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Erosion Wear Analysis of Coated and Uncoated Ductile Materials at Different Velocities and Angles

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Abstract: *Wear is the gradual, layer-by-layer destruction of the surface of metallic materials by mechanical action of erodents,or passage of slurry. The wear of metals occurs upon the frictional rubbing of surfaces, wear, and cavitations, as well as upon the action of strong gas or liquid currents upon a surface, especially at high temperatures and pressures. Various parts of jet engines, nuclear reactors, and steam turbines boilers and pipes in the thermal power plants and cement industries where the pipe carries the slurry were subjected to destruction by erosion. Increased resistance of parts against erosion can be achieved by improving process technology or unit design and by selecting more suitable material; heat treatment also increases resistance against erosion. Structural materials have been developed that provide durable operation of parts under erosive conditions, such as some niobium and molybdenum alloys. In the present work the effect of erosion wear on 18Cr8Ni based steel strip coated with Epoxy polyester and powder coating has been investigated experimentally. Comparison of the erosion resistance and loss of metal for different mass flow rate and angle's are done.*
Keywords*: Erosion wear, 18Cr8Ni,Epoxy coatings.*

I. INTRODUCTION

The removal of material from the surface of a ductile metal by small impacting particles is a design consideration. Erosion wear is a process of progressive removal of material from the surface ductile material due to repeated impacts of solid particles. The particles suspended in the flow of solid liquid mixture erode the surface in contact with it. There by limiting the service life of equipment used for slurry transportation system. Erosion wear caused by the kinetic energy transferred to target surface by impinging solid particles. Higher the loss of material for higher kinetic energy of the impinging particle. So impact velocity largely affects the erosion wear of target material. Also erosion wear depends on the impact angle, slurry concentration, size of erodent, its shape etc Erosion wear can be classified into three categories solid particle erosion, liquid impact erosion and cavitations erosion. Solid particle erosion is the loss of material volume from target material due to continues impingement of solid particles present in the flowing fluid. The continues striking of liquid jet on material surface cause liquid impact erosion. The deformation and removal of material from target surface due to repeated nucleation, growth and sudden collapse of bubbles is known as cavitation.

II. Epoxy Polyester ,Powder Coating

Limited availability of time for the maintenance or the replacement of the piping system in the industries have emphasized on the need for the better coatings..In a day to day working operational processes in different conditions tend erode the internal surface of pipes [1].So, problem lies. on Erosion wear and emphasized on the material which are largely used in the industries like thermal power plants, cement industries and the textile mills where generally hot stream of air, slurries and the ash particles were transported through these pipes and during this process they largely suffers the internal wear which further enhances the possibility of formation of micro level cracks with the passage of time and gradients like temperature and pressurized jet of stream and of sediments may some time causes sudden leakages or failure of the pipes.[2] Various experimentation work has been conducted with different coatings the machine parts like turbines where direct contact of the jet with the blade. Major problem in the piping system faces is the costlier coating processes.[3]Epoxy powder coating shows the improved erosion resistance. Based on review of the reported research work, the attempt has been made to investigate ant find the better and economical coating over the conventional coatings .

III. Experimental Set Up

A. Dimensions and material of construction of Erosion Wear tester.The effective area of specimen is 55mmX50 mm

Fig. 1: Actual viw of the specimens

Fig.2 Actual view of the set up

B. Material used

18Cr8Ni steel srtps were purchased Aggarwal Metal pvt ltd.The specifications are:
Particle shape:Rectangular
Hardness: 540VHN
Chromium:18.090
Nickel:8.010
Carbon:0.0516
Magnese:0.84
Phosphorous:0.034
Fe:72.69

C. Preparation of Epoxy powder and polyester coatings.

Firstly the wight 18Cr8Ni specimen is calculated for epoxy Polyester and powder coating.

Properties of Epoxy polyester-

Table 2 -Properties of Epoxy Polyester

Powder Size (µm	*- 45 + 22*
Apparent Density	*1.8*
Coating Thickness (µm	*200 ± 10*
Hardness (Kg/mm^2	*1150*
Compressive Strength (MPa	*2000*

Properties of Epoxy Powder Coating

Table-3 Properties of Epoxy Powder

Powder Size (µm	*- 35 + 22*
Specific Gravity	*5.22*
Coating Thickness (µm	*200 ± 10*
Hardness (Kg/mm^2	*1320*
Compressive Strength (MPa	*2200*

D. Experimental procedure

The schematic of the experiment is shown in Fig.2.The Erosion testing machine was experimentally at Baddi University,India .The flow rate of the slurry or sediments is conrtolled through the stop valve.The veocity meter is set up to measure the velocity of the pumped slurryand can be regulated through stop valve.Metallic tank is being used to collect and reuse the slurry. Various results in the graphical form were plotted between cummulative weight loss vs time,

IV. RESULTS AND DISCUSSIONS

A. Variation of slurry velocity or flow rate and different impact angles for the erosion discussed as-

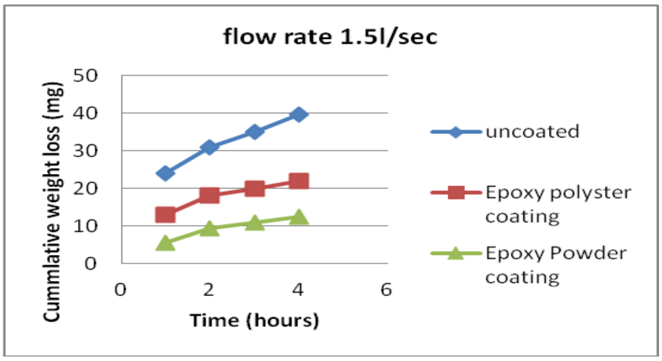

Figure 3 Variation in cumulative weight loss with respect to time at 30° impact angle**.**

During the experimentation on 18Cr8Ni with the velocity rate of 1.5l/sec epoxy powder coating shows higher resistance against erosional wear during the experimentation period for interval of each 1 hour, epoxy powder coating shows increased erosion wear as compared to epoxy polyester and uncoated 18Cr8Ni metal base with the minimum weight loss of 12mg in experimentation work of 4 hours.

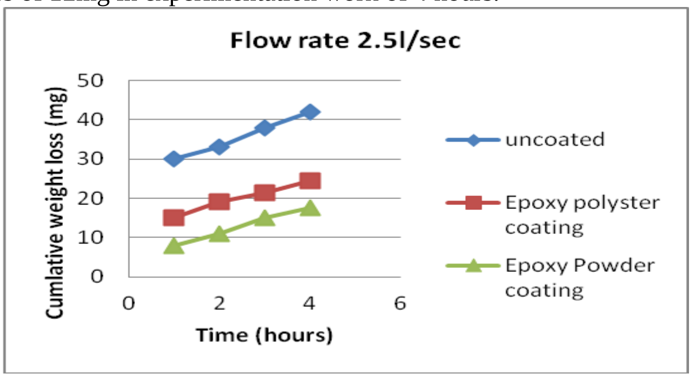

Figure 4 Variation in cumulative weight loss with respect to time at 30° impact angle.

During the experimentation on 18Cr8Ni with the velocity rate of 2.5l/sec with an striking angle of 30 degrees there is a increased in metal loss is observed with increased velocity rate. During the experimentation work in first two hours there is loss of 7 mg of metal in epoxy powder coating whereas as this loss of metal is higher in epoxy polyester coating about 15 mg. While the loss of metal in uncoated metal strips of 18Cr8Ni is about 30 mg.

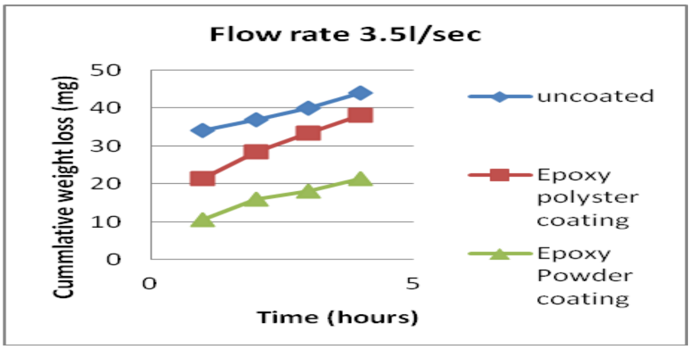

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Figure 5 Variation in cumulative weight loss with respect to time at 30° impact angle.

In the third factor with varying the flow rate with velocity of 3.5l/s with keeping the same angle of striking the resistance epoxy powder is much higher as compared to the epoxy polyester coating. During the experimentation duration of 4 hours the loss of metal in epoxy powder coating is of 20 mg while the readings for epoxy polyester and un-coated strip of 18Cr8Ni metal strip is 38mg and 44 mg.

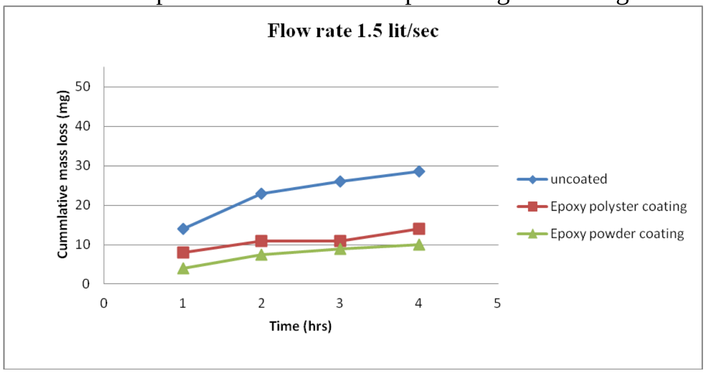

Figure 6 Variation in cumulative weight loss with respect to time at 60° impact angle

During the experimentation on 18Cr8Ni with the 1.5l/sec epoxy powder coating shows higher resistance against erosional wear during the experimentation work of gap of each of 1 hour epoxy powder coating shows increased erosion wear as compared to epoxy polyester and uncoated 18Cr8Ni metal base with the minimum weight loss of 9.5mg during experimentation work of 4 hours. At lower angles, the effect of bond strength of coating is more than at normal angles. A slight decrease in weight loss is observed when angle is changed from 30^0 to 60^0. The variations in cumulative weight loss with respect to time at different impact angles and flow rate are shown in figures from 3 to 12.

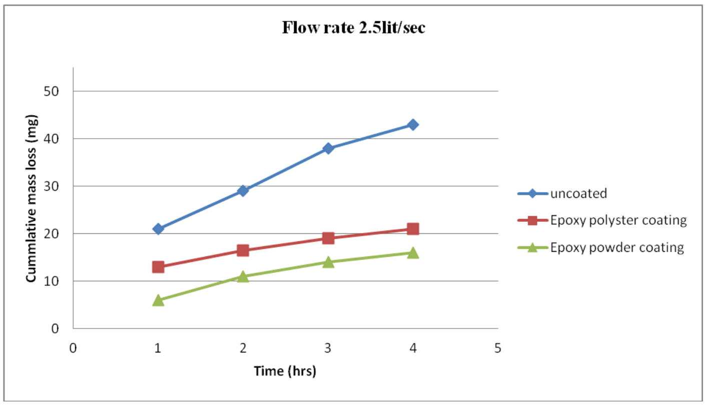

Figure 7 Variation in cumulative weight loss with respect to time at 60° impact angle

During the experimentation on 18Cr8Ni with the velocity rate of 2.5l/sec with an striking angle of 60 degrees there is a increased in metal loss is observed with increased velocity rate. During the experimentation work in first two hours there is loss of 5 mg of metal in epoxy powder coating whereas as this loss of metal is higher in epoxy polyester coating about 12 mg. While the loss of metal in uncoated metal strip of 18Cr8Ni is about 21 mg.

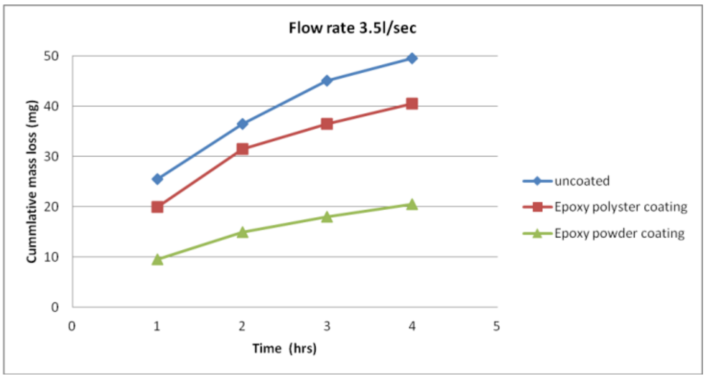

Figure 8 Variation in cumulative weight loss with respect to time at 60° impact angle

In the third factor with velocity rate of 3.5l/s with same angle of striking the resistance of epoxy powder is much higher as compared to the epoxy polyester coating. During the experimentation of duration of 4 hours the loss of metal in epoxy powder coating is of 20 mg while the readings for epoxy polyester and un-coated strip of 18Cr8Ni metal strip is 40 mg and 48 mg. At lower angles, the effect of bond strength of coating is more than at normal angles

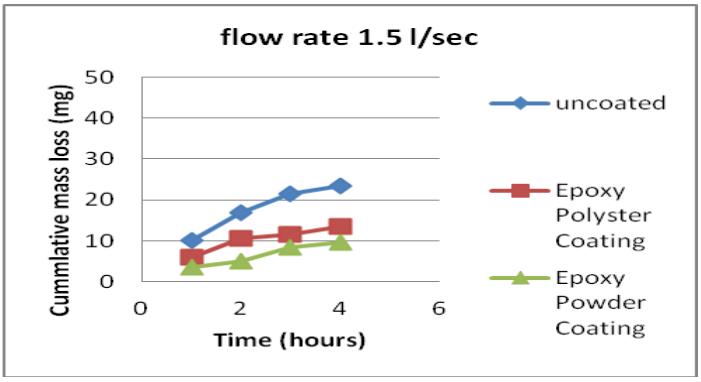

Figure 9 Variation in cumulative weight loss with respect to time at 90° impact angle

During the experimentation on 18Cr8Ni with the 1.5l/sec epoxy powder coating shows higher resistance against erosional wear during the experimentation work of gap of each of 1 hour epoxy powder coating shows increased resistance of erosion wear as compared to epoxy polyester and uncoated 18Cr8Ni metal base with the minimum weight loss of 9.8mg during experimentation work of 4 hours.

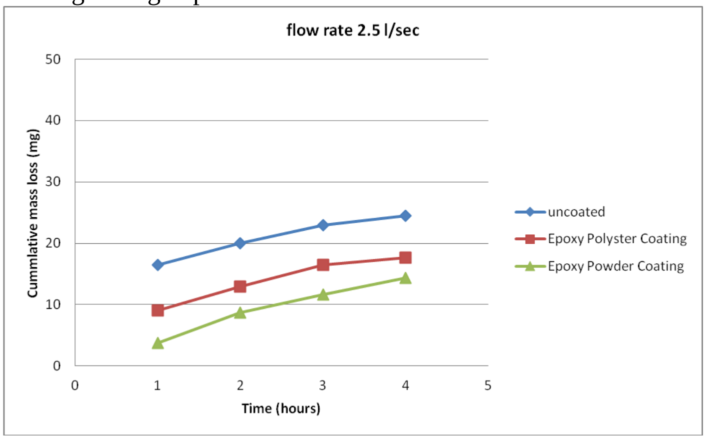

Figure 10 Variation in cumulative weight loss with respect to time at 90° impact angle

During the experimentation on 18Cr8Ni with the velocity rate of 2.5l/sec with an striking angle of 90 degrees there is a increased in metal loss is observed with increased velocity rate. During the experimentation work in first two hours there is loss of 14 mg of metal in epoxy powder coating whereas as this loss of metal is higher in epoxy polyester coating about 18 mg. While the loss of metal in uncoated metal strip of 18Cr8Ni is about 25 mg.

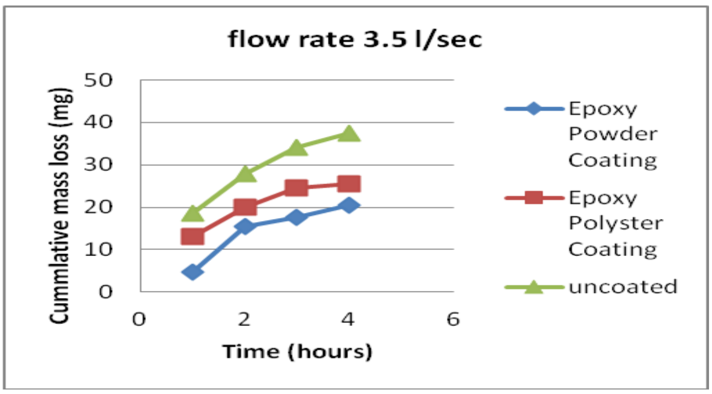

Figure 11 Variation in cumulative weight loss with respect to time at 90° impact angle

In the third factor with velocity rate of 3.5l/s with same angle of striking the resistance of epoxy powder is much higher as compared to the epoxy polyester coating. During the experimentation of duration of 4 hours the loss of metal in epoxy powder coating is of 20 mg while the readings for epoxy polyester and un-coated strip of 18Cr8Ni metal strip is 25 mg and 37 mg.

EFFECT OF TIME ON EROSION WEAR

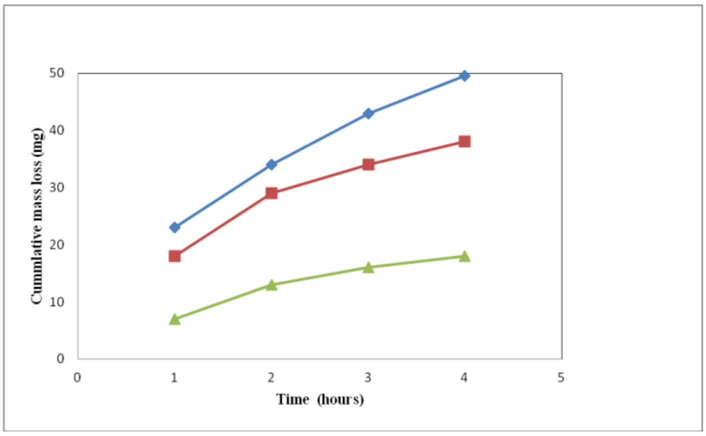

Figure12 Variation in weight loss with respect to time.

The weight loss of uncoated steel is nearly equal in all time intervals and show maximum weight loss. Both coatings shows higher wear initially intervals and then reduction in wear in lateral time intervals. Epoxy Powder coating shows a superior erosion wear resistance than both Epoxy Polyester coated and uncoated steels.

V. CONCLUSION

Coatings of Epoxy Polyester and Epoxy powder using the powder coating method were possible on 18Cr8Ni steel. During the experimentation work both coatings show better performance than uncoated steel in all conditions in which erosion wear test was performed..Epoxy Powder coating shows the minimum wear as among the other Epoxy Polyester coating and uncoated, 18Cr8Ni base steel. Maximum erosion wear was reported at 30° impact angle and minimum at 90°. Epoxy Powder coated steel shows approximately 3 times better performance than uncoated 18Cr8Ni steel base. Erosion wear rate with both epoxy polyester and powder coating is observed higher in initial running hours and reduces with respect to time. The erosion of uncoated steel under normal impact is due to platelet mechanism but for coatings under similar condition is due to crack formation.

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