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Development of Asbestos free Friction Material

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ABSTRACT

The use of asbestos fiber is avoided due to its carcinogenic nature that might cause health risks. Asbestos has been used for so long as automobile brake lining material because of its good physical and chemical properties. However, due to the health hazard associated with its handling, it has lost favor and several alternative materials are being increasingly used. Asbestos-free brake lining was developed in this work by using pistachio shell powder along with epoxy resin, graphite and copper. Samples of brake linings were produced using compressive molding in which the physical and mechanical properties of the samples were studied. The hardness, compressive strength, water and oil absorption, density of the brake linings were determined and compared with existing brake lining properties.

Keywords: *Asbestos free, asbestosis, friction material, pistachio shell*

1. INTRODUCTION

Usually the friction material of brake lining converts kinetic energy into heat, which, in turn, must be dissipated so that the friction device does not over heat. Friction materials are applicable for braking and transmission in various machines and equipment. Their composition keeps changing to keep pace with technological development and environmental/legal requirements.

In the past decade, friction materials were made from asbestos because of its heat absorbing properties and quiet operation. Asbestos is a mineral composed of a mixture of silicates, mainly magnesium and iron silicates. The property of asbestos that makes it attractive for use in friction material industry is its fibrous nature, which combines strength and flexibility with resistance to heat and chemical. However, friction materials composition changed dramatically when it’s main composition, asbestos, was found to be carcinogenic. Nowadays, the use of non-asbestos friction materials is increasing. Exposure to asbestos dust occurs particularly during dusty operations such as the opening of bags of asbestos, or where handling, cutting, grinding, and drilling are performed upon materials containing asbestos. The major diseases resulting in the long term from asbestos exposure are asbestosis, lung cancer and mesothelioma.

World Health Organization (WHO) estimates that 1, 07,000 global annual deaths are caused by mesothelioma, asbestos-related lung cancer and asbestosis.[4] In 2005, occupational exposure to asbestos was estimated to cause 43,000 mesothelioma deaths and 7000 deaths due to asbestosis worldwide. This led to the use and development of other materials which could take the place of asbestos in the manufacture of brake pads and clutches in automotive industry. These other materials which are currently in use include; metals, ceramics, carbon and organic materials. However these materials have different advantages and disadvantages when solely used to construct a brake pad. Hence more research is being carried on a combination of different materials so as to optimize the performance requirements. Development of innovative friction materials by adopting sustainable approaches via utilization of organic wastes products would be a solution not only to control the health hazards but also to reduce the extent of dependence on depleting resources and to save the environment from the end products.

Constituents of brake pad frictional lining

a) Frictional additives, which determine the frictional properties of the brake pads and comprise a mixture of abrasives and lubricants.
b) Fillers, which reduce the cost and improve the manufacturability of brake pads.
c) A binder, which holds components of a brake pad together.
d) Reinforcing fibers, which provide mechanical strength.

Vlastimil Matejka [3] studied the potential application of jute fibers in combination with powderised hazelnut shells as natural and biodegradable fillers in Non-Asbestos Organic (NAO) friction composites. They prepared two groups of the samples, based on a combination of jute fibers and graphite as a solid lubricant, and the jute containing samples where graphite is replaced with hazelnut shells. U.D. Idris [1] produced a new brake pad using banana peels waste to replaced asbestos and Phenolic resin (phenol formaldehyde), as a binder. F. N. Onyeneke [2] manufactured brake friction lining using palm kernel and coconut shell powder as base materials, araldite and epoxy resin as binder materials and carbon as fiber reinforcement. Aluminum, copper, zinc and cashew nut shell were used as abrasives and rubber dusts from shoe as filler.

2. MATERIALS USED IN THE FRICTIONAL LINING FORMULATION

2.1 Copper

It is a ductile metal with very high thermal and electrical conductivity. The morphology of copper nano-particles is round, and they appear as a brown to black powder. The porous copper powder proportionally responds to temperature and mechanical forces generated during a brake application by deforming and smearing to aid in the formation of a glaze between the engaging surfaces of the friction pads and rotor. This glaze prevents scoring of the rotor while at the same time maintaining a substantial stable coefficient of friction

2.2 Graphite

Graphite is one of the allotropes of carbon. It is commonly used as a lubricant especially for dry lubrication since it is able to form a lubricant layer on the opposing counter friction material rapidly. It is used for stabilizing friction coefficient. It was chosen because of its good lubrication properties and thermal conductivity. Graphite is best suited for lubrication in a regular atmosphere.

2.3 Silica

A mineral is highly resistant to heat, with a melting point of 1650 °C and has high hardness hence it is used in brakes as an abrasive.

2.4 Phenolic Resin

Phenolic resin has desirable characteristics, such as superior mechanical strength, heat resistance, and dimensional stability as well as high resistance to various solvents, acids, and water. Its ability to maintain good mechanical strength at high temperatures is its best characteristic.

2.5 Pistachio shell powder

The disposal of solid wastes such as biomass, industrial and municipal wastes is one of the main problems of the world and it is necessary to find out new ways to reuse this great potential as raw materials to produce advantageous products. Pyrolysis is one of the primary thermo-chemical conversion methods to convert biomass into valuable products, namely; solid char, liquid and gas product yields and compositions of which depend on Pyrolysis conditions. Natural materials have been applied to different industrial sectors because of their price-to-performance ratio, biodegradability, and lightness with advancements in automotive industries, natural materials have been remarkably. Natural resources have been used to produce fillers and fibers, including wood flour, groundnut, husk ash, rice straw, rice husk, cotton, jute, and cellulose. These materials help improve the mechanical properties of composites, entail low costs, increase impact strength, and enhance other mechanical properties, such as tensile strength, percentage elongation, tear strength, and hardness. They are also used as reinforcing agents in plastic materials and provide significant advantages over synthetic fibers and fillers. Composites can be prepared by including fillers into a matrix to obtain the desired properties with different applications. Coconut shell, wood fiber, groundnut husk, rice straw, and rice husk have been commonly used to fill and reinforce various composite matrices.

The pistachio nut is one of the popular tree nuts of the world and there has been a dramatic increase in production of pistachio in different regions of the world during the two last decades .Pistachio is mainly cultivated in some parts of the world such as Iran, Turkey, and USA. Based on FAO statistics (Food and Agriculture Organization, 2006), Iran produced about 190,000 Mt of pistachio nut in 2004, which is approximately 63.33% of the world's pistachio production.

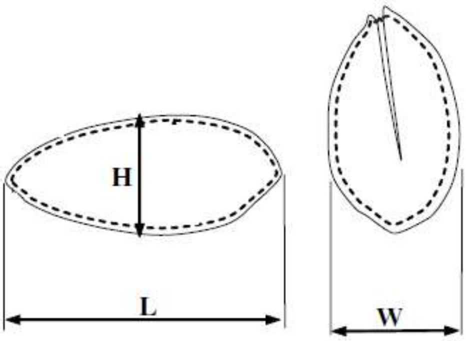

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Fig.2.1 Pistachio shell

Fig. 2.2Pistachio shell configuration

Average length (L) = 16.07 mm
Average width (W) = 12.41 mm
Average height (H) = 10.98 mm

3. PROCESSING TECHNIQUE

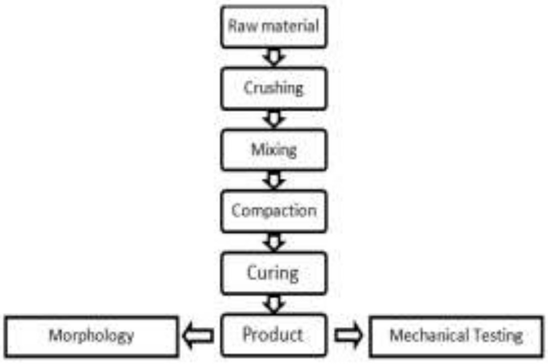
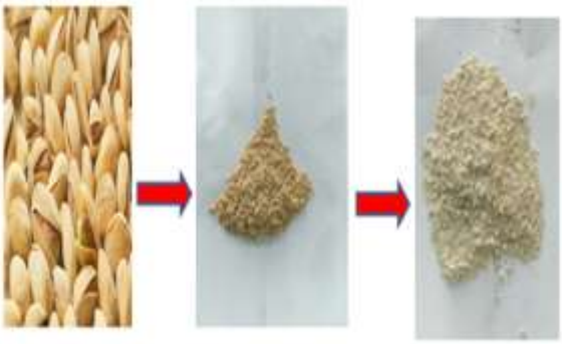


Fig. 3.1 Powder metallurgy processing

3.1 Crushing
Crushing of pistachio shell is carried in domestic mixer



(a) (b) (c)

Fig. 3.2 Crushing process (a) Pistachio Shell (b) Coarse powder (c) Fine powder.

3.2 Carbonization
For producing carbonized powder burning of pistachio shell is carried out in the electric furnace at a temperature of 370°C.

Fig. 3.3Carbonization process

Table 3.1 Content of pistachio shell

Content	Un-carbonized%	Carbonized%
Moisture	5.3	-
Carbon	45.5	68.74
Hydrogen	5.4	3.38
Ash element	1.2	0.608
Sulphur	0.1	0.07
GCV (MJ/Kg)	17.0	2.70

3.3 Sieve analysis

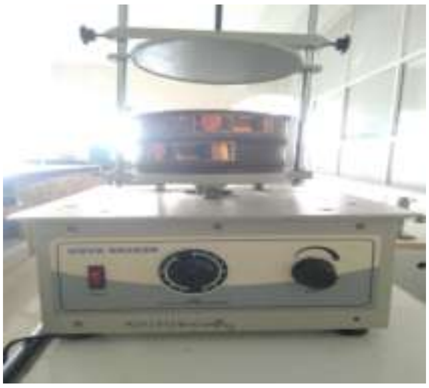


Fig. 3.4 Sieve Shaker

A sieve analysis (or gradation test) is done to assess the particle size distribution of a material. A typical sieve analysis involves a nested column of sieves with wire mesh cloth (screen). A representative weighed sample is poured into the top sieve which has the largest screen openings. Each lower sieve in the column has smaller openings than the one above. At the base is a round pan, called the receiver.

- Sieve used- 120microns, 60microns, 40microns
- Sieving time- 10 minutes

Table3.2 vol. (%) for three different composition

Material	Composition1	Composition2	Composition3
Phenolic resin	35	30	25
Copper	25	25	25
Graphite	5	5	5
SiO2	10	10	10
Pistachio shell Powder	25	30	35
Total	100	100	100

3.4 Mixing

A ball mill, a type of grinder, is a cylindrical device used in mixing

- RPM- 120
- Time- 4 hours
- No. of Balls- 6 stainless steel balls with 10mm diameter and 2 balls with 5mm diameter (Ni coated)

Fig. 3.5 Ball Mill setup

3.5 Compaction

The composite powder from ball mill is taken out after ensuring proper mixing. Powder is poured into die for manufacturing of pins. For compaction compression testing machine is used.

- Die and punch were lubricated with Hydraulic 68 anti-wear oil.
- The mixture was then poured into the die and quasi-statically compacted up to 350MPa at atmospheric pressure and temperature.
- Material was kept for 15 min under this pressure condition.

3.6 Sintering

The principal goal of sintering is the reduction of compact porosity. The temperature used for sintering is below the melting point of the major constituent of the Powder Metallurgy materials. After sintering, neighboring powder particles are held together by cold welds, which give the compact sufficient green strength

- Furnace used- electric furnace
- Temp.-150°C

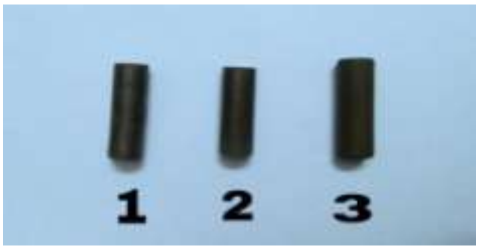


Fig. 3.6 Specimen of different compositions

4. CONCLUSION

Selection of material, particle size and composition plays vital role in imparting properties to the composite. Proper mixing of powders leads to uniform distribution of reinforcement particles and results in less anisotropy of material. When a mixture is compacted at suitable pressure, it makes structure less porous structure and helps to provide less reduces brittleness of composite.

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