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# Furnace Temperature Effect on Tribological Behavior of Metal Matrix Composites Produced By Plunger Technology

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## Abstract

There is a growing attention among researchers to the production of new composites with low- density and low-cost processes. Aluminum based metal-matrix composites (AMMC) offer solutions for new product development. Plunger technology is the low cost high effectiveness method for production of Aluminum based metal-matrix composites (AMMC) by liquid route. Al-2Mg-10SiC composite was manufactured by plunger technology with weight percentage at different furnace temperature such as 700$^0$C, 800$^0$C, 900$^0$C. The samples are collected for dry sliding wire on "pin on disc" method and the results were analyzed.

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 are used 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 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$^0$C, 800$^0$C, 900$^0$C. 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 furnace temperature has great influence on hardness and wear properties. Sliding wear is conducted in dry condition using Pin-On–Disc method where pin is the 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 prepaired composite is calcul;ated by measuring the initial mass and final mass using the weight balance. The wire rate is calculated using the formula 1.


**Figure1-** Sample and pin-on-disc wear-test apparatus for the wear-test.

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.

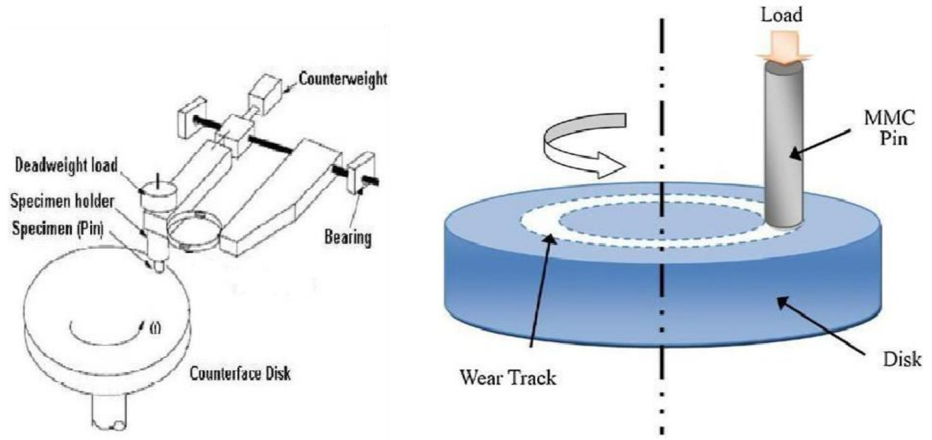


Figure 2- Spin-on-disk apparatus schematic diagram

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

$$\mathbf{W_r = \Delta w/L\rho} \quad \text{in } mm^3/m \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

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 given below such as Table-I, Table-II and Table-III.

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

| Exp no | Sliding distance (L) | Wear rate(Wr)[mm3/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 8000C, 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 9000C, 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.

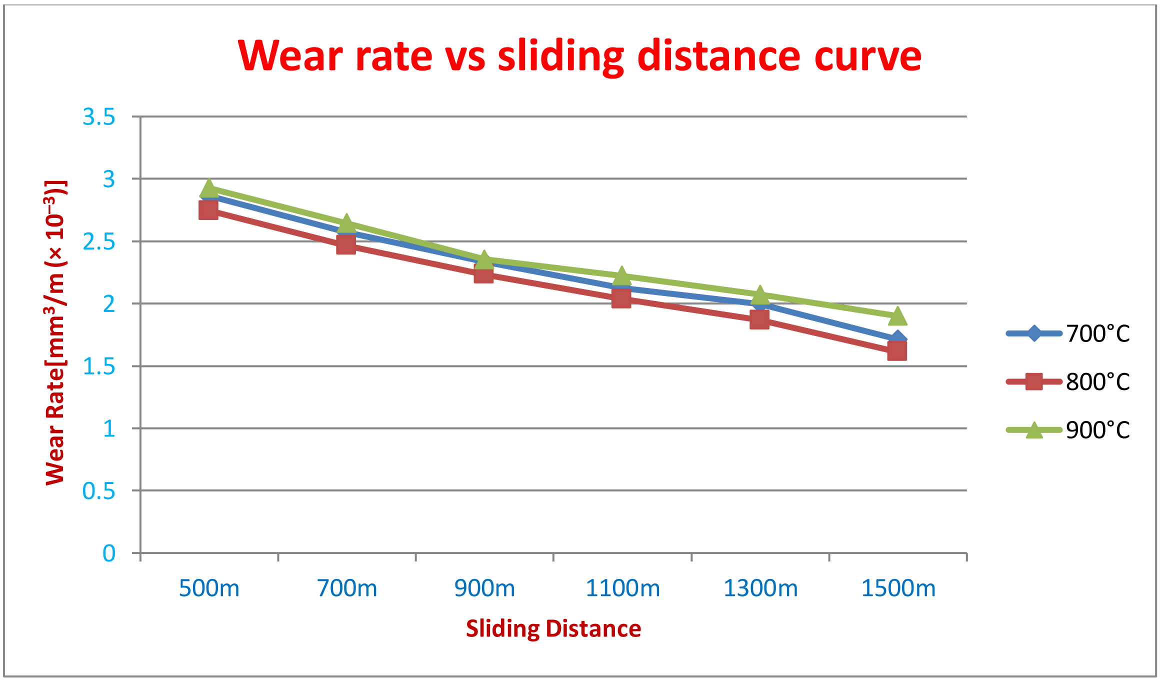


Figure 3- Graph for wire rate vs Sliding Distance

## 4. CONCLUSION:

1. AMMC was produced successfully using plunger technology.
2. The product was manufactured at different temperature and tested for dry sliding wire which is 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 8000C is less as compared to the manufactured at 7000C and 9000C.
5. The result may be standardized for industrial use.

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