

Study of Wear behaviour and Temperature variation of Mild Steel under Different Surface Treatments using Disc-on-Disc Type Rolling Wear Analysis Machine

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Abstract— Abrasive wear of engineering, agricultural machine components and in food processing machinery caused by the abrasive particles is a major industrial problem. Therefore, a full understanding of the effects of all system variables on the abrasive wear rates is important in order to improve design of the machinery and the choice of materials to control wear. The present research work is undertaken to development and testing of disc-on-disc type rolling wear analysis machine. This machine is designed and patented by Dr. SIRAJ AHMED. (Professor, MANIT, BHOPAL). This work is carried out further development and testing of disc-on-disc type rolling wear analysis machine. This machine is used to analysis of rolling wear behaviour of materials. Present work consist of testing of mild steel specimens under different surface treatment conditions like hammer peening, carburized (6 hrs.) and carburized (12 hrs.) and compared with virgin specimen. These specimens are tested under 5 and 10 kg load and wear behaviour is studied. Each specimen is tested on machine for 20 hrs. Study of temperature variation is also studied under different loading conditions and different surface treatments.

Key words: Wear, Carburized, Hammer Peening, Disc-On-Disc Type Rolling Wear Analysis Machine

I. INTRODUCTION

Wear is system response it is not a material property. It depends on operating conditions like load, sliding speed, and lubricating conditions. [2]

Wear of material is classified into two types two body abrasive wear and three body abrasive wear.[5] It can be also classified as sliding wear and rolling wear.[2]

Disc-on-disc type of rolling wear analysis machine is designed and patented by Dr. Siraj Ahmed (MANIT BHOPAL). This machine is used for testing of rolling wear. Specimen of 90 mm and 60 mm outer diameter are used for testing. [1]

II. EXPERIMENTAL SETUP

Disc on disc type rolling wear analysis machine is shown in figure 1. Power supply is given by 1 HP electric motor and it is transmitted by belt pulley system. Loading weights are also there to test under different loading conditions. Vertical shaft is supported by two ball bearings and it is freely sliding shaft in vertical direction.



Fig. 1: Disc on disc type of rolling wear analysis machine

A. Specimen

Specimen for wear testing is made with following dimensions (Table 1). Two specimens are used for testing. 60 mm specimen is mounted on horizontal shaft. And 90 mm specimen is mounted on vertical shaft. [1] As shown in figure 4.

Geometry	Specimen 1	Specimen 2
Outer diameter	60 mm	90 mm
Inner diameter	20 mm	20 mm
Thickness	6 mm	6 mm

Table 1: Specimen dimensions

Chemical composition of mild steel is given below in table 2. Carbon percentage is 0.15 % which means it is low carbon mild steel.

C	Mn	S	P	Si	Al
0.15	0.55	0.007	0.017	0.11	0.027

Table 2: Chemical composition of M.S. (%)

Two specimens of 90 mm and 60 mm outer diameter are prepared. Inner diameter of both the specimen is 20 mm. Thickness of both the specimens is 6 mm. As shown in figure 2 and figure 3.



Fig. 2: Specimen 90 mm



Fig. 3: Specimen 60 mm

Surface treatments are done on these specimens. Such as carburizing (6 Hrs.), carburizing (12 Hrs.), and hammer peening. Then these specimens are tested under 5 kg and 10 kg load.

B. Hammer Peening

It is done on the specimen with 0.5 kg hammer. Hammering is done for 0.5 Hrs. For specimen of 60 mm it is done on its periphery. And for specimen of 90 mm hammer peening is done at outer side of disc.

C. Carburizing

It is done in programmable heat treatment furnace in presence of charcoal. Carburizing is done at 600 °C. Two pairs of specimens are carburized for 6 Hours. And another two pairs are carburized for 12 Hours.

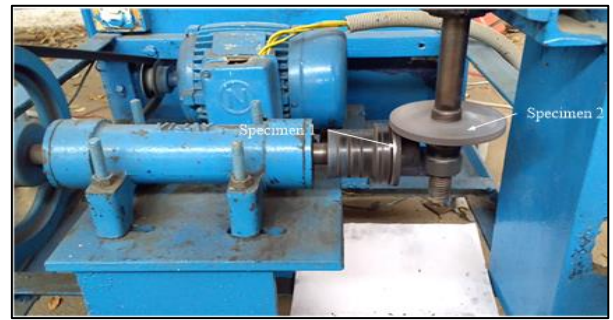


Fig. 4: Testing of specimens

III. RESULT AND DISCUSSION

Testing of specimen is carried out for 20 Hours for each pair of specimen.

Initial and final weight of specimen is recorded by high precision balance machine. It is tabulated in table 3.

Sr. No	Test	Specimen 60 mm (weight in gram)			Specimen 90 mm (weight in gram)		
		Initial weight	Final weight	Weight loss	Initial weight	Final weight	Weight loss
1	Virgin 10 Kg	117.791	111.335	6.456	279.568	275.414	4.154
2	Virgin 5 Kg	117.396	114.553	2.843	280.438	279.014	1.424
3	Hammer Peening 10 Kg	117.244	109.319	7.925	278.664	272.678	5.986
4	Hammer Peening 5 Kg	118.739	115.902	2.837	278.273	276.154	2.115
5	Carburizing 6 Hrs. 10 Kg	118.273	112.533	5.74	279.478	276.178	3.3
6	Carburizing 6 Hrs. 5 Kg	118.69	117.165	1.525	280.672	279.341	1.331
7	Carburizing 12 Hrs. 10 Kg	116.936	115.494	1.442	278.674	277.443	1.231
8	Carburizing 12 Hrs. 5 Kg	118.580	118.006	0.574	280.240	279.869	0.371

Table 3: Wear of different specimens (grams)

Weight loss of 60 mm specimen for different surface treatments is shown in figure 5.

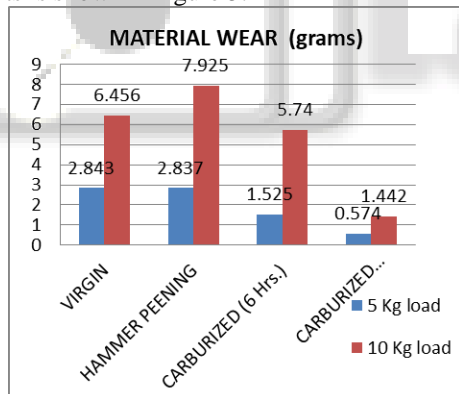


Fig. 5: Wear of material for 60 mm specimen

Percentage change in wear of specimen with different surface treatments with respect to virgin specimen is tabulated in table 4.

Surface Treatment	Change in Wear Rate (%)	
	5 Kg	10 Kg
Hammer peening	-	+ 22.75
Carburized (6 Hrs.)	-46.36	-11.09
Carburized (12 Hrs.)	-79.81	-77.66

Table 4: Change in wear rate of 60 mm specimen

Weight loss of 90 mm specimen for different surface treatments is shown in figure 6.

Percentage change in wear of specimen with different surface treatments with respect to virgin specimen is tabulated in table 5.

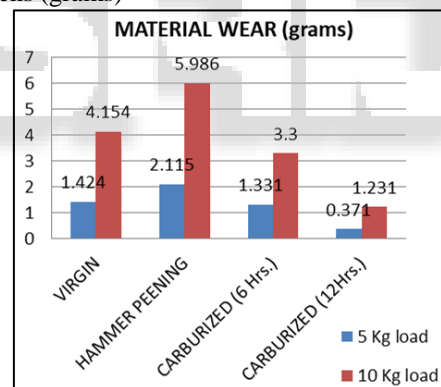


Fig. 6: Wear of material for 90 mm specimen

Surface Treatment	Change in Wear Rate (%)	
	5 Kg	10 Kg
Hammer peening	+48.52	+44.10
Carburized (6 Hrs.)	-6.53	-20.55
Carburized (12 Hrs.)	-73.94	-70.36

Table 5: Change in wear rate of 90 mm specimen

A. Temperature Variation

Temperature of 60 mm specimen is recorded with infrared thermometer.

It is measured in the interval of 5 minutes and recorded for initial 150 minutes.

Temperature is recorded in degree Celsius.

Temperature variation of 60 mm specimen with 5 kg load is shown in figure 7 graphically. Carburizing (12 Hrs.) gets heated more than all other specimens and carburized (6 Hrs.) shows lower variation of temperature out of all other

specimens. Virgin and hammer peening specimens are in between these two specimens.

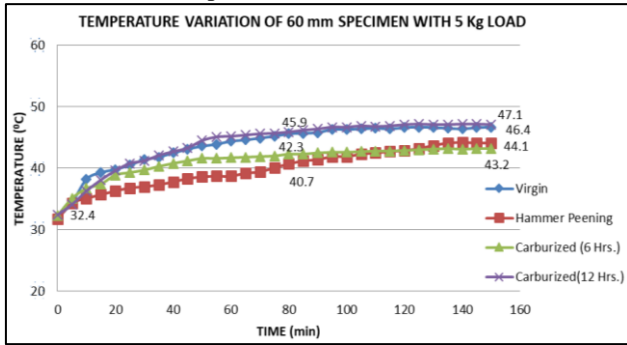


Fig. 7: Temperature variation of 60 mm specimen with 5 kg load

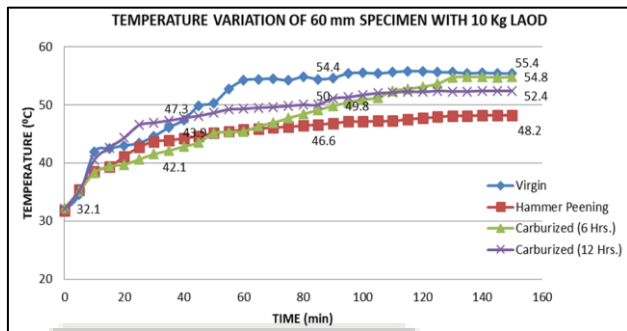


Fig. 8: Temperature variation of 60 mm specimen with 10 kg load

Temperature variation of 60 mm specimen with 10 kg load is shown in figure 8 graphically. Carburizing (12 Hrs.) gets heated more than all other specimens and hammer peening shows lower variation of temperature out of all other specimens. Virgin and carburized (6 hrs.) specimens are in between these two specimens.

IV. CONCLUSION

Carburizing (12 hrs.) shows good wear resistance in both cases of loading conditions i.e. 5 and 10 kg.

Hammer peening specimen gets wear out more than all other specimens. Because poor surface finish after hammer peening. Variation in results is due to manual process.

Carburized (12 hrs.) gets heated more than all other specimens. Temperature rise for all specimens is higher at 10 kg load.

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