Erosion Analysis on Copper Fly-Ash Composite

P. Balamurugan, M. Uthayakumar, S. Vigneshwaran, H. Akilan, N. Krishnakumar, Vigneshpandikumar

Abstract - In the present study, solid particle erosion behaviour on copper – fly ash composite is studied. Composite with addition of 2.5 (wt.%) fly ash as reinforcement is prepared through powder metallurgy(P/M) technique. Solid particle erosion studies were carried out by varying the input parameters such as erodent velocity and erosion time. The results revealed that addition of fly ash reduced the resistance to erosion.

Keywords* : *Copper, Erosion, Fly ash.

I. INTRODUCTION

Solid particle erosion is one of the prominent wear occurs on the inner surfaces of gas pipelines and control valves, compressors, vanes of the ID and FD fans[1]. It results in material loss on the surface due to particles in the flowing media generally air. Various of parts of aero engines[2] experience high erosive wear due to dust particles and salt crystals in air which comes along with the air stream during operation. To improve the resistance towards erosion, various researchers are providing solutions such as coating of the surfaces with hard reinforcements, metal matrix composites with ceramic reinforcements[3] etc. The parameters which affects the erosion behaviour are impact angle, velocity of particle, stand-off distance, particle shape, size and strength of the particle[4]. Fly ash is one the promising reinforcement material to the metal matrix composite, since it increases the strength, wear resistance and hardness when added to a ductile matrix such as aluminium or copper[5]–[7].

In the present study an attempt has been made to find the erosion behaviour on copper fly ash composite with varying velocity of impingement, erosion time and percentage reinforcement.

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II. MATERIALS AND METHODS

Copper powder (99.7% purity) obtained from Otto Chemicals, India is used as the matrix. Fly ash obtained from Thermal Power Station located in Tuticorin, India is used as reinforcement. The chemical composition of fly ash is shown in the Table-I

Table-I: Composition of Fly ash

Composition	**Percentage**
Al_2O_3	25%
Fe_3O_4+Fe_2O_3	5%
SiO_2	62%
MgO	1%
CaO	2%
Unburnt Carbon	4%
Traces	Remaining

Two different compositions of specimens were prepared using P/M Route, with 0, 2.5 and 5(wt%) fly ash as reinforcement, first the powders of required weight is measured using the Mitutoyo digital weighing balance of accuracy 0.1milligrams. The measured amount of powders is mixed manually using mortar, a small amount of acetone is added with mixture for better mixing of the powders. After through mixing, the blended mixture is poured in to a single action compaction die for compaction. The compaction is done under a pressure of 500MPa. Before compaction the mixture is heated to 150°C to remove the moisture. After compaction, the sintering of the green compact is done at 950°C for a period of 30 minutes.

III. RESULTS AND DISCUSSION

Fig. 1(a-c) shows the erosion behaviour of the pure copper and the copper – fly ash composite tested with the erodent flowing at velocities ranging from 100m/s to 200 m/s. The results indicate that the addition of fly ash increases the erosion rate irrespective of the other parameters. During erosion, the erodent hits the exposed surface with high velocity which create a impact force on the surface. Because of this impact three cases of phenomenon are possible, one is that the erodent may stick in to the material, if the material is soft and ductile.

The second case may be the erodent can remove a small amount of material when it comes in contact with the surface like localized machining. The third may be erodent when it hits the interface of the hard reinforcement and a ductile matrix, it creates localized stress at the interface which may lead to crack formation and ultimately results in the particle earlier. The erosion rate is calculated based on the difference in mass before and after the erosion test.

The results indicate that as the erosion time increases the mass of material removed from the specimen in pure copper specimen is lower when compared to composite specimen. Since as the erodent hits the composite specimen, more material removal is take place due to the fly ash particle comes out from the matrix. As the erodent velocity increases

pull out from the matrix. The removal the erodent adhered to the soft exposed surface is also possible since when the erodent flow is continuous, the erodent hits on the later time may remove the erodent which already adhered in the softer areas similar to the third phenomenon explained

the force created by the erodent on the surface increases, this leads to increase in erosion rate as the erodent velocity increases for both pure copper and composite. As the sliding velocity increases from 100 m/s to 150 m/s, the erosion rate nearly doubled. The Fig. 2 and Fig. 3 shows the surfaces of the composite exposed to 100m/s and 200m/s for a period of 20minutes.

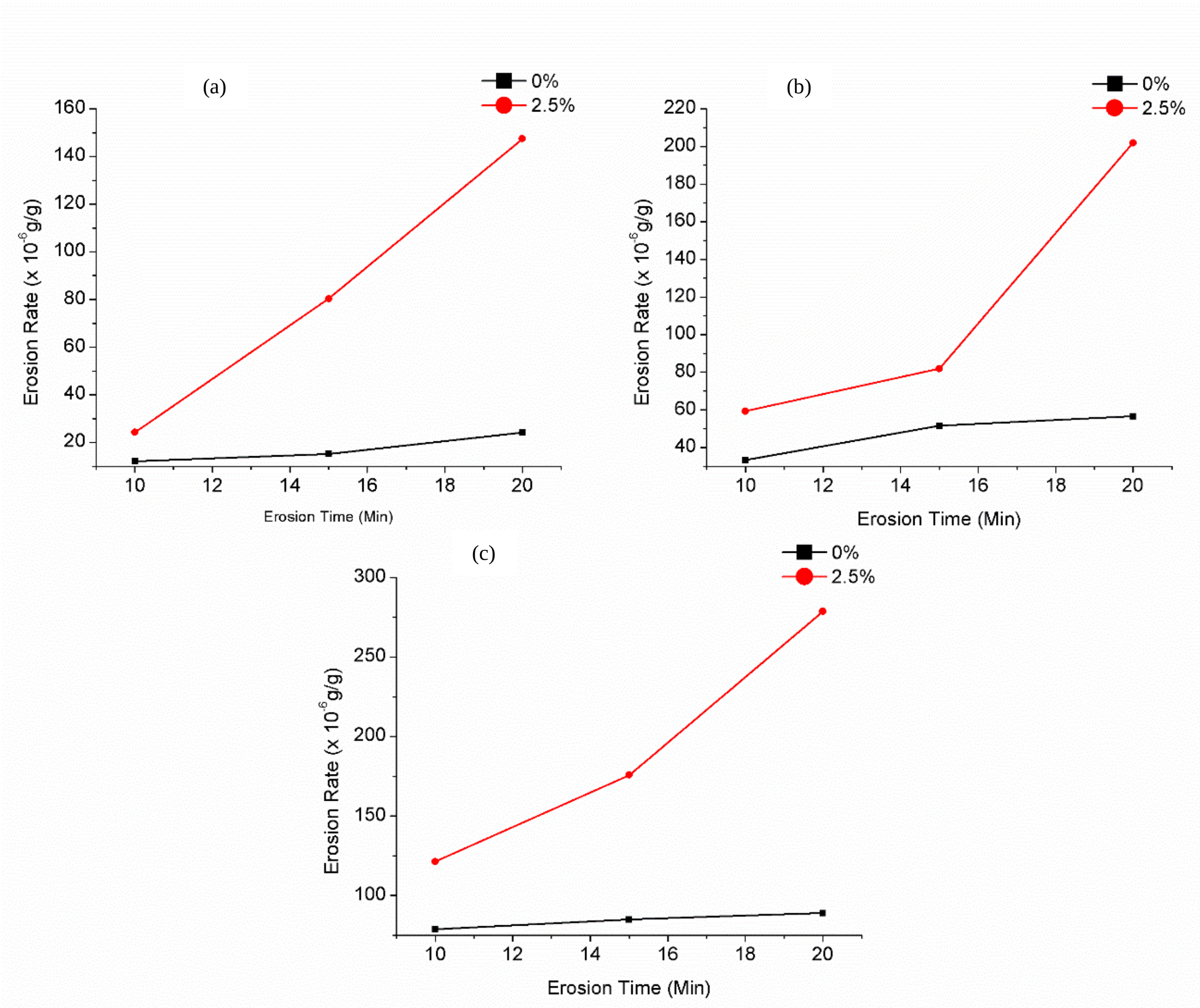

Fig. 1. Erosion studies under different erodent velocities:(a) 100 m/s, (b)150 m/s & (c) 200 m/s

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- As the erodent velocity increases the erosion rate increase
- The addition of fly ash adversely affect the erosion behaviour
- More pits are formed on the surface of the composites with the addition of fly ash as well as with the increase in erodent velocity

- Erosion time also significantly affects the erosion rate

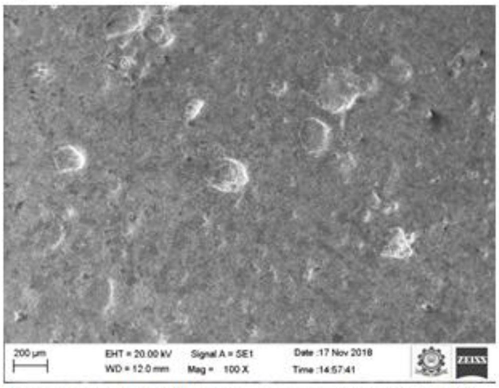

Fig. 2. Eroded surface of composite at 150 m/s for 20 min

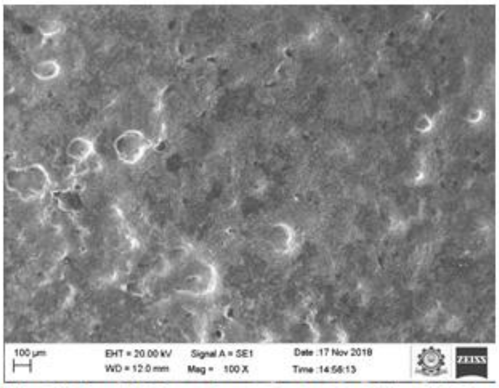

Fig. 3. Eroded surface of composite at 200 m/s for 20 min

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