REVIEW ON INVESTIGATION OF ERROSIVE WEAR ON POLYMER COATED MILD STEEL USING RESPONSE SURFACE TECHNIQUE

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Abstract — *In thermal power plant large amount of ash is produce due to burning of coal. The phenomenon of erosion wear due to the cutting action of ash particle in ash-liquid (slurry mixture) on mild steel has been studied in a slurry erosion tester. The fixture is used to hold the work piece in the slurry erosion tester. Experiment perform at different speed .polymer coating is suggested to reduce the erosive wear. response surface methodology(RSM) is used to investigate the erosive wear*

***keywords*: Erosive wear1, slurry2, , response surface methodology3**

1.INTRODUCTION

In thermal power plant, large amount of ash is produced due to the burning of coal. The bottom ash is collected at the bottom of the coal furnace and fly ash is raised with flue gases . Electrostatic precipitators fly ash is collected. The major constituents in fly ash present are SiO_2, Al_2O_3 and Fe_2O_3. Some material like carbon steel, mild steel ,cast iron are used in thermal power plant act as centrifugal pump, piping etc.

In the past few decades, research has been done on the study of material loss in order to conserve material and energy [1]. A variety of methods were adopted to protect materials from damage due to erosive wear, by the use of efficient materials [2], processing techniques [3], surface treatment [4] of the exposed components and use of engineering skill leading to less impact of wear on the material, such as appropriate impingement angle of erodent and velocity of slurry. Studies provide information

about the mechanisms of material removal during the erosive wear [5]. There are a number of methods to test the erosive wear of materials using equipment, such as small feed rate erosion test rig [6], particle jet erosion test rig [7], coriolis erosion tester [8] and slinger erosion test rig [9].

Study has been carried out for various slurries from low to medium concentration range and found that none of the correlation is universally applicable for modeling slurries for well graded particle size distribution[10].

applied Ceramic coating to increase the performance of a slurry pump by reducing the erosive wear [11-12]. Before applying coating, specimens should be cleaned by acetone and abrasive shot blast [13]. The thermal spray technique may be used for applying coating. The extreme hardness and high density of Al_2O_3 leads to a superior erosion and corrosion resistance at both high and low impact angles [14]. The detonation gun thermal spray technique provides the dense microstructure with less porosity [15].

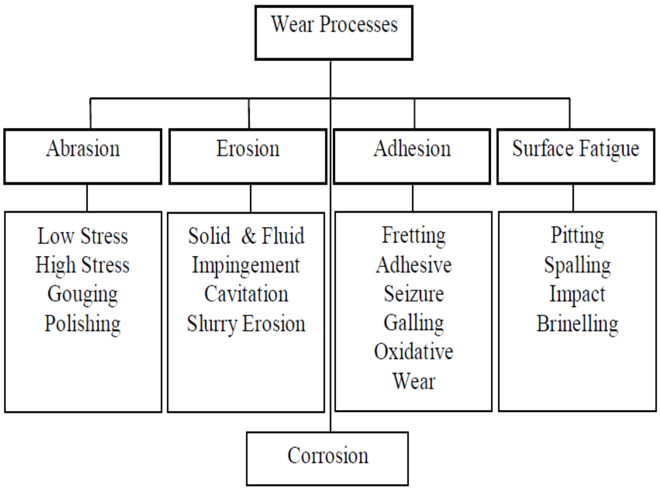
1.2WEAR

Wear is one of the most common problems encountered in industries like hydropower plants, thermal power plants, mining industries, food processing industries etc. in which solid liquid mixture is transported through pumps and pipes. Wear is the loss of material from a component due to a mechanical interaction with another object. Many types of solids, liquids, and even high-velocity gases can remove material and change the physical dimensions and functionality of a part. Corrosion and erosion are the main causes of wear. Corrosion is caused by chemical reaction of material with its environment. Erosion wear is due to exposure to moving liquids and gases, which may or may not contain hard particulate. Effect of erosion wear in slurry pumps and pipes is predominantly more as compared to the corrosion. The service life of equipment of slurry transport system is reduced by erosion caused by solid-liquid mixture following through the slurry transport system. So slurry erosion is important field should be investigated.

1.3 Occurrence of Wear depends on

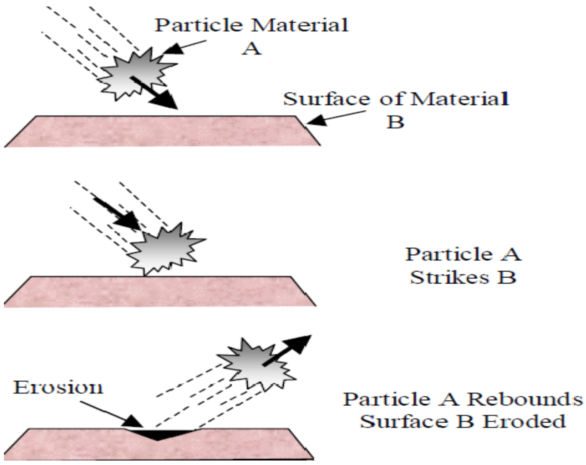
1. surface Geometry .
2.load or pressure applied.
3. The moving velocities like rolling and sliding velocities.
4 .based on Environmental conditions.
5. Mechanical, Thermal, Chemical and Metallurgical properties of the material.
6. lubricanting properties.

1.4 Types of wear process



2.Erosive wear

The impingement of solid particles, drops of liquid or gas on the solid surface cause wear which is known as erosion of materials and components.
Erosion is defined as a process by impacted a stream of abrasive particles by which material is removed from the layers of a surface. Erosion can be classified by three categories like solid particle erosion, slurry erosion and cavitation erosion. When the particles strike the substrate, parts of their kinetic energy is spent on creating new particles, a part on rebounding and part on indentation of substrate.In case of brittle materials, erosive wear is predominant in case of normal impact, whereas in case of metals, maximum erosive wear occurs at shallow angles.



Pressure generated due to change in velocity

$$P = \Delta V\sqrt{E\rho}$$

P = Impact pressure
E = Modulus of elasticity of impacted material
ρ = Density of the fluid
V = Velocity

2.1Types of erosion

- Solid particle erosion Surface wear by impingement of solid particles carried by a gas or fluid. **e**g. Wear is occurs on helicopter blade leading edges in dusty environments.
- Liquid drop erosion wear is done by impingement of liquid drops. e.g. by condensate droplets Wear on centrifugal gas compressor blades .
- Cavitation erosion Surface wear occurs in a flowing liquid by the generation and implosive collapse of gas bubbles. e.g.related to Fluid-handling machines as marine propellers, dam slipways, gates, and all other hydraulic turbines.

3.OPTIMISATION TECHNIQUES USE TO OPTIMISE THE PROCESS PARAMETERS OF ERROSIVE WEAR

. Finnie [1] proposed the first analytical erosion-model. This system included a variety of parameters that influence the amount of material eroded from a target surface and the mechanism of erosion. It was observed that the wear of a surface due to solid particle erosion depends on the motion of the particles in the fluid, as well as the behavior of the surface when struck by the particles. These two parts of the problem are related in that a surface wear, roughened by erosion, may increase the fluid turbulence, and hence due to this, accelerate the rate of material removal.

Hutchings and Winter [2] studied the mechanism of metal removal by impacting the metal targets at an oblique angle by metal balls at velocities up to 250 m/s. They suggested that the initial stage removal of metal is the formation of lip at the exit end of the crater, caused by shearing of the surface layers. Above a critical velocity, this lip is detached from the surface by the propagation of ruptures at the base of the lip.

Jennings et. [3] derived mathematical system based on target melting and kinetic energy transfer for predicting ductile target erosion. Dimensional analysis is employed in the development of a mathematical model for predicting the erosion on ductile materials. The model identified an erosion mechanism (target melting) which was verified in an erosion testing program using three stainless steels, two aluminium alloys, a beryllium copper alloy and a titanium alloy; the erosive agents were three dusts with hard angular particles, and one dust with spherical particles.

By extending the relations of Hertz and Raleigh, Soo [4] studied ductile and brittle modes of erosion by dust and by granular materials suspended in a gas moving at moderate speeds with conditions including directional impact, random impact, and sliding-bed motion. According to this experimental results show that the ductile mode, which is typical of metal targets, is characterized by maximum erosion occurring at some intermediate incidence angle between 0 and 90_.

Foley and Levy [5] investigated the erosion of heat-treated steels. The testing has conducted at room temperature using aluminium oxide particles with an average size of 140 lm in an air stream. And according to this attempt was made to characterize the erosion behaviour as it relates to the mechanical properties obtainable in these alloys by conventional heat treatments. It was found that the ductility of the steels had a significant effect on their erosion resistance which increased with increasing ductility, and that hardness, strength, fracture toughness and impact strength had little effect on erosion behaviour.

Sundararajan and Shewmon [6] proposed a correlation between the erosion rate and the thermo-physical properties of the target, for the erosion of metals by particles at normal incidence. This model employs a criterion of critical plastic strain to determine when the material will be removed. They have concluded that their new erosion model (localized model), rather than the fatigue-type model, predicts very well the experimentally observed rates of erosion. The effect of hardness on erosion rate was also find to investigated. The volume erosion rate regard for pure metals is inversely related to the static hardness. Such behavior has to be rationalized on the basis of the fact that the melting point of a pure metal is directly proportional to its static hardness value. In the case of high-temperature erosion, there may be significant hardness effect on erosion, but in the case of room temperature erosion, the influence is negligible.

Levy et al. [7] they are investigated elevated-temperature erosion of steels. The elevated-temperature erosion behavior of many several commercial ferritic and austenitic steels was determined over a range of temperatures from room temperature to 900_C. Due to this Austenitic steels were determined to have lower erosion rates than ferritic steels, and their hardness had no correlation with their erosion rate.

Meng and Ludema [8] analyzed the origin, content and applicability of most wear models and equations in literature. Their work focuses on the need for new methods of wear modeling and offers recommendations on how to model the wearing process; the authors have found over 300 equations for wear and friction.

Wang [9] investigated the erosion-corrosion behavior of two steels and several thermal spray coatings due to impaction by fly-ash from a bio-mass fired boiler through laboratory tests using a nozzle-type, elevated-temperature erosion tester. They found that this bio-mass fired boiler fly ash had relatively high erosive effect due to its composition containing high concentrations of chemically-active compounds of alkali, sulfur, phosphorous and chlorine.

Xie and Walsh [10] measured the erosion of carbon steel by fly-ash and unburned char particles in the convection section of an industrial boiler firing micronized coal. Ash like fly ash and char particles suspended in the flue gas entrained by the jet were accelerated towards the surface of the specimen under varying temperatures (450–650_).Changes in the surface has been measured using a surface profiler. They observed that erosion was slowest or low at the lowest metal temperature, regardless of the jet gas composition; and, under the nitrogen jet, erosion increased with increasing temperature. They have presented a model /system for simultaneous erosion and oxidation which is consistent with the temperature and oxygenation dependencies of the erosion rate.

Hubner and Leitel [11] carried out investigations on an erosion-corrosion apparatus to investigate time behaviour of corrosion-resistant high-alloy iron-base materials containing hard phases, and optimized the materials for increased wear resistance under complex stress conditions.

Oka et al. [12] he was investigated the impact-angle dependence of erosion damage caused by solid particle impact. The Erosion tests were conducted using a sand-blast type erosion test rig which included shallow impact angles. The dependency of erosion rates on impact angle was characterized by type of metallic (Al, Pb etc.), plastic aluminium and ceramic material. Impact velocity always increased the erosion rate, but did not affect the dependence of erosion behaviour on the impact angle for the metallic materials. Impact angle dependency was simulated by a basic equation involving a trigonometric function both of impact angle and of material hardness.

Hussainova et al. [13] investigated the surface damage and material removal process during particle–wall collision of solid particles with hard metal and cer-met targets. Targets were impacted with particles over a range of impact velocities (7–50 m/s) at impact angle of 67_. The experimentally-observed variations of the efficient of velocity of restitution as a function of the test material properties, impact velocity and hardness ratio were adequately explained by a theoretical model presented by them.

4. CONCLUSION:-

The present study is an overview of latest research works on erosive wear on metal.It give you a brief information about the errosive wear ,its parameters and about its technique used to optimize the parameters and erosion quality.

REFERENCES

1. Finnie I (1960) “Erosion of surfaces by solid particles. Wear 3:87–103

2. Hutchings IM, Winter RE (1974) Particle erosion of ductile materials: a mechanism of material removal. Wear 27:121–128

3. Jennings WH, Head WJ Jr, Mannings CR (1976) A mechanistic model for the prediction of ductile erosion. Wear 40:93

4. Soo SL (1977) A note on erosion by moving dust particles. Powder Technol 17:259–263

5. Foley T, Levy A (1983) The erosion of heat-treated steels. Wear 91:45–64

6. Sundararajan G, Shewmon PG (1983) A new model for the erosion of metals at normal incidence. Wear 84:237–258

7. Levy AV, Yan J, Patterson J (1986) Elevated temperature erosion of steels. Wear 108:43–60

8. Meng HC, Ludema KC (1995) Wear models and predictive equations: their form and content.

Wear 181:443–457

9. Wang BQ (1995) “Erosion-corrosion of coatings by bio-mass-fired boiler fly ash”. Wear 188:40–48

10. Xie J, Walsh PM (1995) Erosion-corrosion of carbon steel by products of coal combustion.Wear 186:256–265

11. Hubner W, Leitel E (1996) Peculiarities of erosion-corrosion processes. Tribol Int

29:199–206

12. Oka YI, Olmogi H, Hosokawa T, Matsumura M (1997) The impact angle dependence of

erosion damage caused by solid particle impact. Wear 203:573–579

13. Hussainova I, Kubarsepp J, Shcheglov I (1999) Investigation of impact of solid particles against hard metal and cermets targets. Tribol Int 32:337–344