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Studies on the Influence of Fe on Mechanical And Tribological Properties of As Cast, Cast Aged $Al25Mg_2Si2Cu4Fe$ Alloy

D. G. Sondur[a*], M.D. Harlapur[b] and C. Sateesha[c]

[a*]Research Center, Department of Mechancial Engineering, R.T. E. Society's Rural Engineering College, Hulkoti, 582205, Karnataka, India.
[b]Research Center,Department of Mechancial Engineering, R.T. E. Society's Rural Engineering College,Hulkoti, 582205,Karnataka, India.
[c] Department of Mathematics, R.T. E. Society's, Rural Engineering College Hulkoti-582205, Karnataka, India.
*Corresponding Author: email: dgsondur_tce@yahoo.co.in

Abstract

This paper covers the studies carried out on the tribological behavior of $Al25Mg_2Si2Cu4Fe$ alloy under dry sliding conditions. $Al25Mg_2Si2Cu4Fe$ alloy in the ingot form was cut into wear test pin specimens and treated for solutionizing and homogenizing heat-treatment. Results from wear test and optical microstructure studies were carried out. In the present paper, wear resistance has been studied to determine the effect of artificial ageing on Al6061 alloy. However, under identical heat treatment conditions, the precipitation hardened alloy exhibited better wear resistance in comparison with as-cast alloy.

Keywords: Volumetric wear rate, sliding speed, friction coefficient, solutionizing.

1. Introduction

Highly alloyed 6xxx series alloys have complex intermetallic phases that originate from the casting stage in the form of ingot. Since iron is the only present impurity having very low solubility in aluminium, iron rich phases are seen in aluminium alloys that adversely affect the ductility and castability. Presence of copper, manganese leads to the formation of (Fe, Mn, $Cu)_3SiAl_{12}$ phase. Mg_2Si is the other phase that easily dissolves during solutionizing and contribute to the precipitation hardening process. Addition of copper leads to the formation of metastable phases and precipitates in the supersaturated solid solution such as β'(Mg_2Si), β''(Mg_2Si) along with 'Q' phase with specific properties [1]. Formation of complex intermetallic phases adversely affects the tensile strength of the alloy. These alloys contain Al, Mg and Si, however Cu is added to them to increase their ability to age harden so that their strength increases. This strength needs to be increased further to increase their performance at higher temperature. It is shown that increasing copper results in decrease in the equilibrium

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solidus from 540^{0}C to 505^{0}C. Iron is bound in the quaternary $Al_8FeMg_3Si_6$ phase in low iron alloys and in the ternary Al_9FeNi and Al_5FeSi phases in high iron alloys [2]. Copper forms $CuAl_2$ phases and other intermetallic compounds that increase strength. [3].

2. Experimental details

Alloy was formed by casting an ingot by melting process. Sample pins for as cast samples were prepared by machining and cast aged samples were prepared by first solutionizing the ingot and then homogenizing the pins. As cast and cast aged samples were examined by optical microscopy, SEM attached with energy dispersive x-ray analysis. All the pin samples were tested on pin-on-disc wear testing machine supplied by DUCOM instruments, Bangalore, India.

Chemical composition of the alloy is given in table 1.

Table 1 Shows chemical composition of the alloy

Alloy	%Si	% Fe	%Cu	%Mg	%Al
Al-25Mg_2Si-2Cu-4Fe	13.68	5.01	2.61	23.2	Balance

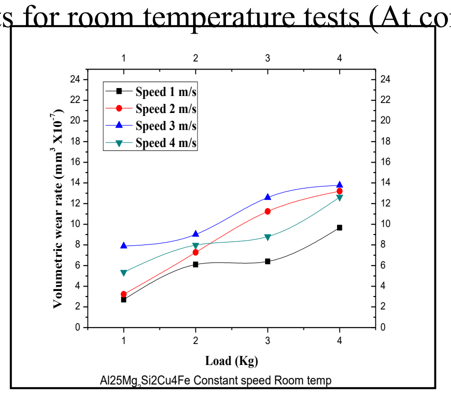
2.1. Dry sliding wear test

The wear test is carried out using a pin-on-disc type wear-testing machine (DUCOM, Bangalore, India) according to ASTM: G99-05 (ASM, 1992) standard. Wear specimen of size 30mm length and 10mm diameter are machined from differently processed samples.

3. Results and discussion

3.1. Wear test: Volumetric wear rate

Results for room temperature tests (At constant sliding speed and constant load)



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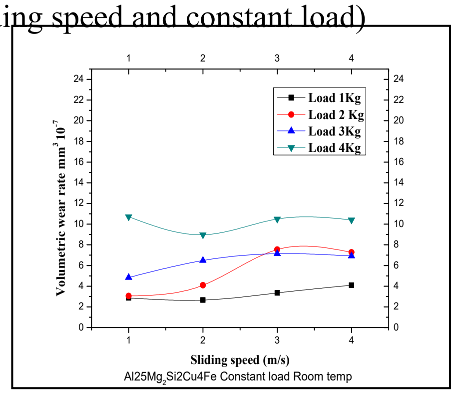

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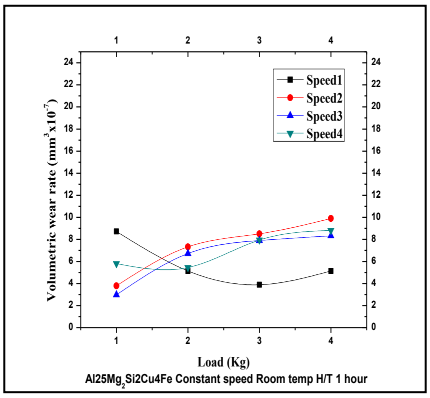
(c)

Fig. 1 Volumetric wear rate at (a) constant speed, (b) constant load and (c) Microstructure without heat-treatment

Result: Volumetric wear rate is observed to be sensitive to the change in the sliding speed and not the change in the load.



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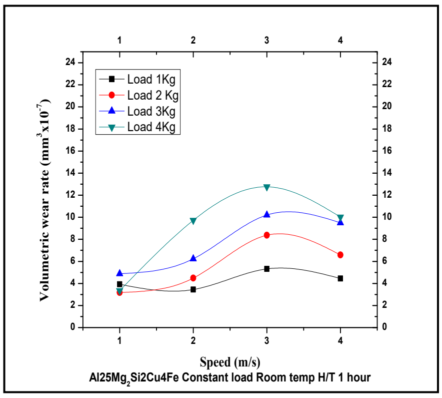

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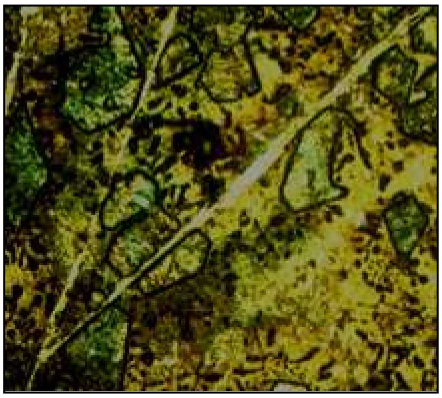
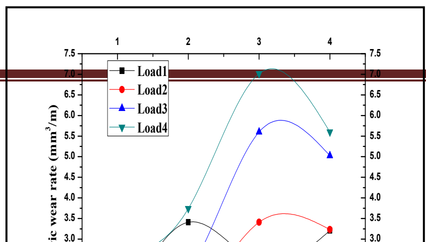
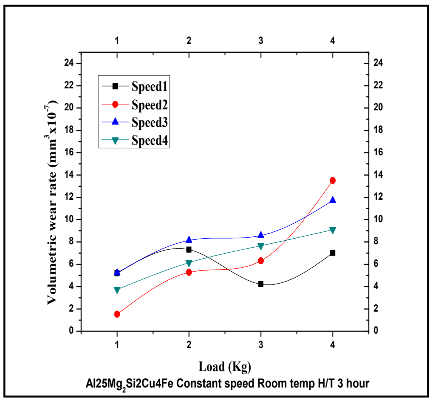


(c)

Fig. 2 Volumetric wear rate at (a) constant speed, (b) constant load and (c) Microstructure 1 hour homogenizing

Result: Volumetric wear rate remains unaffected at lower sliding speed and lower load.





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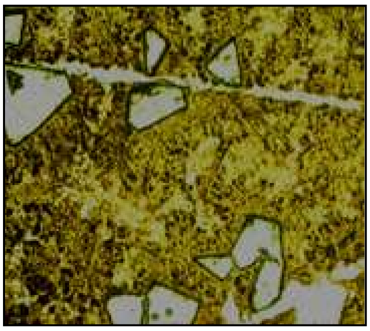
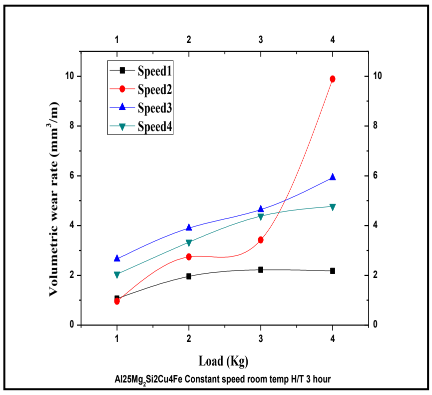


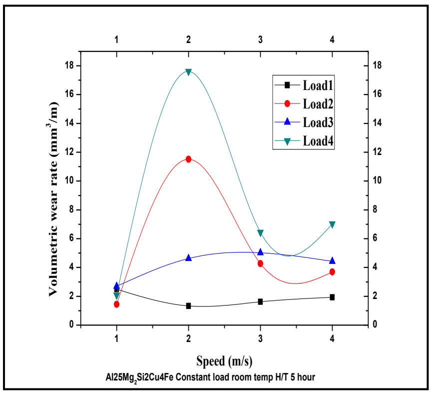
(c)

Fig. 3 Volumetric wear rate at (a) constant speed, (b) constant load and (c) Microstructure 3 hour homogenizing

Result: Overall volumetric wear rate is observed to be lower at 3 hour homogenizing heat treatment compared to those non heat-treated samples. However, an increasing trend is observed for constant load with increase in the sliding speed.



(a)



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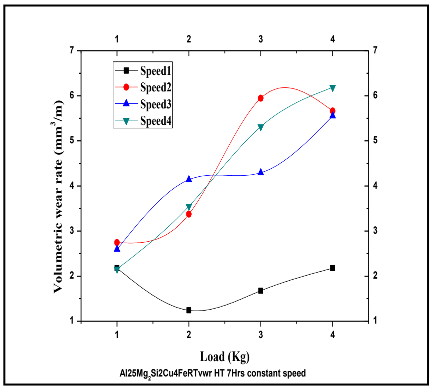
(c)
Fig. 4 Volumetric wear rate at (a) constant speed, (b) constant load and (c) Microstructure 5 hour homogenizing

Result: Overall trend is increase in the volumetric wear rate with increase in the load at lower sliding speeds.



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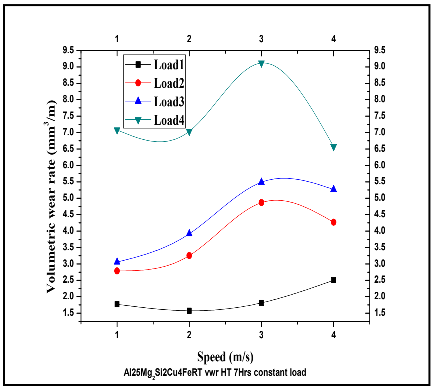

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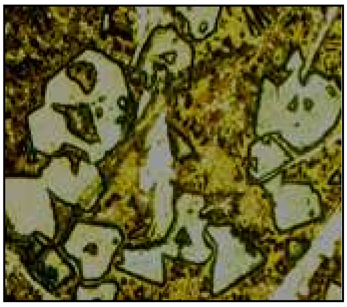

(c)
Fig. 5 Volumetric wear rate at (a) constant speed, (b) constant load and (c) Microstructure 7 hour homogenizing

Result: Volumetric wear rate for the 7 hour aged samples is minimum at lower sliding speeds and lower loads. For higher sliding speeds and loads volumetric wear rate increases.

Conclusion: Volumetric wear rate is sensitive to the load applied. With increase in load volumetric wear rate increases. At higher sliding speeds volumetric wear rate remains almost unaffected.

References

[1] Alireza Darvishi, Ali Maleki, Mehdi Mazar Atabaki, Mohammad Zargami, Association of Metallurgical Engineers of Serbia, AMES, UDC: .69.715'782.017.1.

[2] N.A.Belov, D.G.Eskin, N.N.Avxentieva, "Constituent phase diagrams of the Al-Cu-Fe-Ni-Si system and their application to the analysis of aluminium piston alloys", Acta Materials 53 (2005) 4709-4722.

[3] S.G.Shabestari, H. Moemeni, "Effect of copper and solidification conditions on the microstructure and mechanical properties of Al-Si-Mg alloys", Journal of Materials Processing Techanology 153-154 (2004) 193-198.

[4] E.Sjolander, S.Seifeddine, Material Science and Engineering A 528 (2011) 7402-7409

[5] Alireza Hekmat-Ardakan, Xichun Liu, Frank Ajersch, X. Grant Chen, "Wear behavior of hypereutectic Al-Si-Cu-Mg casting alloys with the variable Mg contents", WEAR, 269 (2010) 684-692.

[6] E.R. Wang, X.D. Hui, S.S. Wang, Y.F. Zhao, G.L. Chen, "Material Science and Engineering A 527 (2010) 7878-7884.