Thermal And Tribological Behaviour Of Non-Asbestos Brake Pads Of Passenger Cars

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Abstract-Effect of using the asbestos brake pads on environment and human health became dangerous and these are phased out. Asbestos brake pads cause carcinogenic effects on human health. This leads to the studying about alternate materials like agricultural wastes and other fibers along with other frictional compositions. The brake pad composite consists of filler, binder, fiber and other frictional additives. Studying about thermal and tribological behavior of non-asbestos brake pads is got importance for testing the performance and other parameters. In this present paper three different samples of non-asbestos brake pads are tested for their friction, wear rate and thermal stability at different temperatures. Thermal conductivity and its effect on wear rate are also studied.
Keywords – Asbestos, fiber, filler, binder, friction additives etc

I. INTRODUCTION

Brakes plays a vital role in any automotive vehicle so as to slow down the vehicle or to stop the vehicle completely. During the application of brake, friction between brake pads and rotating disc causes to stop the vehicle by converting kinetic energy of the vehicle into heat energy. Therefore, the brake pads should quickly absorb heat, should withstand for higher temperatures and should not wear. The brake pad material should maintain sufficiently high friction coefficient withthe brake disc, not decompose or break down in such a way thatthe friction coefficient with the brake disc is compromised at high temperatures andexhibit a stable and consistent friction coefficientwith the brake disc. In past years asbestos is used in brake pads. But asbestos causes carcinogenic effects on human health. It leads to the investigation on new materials particularly agricultural residues or wastes are now emerging as new and inexpensive materials in the brake pads development with commercial viability and environmental acceptability for brake pad which possesses all the required properties. There are metallic, semi metallic and organic brake pad materials.

Generally, brake pad consists of a composition of reinforced fibers, binder, fillers, friction additives. All these constituents are mixed or blended in varying composition and brake pad material is obtained using different manufacturing techniques. Reinforced fibers increase mechanical strength to the friction material. The purpose of a binder is to maintain the brakepads structural integrity under mechanical and thermalstresses. It holds the components of a brake padtogether and to prevent its constituents from crumblingapart. Fillers in a brake pad are present for the purpose of improving its manufacturability as well as to reduce the overall cost of the brake pad. Abrasives and lubricants are considered as friction additives, abrasives in a friction material increase the friction coefficient. They remove iron oxides from the counter friction material as well as other undesirable surface films formed during braking. Lubricant stabilizes developed friction coefficient at high temperature.

In the present paper three non-asbestos brake pad samples of different compositions are prepared and their tribological performance and thermal behavior etc are studied. The composition contains filler materials like $CaCO_3$, binder like phenolic resin, fiber like steel wool, aramid fiber etc along with graphite, Al_2O_3 as frictional additives and abrasives respectively.

II. EXPERIMENTAL PROCEDURE

A. Preparation of the Brake pad composite:

Once the chemical treatment and mechanical treatment for raw materials is over, the final composition is made with other ingredients like filler, fiber, binder, frictional additives etc in different formulations. Each formulation is mixed to obtain a homogeneous mixture of ingredients. Then, the mixtures are compacted at a pressure of 15-17 MPa using a unaxial, hydraulic hand-press machine for the green body of the brake pad composite Then, the green body was compacted further and cured using a hot press at 150 °C with 60 tons of compressive molding pressure for five minutes. At the end of the hot-pressing process, samples were taken out of the molds, allowed to cool to room temperature, and cured further at a constant temperature of 150 °C in air oven for four hours [5].

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Figure 1 Sample brake pad after final finishing

B. Testing and Analysis:

Inertia dynamometer is used for conducting friction and wear tests as shown in Figure 2. Brake pad sample along with back plate is assembled in disc brake pad caliper as shown in Figure 3.Once the brake pad assembly is over dynamometer is operated until the pad fully worn out. During this period friction coefficient, wear at different temperatures and at different speeds are recorded by data acquisition system. Stopping time, brake release time, temperature generated at contact surfaces etc are also monitored. From these results life time of the brake pad can be estimated. Rockwell Hardness numbers of three samples are found by Rockwell Hardness Testing equipment(Saroj, RAB 250), steel ball indent 1/16" and 100kgf load are used for measuring the RHN. Thermal stability analysis is done using Thermo gravimetric analyzer (TGA). The percentage of weight loss with increasing temperature is monitored by TGA. The results are obtained in the form of graphs. The maximum temperature up to which weight loss can be measured is 1000oC. Thermal conductivity of three samples for measured at a temperature of 55oC using DTC-300 thermal conductivity test apparatus for solids, liquids and pastes.

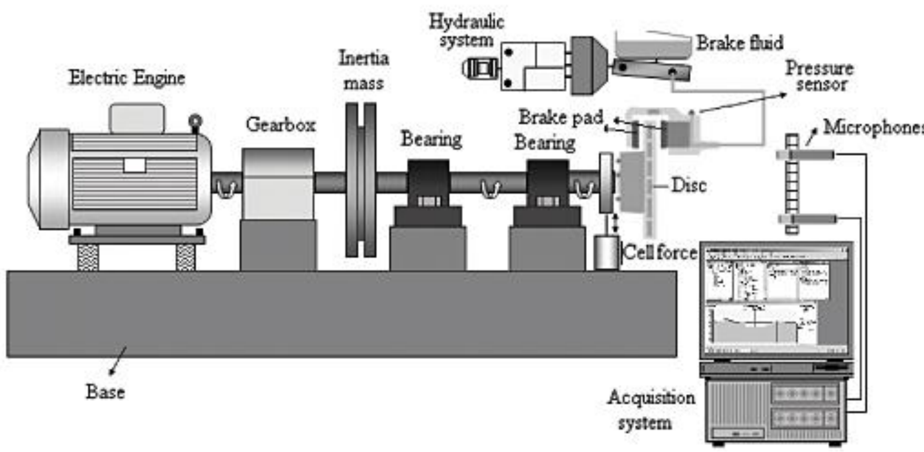

Figure 2: Schematic representation of the Inertia dynamometer

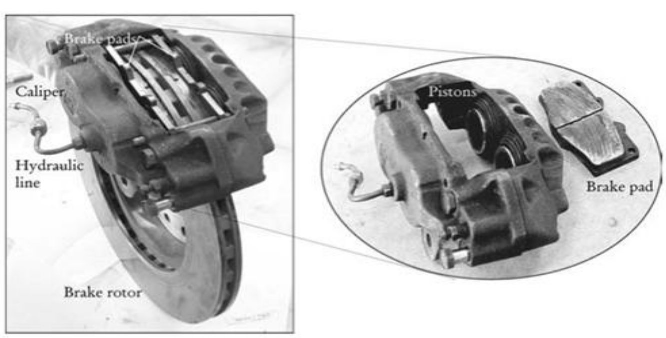

Figure 3 Brake pad assembly

III. RESULTS AND DISCUSSIONS

A. Friction and Wear tests

Friction and wear tests are conducted on inertia dynamometer and results are plotted with respect to temperature. Figure 4 shows friction coefficient Vs temperature graph. The variation at low temperature is due to the presence of phenolic resin and other constituents. Change in the friction coefficient is due to the fading of friction material. At higher temperature friction coefficient drops for assisting the fade resistance[15].But sample B shows stable friction coefficient even at higher temperature that is due to the ingredients present in the sample. Figure 5 shows wear Vs temperature graph. Brake pad wear rate depends on hardness, thermal stability and ingredients present in the sample [15]. From figure 5 and 7, It is proven that wear is proportional to the thermal stability results along with temperature. Figure 6 shows increasing the hardness causes decreasing the wear which indicates that Hardness values can be used to predict the wear resistance[15].

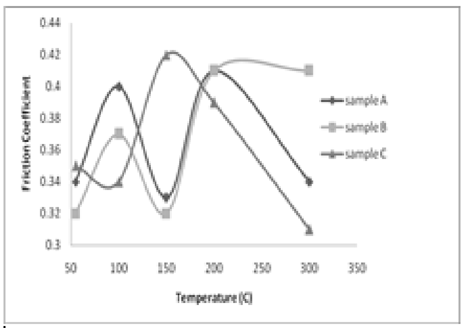

Figure 4 Friction coefficient Vs Temperature

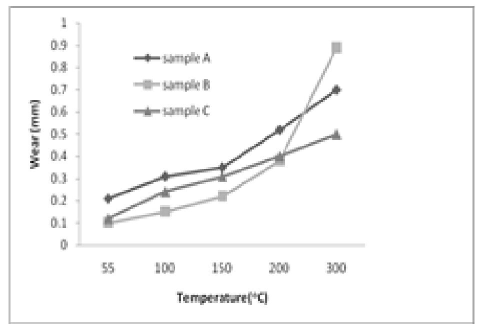

Figure 5 Wear Vs Temperature

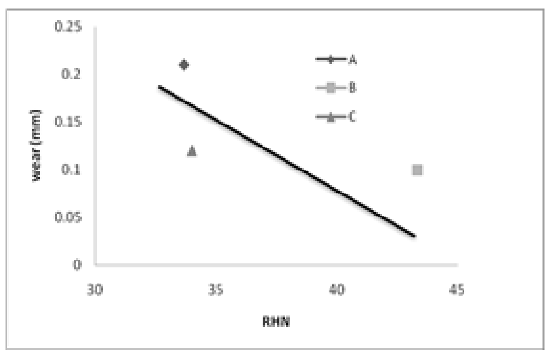

Figure 6 Wear Vs Rockwel Hardness

B. Thermal stability analysis:

Figure 7 shows Thermal stability analysis of the three samples. All samples exhibit slight variation up to 275oC.After that TG % decreases with temperature due to the presence of heat absorption of ingredients. The weight % for sample C increases at a temperature of 600oC due to the occurrence of phase change of constituents present in the material.

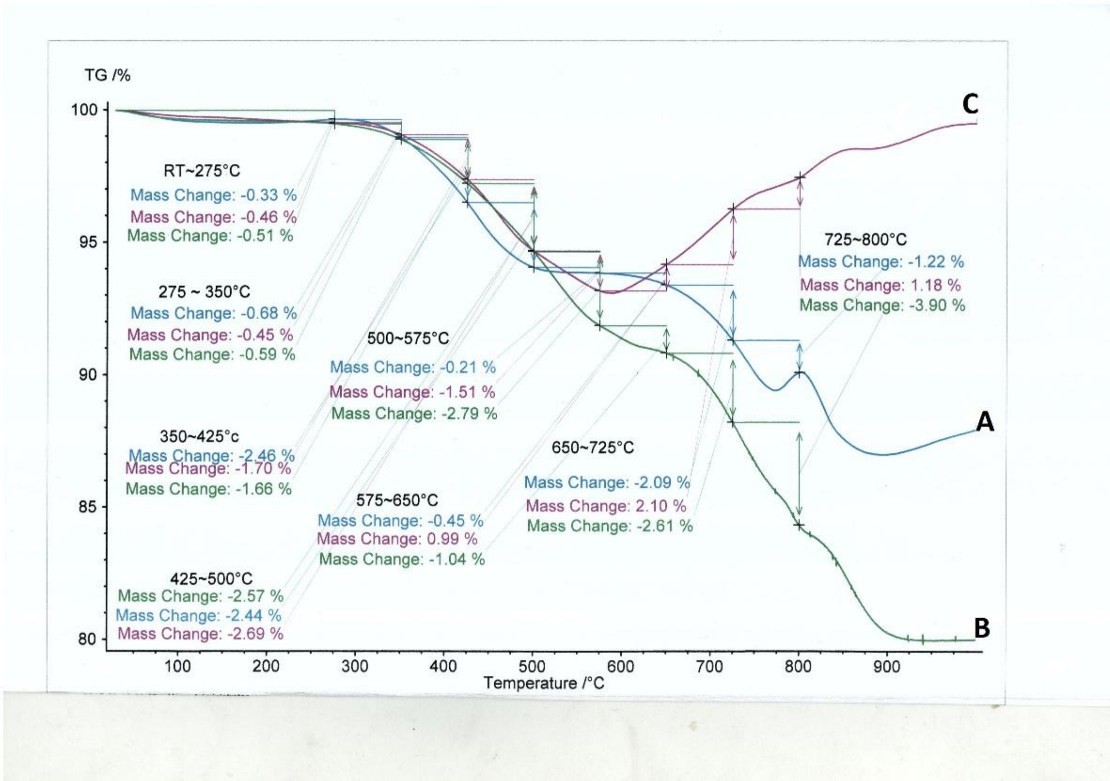

Figure 7 Thermo Gravimetric Results

C. Significance of thermal conductivity of Brake pad:

Higher thermal conductivity causes for the transfer of heat from brake pad to brake fluid and causes for fluid evaporation which decreases the braking performance. Even though large amount of heat transfers to the brake disc but thermal resistance between the pad and the disk prevent the disk from absorbing the generated heat at the contact surface of the pad [9]. So brake pad should have less conductivity and three samples have thermal conductivities less than that of asbestos brake pads as shown in table 1

Table 1. Thermal conductivity of samples

Sample	Thermal conductivity (W/mK)
Asbestos based brake pad [1]	0.539
A	0.191
B	0.186
C	0.191

IV. CONCLUSION

In the present work three brake pad samples of different composition are tested for their thermal and tribological behavior. From friction and wear tests it was concluded that sample B is showing stable friction coefficient at higher temperature and less wear. But at higher temperature wear increased. TGA results shown that all samples have similar trend up to a temperature of 600oC, after that mass change for sample B is higher and sample C is lower. Thermal conductivity of three samples are lesser than that of Asbestos based brake pad.

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VI. REFERENCES

[1] A. O. A. Ibhadode, I. M. Dagwa, (June 2008) Development of Asbestos-Free Friction Lining Material from Palm Kernel Shell,Journal of the Brazil,Society of Mechanical Engineering and Sciences.

[2] Arnab Ganguly , Raji George, (2008). Asbestos Free Friction Composition For Brake Linings Bull. Mater. Sci., Vol. 31, No. 1, , Pp. 19–22. © Indian Academy Of Sciences.

[3] Blau, P. J., (2001). Compositions, Functions and Testing of Friction Brake Materials and their Additives. Oak Ridge National Laboratory for U.S. Dept. of Energy. http://www.Ornl.-gov/-webworks/cppr/y2001/rpt/112956.pdf, 78–80.

[4] C. M. Ruzaidi, H. Kamarudin, J. B. Shamsul, M. M. A. Abdullah(2011), Comparative Study on Thermal, Compressive, and Wear properties of Palm Slag Brake Pad Composite with Other Fillers, Advanced Materials Research, Vols. 328-330 (2011) pp 1636-1641.

[5] C.M. Ruzaidi, H. Kamarudin, J.B. Shamsul, A.M. Mustafa Al Bakri,J. Liyana,(2013),Mechanical Properties and Morphology of Palm Slag, Calcium Carbonate and Dolomite Filler in Brake Pad Composites, Applied Mechanics and Materials, Vols. 313-314 (2013) pp 174-178

[6] Dagwa, I. M., Ibhadode, A. O. A., (2008), Some Physical and Mechanical Properties of Asbestos – free Experimental Brake Pad, Journal of Raw Materials Research (JORMAR).

[7] D Chan and G W Stachowiak,(2004), Review of automotive brake friction materials, School of Mechanical Engineering, University of Western Australia, Crawley, Australia D13103 © IMechE 2004 Proc. Instn Mech. Engrs Vol. 218 Part D: J. Automobile Engineering.

[8] IDris, U.D., Aigbodion, V.S., Abubakar, I.J., Nwoye, C.I., (2013). Ecofriendly asbestos free brake- pad: using banana peels. J. King SaudUniv.-Eng. Sci., 1–8, http://dx.doi.org/10.1016/ j.jksues.2013.06.006

[9] Faramarz Talati Æ Salman Jalalifar (2009), Analysis of heat conduction in a disk brake system, Heat Mass Transfer Springer-Verlag 45:1047–1059 DOI 10.1007/s00231-009-0476-y

[10] K.K. Ikpambese, D.T. Gundu, L.T. Tuleun(2014) Evaluation of palm kernel fibers (PKFs) for production of asbestos-free automotive brake pads. Journal of King Saud University-Engineering sciences.

[11] M.A. Maleque, , A. Atiqah, R.J. Talib and H. zahurin, (2012), New natural fibre reinforced aluminium composite for automotive brake pad, (IJMME), vol. 7 no. 2, 166-170.

[12] P. De Vuyst, P. Dumortier, G.M.H. Swaen, J.C. Pairon, P. Brochard,(1995),Respiratory health effects of man-made vitreous (mineral) fibres, Eur Respir J,8,2149–2173 DOI:10.1183/09031936.95.08122149

[13] Poh Wah Lee, Peter Filip, (2013), Friction and wear of Cu-free and Sb-free environmental friendly automotive brake materials,Wear 302,1404–1413.

[14] P.V. Gurunath, J. Bijwe, (2007) Friction and wear studies on brake-pad materials based on newly developed resin, Wear 263 1212–1219.

[15] Yun Cheol Kim, Min Hyung Cho, Seong Jin Kim, Ho Jang, ,(2008) ,The effect of phenolic resin, potassium titanate, and CNSL on the tribological properties of brake friction materials Wear 264 204–210

[16] Zhezhen Fu, Baoting Suo, Rongping Yun, Yimei Lu, Hui Wang, Shicheng Qi, Shengling Jiang And Yafei Lu,(2012) Development of Eco-Friendly Brake Friction Composites Containing Flax Fibers, http://hdl.handle.net/10084/94936 , 31/07/2012.