Study of Wear in axles and its classification of Wear with protective measures to improve wear by using EN-45 steel

Veerpaul Soi
Department of Mechanical Engineering
GKU, Talwandi Sabo, Punjab, India

Kanwaljeet Singh
Department of Mechanical Engineering
MRSPTU, Bathinda, Punjab, India

Abstract- This paper comprises of the problem found, definition of wear, classification of wear, their influences, and precautions. Many protective measures have also been expressed in this study.

Keywords – EN-45 steel, Haar Wavelet, DWT, PSNR

I. Introduction

The problem of wear chosen as analysis study is originated in axles of light weight truck wheels. The top layer of axle is worn out because of abrasive wear, sliding wear and fractured by surface exhaustion. In this analysis more work done to minimize the wear rate of axle which is consists of EN-45 steel [1] with thermal spray protective coatings. To minimize the problem of wear, thermal sprayed wear protective powders have been sprayed on the EN-45 steel. Standard analysis procedure for wear resistance testing with the help of pin-on disc wear testing machine has been used to determine the wear resistance testing of the bared and coated EN-45 steels

II. DEFINITION OF WEAR

Wear is usually damage, erode, wear out of surface by friction with continuous use and may be defined as the removal of matter as movable molecules from solid particles due to mechanical work [2].Wear is frequently and rigorous trouble in farming, mining, steel and in company. Wear devastate public assets in the multibillion money range annually. Modern high performance machinery, subject to extremes of temperature and mechanical stress, requires surface protection against mechanical wear.

III. Classifications of wear

The following classification of wear [3] is shown below:

3.1 Sliding wear

When wear of metal occurs for a length of time, friction and wear of contacting surfaces are gradually minimized. Sliding wear is most essential kind of wear which is originated in axles of wheel rim. It starts when one part of machine slides above other then particles of metal misplace from one part or both parts without lubricant.

3.2 Adhesive Wear

Adhesive wear is a phenomenon occurs when surfaces experience metal transfer by rubbing together with huge force to remove the material from the surface with less wear resistance properties. Adhesive bonds are produced between mating surfaces which are stronger than the solid force of the metal parts. Due to this losing of particles that may be lost from the surface to which they shift, during succeeding traversals. The adhesive wear is reliant on physical and chemical properties such as material properties, presence of corrosive environment or chemicals, as well as the dynamics such as the velocity and applied force.

3.3 Abrasive wear

Abrasive wear which occurs when a hard irregular surface glides across a softer surface of metal parts. American Society for Testing and Materials (ASTM) defines it as the failure of material because of hard parts that are forced against and move along a solid part. This can be mostly investigated by assessment of a material being displaced or separate through a plowing or cutting process.

3.4 Surface fatigue

Surface fatigue is a method by which the exterior of a material is damaged by cyclic loading. It is a type of common material fatigue. Fatigue wear is created when the wear particles are removed by cyclic fracture increase of micro cracks on the metal parts. This method is dissimilar from other kinds of fatigue failures because it is originated solely on the surface of metal parts.

3.5 Fretting wear

Fretting wear is the frequent cyclical roughness between two mating parts, which is known as fretting, over a period of time which will lose material from one metal part or both parts in contact with each other. It is found in occurs typically in bearings of machines other equipment's. Fretting wear is material removal that found between two mating surfaces experiencing cyclic movement of small amplitude. At the contact surface areas, lubricant is squeezed out, resulting in metal-to-metal contact of surfaces.

3.6 Erosive wear

Erosive wear can be defined as a particularly small sliding motion and is occurred within a small time period. It is executed on the contacting parts of solid or liquid surfaces of an object. The contacting particles slowly eliminate matter from the outside through frequent deformations and cutting events. It is a generally occurred method in the engineering. A general pattern is the erosive wear coupled with the passage of slurries through piping and pumping machines. The amount of erosive wear is reliant upon many factors: the features of the particles of material, such as their nature, rigidity, impact velocity and impingement angle. Erosive wear may be defined as removal of matter because strike of particles moving with large velocity. A tribo method occurring from erosive wear can be regarded as as an open method. In such a method the offset body is constantly removed. This type of wear can be classified into three categories:

- Solid particle erosion. Solid particle erosion is the removal of material quantity from a end surface due to constantly striking of solid particles available in the passing liquid.
- Liquid impact erosion. The constantly impact of fluid jet on the matter of outer surface subjected to liquid impact erosion.
- Cavitation's erosion. The vapor or gas particles in a liquid make cavities or bubbles which subjected cavitation's erosion wear.

3.7 Corrosive and oxidation wear

Corrosive wear is a matter removal method which is occurred with the combined action of corrosion and wear. It may be defined as the wear method in which sliding occurs in a corrosive atmosphere. In the lack of sliding, the process of the corrosion (e.g., oxides) would produce a film normally less than a micrometer wide on the outer surfaces, which would have a tendency to slow down or even remove the corrosion, but the sliding motion wears out the film present on the surface so that more corrosion can continue. Oxidation wear is one of the ordinary type of corrosive wear because an oxygen-rich atmosphere is a typical atmosphere in which this wear method occurs. Corrosive wear requires both corrosion and roughness. Chemical corrosion presents in extremely corrosive atmospheres and high temperature and high humidity atmospheres.

IV. MAIN CAUSES OF WEAR

The wear is occurred due to many factors. But there are three main mechanisms that causes wear [4] which are:-

- Abrasion
- Impact
- Combination of Abrasion and Impact

4.1 Abrasion

Abrasive wear accounts for 60% of all wear. Abrasion is the scratching or grinding of hard particles into a softer surface. Two forms of abrasion are low stress, sliding abrasion and high stress, grinding abrasions.

4.2 Impact

Wear from impact is caused by rapid, repeated application of a compressive load, causing the metal to deform, fracture or peel off, directly below the point of impact. Examples of impact applications include rock crushing equipment such as impact and roll crushers, mill hammers etc.

4.3 Abrasion and Impact wear

When abrasion is combined with some degree of impact and weight, the resulting wear is very severe. This type of wear occurs when large abrasive objects, such as rocks, are forced under pressure against a metal surface, leaving prominent grooves. There are many applications where impact is accompanied by abrasion. Good examples of impact is accompanied by abrasion are dragline, power shovel and clamshell buckets.

V. PREVENTIVE MEASURES

The Preventive measure of wear [5] are:-

1) Select better material for use which is protective against wear.
2) Use of the lubricant-to-surface friction is much less than surface-to-surface friction in a system without any lubrication. Thus use of a lubricant reduces the overall system friction. Reduced friction has the benefit of reducing heat generation and reduced formation of wear particles as well as improved efficiency.
3) Use of protective coating is very efficient method to prevent wear of materials. As the wear occurs at outer surface of the material, therefore use of protective coatings to reduce wear is increasing now days because coatings are easily applied on the outer surface of material.

VI. PROTECTIVE COATINGS

Wear-related problems can be minimized mostly either by using high-cost wear resistant alloys/metals that are better than the existing low-cost alloys, or by improving the wear resistance of the existing metals and alloys by surface modification. The best surface modification method is thermal spray coating method, which is used in a wide range of industries to improve the abrasive, erosive, and sliding wear of machine components. Thermal spraying is a family of processes that use combustion or plasma energy to heat and accelerate the millions of particles, which impact onto the surface of a target/forming remarkable continuous uniform solid layers [6].

Surface treatments are applied to castings for engineering, aesthetic and economic reasons and also for improved surface-related properties such as wear, fatigue and corrosion resistance. Surface treatments commonly applied to Ductile Iron castings include: thermal and mechanical hardening treatments: the application of fused coatings to reduce friction and improve wear and corrosion resistance; the use of hot dipped metal coatings to improve appearance and corrosion resistance: the electro deposition of metal coatings to increase corrosion and wear resistance and improve appearance and the application of diffusion coatings to increase resistance to wear, oxidation and corrosion. The wear process of grey cast irons is affected by various factors such as abrasive wear, oxidation wear and cracking by surface fatigue. Thermal surface hardening is a common and highly cost-effective method of improving the wear and fatigue resistance of Ductile Iron castings. Surface rolling hardens the casting surface by the introduction of controlled deformation. Surface rolling significantly increases the fatigue strength of conventional Ductile Iron.

VI. CONCLUSION

The problem of wear in axles of light weight truck wheels was analyzed and the effect of thermal spray protective coatings on the wear resistance of EN-45 steel was investigated. The wear mechanisms involved were sliding wear, abrasive wear and surface exhaustion. The wear resistance testing was performed using a pin-on disc wear testing machine and the results showed that the coated EN-45 steel had better wear resistance than the bare EN-45 steel. Therefore, thermal spray protective coatings can be used to minimize the wear rate of axles and extend their service life. Double coating of EN-45 steel increases the life and overall strength of the axle.

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