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DEVLOPMENT OF ASBESTOS FREE BREAK PAD USING NYLON MATERIALS

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ABSTRACT

Asbestos, A naturally occurring fibrous mineral used for fireproofing, electrical insulation, building materials, brake linings, and chemical filters. When inhaled the asbestos fibres this can cause cancer. In this experiment engineering plastics Nylon 6-30% glass filled (Nylon 6 -30%GF), Nylon 66-30%GF and also Nylon 66-50%GF are processed. And Injection moulding machine are used to make test specimens. The specimens are tested as per the ASTM standard. The results are compared with the Asbestos brake pad properties. From that it is concluded that the Nylon 66-30%GF is more suitable for processing also having improved properties than the asbestos material. The material is analyzed using Ansys12.0 under brake pad condition.

I. INTRODUCTION

Principal of break pad system

To convert speed we must convert stored kinetic energy to heat, over a desired time frame. The performance of the grip defined by measuring the Mu, a function of the material coefficient of friction over temperature. Pads are said to have rising, linear or digressive rates, based on the Mu. A digressive rate pad means we have to push harder to maintain the friction of the brake pad on the rotor. A rising rate means we have to push less as the braking effect increases. A linear rate means we maintain the same pressure. The friction increases with temperature in a rising rate pad. Linear Mu means the friction value is maintained as the temperature increases. Many performance pads show rising friction values as the temperature goes up, then drop off as the temperature reaches a point where the pad out gasses, and powders, reducing the friction with the breakdown film.

Asbestos brake pad

Many substances burn when they are heated. Others melt or evaporate. Some substances, such as asbestos, do not change when they are heated. This property can be very useful. For centuries, people have known that this fibrous mineral has many useful properties. It is fire resistant.

It does not melt or react with air, at least not until it gets very hot. One form of the mineral withstands temperatures up to 2750 °C. It is a very good insulator. It is strong. It resists acid. It is chemically inactive. It can be woven into cloth. Asbestos has some very useful properties, and it is readily available at a low cost.

But It causes delicate lung tissue to stiffen. A lung disease, called asbestosis and a type of cancer may occur years after the original exposure. There are many types of asbestos among all Crysotile is most commonly used in many applications.Chrysotile appears under the microscope as a white fiber. Its idealized chemical formula is $Mg_3(Si_2O_5)(OH)_4$. The crysotile was used in Industrial and marine gaskets, Brake pads and shoes, Stage curtains, Fire blankets, Interior fire doors, Fireproof clothing for firefighters, Thermal pipe insulation, etc

Problems in asbestos brake pad

When asbestos-containing materials are disturbed or damaged, they release a dust filled with microscopic asbestos fibers into the air. As a result, the very nature of brake and clutch functions causes continual abrasion, and this releases the imbedded asbestos fibers. A large portion of the toxic material is trapped inside the brake housing or clutch space, and is then released when replacement or repair work is performed.

Asbestos fibers can be further spread into the surrounding air by the vacuums used to clean the work area during and after the job. The fibers tend to linger in the air long after a job is done and can spread 75 feet from the work area,

potentially exposing other mechanics and customers who enter the shop. Airborne asbestos fibers are easily inhaled and can be ingested if fibers get on hands and clothes. This is a particularly difficult problem for mechanics, since they often get grease on their hands and asbestos fibers can stick to the grease. Tragically, asbestos can even be carried home on workers' clothing, exposing their families to the hazardous material.

Objectives:-

The objective of our paper is as follows:-

- To replace the asbestos material
- To improve the properties of brake pad
- Also with simple processing, reducing cost.
- To avoid the hazards of asbestos

II. LITERATURE REVIEW

Development of Asbestos Free Brake Pad

Brake pads are important parts of braking system for all types of vehicles that are equipped with disc brake. Brake pads are steel backing plates with friction material bound to the surface facing the brake disc. Different types of brake materials are used in different machines.

The brake pads generally consist of asbestos fibers embedded in polymeric matrix along with several other ingredients. The use of asbestos fiber is been avoided due to its carcinogenic nature. Therefore a new asbestos free friction material and brake pads has been developed.

It is envisioned that future developments in the field of brake friction materials will closely mimic the current trends of the automotive industry. The shift towards environmentally friendly cars has already seen the release of hybrid cars such as Toyota Prius and Honda Insight.

Material:-

Nylon 6 (Virgin)

Properties

The properties of Nylon 6 are listed below:

- Nylon 6 fibres are tough
- Possessing high tensile strength, as well as elasticity and lustre.
- They are wrinkle-proof
- Highly resistant to abrasion and chemicals such as acids and alkalis.

III. EXPERIMENTAL WORK

Three important materials are taken into consideration from the polyamide group because the materials are most widely used in engineering applications like gears, links, shafts etc., The materials are

Nylon 6 – 30% Glass Filled
Nylon 66 – 30% Glass Filled
Nylon 66 – 50% Glass Filled

Characteristics of Nylon 6 – 30% GF

Physical Properties	Metric
Density	1.17 - 1.62 g/cc
Water Absorption	0 - 7.5 %
Moisture Absorption at Equilibrium	0.9 - 2.5 %
Water Absorption at Saturation	1.8 - 8.2 %
Linear Mold Shrinkage	0.0015 - 0.007 cm/cm
Linear Mold Shrinkage, Transverse	0.007 - 0.017 cm/cm

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Characteristics of Nylon 66-30% GF

Density	1.11 – 1.68%
Filler Content	25.0 – 35.0%
Water Absorption	0.200 – 7.0%
Moisture Absorption at Equilibrium	0.170 – 5.70%
Viscosity	20.0 - 774772 cP @Temperature 260 - 315 °C
Melt Flow	1.00 - 198 g/10 min
Processing Temperature	70.0 - 310 °C
Nozzle Temperature	250 - 340 °C
Melt Temperature	230 - 340 °C
Mold Temperature	20.0 - 140 °C
Drying Temperature	65.6 - 130 °C
Moisture Content	0.0300 - 2.00 %
Dew Point	-30.0 - -17.8 °C

properties of nylon 66-30%GF

Characteristics of Nylon 66 – 50% Glass Filled

Processing Temperature	70.0 - 310 °C
Nozzle Temperature	270 - 310 °C
Melt Temperature	143 - 325°C
Mold Temperature	50.0 - 124 °C
Drying Temperature	70 - 121 °C
Moisture Content	0.0300 –0.2 %
Dew Point	-30.0 - -17.8 °C
Injection Pressure	4.96 - 150 MPa
Hot working temperature	300 -315 °C

properties of nylon 66-50% GF

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Density	1.11 – 1.68%
Filler Content	25.0 – 35.0%
Water Absorption	0.200 – 7.0%
Moisture Absorption at Equilibrium	0.170 – 5.70% 0.170 - 5.70 %

properties of nylon 66-50% GF

Processing:-

Materials USED:-

Commercially available injection moulding grade Nylon 6 – 30% GF, Nylon 66- 30% GF and Nylon 66 – 50% GF has been procured from Formulated Polymers Private Limited. And the properties are given in the table

Injection moulding

The ASTM standard test specimens are prepared by Injection moulding using the three materials such as Nylon 6-30% GF, Nylon 66-30% GF and Nylon 66-50% GF. The specimens are tested in CIPET and results are obtained as per the ASTM standard.

Processing Parameters of materials

Nylon 6-30% GF

Pressure 500 Kg/cm²
Speed 45 rpm
Temperature (°C)

	50	**220**	**230**	**242**	**250**

Nylon 66-30% GF

Pressure 500 Kg/cm²
Speed 45 rpm
Temperature (°C)

	50	**220**	**233**	**249**	**258**

Nylon 66-50% GF

Pressure 500 Kg/cm²
Speed 45 rpm
Temperature (°C)

	62	**276**	**290**	**300**	**320**

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Testing analysis

Tensile Strength

The ability of the materials to resist breaking under tensile. The force per unit area (MPa or Psi) required to break a material in such a manner is the tensile strength at break. The rate at which a sample is pulled apart in the test can range from 0.2 to 20 inches per minute and will influence the results.

ASTM D638 is one of the most common plastic strength specifications and covers the tensile properties of unreinforced and reinforced plastics. This test method uses standard "dumbell" shaped specimens under 14 mm of thickness. A universal testing machine (tensile) testing machine is needed to perform this test.

Impact strength (Izod test).

The test specimens can be prepared either by moulding or cutting them from a sheet. Izod test specimens are 2½ × ½ × 1/8 in. the most common specimen thickness is 1/8 in. but ¼ in. is preferred since they are less susceptible to blending and crushing. A notch is cut into a specimen very carefully by a milling machine or a lathe. The recommended notch depth is 0.100 in.

Hardness

The hardness numbers derived are just numbers without units. Rockwell Hardness numbers are always quoted with a scale symbol representing the indenter size, load, and dial scale used. The hardness scales in order of increasing the hardness are R, L, M, E, and K scales. The higher the number in each scale, the harder the material. The standard specimen of ¼ in. minimum thickness is used. The specimen can either be molded or cut from a sheet.

Asbestos Brake pad properties

Properties	Optimum Formulation Laboratory brake pad (PKS based)	**Commercial brake pad (asbestos based)**	New Formulation Laboratory brake-pad (bagasse based) Recommended
Specific gravity	1.65	**1.89**	1.43
Average wear (mg/m)	4.40	**3.80**	4.20
Thickness swell in water after 24 hrs (%)	5.03	**0.90**	3.48
Compressive strength (MPa)	103.50	**110**	105.60
Hardness, Brinell (at 3000 kgf)	92	**101**	100.5
Flame resistance test after 10 Minutes	Charred with 46% ash	**Charred with 9% Ash**	Charred with 34% ash
Thickness swell in oil (SEA 40) after 24 hrs (%)	0.44	**0.30**	1.11

Comparison of polyamide properties with Asbestos properties

Properties	**Asbestos brake pad**	**Nylon 6-30% GF**	**Nylon 66-30% GF**	**Nylon 66-50% GF**
Specific gravity	1.89	1.14 – 1.67	1.1-1.68	1.40-1.78
Water absorption after 24 hours (%)	0.90 (swell in water)	3.22	0.200-7.00	0.300-4.50
Compressive	110	140-222	28-241	

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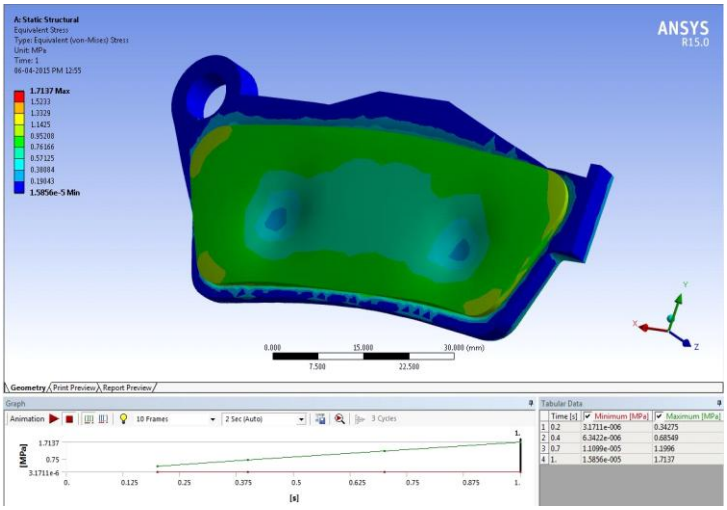
strength (MPa)				
Hardness, Rockwell (MPa)	101	70 – 230	125-280	131-340

Comparison of Nylon properties with Asbestos

IV. RESULT AND DISCUSSION

Structural Analysis of brake pad using nylon 6-30 GF
(Stress formation in Nylon 6-30% GF)



Stress formation in Nylon 6-30% GF

Details of "Part 1"	
Definition	
Material	
Assignment	NYLON
Nonlinear Effects	Yes
Thermal Strain Effects	Yes
Bounding Box	
Length X	92.856 mm
Length Y	39.146 mm
Length Z	9. mm
Properties	
Volume	18910 mm³
Mass	2.1557e-002 kg
Centroid X	-43.996 mm
Centroid Y	-10.665 mm
Centroid Z	0.89187 mm
Moment of Inertia Ip1	1.7216 kg·mm²
Moment of Inertia Ip2	10.915 kg·mm²
Moment of Inertia Ip3	12.367 kg·mm²

Material data of Nylon 6-30

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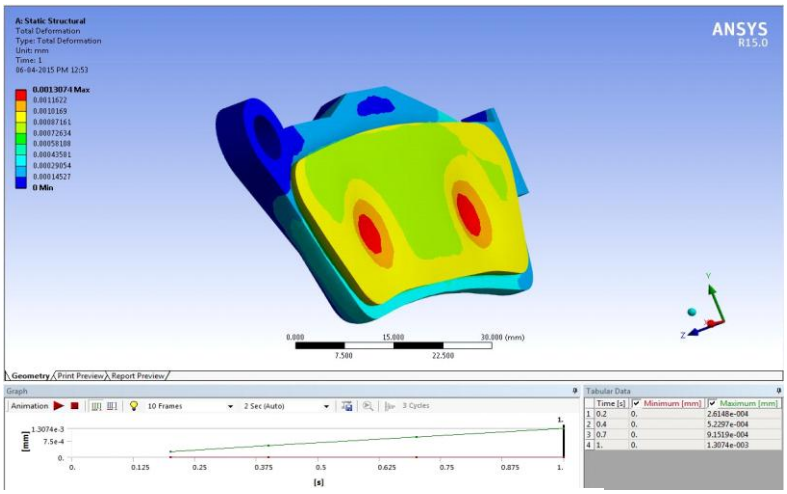
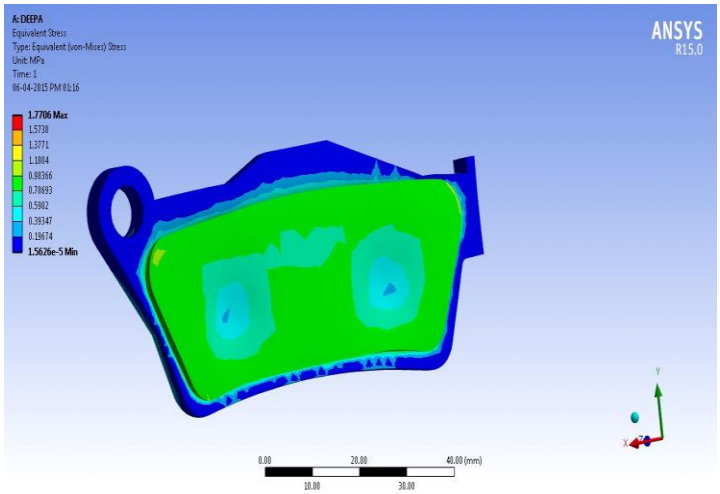
Total deformation in nylon 6-30% GF



Total deformation in Nylon 6-30% Gf

Structural analysis of nylon 66-30% GF

Stress formation in Nylon 66-30% GF



Stress formation in Nylon 66-30% GF

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Details of "Part 1"	
Stiffness Behavior	Flexible
Coordinate System	Default Coordinate System
Reference Temperature	By Environment
Material	
Assignment	Epoxy_EGlass_UD
Nonlinear Effects	Yes
Thermal Strain Effects	Yes
Bounding Box	
Length X	92.856 mm
Length Y	39.146 mm
Length Z	9. mm
Properties	
Volume	18910 mm^3
Mass	3.7819e-002 kg
Centroid X	-43.996 mm
Centroid Y	-10.665 mm
Centroid Z	0.89187 mm
Moment of Inertia Ip1	3.0204 $kg \cdot mm^2$
Moment of Inertia Ip2	19.149 $kg \cdot mm^2$
Moment of Inertia Ip3	21.696 $kg \cdot mm^2$

Material data of Nylon 66-30% GF

Comparison of analysis results

Properties	Limit	Nylon 66-30% GF	Nylon 6-30% GF
Equivalent stress (MPa)	Max	1.770	1.713
	Min	1.56e-5	1.585
Equivalent elastic strain	Max	2.08e-4	0.218e-3
	Min	3.406e-9	6.58e-9
Total deformation	Max	0.0011	0.0013
	Min	0	0
Directional deformation	Max	1.0e-4	4.86e-4
	Min	-9.02e-5	4.44e-4

V. CONCLUSION

From the results of mechanical test as per the ASTM Standard and the structural and thermal analysis using Ansys 12.0, it is concluded that the Nylon 6-30% GF material is suitable for processing brake pad at low temperature. But the wear resistance of that material is considerably low when it is compared with Nylon 66 materials also concluded that the Nylon 6-30% GF produces high heat during friction i.e. when braking because it s not a self lubricant material. Next the Nylon 66-50% GF material as per the Ansys results is has proved that it has low Von- Mises stress, Elastic strain, total deformation and directional deformation. it has improved property than the other material but it has high glass fibre content so that the glass fibre is significantly exhibit glass fibre during braking it causes problems to the users. And also it has very high melting point so it is very difficult to process. Finally the Nylon 66-30% GF, as per the Ansys results is has proved that it has low Von- Mises stress, Elastic strain, total deformation and directional deformation. It has improved properties than the asbestos fibre like water absorption, Impact Strength, Hardness and Compressive strength so it is concluded that the Nylon 66-30% GF material would be the better replacement for the Asbestos Brake pad in future.

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