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Experimental Investigation and Analysis on Composite Brake Lining for Heavy Loading Crane

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Abstract
An ideal brake lining, which provides uniform and stable friction under all the operating conditions without any fade. The significance of friction material in material handling and earth moving machinery, commonly used friction material earlier contained asbestos as the base material mainly because of its property to resist deformation under action of heat generated due to friction. This review focuses on analysis of the brake friction lining material and other materials for band brake application. The measurement of friction force and the calculation of the coefficient of friction, coefficient of friction COF are critical for many industrial applications, e.g. Brakes, valves, clutches, similarly power and motion control mechanisms. High friction during machine operation not only generates heating that might cause failure of a machine part, but also consume a large amount of energy. It is estimated that one-third to one-half of the world's energy production is wasted through friction.

Keywords: Brake Liner, Composite Material, Compression test

1. INTRODUCTION

A variety of techniques have been employed to investigate the development of ingredients for friction materials in order to provide stable friction, durability, adequate wear resistance, thermal conductivity and vibration for all braking, and acceptable environmental conditions. Limited reports are available in the literature on the investigation of the manufacturing processes of brake friction materials, even though they are critical for the tribological as well as the physical properties of the brake friction materials. In the automotive brake friction industry, friction material is manufactured using powder metallurgy techniques according to two crucial methods; hot molding of a mixture under high pressure and heat treatment. Brake friction material is a heterogeneous material that is diverse in the physical, mechanical and chemical properties of the developed formulation. Such materials are classified as binders, reinforcements, fillers, friction modifiers. Friction and wear characteristics of the developed formulation cannot be predicted based on physical and mechanical properties. Selection of ingredient materials is the difficult task as it requires a great number of experiments to obtain reliable brake performance. A variety of techniques have been employed to investigate the development of ingredients for friction materials in order to provide stable friction, durability, adequate wear resistance, thermal conductivity and vibration for all braking, and acceptable environmental conditions. In the automotive brake friction industry, friction material is manufactured using powder metallurgy techniques according to two crucial methods; hot molding of a mixture under high pressure and heat treatment. The molding processes involves rearrangement of powder particles, the elastic deformation of the particles and finally, plastic deformation accompanied by reduction in porosity. Heat treatment is performed to enhance curing uniformity and to relieve the residual stresses in the brake friction materials. Phenolic resin used as a binder in brake friction materials plays a crucial role in finding the tribological properties since the

manufacturing conditions are affected by the thermal properties of the binder. Hence, according to studies in this work, the economical and viable experimental strategy based on Taguchi's parameter design has been used to analyze the effect of various manufacturing parameters in the molding process of friction materials in order to improve tribological properties.

1.1 Objective: The braking system under study is used in industrial crane application. The brake liners are consumable items in the system. The selection of study depends upon two basic reasons .

a. Cost effectiveness

b. Safety

Cost effectiveness:

1.As the liners are consumables, they have to change periodically. Its material cost has to be abridged.

2. If liners are used in worn out condition, the brake drum may be affected and worn out. So maintenance cot increase.

3. As liners have to change. It is not possible to change them in running condition. It means that the shut down time of crane get increased and ultimately it expenses more.

4. The different issue is that, if particular industry is using expensive liner more than their application, they may be suggested with different option with lower cost, through this project work.

3. MATERIALS AND METHODS

3.1.Selection Criteria for ideal material :

Ideal Brake liner should have following properties The material used for the brake lining should have the following characteristics :

1.It should have high coefficient of friction with minimum fading. In other words, the coefficient of friction should remain constant over the entire surface with change in temperature.

2. Wear rate should be low.

3. Heat resistance should be high.

4. Heat dissipation capacity should be high.

5.It should have low coefficient of thermal expansion.

6.It should have adequate mechanical strength.

7.It should not be affected by moisture and oil

Currently moulded material is used in heavy duty application thus to find another better alternative material to increase the efficiency of braking system study has been done. From above mostly moulded and woven brake liner properties seems similar and better hence these two material have compared for performance. ϖ In lifting machine following brake liners are used :

3.1.1 Moulded asbestos based brake liner (FTL097) is a rigid moulded friction material having a non-asbestos base. It is grey in colour and incorporates a blend of selected friction modifying agents. This complex matrix of ingredients is consolidated with a specially developed binder system. FTL097 has a high friction coefficient, which is combined with an excellent resistance to fade and wear. Its high performance characteristics are particularly suited to severe duty

applications. This material although not intended to operate in oil is not physically damaged by moderate oil contamination.

3.1.2 CHARACTERISTICS : Extremely low noise operation Excellent fade & recovery Excellent wear rate. High tensile strength

3.1.3MECHANICAL PROPERTIES Specific Gravity (SAE J380) : 1.87 Gogan Hardness (SAE J379A) : 18 Tensile Strength, PSI (ASTM D638) : 3300min Impact Resistance (ft-lb/inch2) : 2.3 FRICTIONAL PROPERTIES Coefficient of Friction (SAE J661): Normal : 0.15 Hot : 0.15 Wear Rate (SAE J661) (inch3/hp-hr): 0.002max Maximum Operating Limits

Fig 1:Moulded Brake Liner

3.2.1 Woven asbestos based brake liner (**WA8):** It is a flexible, solid woven, asbestos based friction material made from asbestos yarn, spun around brass wire, which contributes considerably to its strength.WA-8 has a medium/high co-efficient of friction combined with moderate temperature and wear resistance. WA-8 is available in roll form. Segments, Cones and special shapes can easily be cut from it. Being a flexible material, it is possible to form it to radius when fitting it. Forming can be made easier by placing the material in an oven at a temperature of not more than100°C (212°F) until it has heated throughout to soften the impregnant.WA-8 is designed solely for use under dry conditions (i.e. it is not suitable for use in oil).WA-8 can also be supplied with both surfaces ground.Nonasbestos woven brake lining made of glass fiber yarn and fine brass wire, impregnated with special resin binder. Colour is yellowish. Density : 1,200 kgs/m3 approx.

3.2.2 CHARACTERISTICS: Uniform friction Non-abrasive Premium life characteristics High tensile strength.

Fig:2 Woven brake Liner

3.2.3 MECHANICAL PROPERTIES :

Specific Gravity (SAE J380) : 1.23
Tensile Strength, PSI (ASTM D638) : 1500 min

4 .Compression Test

Compressive strength is a capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, in which elongation is tendancy. Compressive strength resists compression (being pushed together), whereas tensile strength resists tension (being pulled apart). According to observation strength of materials, tensile strength, compressive strength, and shear strength can be analyzed independently. It can be measured by plotting applied force against deformation in a testing machine, such as a universal testing machine. Compressive strength is a key value for design of structures.

When a specimen of material is loaded in such a way that it extends it is said to be in tension. On the another side, if the material compresses and shortens it is said to be in compression. On an atomic level, the molecules and atoms are loaded apart when in tension whereas in compression they are forced together. As Atoms in solids always try to obtain an equilibrium position, and distance between other atoms, forces arise throughout the entire material which oppose both tension as well as compression compression.

4.1 Purpose of the test:

When the brakes are applied continuously, the liners are get compressed. As they get compressed, the density of their material increases. Increased density causes in improved hardness. Improved hardness causes in poor softness. Lesser the softness means poor braking properties we will get. In short, lower compressibility gives better results.

Hence, we are going to check the change in thickness for different liner materials with same loads.

Description of setup:

1. The compression test can be carried out on any hydraulic press. The easily available press for us is universal testing machine. 2. The initial thickness of liner is measured. 3. The specimen is kept on machine table. 4. The steel round is placed on material. 5. The ram is lowered with the help of lead screw motion. 6. Hydraulic power pack is turned on. 7. The force applied on the liner is kept constant for 3 hours. 8. After 3 hours, the thickness of liner is measured.

Fig.No.3:Front view of UTM Equipment for compression test Moulded brake liner

Fig No 4: Front view of UTM Equipment for compression test Woven brake liner

4.2 OBSERVATION TABLE:

For material 1 :Moulded brake liner

Specimen No	Force A[ppliied (N)	Time(Hrs)	Initial Thickness (mm)	Final Thickness (mm)
1	1000	3	6	5.32
2	1000	3	6	5.35
3	1000	3	6	5.38
4	1000	3	6	5.36
Average	1000	3	6	5.352

Table 1 :Result obtained for compression test for Moulded brake liner

For material 2 :Moulded brake liner

Specimen No	Force A[ppliied (N)	Time(Hrs)	Initial Thickness(mm)	Final Thickness (mm)
1	1000	3	6	5.48
2	1000	3	6	5.52
3	1000	3	6	5.55
4	1000	3	6	5.56
Average	1000	3	6	5.527

Table 2 : Result obtained for compression test for Woven brake liner

4.3:Comparative Analysis

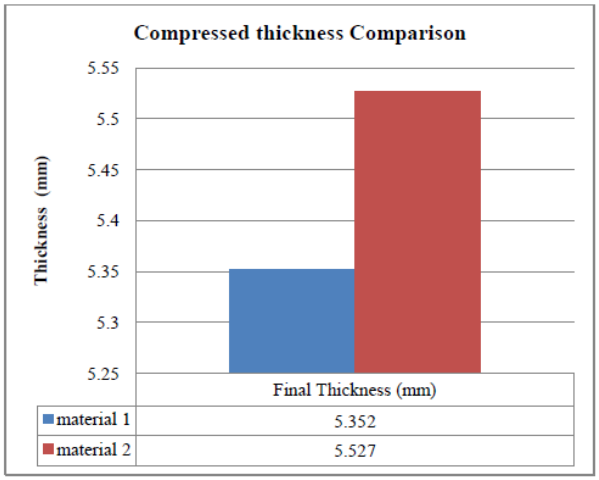

Fig No 5: Comparison of thickness between both Material

4.3.1 Comparative analysis:

Moulded Material get more compressible with same load as compare to woven material . Woven Material will be more reliable through load point of view.
Initial hardness of Moulded material is better than that of Woven material
Final hardness definitely increases in both materials.
Percentage increase in hardness is lower in Woven material .
In this test, Woven material shows better reliability as its softness and hence braking properties remain for more duty time.

5 :CONCLUSION

1. Moulded material is better where lower braking pressure is possible while Woven material is applicable foe heavy forces.

2. Maintenance cost and shut down time is more in case of Moulded material on the other hand, frequency of change of liners will be lesser in case of Woven material.

3. As there is necessity of heavy force to apply torque, in case of Woven material, it will take more time to get compressed and will be better for heavy applications i.e. cranes.

4. Moulded Material loses its softness with respect to time and hence Woven material will be better for life
of brake drum as it will be designed as per its initial hardness.

5. For large and heavy duty cranes, it is difficult and expensive to change liners and hence, Woven material will be preferable as per cost effectiveness.

6. Manufacturing cost of Moulded material is less. It is preferable when poor quality of lifting crane is acceptable.

7. Moulded Material absorbs more water than Woven liner. Hence for open cranes, Woven material should be used (preferably in rainy season).

8. Moulded material absorbs oil more than Woven material. The cranes which are used to convey greasy materials or used in same environment, the Woven material is preferable.

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