International Journal of Engineering Sciences Paradigms and Researches [Volume 47, Issue: Special), March 2018]
www.ijesonline.com ISSN (Online): 2319-6564

Effect of Furnace Temperature on the Tribological Behavior of Plunger-Produced Metal Matrix Composites

Sanjay Kumar Behera
,Raajdhani Engineering College, Bhubaneswar
sanjaybehera@rec.ac.in

Abstract

Researchers are paying more and more attention to developing novel low-density composites using inexpensive manufacturing techniques. Metal-matrix composites (AMMC) with an aluminum basis provide solutions for developing new products. The low-cost, very successful approach for producing aluminum-based metal-matrix composites (AMMC) via a liquid process is called plunger technology. Al-2Mg-10SiC composite was produced using a weight-percentage method using plunger technology at various furnace temperatures, including 7000C, 8000C, and 9000C. Samples are gathered using the "pin on disc" method for dry sliding wire, and the outcomes are examined.

Keywords: Aluminum metal matrix composites, Plunger Technique, dry sliding wire, wear rate.

1. INTRODUCTION:

Light weight and high performance composites are used for different industrial, automotive and aerospace applications. SiC particles are uniformly distributed in Al-Mg melt matrix using plunger technology [1-3,21-22]. Here plunger rods are used to incorporate uniformly the particles inside the melt. The most commonly used composite system with the metal matrix Aluminum-Mg alloy reinforced with silicon carbide prepared an aluminum-metal matrix composite through liquid route. Here the SiC particles are uniformly distributed in the Matrix melt which provides homogeneous mixture so that properties are uniform throughout [4-7]. An aluminum-alloy has excellent mechanical properties such as low density, higher thermal conductivity, strength to weight ratio, good ductility, and corrosion resistance, among others [8-9, 21-22]. Aluminum-alloys have high strength and areused in aeronautics as well as all automotive sectors. The addition of SiC to matrix aluminum improves strength and mechanical-thermal properties. The hard particles of SiC increase the strength of the composite so that its wire properties improve which is used for load sustaining components [10-11]. In the stir-casting method, the ceramic reinforcement, i.e., silicon carbide melted with aluminum metal-matrix, achieved improved properties of the composites [12-13]. All mechanical components that slide or roll, like brakes and clutches, bearings, piston rings, terrain, gears, guides,

and seals, are exposed to wear[14-15]. The Pin-On–Disc method where pin is the

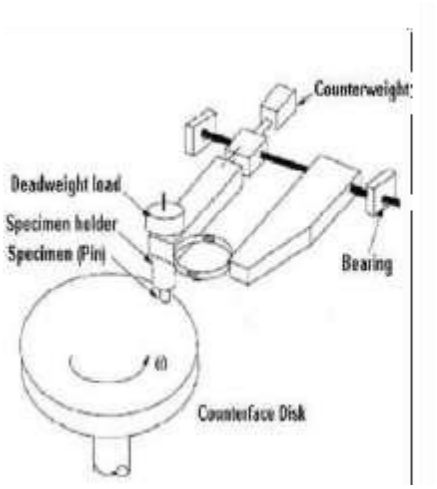
Sample for the wear test

Pin-on-Disc Wear test Apparatus

tribological behavior of the prepared composite was tested in dry sliding condition where the pin is made of the sample Al-1%Mg-10%SiC composites [16-20]. Dry sliding wire was conducted on pin-on-disc method to the samples of aluminium-1%Mg-silicon carbide manufactured at three furnace temperatures such as 700^0C, 800^0C, 900^0C. The wire rate was calculated for the Aluminum based metal-matrix composites (AMMC) and the wire properties are compared at different sliding distance.

2. EXPERIMENTAL PROCEDURE:

Aluminium-1%Mg-silicon carbide composite was manufactured by plunger technology which has been published elsewhere. Here plunger rods are used to introduce silicon carbide particle to the Al-Mg alloy melt and the composites are manufactured as per required composition. The furnacetemperature has great influence on hardness and wear properties. Sliding wear is conducted in dry condition using sample. The instrument used is DUCOM-PIN- ON-DISC apparatus as shown in Figure-1 and Figure-2. The pin (sample) and disk (EN31 steel) was cleaned by Emory paper so that smooth contact will take place between pin and disk. The test was conducted using the standard ASTM G-99 at room temperature. The mass loss of the sample made of prepared composite is calculated by measuring the initial mass and final mass using the weight balance. The wire rate is calculated using the formula 1.



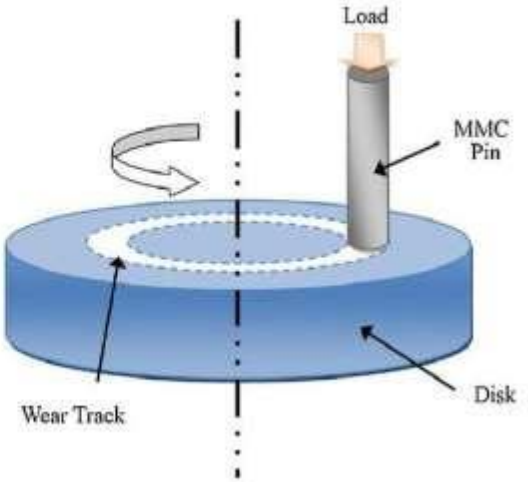


Figure 2- Spin-on-disk apparatus schematic diagram

The samples of size length 30mm and diameter 10mm was fitted as pin and EN31 steel was taken as disc. The dry sliding wire test was conducted at sliding velocity 2m/s and load 20N for different sliding distance such as 500m, 700m, 900m, 1100m, 1300m, 1500m. The wire rate was calculated as follows.

The wear rate (W_r) of the materials were calculated by

$$Wr = \frac{\Delta w}{L\,p} \quad \text{In } mm^3/m \text{.....(1)}$$

Where Δw= weight loss of the pin (AMMC) in mg.

L= sliding distance in meter

ρ = density of the AMMC in mg/mm^3

3. RESULT AND DISCUSSION:

The samples were tested for different sliding speed and the results are shown in three tables givenbelow such as Table-I, Table-II and Table-III.

Table I: Furnace Temperature 700^0C, Load 20N, Sliding Speed 2 m/s.

Exp no	Sliding distance (L)	Wear rate(Wr)[mm 3/m (× 10–3)]
1	500m	2.8632
2	700m	2.5691
3	900m	2.3326
4	1100m	2.1246
5	1300m	1.9984
6	1500m	1.7126

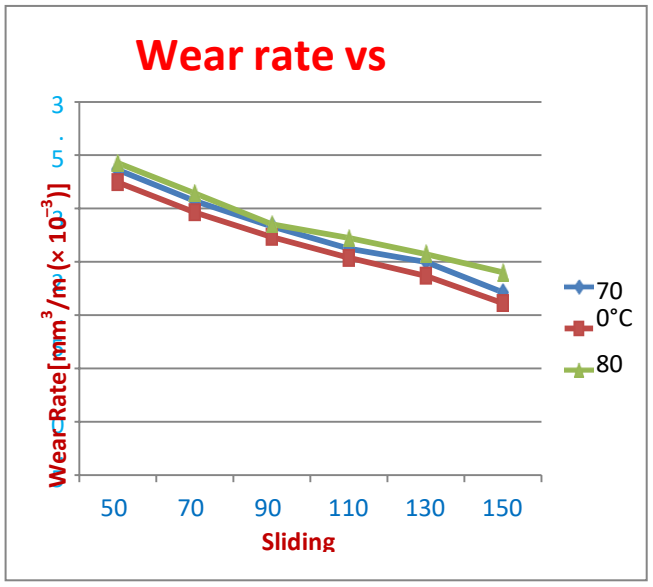
Table II: furnace temperature 800^{0}C, Load 20N, sliding speed 2m/s.

Exp no	Sliding distance	Wear rate [mm3/m (× 10–3)]
1	500m	2.7451
2	700m	2.4632
3	900m	2.2326
4	1100m	2.0359
5	1300m	1.8672
6	1500m	1.6111

Table III: Furnace Temperature 900^{0}C, Load 20N, Sliding Speed 2 m/s.

Exp no	Sliding distance	Wear rate [mm3/m (× 10–3)]
1	500m	2.9256
2	700m	2.6432
3	900m	2.3529
4	1100m	2.2228
5	1300m	2.0724
6	1500m	1.8999

The wire rate vs. sliding distance curve was shown in figure 3.



4. CONCLUSION:

1. AMMC was produced successfully using plunger technology.
2. The product was manufactured at different temperature and tested for dry sliding wire whichis highly useful in automobile industries.
3. The wire rate is much less as compared to the base metal aluminum.
4. The wire rate of the AMMC manufactured at 800^{0}C is less as compared to the manufactured at 700^{0}C and 900^{0}C.
5. The result may be standardized for industrial use.

ACKNOWLEDGEMENT

The authors are thankful and submit their gratitude to the Management of Nalanda Institute ofTechnology for their co-operation and support to complete the project.

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