Proceedings of Malaysian International Tribology Conference 2015, pp. 165-166, November 2015

Effect of lubricant and thermal resistance filler on the pressure and speed sensitivity characteristics of non-asbestos low metallic disc brake pad formulation

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Keywords: Fade & recovery; non asbestos low metallic disc brake pad; inertia brake dynamometer

ABSTRACT – In this work Non Asbestos Low Metallic Disc Brake pads are developed by varying the lubricant namely artificial graphite, thermal resistance filler Mica flakes and designated as LM01, LM02, and LM03. The various characterizations of the developed pads are done based on IS2742 and ISO6312 standards. The thermal stability is found using TGA. The fade and recovery characterizations are done based on JASO-C-406 standards in inertia brake dynamometer. It was observed that LM02 proved to be best with good thermal stability leading to low fade and high recovery characteristics. SEM studies helped to study the surface wear morphology.

1. INTRODUCTION

The Brake system is used to slow down and stop the vehicle in motion. In the braking process the kinetic energy of the moving vehicle is converted in to thermal energy [1]. Brake friction materials mostly contain compositions of different raw materials which mostly include fibers, fillers, binders, lubricants, abrasives and friction modifiers [2]. Fibers are mostly used for structural reinforcement. Fillers are mostly of two types, functional filler and space filler, function filler are used for specific function namely mica for increasing the thermal resistance and space filler used to fill up the space , primarily to reduce the cost and improve manufacturability. The resin acts as a binder and holds the composition together [3]. Solid lubricants such as graphite are used to stabilize the coefficient of friction. The friction modifiers are added to ensure the stable mechanical and frictional properties as well as to control the wear rate of both the pad and disc.

2. MATERIALS AND METHODOLOGY

2.1 Formulation of the Composites

The non-asbestos low metallic disc brake pad consists of more than 15 elements were the lubricant artificial graphite coarse powder, the mica flakes as fillers are all varied by weight % in a complementary manner which results in three low metallic disc brake pad formulations LM01, LM02, LM03 as shown in Table 1.

2.2 Fabrication of the Composites

Fabrication of the full low metallic disc brake pad was carried out in four steps; (i) mixing of raw materials (ii) hot compression moulding, (iii) post curing of composites and (iv) centre cut and grinding [4]. The details are given in Table 2.

Table 1 Varying Ingredients in the brake pad formulation.

Si. No	Raw Material	LM01 by wt%	LM02 by wt%	LM03 by wt%
1	Artificial graphite	16	12	10
2	Mica Flakes	5	9	11

Table 2 Fabrication methodology.

Si.No	Procedure	Conditions
1	Sequential mixing in Plough Shear Machine	Total duration 20 minutes shovel 140 RPM Cutter Speed 3000 RPM and 25 Kg mix is prepared Sequence (a) Fibres (b) Powdery Ingredients (c) Binders
2	Curing	Compression Moulding machine with 8 cavities, Temp. 140°C; Compression Pressure 17 MPa; Each cavity is filled with 110gms of the mixture Curing time : 7minutes (Curing Time: Thickness of pad/ 2)
3	Post- curing	120°C, 5.5 hours.
4	Finishing	Grinding and centre cut on finished pad

2.3 Characterization of the Composites

The composites were characterized for physical properties like specific gravity, porosity, chemical properties like acetone extraction, and mechanical properties like hardness, hot shear strength, cold shear strength, thickness loss and thermal properties like loss of ignition as per IS2742 Part3 and ISO 6312 standard practice [4]. Table 3 shows the various characterizations of composites, in which LM02 was superior compared to other LM01 and LM03 due to the optimal percentage of graphite, MoS_2 and Mica flakes.

Table 3 Various characterizations for the developed composites.

Si. No	Properties	Unit	LM01	LM02	LM03
1	Specific gravity	g/cc	2.2	2.25	2.3
2	Hardness	HRS	96	100	90
3	Acetone Extraction	%	1.96	1.45	2
4	Loss of Ignition	%	24	23	25
5	Cold Shear	Kg/cm^2	44	46	42
6	Hot Shear /200ºC/ 30Min	Kg/cm^2	26,27	30,31	27,28
7	Normal µ	Mue	0.43	0.45	0.4
8	Hot Friction	Mue	0.36	0.4	0.38
9	Weight Loss	%	4.6	3.6	4.4
10	Thickness loss	%	3.4	3.4	3.8

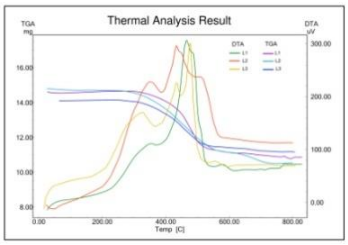

Figure 1 TGA for developed samples.

The TGA gives the weight loss for the samples by which lesser the weight loss higher stable the sample, which was proved by LM02, which has the 23.152% followed by LM01 (24.969%)and LM03(26.973%).

2.4 Fade and Recovery Characteristics using Dynamometer

The Full scale brake inertia dynamometer is used to evaluate the developed brake pads for its tribological performances [5] following JASO C 406 standards The results of the dynamometer tests are shown in figure in which the LM02 has low fade, high recovery and less wear when compared to other two composites and also has optimal friction characteristics throughout without much fluctuations in the friction graph as shown in figure 2. Even in pressure and speed fade characteristics the LM02 found to be producing lesser pressure and fade characteristics as shown in table 4 based on the equation 1.

$$\text{Pressure/ Speed Fade} = \frac{\mu \max - \mu min}{\mu max} \times 100 \qquad (1)$$

3. CONCLUSIONS

Based on the experimental characterizations following conclusions were arrived.

1) The hardness, cold shear, hot shear increased while the acetone extraction and loss of ignition decreased.
2) TGA revealed that LM02 proved with less weight loss at 800ºC which shows it better thermal stability.
3) The Coefficient of friction was not fluctuating and the higher pressure and speed attributed to the increase in friction.
4) The pressure and speed fade characteristics of LM02 was less compared to other two composites.

Thus LM02 proved to be best performer due to the thermal stability of mica, graphite which we are in optimized percentage and by literature if there is increase in lubricants there exist a drop in friction, which was proved by this way.

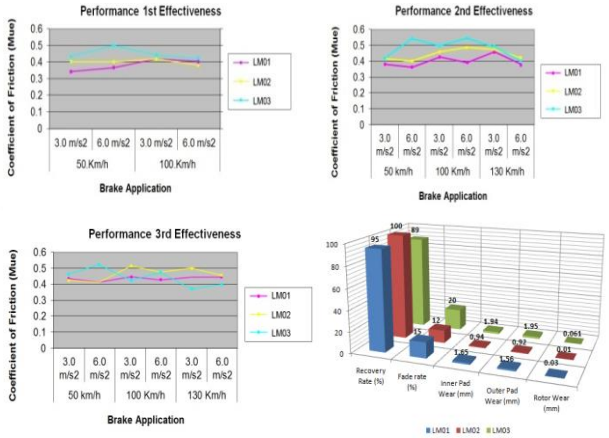

Figure 2 Performance, fade and recovery characteristics.

Table 4 Pressure and speed characteristics.

Pressure	3 Bar			6 Bar		
speed	LM02	LM01	LM03	LM02	LM01	LM03
50	20.93	4.762	8.6956	12.195	2.439	16
100	6.818	19.6	16	6.976	20.41	25.46
130	4.347	6.12	24.489	4.545	6.25	9.09

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