INVESTIGATION OF WEAR AND FRICTION PROPERTIES OF CARBONE BRUSH MATERIAL

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ABSTRACT

In today’s scenario the wear and friction in carbon material is the main domination factor which affects the material property and reduce the efficiency of material. So many scholars had been worked on wear to reduced their effect and improve material efficiency. The present paper is based on the wear and friction properties of carbon brush material. The aim of this investigation is to study of wear and friction properties of carbon brush material at different velocity and applied load through experimental setup. Pin on dick tribometer was used for this investigation carburizing at 1000 °C was done on carbon brush material sample. This specimen ware tested at three different relative velocities at 40mm, 50mm, 60mm track radius and this specimen subjected to three different loads of 30N, 40N, 50N to obtain different material properties combination. The three deferent relative velocities ware taken at 40mm, 50mm and 60mm. The result showed that carburizing in carbon brushing improved the wear resistance due to free graphite particles brushing which is self lubricating and brittle which the reason for drastic reduction in wears of the brushing. Coefficient of friction showed the little change in the temperature and further in ensured the stable state of sliding. This result will helpful for academic as well as industrial purpose to use carbon composite at required properties.

Key words: Wear, Coefficient of friction, sliding velocity and Pin on disc.

INTRODUCTION

In electrical-rotor systems, the purpose of electric brushes is to conduct current from the rotating part to the stationary part of a motor, and the performances of brushes are of vital importance for motors to run normally. Many scientists have been studied to develop the brush materials with high performances (Qiang et al., 2000, Uecker, 2003 and Feng et al., 2004). Recently, high speed motors have been largely developed to satisfy the household appliance industry, accordingly, high resistivity carbon brushes have been invented to match the motors (Zhang et al., 2005), and they are often made of graphite, resin binder and solid lubricant. Carbon materials are of low friction, low wear rate and good conductivity; they are extensively used as materials of brushes. The wear rate of brushes is one of the most important indicators for performances. However, the wear mechanism of brushes is very complex because there are many factors that can influence it. Brushes are exposed to mechanical and electrical loading together. Because brushes are always loaded against the sliding contact surface with sufficient force by a spring to ensure continuous contact. While mechanical wear takes place due to the brush–rotor friction, electrical wear takes place due to the current passing across brushes which cause arcing. From the viewpoints of electrical and frictional heating and abrasive wear; there could be an optimized load for a certain application. During the service of the brushes, mechanical and electrical power losses appear due to the normal load and the current, respectively. The wear rate of the brushes is affected by many factors, such as contact force, sliding speed, contact temperature, properties (electrical, mechanical and thermal) of the brush material, surface roughness and rubbing conditions (Jin-tong et al., 2005). Mechanical and electrical contact wear involves a number of damage processes such as abrasive and adhesive wear, erosive wear, oxidation wear, and transfer film and structure modification (Roberge. 2001). Some workers (Holm, 1958, Lancaster, 1963, Casstevens et al., 1978 and Roberge. 2001) concluded that in steady state for carbon materials, micro cutting and grinding of their surfaces by the abrasive wear products and by the counter body micro asperities primarily contribute to wear. The current study is based on the temperature effect on the wear rate of carbon brushes.

Experimental Setup:

For experiment we used Carbon brush of C-4 grade. Carbon brush are use to make the sample piece in 8mm dia. and 30mm length and then take the testing in wear testing machine at different load 30N, 40N,50N in same track radius of 40mm and check the wear and then again testing in previous load at 50mm and 60mm track radius. In second case the specimen were tested at same load as applied in previously but the track radius has been changed. This helps to find the rate of wear and coefficient of friction with respect to time (Fig 1-2).

RESULTS AND DISCUSSIONS:

Case I: 30 Newton load and track radius 40 mm

When we sintered the bush materials by charcoal dust at 1000 deg C then the free graphite particle are increased at the surface of the bush which is self lubricating and brittle, which the reason for drastic reduction in wears of the bushing (Fig 3).

At low speed with low or moderate loading the sintered bush are shown the stick and slip type of friction behaviour, that's the reason for the initial disparities of the plots (Fig 4). But for low speed and low load condition sintering in not very effective for reduction of friction.
**Case II: 40 Newton load and track radius 40 mm**

Material removal rate is significantly reduced by carburizing of bushing it is very prominently shown by the plot in Fig 5. Average coefficient of friction is drastically increased by the carburizing, it is almost 4 times then the normal bush, it is due to sticking behavior of the graphite particle and the result of this sticking friction is increasing temperature between the interface of the slider and bush (Fig 6).

**Case III: 50 Newton load and track radius 40 mm**

In general the material removal is increased by increasing the load of the interface after some time of relative sliding the carburizing bush are more stable and shown lesser wear as compare to other bushing (Fig 7). When the load increases the stick and slip type of friction concept vanished and the average frictional values are almost synchronized and the marginal frictional dominancy shown by the carburized bush (Fig 8).

**Results and discussion on same relative velocity but different load condition**

It is simply recognized by these plots that the sintering operation reduces the wear rate of the bushing material drastically and the life of the bush is increases remarkably (Fig 9). General bush material at same wear speed and different loads gives much more wear rate then the carburized sintered bush at 1000 deg C due to free graphite particle and Fe3C (cementite) formation. Wear rate is proportional to the load applied which is obvious and also experimentally observed (Fig 10). As the speed increases the friction coefficients is reduced drastically, for low speeds the friction coefficient is much higher than the higher one due to dynamic friction. In general cases stick and slip phenomenon is dominated at low speed and high load consideration, which is responsible for high frictional coefficients.

**CONCLUSION**

The friction and wear behavior of carbon bush and carburized carbon bush were investigated. The following conclusions could be drawn:

1. The incorporation of carburizing in carbon bushing improved the wear resistance greatly.
2. As the load and rotating rate increased, the wear mass loss increased. The wear displayed a linear evolution in all the range of load.
3. As the load and rotating rate increased, the wear weight loss increased. The wear displayed a linear evolution in all the range of load.
4. Carburization at around 1000 deg C reinforced the graphite particle in Iron matrix and reduced direct contact between the matrix and counterpart. Some free graphite particles were presented on the bushing surface, which improved the wear resistance greatly.

The low friction coefficient of carbon composite caused little change in the temperature and further ensured the stable state of sliding.

**REFERENCES**


Fig. 3 Wear rate at 40 mm track radius

Fig. 4 Coefficient of friction

Fig. 5 Wear Rate

Fig. 6 Coefficient of friction

Fig. 7 Wear Rate

Fig. 8 Coefficient of friction

Fig. 9 Wear Rate

Fig. 10 Coefficient of friction