International Journal of Advanced Mechanical Engineering.
ISSN 2250-3234 Volume 4, Number 3 (2014), pp. 285-290

http://www.ripublication.com/ijame.htm

Effects of Applied Pressure on the Wear Behavior of Brake Lining Sliding Against Ferrous and Nonferrous Disc

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Abstract

In this paper deals an indigenous pin on disc wear test setup is developed to study the wear behavior of truck brake lining material sliding against low carbon steel and aluminium disc. The wear performance of the brake lining pin with a EN32 and the aluminium A356 disc is investigated. Wear tests were carried out at low applied pressure (0.05 to 0.2MPa) and high applied pressure(0.2 to 0.8MPa).Under two different speeds 1.24 and 3.42m/s for a constant sliding distance of 1000m. The results showed that the wear rate of the brake lining pin sliding against the aluminium disc decreased than steel disc at high applied pressure and low speed. However, the wear rate of brake lining pin sliding against the steel disc decreased than aluminium alloy at low applied pressure and high speed. For all the sliding distances the wear rate of brake lining increased. The worn surfaces of disc track and EDAX pattern confirmed the presence of the main elements in the brake lining material.

Keywords: wear test setup, steel, aluminium disc and bake lining pin.

1. Introduction

In recent years there is a dynamic development of brake lining composite material and is manufactured in enormous quantities with an optimization. It helps in the improvement of wear and friction performance of the component during sliding. The brake pad which is normally used in automotive applications must possess the

following properties such as higher thermal conductivity, wear resistant, stable friction coefficient and less thermal expansion [5]. The main purpose for the development of this setup is to reduce the cost of technological applications. Nowadays aluminium matrix composite reinforced SiC particle have been used as a substitute for cast iron brake rotor disc, which is used in ground transportation systems such as passenger cars and train etc., In moving vehicle the brake pads are subjected to high pressure and becomes the necessity to study the wear performance of material by the construction of these setups. The investigation performed by N. Natrajan et.al has chosen pin on disc machine using brake shoe lining material as a pin and disc material as A356/25SiCp MMC and gray cast iron. The results showed that the wear resistance of MMCs is higher when compared to conventional gray cast iron. Wear of brake lining material was found high during sliding [8]. A. Daoud, et.al performed his investigation on a pin on disc test setup in which first sandcastle brake rotor of A359-20vol%SiC material is used as disc made for sliding against the automobile friction material as pin and the results of AlMMC disc shown that when the pressure is applied increasingly from 30N to 50N wear rate has been decreased. When the pressure is increased from 50N to 100N begins to increase. The cast iron disc is made to slide against the brake lining material and it was observed that the wear rate increases linearly with the applied pressure. In the brake pad have been sliding against A359/25-vol%SiC and is seen that the wear rate decreases between 30to 50N and increases at 50 to 100N on applying pressure [1]. R.C. Shivamurthy et.al their investigation of wear using A356 alloy and composites are used as disc and brake pad as a pin. At a sliding speed of more than 2m/s wear rate of the A356 alloy-20vol% SiC composite disc/brake pad tends to decrease [12]. In general, many researchers have published the wear rate of brake lining with aluminium alloy and its composites were compared with cast iron discs. In our best of our knowledge minimum research work has been carried out on brake limning with an EN32 steel disc so far. Hence, in this paper EN32 steel disc with brake pin wear performance is studied and the results are compared with aluminum disc [7] [12].

2. Experimentation

2.1 Materials

A356 disc material is fabricated using sand cast molding process. In commercial EN32 disc is directly purchased and machined. Both these discs hasdimensionsas 180 X12mm shown in fig. 1 (a) & (b). The both disc surface is polished using P320 silicon carbide emery paper. The commercial brake lining material is purchased and machined in the dimension 30X10mm used as a pin.

2.2 Experimental setup and test procedure

In fig. 2. The disc is a rotating element on which the pressure is applied through a fixed pin with the help of pneumatic actuator. The setup has been designed for easy replacement of the disc and pin material which is used for evaluating wear performance. The speed can be varied with the help of stepped pulley. Three test

analysis is being done to study the wear behavior of pin materials in which pressure is varied (0.2 to 0.8 MPa) with the help of pressure regulator which is connected to the pneumatic system, keeping constant sliding speed of 1.2m/s and 3.4m/s. The sliding distance is varied (500 to 2000m) during wear test maintaining the sliding speed and pressure as constant. The wear rate of the pin is calculated by a change in weight loss from original weight. It is calculated with the help of electronic weight (0.1mg accuracy) balance.

Fig. 1 (a.)Aluminum disc

Fig. 1 (b) Steel disc

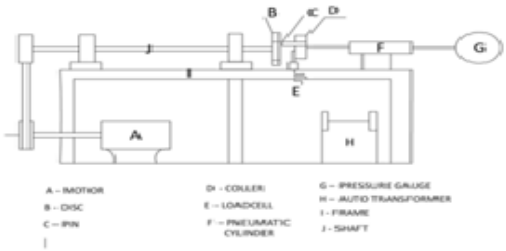

Fig. 2: Schematic diagram of pin on disc setup.

2.3 Other measurements

The surface roughness of the discs were measured using Talysurf 10^{TM} profiling instrument with 2.5mm tip radius. The formed wear traces in the disc are analyzed using an Olympus optical microscope (BX51M) and EDAX analyzer (Shimadzu EDX-720) for presence of elements in the brake lining material.

3. Results and Discussions

3.1 Variations of pressure on wear rate of friction material sliding against aluminium and steel disc

The wear rate of brake lining pin sliding against the aluminium and steel disc at high applied pressure and low velocity is shown in fig. 4. It was observed that at the sliding speed of 1.2m/s the wear rate of brake lining material on aluminium disc was found to be less compared to steel on varying pressure from 0.2 to 0.8MPa.In both discs, the wear rate of pin linearly increasing which the applied pressure was increased. It can be seen that the wear rate of pin sliding against the aluminium disc decreased than the sliding against the steel disc. The reason may be high applied pressure produce more stresses than the fracture strength of the brake lining elements; therefore the heavy elements (evident from fig. 3) Of the brake lining such as BA, Si, etc., Particles are direct contact with high hardness steel disc occurs more wear [2]. The wear rate of the brake lining pin sliding against the aluminium and steel disc at low applied pressure and high speed shown in fig. 5. In the wear rate of pin sliding against the aluminium and steel disc was not consistent with the given testing conditions. The reason may be initially the pin wear particles are acted at pressure bearing element at certain applied pressure, later the pin was plastically deformed due to high speed [14].

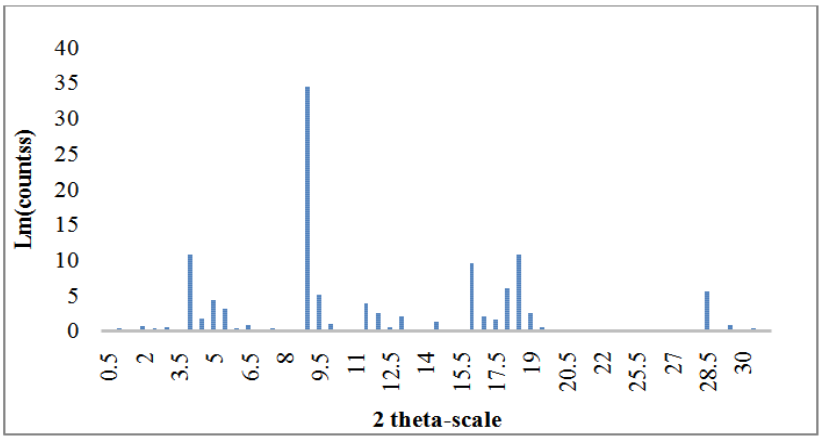

Fig. 3: EDAX analysis report.

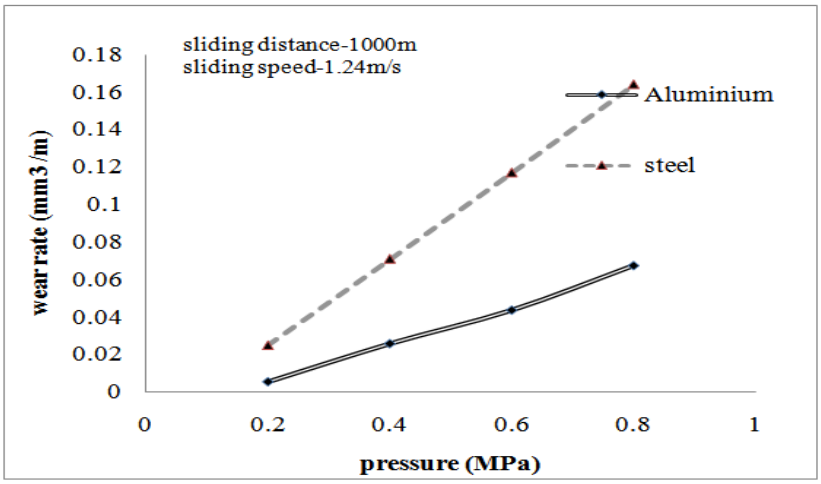

Fig. 4: Variations of wear rate with high applied pressure and low speed.

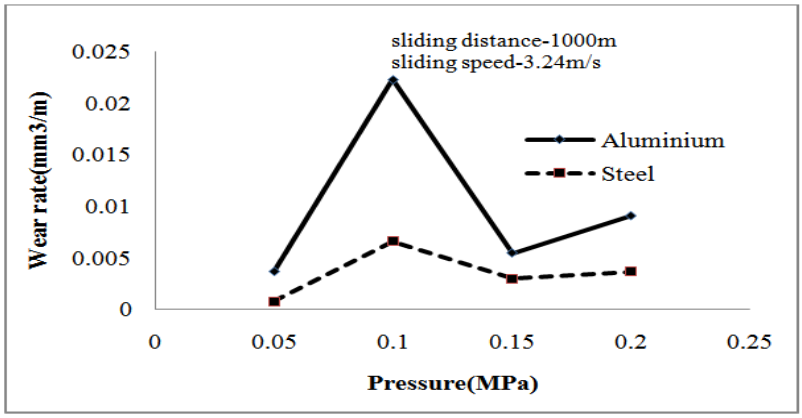

Fig. 5: Variations of wear rate with pressure on the discs.

3.2 Variations of sliding distance on wear rate of brake lining material sliding against aluminium and steel disc

The wear rate of brake lining pin sliding against the aluminium and steel disc at different sliding distance shown in fig. 6. The wear rate of the pin increases with increasing the sliding distance against the both discs at constant pressure of 0.1MPa ad 3.24 m/s. The worn surface produced by adhesive wear due to high temperature in the aluminium disc, it's promoting severe wear occurred in the form of plastic deformation and pin materials transfer to the counterface disc material [11]. The tribolayer of aluminium disc shown in fig 7 (a) & (b)

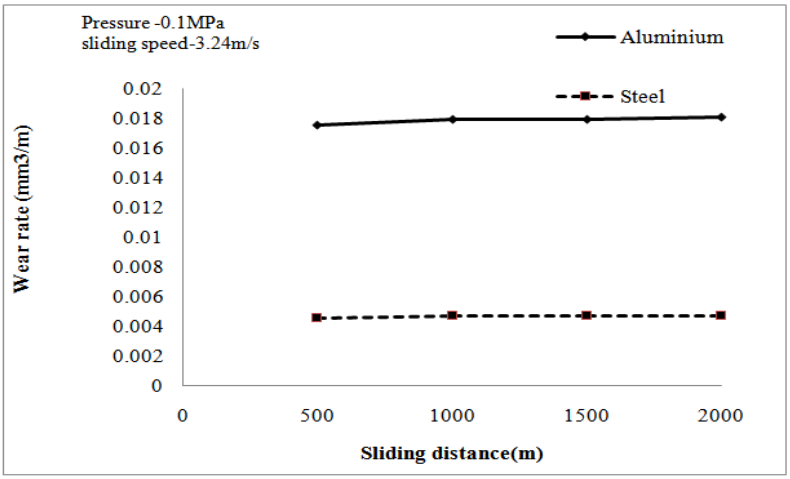

Fig. 6: Variations of wear rate with sliding distance of Brake lining material sliding against aluminium and steel disc.

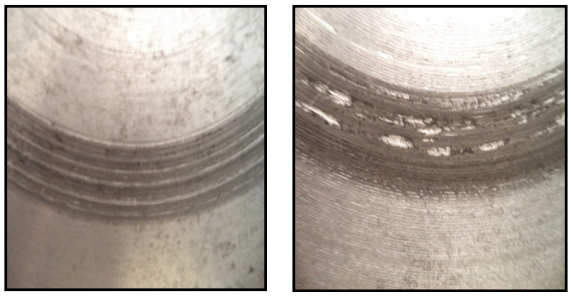

Fig. 7: Wear track (a). Without tribolayer (b) With tribolayer layer

4. Conclusions

1. The experimental setup provides actual wear loss due to friction and an opportunity to evaluate the performance of friction material in actual condition before implementation in real time applications.
2. The wear rate of A356 with the brake lining material was decreased than EN32 with brake lining at low speed and high pressure. The wear rate of EN32 with brake lining was decreased than A356 at low pressure and high speed.

3. On varying sliding distance it is found that the aluminium wear rate is higher than steel disc.
4. The setup helps in analyzing different frictional pin material and counter facing disc material at various operating conditions. It helps in choosing suitable friction material for different application.

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