EXPERIMENTAL WEAR ANALYSIS OF SILICON CARBIDE DISC BRAKE PAD ASSEMBLY

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ABSTRACT

This experimental study investigates the wear analysis of brake pad and disc of an automobile on Pin on Disc experimental setup. The brake pad consisting of silicon carbide and many other binding and filling materials is stamped with the Graphene nanoplatelet and even the graphene nanoplatelet is being mixed with the Cast iron which is usually used as Disc for braking assembly of an automobile consisting of Disc Brake Mechanism. The pins for the experimental purpose were made from the regular commercial brake pad and Stamped brake pad. We found that the surface heating results in the early flow separation and is attributed to such behavior for Cl and Cd. Early flow separation leads to broaden the wake width and static pressure distribution around the airfoil modifies which eventually resulting in an increase in Cd and decrease in Cl on heating the airfoil surface.

Keywords: Pin on Disc, Silicon carbide, Graphene Nanoplatelet, pins, discs, stamping,

INTRODUCTION

The one of the important area in the automobile is the deceleration of the motive vehicle which brings it to rest is its braking system which comprises of a mechanism to control it, the calipers, the disc and the and the brake pads. The main physics behind this system is the conversion of energy from one form to the another. In particular we can say that the moving vehicle producing a kinetic energy is brought to rest by converting that energy to thermal energy by the means of physical contact way. And the most common factor associated with the braking system is brake disc and brake pads assembly and the kind of materials, to exhibit better friction & wear condition the material like Aluminum composed matrix which act as an abrasive in the material foundation of brake pad and it is being re-enforced with SiC particles to provide higher specific het coefficient capacity, and mostly providing the lower density of wear particles. Although many experiments have been carried out to study the behavior of Al-SiC composites against the brake rotor application and very few information being provided over these open journals. Hence, the tribological behavior with the smart material needed to be tested. This will be based on the percentage of different materials being reinforced in the brake pad and disc assembly. With the addition of the nominal percentage of the preferred alternative material for this study.

The following diagram shows the representation of a separate Brake disc and brake pads.

Figure 1.1: Brake pads

Source: (Akebono brake industry company ltd.)

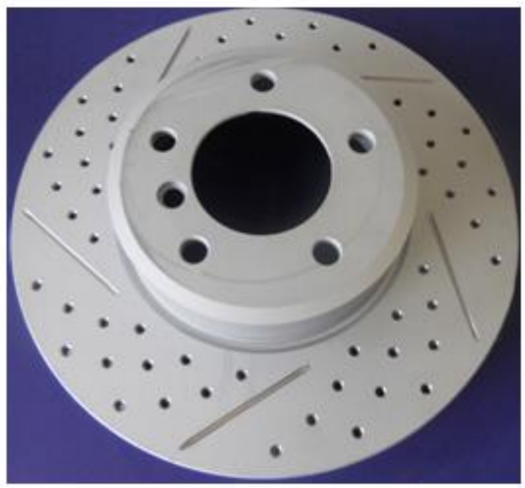

Figure 1.2: Brake Disc

Source: (Cquence Performance Break parts)

All materials of a break pad cannot be displayed as each manufacturers pad's materials are a closely guarded secret but basically, they consist of the following materials mostly in semi metallic brake pads.Steel, copper, brass, iron, potassium, titanate, glass and Kevlar.Harder materials are used in semi metallic brake pads to provide higher co-efficient of friction(μ) 0.28-0.38 they give poor wear at low temperature but excellent wear properties at higher temperatures of more than 200^0c. to increase frictional properties abrasives are used such as Aluminium oxide, iron oxide, quartz and Zircon etc

REVIEW OF LITERATURE

JR Laguna Camacho et al. This study was based for the wear mechanism of brake shoe and disk but on a used pad of serviced for 8 months in a vehicle but the vehicle chosen was belonged to a city of nominal range temperature of 40-50^0C which usually lead to more wear process as the ambient temperature is already high in this region. The images for the worn and unworn surfaces were taken using Scanning Electron Microscopy (SEM). And even Chemical Analysis by Energy Dispersion Electron X-Ray Spectroscopy and perspective degradation was viewed on Atomic Force Macroscopy.

The tribological characterization of disk and Brake shoes conducted by taking small sample or region areas over the break shoe and as well as brake rotor for chemical analysis to compare the results. Micrography of the damaged surfaces and identification of different materials of disc and pads were utilized. These three kinds of tests being conducted for worn and unworn surface for different zones and different weight percentage. And the illustrated images of each tests and results were computed and compared to the unworn pads. And similarly, the result of other city serviced brake pads was computed by the same methodology where the nominal temperature was low comparatively. And conclusions were taken as the disk pads were sliding ad body abrasive wear, and direction of slide gave grooved appearance. [1]

G.P. Ostermeyer et al. In the brake system Characterization structures are to be found in the contact area. The patches formed due to frictional contact and its wear mechanism of the pad lead to a new type of differential equation of second order for the dynamic friction co-efficient describing stationary and transient conditions. After generation of the 2^{nd} order differential equation numerical integrations were computed on the related software. And the results were compared with the result of the optical analysis of the layers showing typical structure on the brake pad. [2]

Hyeong GyuNamgug et al. In order to understand the wear debris of brake pads and its harmful affects on human hence the size of the (PM) particulate matter in the form of emission were needed to be known as the first priority. The increase or decrease due to temperature behavior, force behavior, and atmospheric humidity. The 9 different kinds of braking conditions using different instruments was conducted. And the results were characterized as of mainly of 2 types in terms of braking energy. The wear tests was carried out for criterion like OPC optical particle counter and APS aerodynamic particle size. The test was carried out for particularly high-speed subway trains which consisted of Non-Asbestos Organic (NAO) pad. The speed regulation of the subway train were tested for nominal range 100 kmph to 400 kmphand the brake force required for the braking which was tested was 60KN. Higher the speed higher the brake force for particular time period were conducted. [3]

Jehns Wahlstrom, et al. A major challenge when numerically simulating the disc brake contact is that various phenomenon occurs at different size scales, which makes it difficult to determine the model that adequately describes the contact situation. Numerical simulation can be performed in various approaches one of the best in that is (FEA) Finite element Analysis which does the simulation on a macroscopic scale. The numerical simulation approach in FEA was hard to achieve hence Whalstromdeveloped a cellular automation approach that can be used to simulate braking times in terms of seconds and length in terms of centimeters. Thus this literature approaches in the findings of microscopic and macroscopic scales for input parameters[4]

THE EXPERIMENTAL SETUP

The following Block Diagram shows the Pin on Disc Bench setup on which the Experimental work will take place

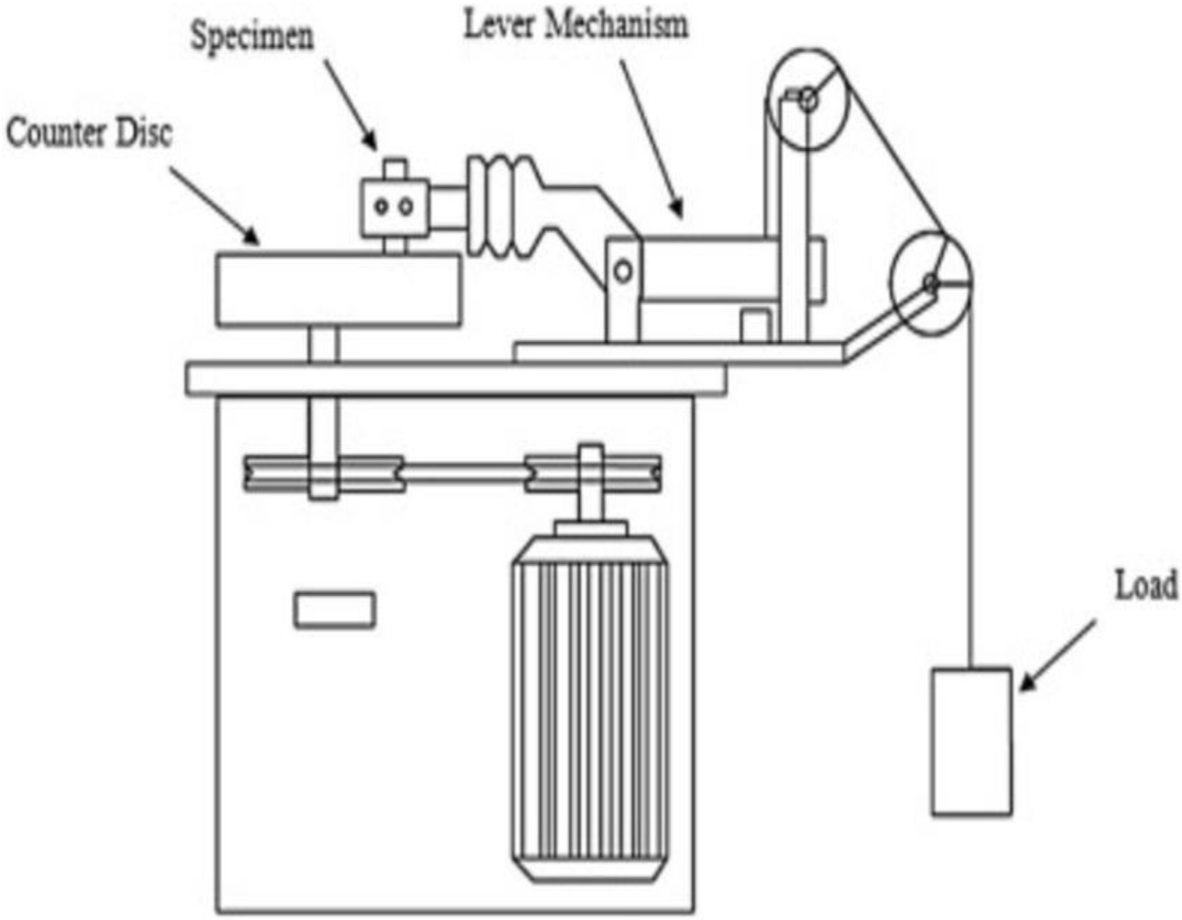

Figure3.1:Schematic diagram of Pin on Disc Test Setup

Table 3.1: Pin On disc test setup motor and load specification.

Motor Power	1 kW
Motor Rpm	1000(max)
Track Diameter	0-100 mm
Maximum load capacity	10-100 N

The experiments were conducted and the calculations were based on the Archard's linear wear Law according to which the following formulas were used to calculate the wear rate coefficient and wear volume. And the computational result giving the frictional coefficient value. Hence other parameters like sliding distance, sliding velocity etc. were needed to be calculated.

RESULTS & DISCUSSION

Experiment no.1

Test conditions for commercial Brake pad Pin with Cast iron disc.

Table 4.1: Test conditions for experiment no. 1

Normal force applied	5kg i.e. 49N
Material of Pin	Semi metallic Brake Pad
Rotating speed	500 RPM

Length of pin	32mm
Diameter of pin	6mm
Contact Track diameter	40 mm
Initial mass of Pin	3.18958 g
Sliding distance	1885 meters
Sliding(wear) time	1800 seconds
Disc material	Cast iron
Sliding velocity	1.0471 m/sec
Volume of each pin	904.77 mm^3
Density of pin	$3.525*10^{-3}$ g/mm^3

After test

Table 4.2: Calculated values after experiment no.1

Final Mass of the pin	3.18364 g
Worn out mass	0.00594 g
Wear rate coefficient 'K'	$1.8242*10^{-5}$ mm^3/Nm
Final volume of pin	903.0851 mm^3

Hence the following results were obtained by comparing worn out volume with respect to sliding distance.

Table4.3: Worn out volume with respect to Sliding Distance

Sliding distance	Worn out volume
0	0
200	0.178
400	0.357
600	0.536
800	0.715
1000	0.893
1200	1.072
1400	1.251
1600	1.43
1800	1.608
2000	1.787

Figure4.1:Wear volume v/s sliding distance in experiment no.1

Similarly, from Computational result we get coefficient of friction with respect to time.

Table 4.4: coefficient of friction with respect to time for experiment no. 1

Time	Coefficient of friction
0	0.09664
100	0.23996
200	0.25403
300	0.26626
400	0.26463
500	0.24689
600	0.24546
700	0.23853
800	0.23445
900	0.23303
1000	0.23629
1100	0.23466
1200	0.23017
1300	0.2665
1400	0.22222
1500	0.21713
1600	0.21244
1700	0.20999
1800	0.21244

Graphical Representation

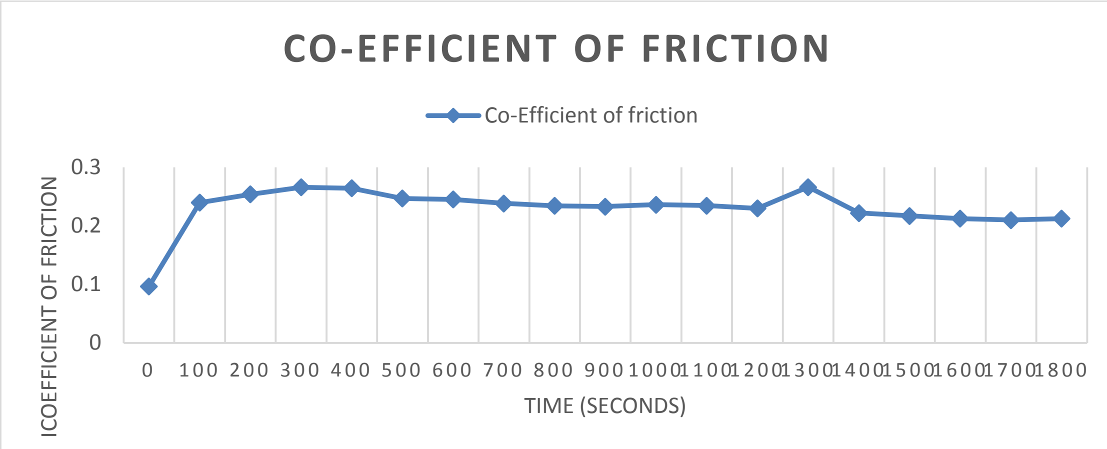

Figure4.2:Coefficient of Friction with respect to time in experiment no.1

CONCLUSION

From the acquired above result we come to a conclusion that the use of Graphene Nano Powder with Silicon carbide pad and disc assembly gives an impeccable strength to the pad and disc assembly commencing in low wear rate compared to the commercial brake pad and cast-iron disc assembly The above experimental analysis had lack of proper skilled resources as it was done on student level and graphene nanoplatelet availability is also less as still is under research criteria. On the other hand, materials were expensive specially graphene, the experiment was also based on experimental setup i.e. noncommercial setup not on actual commercial brake pad and disc assembly hence I would like to say that if it could be done on mass production basis the cost will be less and results will be even better

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