MANJUNATHA
ADARSH B M
RAKSHITH B S
RAKESH B S
and
VENKATESHA B K

Study on the three body abrasive wear behaviour of EN8-steel before and after coating of wear resistance material

The effects of aluminum, zirconium, and fly-ash mixture additions on three-body abrasive wear behaviour of EN8-steel have been systematically investigated using a three-body abrasive machine and SiO_2 as abrasive.The coating material is preferred by using 49% aluminum and 49% zirconium is mixed by using 2% fly-ash, the fly ash works as a binder between aluminum and zirconium. Investigate the worn surface of EN8-steel specimen before and after coating of Al_2O_3, $ZrSiO_4$ and fly-ash mixture. The Al_2O_3, $ZrSiO_4$ and fly-ash coated working specimen will give less wear rate in grams compared to working specimen without coating. It clearly shows that using Al_2O_3 and $ZrSiO_4$ will reduce the wear rate and increase life of EN8 steel.

Keywords: EN8-steel, aluminum, zirconium, fly-ash, three body abrasive machine.

1.0 Introduction

Three-body grating wear is characterized as "Wear set off by free rolling and sliding of particles that are restricted by two counter faces encountering a general sliding movement" [1]. The particles associated with three-body rough wear could be created by wear flotsam and jetsam or have an outside source like sand and ash. The job of oil borne garbage and their disfigurement and crack on three body rough wear was examined in Ref. [2]. Three-body rough wear started from the presence of residue particles in greased up contacts is a vital supporter of wear in diesel motors [3, 4]. Raised working temperatures, higher rubbing, and increased wear rates in gears due to ointment tainting were additionally examined [5]. Reza Gheisari.et.al [6] covered three body rough wear of hard coatings. They reasoned that proportion of rough hardness to bearing surface assumes a significant part in three body grating circumstances. Alotaibi et.al [7] contemplated the wear conduct and wear component of various metals sliding against hardened steel counter face. They reasoned that particular wear rate as opposed to sliding distance is practically same for all metals sliding treated steel. It is separated into two districts, running in and consistent state. Later the particular wear rate is practically consistent with expansion in sliding distance. Boachaozheng et.al [8] considered the three-body grating wear conduct of cementite with various chromium fixations. They presumed that when Cr content under 6.03wt% single stage cementite was acquired by MA and SPA and expansion in Cr prompted further development hardness and wear opposition. At the point when Cr content under 8.22%, Cr iotas are conveyed in cementite to frame Cr-rich zones of more hardness. These zones diminish the pit dept and harshness and further develops the cementite rough opposition. S. Das Bakshi, et.al [9] provided details regarding the three body grating wear of fine pearalite, nano-organized bainite, and marten site. They reasoned that hardest stage marten site has more noteworthy wear rate, while pearlite is better opposition scraped area. It additionally inferred that bainite wears by blend of scoring and little minor pitting, while in marten site cutting component is predominant. Kaihongzhang, et.al [10] contemplated the three-body grating wear opposition of iron lattice composites built up with artistic particles. They reasoned that wear opposition of the composite is mostly identified with the break strength and bowing strength of artistic particles. The ZTA (55-60ZRO2) built up Cr25 composite shows great wear opposition which in multiple times is more than that of cast iron lattice. Cenna, et.al [11] explored on wear instruments in polymer grid composites scraped by mass solids. They presumed that the rough obstruction of built up composite material is a miniature systems measure that happens during grating wear are emphatically subject to the hardness of wear media. Both two-body and three-body wear designs are conceivable by mass solids sliding across polymer network composites. Antoriao.et.al [12] concentrated on wear obstruction and wear system of WC-12% CO warm splashed coatings in three-body scraped area. They presumed that

Messrs. Manjunatha, Assistant Professor, Adarsh B M, UG Student and Rakesh B S, Assistant Professor, Vivekananda Institute of Technology, Rakshith B S, UG Student, City Engineering College, and Venkatesha B K, Assistant Professor, School of Mechanical Engineering, REVA University, Bengaluru, India. E-mail: manjugowdauvce@gmail.com, / adarshbm123@gmail.com, / rakshubs007@gmail.com, / akeshmechknight@gmail.com / venkatesharvc@gmail.com;https://orcid.org/0000-0003-2315-0880

miniature cleaning and steady corruption of the lamellae was overwhelming wear component in tests with SiO_2 abrasives. The wear instrument with Al_2O_3 abrasives was plastic deformity. Harsha et.al [13] wrote about three-body grating wear conduct of polyaryle ether ketone composites. They presumed that grating wear rate is higher in composites than the perfect framework at various burdens.

2.0 Objectives

- Increasing demand for energy consumption requires the replacement of conventional or synthetic materials in the field of mechanical and tribological applications.
- The development of cost-effective tailor-made polymer composites to address the large scale applications is limited.
- Only limited works have been addressed in green/eco-friendly polymer composites with respect to conventional materials.
- The study is carried out to different target materials, speeds and load.
- Scanning electron microscope (SEM) study to understand wears mechanism.
- Different mechanical properties of the materials.
- Study on parameters on mechanical and wear behaviour of plasma sprayed alumina-zirconia-fly ash coating in abrasion and corrosion application.
- Study on plasma sprays parameters on EN-8 steel coating performance in alumina-zirconia-fly ash based thermal coating.
- Study on effects of plasma spray parameters on alumina-zirconia-fly ash coated on EN-8 steel using design of experiments.

3.0 Methodology

The wear conduct was estimated by the misfortune in weight, which was then changed over into wear volume utilizing the deliberate thickness information. The particular wear rate (KS) was determined from condition (1).

$$K_s = \frac{\Delta v}{L * D}\ m^3/Nm$$

TABLE 1: DETAILS OF THREE-BODY ABRASIVE WEAR CONDITION

Description	Values
Applied load (N)	22 and 32
Angular speed (rpm)	200
Specimen dimension (mm^3)	25.4×76.2×3
Rubber wheel diameter (mm)	228.6
Abrading distance (m)	250, 500 and 750
Silica sand	250 µ-300µ
Weight of silica sand flow gm/ min	250 µ-300µ
Temperature (°C)	Room Temperature

where, "V = Volume misfortune in m3; L = Load in N; d = Abrading distance in m.

The typical parameters were considered for three-body abrasive wear experiment as shown in Table 1.

Fig.1: Three-body abrasion Rig.

3.1 EN-8 STEEL STANDARD SPECIFICATIONS

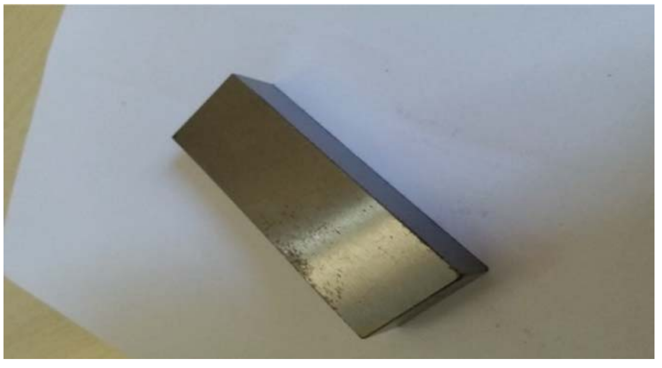

Fig.2 Specimen test sample

3.2 The Metallurgical Structure of the EN-8 Steel

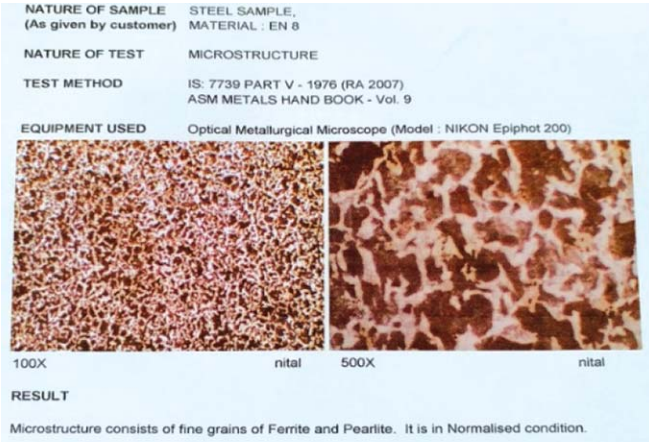

Fig.3: Metallurgical structure of EN-8 steel

3.3 SEM Test

SEM (scanning electron microscopy) is a test methodology that utilizes an electron beam to scan a sample and create a magnified image for analysis. SEM analysis, also known as SEM microscopy, is a technique for microanalysis and failure analysis of solid inorganic materials that is very accurate. High magnification electron microscopy produces high-resolution images and precisely tests very small features and artefacts.

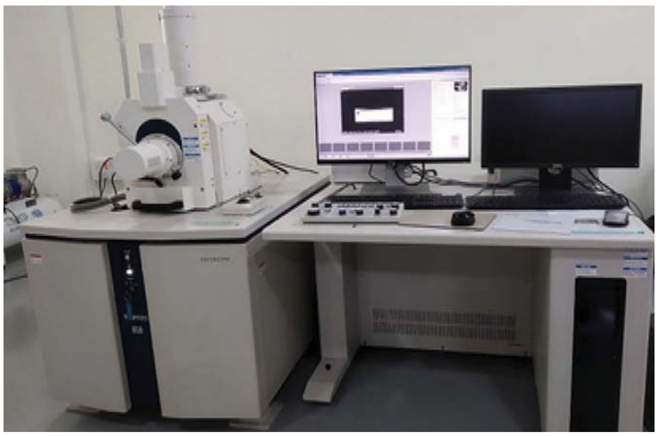

Fig.4: Scanning electron microscopy machine

4.0 Results and discussion

The measurements of mechanical properties and microstructure of test specimen are performed before and after three-body abrasive wear tests. The experimental results are presented and compared as follows.

4.1 Three-body abrasive wear behaviour with and without coating

Figs.7 and Fig.8 show wear rate of EN8 steel with and without coating of aluminium, zirconium and fly ash. From the graph it is clearly known that wear rate of EN8 steel with coating lower than the EN8 steel is without coating.

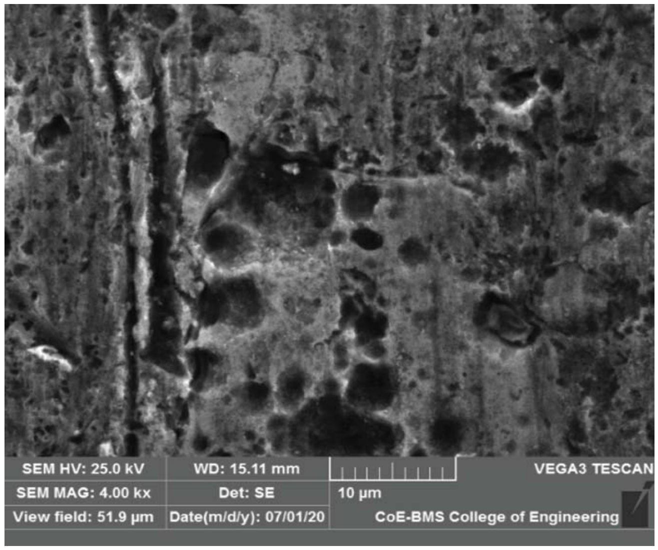

Fig.5: Microstructure for 20 μm

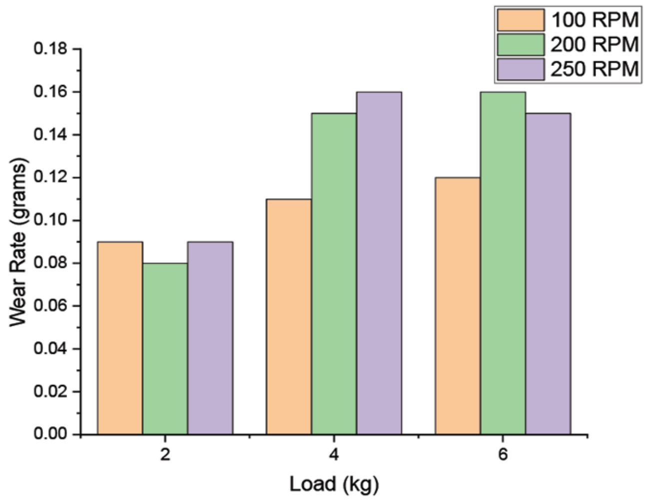

Fig.6: Micronsof 20 without coating

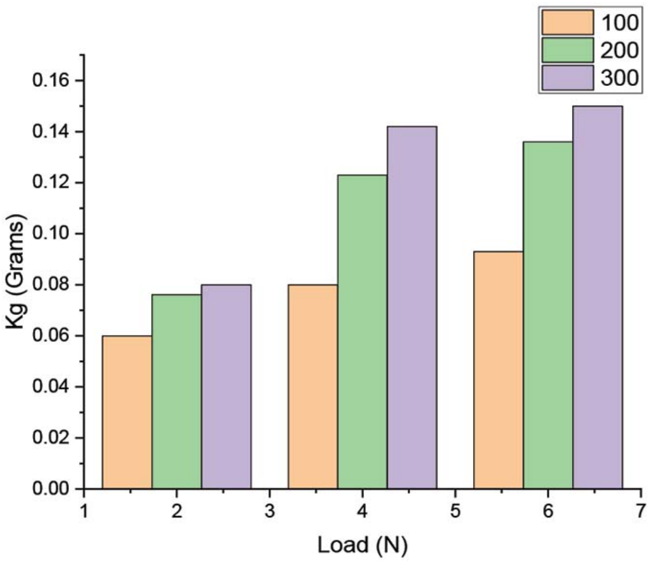

Fig.7: Micron of 20 with coating

5.0 Conclusions

Three-body abrasive wear behaviour of EN8 steel is with or without coating of aluminium, zirconium, and fly-ash mixture.

- The wear volume loss of EN8 steel after coating of aluminium, zirconium and fly-ash decrease in abrading distance as well as load.
- Increase the coating thickness will reduce the wear rate.
- The worn-out surface of the composite, using SEM indicated severe damage of the matrix in the unfilled composite.
- SEM feature shows matrix and fiber debris, the extent of which depends on the load and abrading distance involved.

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