INTERNATIONAL JOURNAL OF RESEARCH IN MECHANICAL, MECHATRONICS AND AUTOMOBILE ENGINEERING(IJRMMAE)
ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 3, October – Dec. 2021 - www.ijrmmae.in – Pages 7-12

Studies on the influence of Ni on mechanical and tribological properties of as cast, cast aged Al25Mg_2Si2Cu4Ni alloy

M. D. Harlapur[1,*], V. M. Patil[2], Altaf Hussain M H[3]

[1*]Research Centre,Department of Mechanical Engineering, R.T.E.Society's, Rural Engineering College, Hulkoti, 582205, Karnataka, India,

[2], Department of Engineering Science, R.T.E.Society's, Rural Engineering College, Hulkoti, 582205, Karnataka, India,

[3]Department of Mechanical Engineering, R.T.E.Society's, Rural Engineering College, Hulkoti, 582205, Karnataka, India,

email: mdhrechulkoti@gmail.com*, email:vmpatilrec@gmail.com,
email: altaf.hussain867@gmail.com

Abstract

Cast Al-25Mg_2Si2Cu4Ni alloys have a widespread application, especially in the marine structures, automotive and aircraft industry due to their excellent properties. The main alloying elements Si, Cu, Mg and Ni partly dissolve in the primary α-Al matrix and to some extent present in the form of intermetallic phases. A range of different intermetallic phases may form during solidification, depending upon the overall alloy composition and crystallization condition. Their relative volume fraction, chemical composition and morphology exert significant influence on technological properties of the alloys.

Keywords: hardness, flow stress, plastic deformation,precipitates and friction coefficient.

1. Introduction

4000 series of Aluminium alloys with silicon as the major alloying element are mostly cast alloys. Most of the Al-Si cast alloys are intended for applications at temperatures less than about 250 ºC. **[1].** In general, large mismatch in lattice coherency contributes to an undesirable microstructure that cannot maintain excellent mechanical properties

ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 3, October – Dec. 2021 - www.ijrmmae.in – Pages 7-12

at elevated temperatures. **[2].** In the aluminium alloys besides the alloying elements, transition metals such as Fe, Mn and Cr are always present. Even small amount of these impurities cause the formation of a new phase component. Depending on the composition, a material may contain $CuAl_2$, Mg_2Si, $CuMgAl_2$, and Si as well as Al(Fe,M)Si particles, where M denotes such elements as Mn, V, Cr, Mo, W or Cu. During homogenization or annealing, most of the as-cast soluble particles from the major alloying additions such as Mg, Si and Cu dissolve in the matrix and they form intermediate-sized 0.1 to 1 μm dispersoids of the AlCuMgSi type. **[3].** Therefore, the particle characterization is essential not only for choosing the best processing routes, but also for designing the optimized alloy composition.Ni is usually employed with copper to enhance elevated-temperature properties. It also reduces the coefficient of thermal expansion. Nickel can be utilized to improve the hot hardness (up to 600 F) of aluminum-silicon (10 to 16 per cent silicon) casting and forging alloys. The maximum benefits are realized by developing a large volume and favorable distribution of nickel aluminide. The addition of more than the eutectic amount of silicon was not particularly helpful in improving hot hardness. **[4].** Alloys were produced by powders metallurgy. Characterizations results indicate that the microstructure of the aluminum-nickel alloys present a thin and homogeneous distribution of an intermetallic compound in the aluminum's matrix, identified as Al3Ni. Furthermore, it was found out that the amount of intermetallic Al3Ni increases as the nickel content in the alloy rises. **[5].**

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.

ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 3, October – Dec. 2021 - www.ijrmmae.in – Pages 7-12

Table 1 shows chemical composition of the alloy

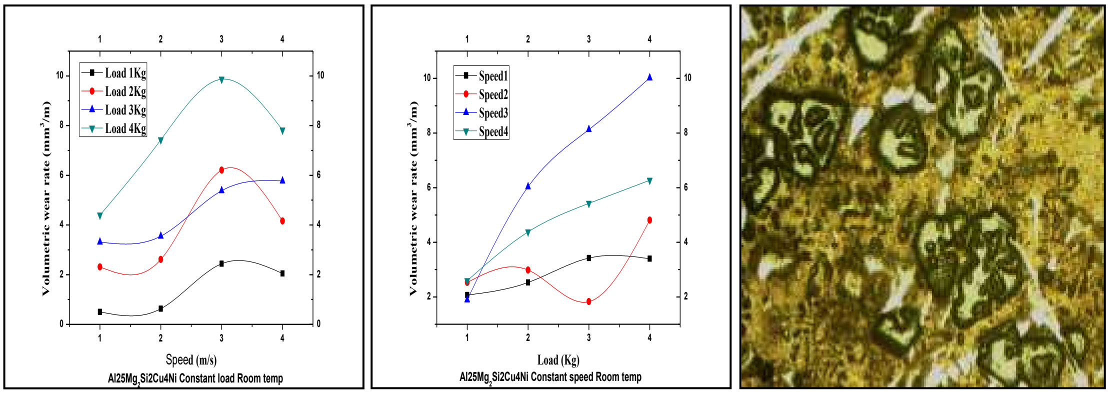
Alloy	%Si	% Ni	%Cu	%Mg	%Al
Al-25Mg_2Si-2Cu-4Ni	13.41	3.36	2.10	13.2	Balance

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 30 mm length and 10 mm diameter are machined from differently processed samples. The wear tests are carried out at sliding velocities for a fixed sliding distance of 2000 m at different normal loads.

3. Results and discussion

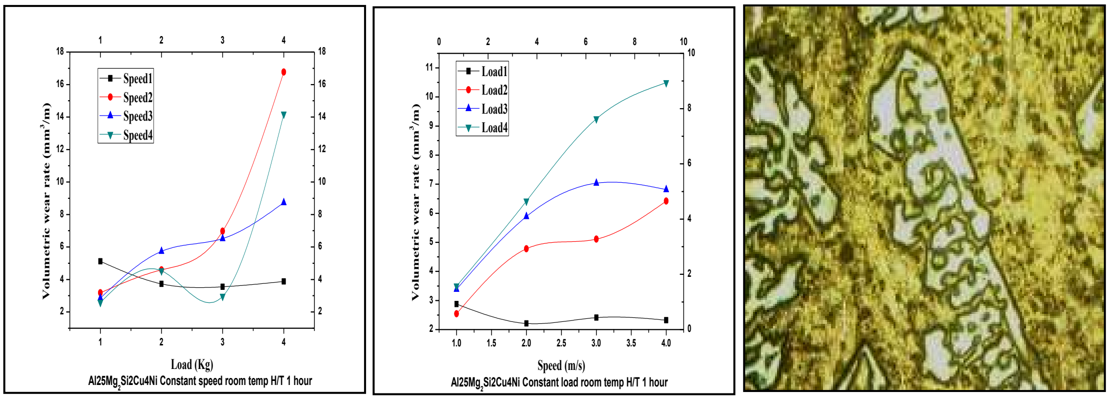
3.1 Wear test: Volumetric wear rate



(a) (b) (c)

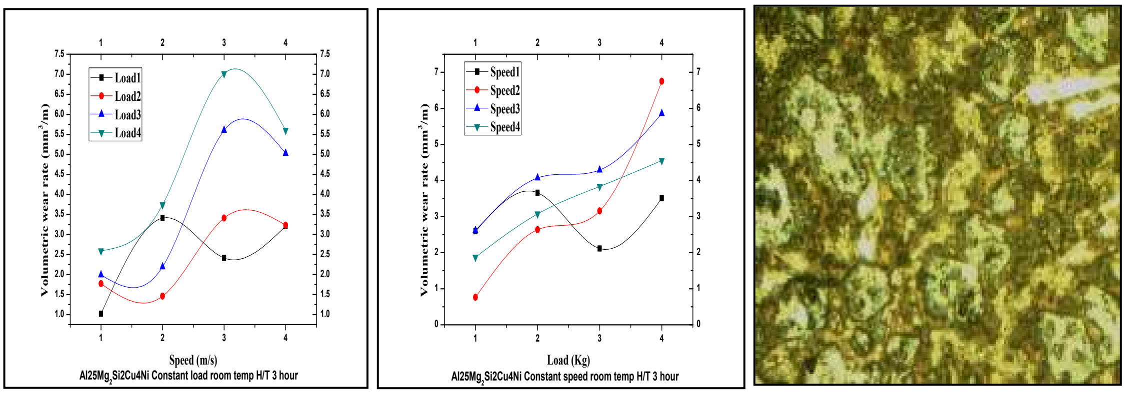
Fig. 1 Volumetric wear rate at (a) constant speed, (b) constant load and (c) Microstructure without heat-treatment

ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 3, October – Dec. 2021 - www.ijrmmae.in – Pages 7-12



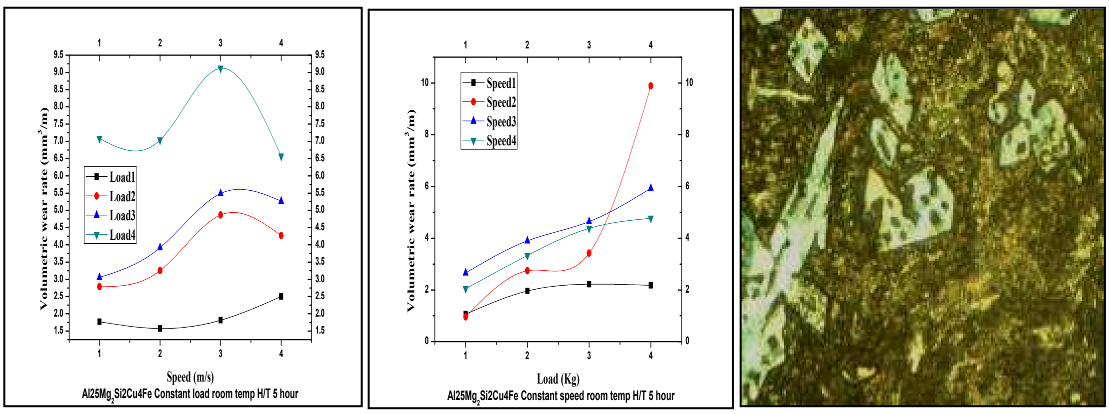
(a) (b) (c)

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



(a) (b) (c)

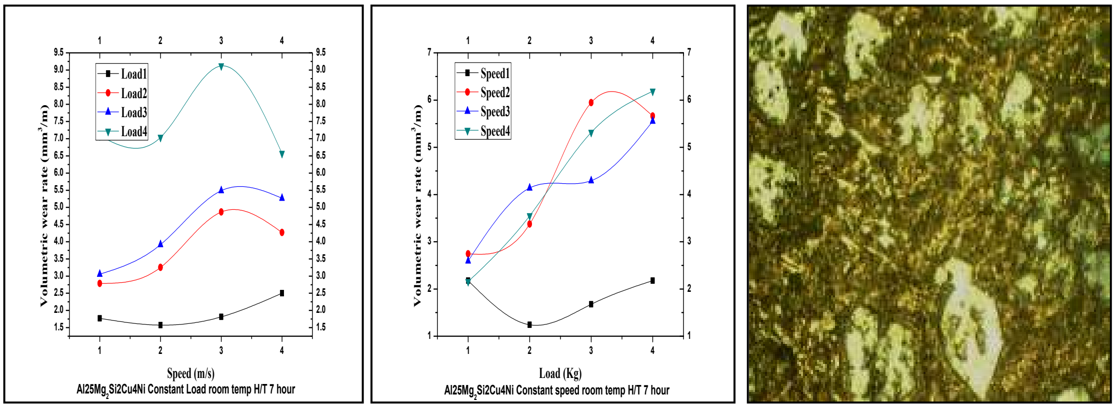
Fig. 3 Volumetric wear rate at (a) constant speed, (b) constant load and (c) Microstructre 3 hour homogenizing



(a) (b) (c)

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

INTERNATIONAL JOURNAL OF RESEARCH IN MECHANICAL, MECHATRONICS AND AUTOMOBILE ENGINEERING(IJRMMAE)
ISSN: 2454-1435 (Print) | 2454-1443 (online)
Volume 5 Issue 3, October – Dec. 2021 - www.ijrmmae.in – Pages 7-12



(a) (b) (c)

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

4. Results:

1. Volumetric wear rate increases with increase in the sliding speed. Fig. 1(b) shows volumetric wear rate increases with increase in the load across all the sliding speeds.

2. Volumetric wear rate is low for lower sliding speed, Fig. 2(b) shows volumetric wear rate is negligible at 1m/s sliding speed across all the loads.

3. Low volumetric wear rate at lower loads and with increase in the load it increases steadily and reaches maximum.

4. Volumetric wear rate is directly proportional to sliding speed and it increases with sliding speed.

References

1. D. Askeland, "The Science and Engineering of Materials," PWS-Kent Publishing Co.,Boston, 1989.
2. L. E. Samuels, "Metals Engineering: A Technical Guide," ASM International, Metals Park, OH,1988.
3. Soo. Woo Nam and Duck Hee Lee "The effect of Mn on the Mechanical Behavior of Al Alloys", Metals and Materials, Vol 6, p 13-16 (2000).
4. J .E. Hanafee, "Effect of Nickel on Hot Hardness of Aluminum-Silicon Alloys" Modern Castings, p 514-520,1968.
5. F. Hernandez-Mendez, A. Altamira no-Torres et "Effect of Nickel Addition on Microstructure and Mechanical Properties of Aluminum-Based Alloys", Material Science Forum , Vol 691, p 10-14, 2011
6. P.S. Wang, S.L. Lee, J.C. Lin, Effects of solution temperature on mechanical properties of 319.0 aluminum casting alloys containing trace beryllium Materials Research .15 (2000) 2027-2035.