle and 30% phenolic resin. The pattern obtained from test shows presence of copper, graphite and silica dioxide.

Figure 9EDAX PATTERN FROM FE-SEM MACHINE

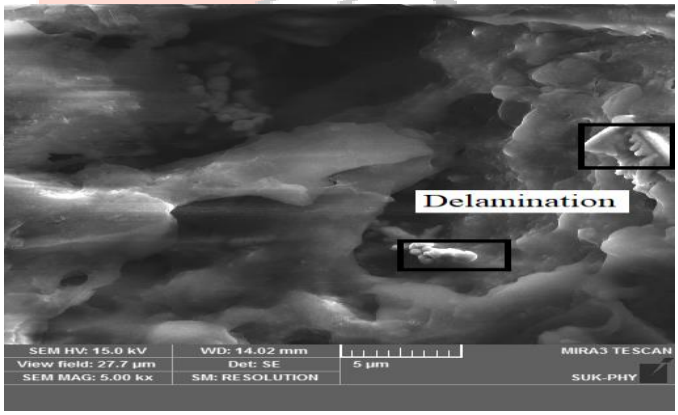


In above pattern we get directly presence of copper and silica dioxide is seen, but graphite is allotropic form of carbon shows carbon present in composition.

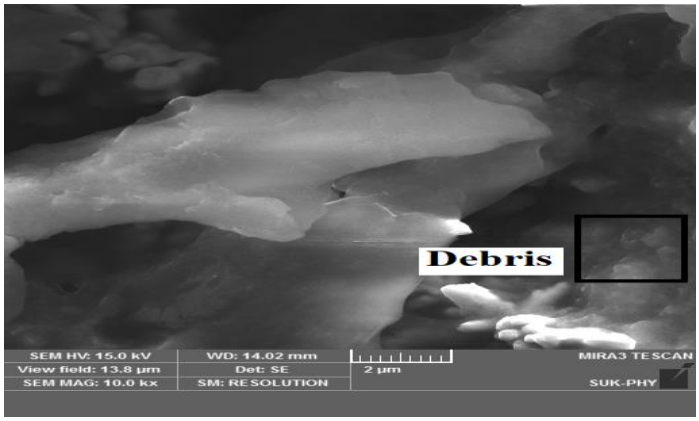
Figure 10 MICROSTRUCTURE OF SAMPLE USING FE-SEM
(a) GROVE (b) DELAMINATION (c) DEBRIS



(a)



(b)



(c)

Two material in relative motion in dry sliding condition that time wear induce transfer element of substance from one to another surface material. In POD test, dry sliding wear show transfer of element of substance between pin and disc from any of substance surface. FE-SEM analysis of wear surface is done for understand wear behaviour. In the above all microstructure figure dark black area is empty area where no material present.

From above Fig. 10 (a) shows that presence of swallow groves in substance which leads to abrasion. That is when one surface moving along with another surface. This swallow groves wear first. This removed material transfer on remaining part of material and attached to surface called delamination. Delamination occur after abrasion Fig. 10 (b). Delamination surface mostly contribute to form debris because after deposition of particle on surface after some collision this laminated material remove more material from surface easily due to heat generation and at both surface material they attached with high bonding. This is why more wear take place after increase in load by keeping rpm constant and after increase in RPM keeping load constant. After removal of material due to collision of material and delaminated surface we get debris at that point Fig.10 (c)

4. CONCLUSIONS

From all above discussion following conclusion are drawn.

- As load increase, wear of surface increases gradually and beyond 30N load, wear increase suddenly.
- As rotational speed increase at constant load, wear of surface increases gradually.
- Wear increases due to swallow groves and delamination of worn out surface..

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