International Journal of Innovative Studies in Sciences and Engineering Technology (IJISSET)

ISSN 2455-4863 (Online) www.ijisset.org Volume: 2 Issue: 7 | July 2016

Tribological Analysis of Aluminium-zinc Alloys by using Taugchi Method

Prof. D.A.Patil[1], Prof V.A.Jundale[2], Prof S.R.Dandwate[3]

[1]A Senior Lecturer at SRES KBP, Polytechnic, kopargaon, Maharashtra, India

[2] Assistant professor, SRES, Sanjivani College of Engineering, Kopargaon, Maharashtra, India

[3]Assistant professor, SRES, Sanjivani College of Engineering, Kopargaon, Maharashtra, India

Abstract: I*n this papereffect of load, sliding Velocity sliding time on frictionand wear behaviourof dry Aluminium- Zinc Alloys are studied. Al-Zn-2Cu-0.4Mn-(0-5) Si was prepared by permanent mould casting. Experiment were carried using a single pin type pin- on-disc machine sliding unidirectional against counter surface materialEN 31 steel.A plane of Experiment based on technique of Taugchi approach and L_9 orthogonal array.Regression analysis are carried out to find empirical relationship in the mathematical model used.It is observed that hardness, wear resistance andtensile strength increases with increasing silicon content, but the trend reserved later ones above 2.5% silicon The Alloy of Al-Zn-Cu-Mn-Si (2.5%) gives best performance and considered as a good tribo-material from friction point of view among the material used in this study.*

Keywords: *unlubricated friction, non-ferrous alloys, wear mechanism, taughci technique, regression analysis.*

1. INTRODUCTION

A number of zinc alloys such as ZA-5, ZA-8, ZA-12, ZA-27, ZA-40Al-2cu-2si, ZA-Mnetc. have been developed in wide research.These Alloys were generally found to be greater to the traditional bearing material including bronze, cast iron, plastics, steel etc.as far as their wear resistance concerned. Amongst them highest strength and wear resistance are obtained from the Zn-40Al-2cu,Zn-40Al-2si, Zn-40Al-2cu-2si Alloys. However the copper contains zinc based ternary and quaternary alloys showed low ductility and extensive amount of dimensional instability [1-5]. Recently it has been shown that these Problems can be overcome to a great extent by supplanting zinc with aluminum. Extensive research on the new Alloys resulted in the development of ternary Al-40Zn-3Cu and Al-25Zn-3Cu and quaternary Al-40zn-3Cu-2si Al-40Zn-3Cu-(1-3) Ni Alloys [6-10]. They are found to be comparable to the zinc based commercial Alloys as far as their strength and wear resistance are concerned but exhibited considerably higher ductility and lower dimensional change.

In this research it is observed that hardness, wear resistance, dimensional stability and tensile strengthof Al-25Zn-2cu-0.4Mn-(0-5) Si increased.

2. EXPERIMENTAL PROCEDURE

2.1 A preparation of Alloys

Alloys were prepared from commercially pure aluminum (99.7, high purity zinc (99.9%), electrolytic copper (99.99%), pure manganese (99.2%), and Si. Alloys were melted in an electric furnace and poured at a temperature of680^{0}C into a steel mould at a room temperature. The mould had a cylindrical shape with a length of 155mm, diameter of 16mm. The chemical compositions of the alloys were determined by atomic absorption analysis.

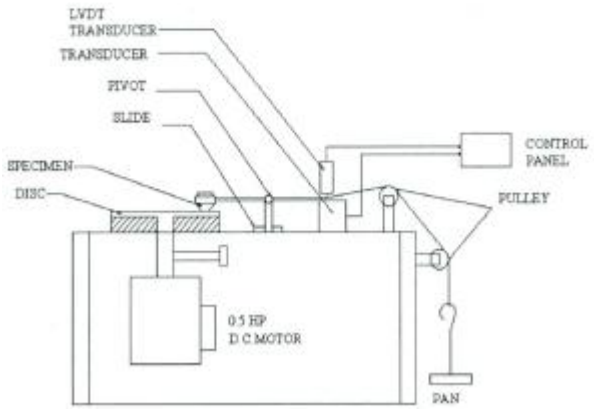

Fig 1: *A schematic diagram of the pin- on- disc machine*

2.2 Physical and mechanical tests

The densityof the alloys are determined by measuring their volume and mass. The Brinell hardness of the alloys was measured using load of 62.5 kg and a 2.5mm steel ball as the indenter. The tensile and compressive strengths of the alloys are measured using round the dimensions (diameter12.5mm, gauge length of 25mm) respectively, at a strain rate of 5.99 10-3 s-1.

At least three readings were taken to determine the density, hardness, tensile and compressive strengths and elongation to fracture of the alloys.

2.3 Friction andWear tests

The friction and wear tests were carried out using a pin- on- disc as shown in fig 1. The machine consists of a disc, pin (specimen)a mounting system, a loading system, friction force and temperature measurement system. The disc was made of EN 31 steel. The hardness of the disc was measured as ± 1hrc, afterthrough hardening and treatments.

Table1. *Levels to the variable as applicable practically*

Level	*Low*	*Medium*	*High*
Pressure, Mpa	0.374	0.749	1.124
Distanced D velocity m/s	1.047	1.570	2.094
Sliding time	30	60	90
Code	-1	0	+1

Friction and wear tests were performed under a constant pressure of 0.375Mpa, 0.749Mpa and 1.124 Mpa with a sliding speed of 1.047m/s, 1.57m/s and 2.94m/s.The friction and wear tests were carried outfor 30, 60, 90 min as shown in table1 [3-4].

2.4 Plan of Experiment

The experiments were conducted as per the standard orthogonal array. The selection of the orthogonal array based on the degrees of the freedom for the orthogonal array should be superior than to sum of those wear parameter. In the present study anL_9 array was chosen shown in table 2.

Table 2: *Model of the experimentation*

Trial No.	*A*	*B*	*C*	*Y=W*
1	-1	-1	-1	Y1
2 velocity m/s	-1	0	0	Y2
3	-1	+1	+1	Y3
4	0	-1	0	Y4
5	0	0	+1	Y5
6	0	+1	-1	Y6
7	+1	-1	+1	Y7
8	+1	0	-1	Y8
9	+1	+1	0	Y9

3. RESULTS AND DISUCUSSION

3.1 Physical and mechanical properties

The variation of the hardness, tensile and compressive strength, density and percentage elongation to fracture of Al-25Zn-2Cu0.4Mn-(1-5) Si Alloys as a function of silicon content are shown in fig.2

It can be seen that the tensile and compressive strength of the alloys showed three distinct changes with silicon content. These include an initial strident decrease with increasing Si content, a gradual increase between 0 and2.5% Si and sharp decrease once again at still higher contents. However their hardness increased continuously with increasing silicon content, although density and percentage elongation to fracture decreased [1-2].

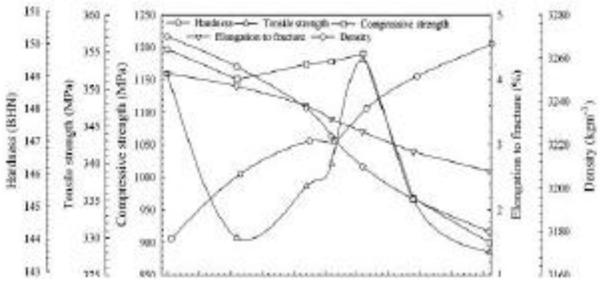

Fig 2: *The change in density, hardness,tensile and compressive strengths percentage elongation to fracture of the alloys with silicon content*

3.2 Friction and wear test results.

The friction coefficient and wear loss versus applied pressure curves for the alloys are shown in fig. 3, 4, 5, 6, 7, and 8 respectively. The friction coefficient of the alloys showed a sharp increases during the initial period of the test run and then reached almost constant levels. The wear loss increased almost linearly with increasing applied pressure. The change of the friction of silicon contentup to 2.5% above which the trend reverses.

From the figure 3, 4, and 5 it can be seen that the material B has lowest coefficient friction than material A and C.

From fig. 6, 7 and 8 it can be seen that the material B has lowest wear loss than material A and C.

Table 3: *chemical composition of alloys*

Alloy	*Zn*	*Cu*	*Mn*	*Al*
A	25.03	2.47	0.48	72.02
B	25.03	2.56	0.42	71.99
C	25.12	2.52	0.46	71.90

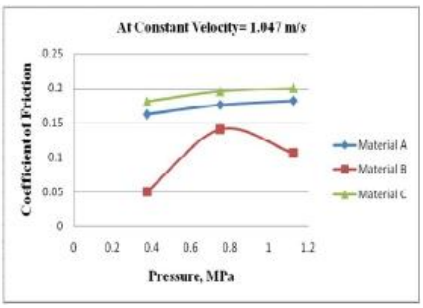

Fig 3: *coefficient of friction v/s pressure (At constant V= 1.047 m/s)*

ISSN 2455-4863 (Online) www.ijisset.org Volume: 2 Issue: 7 | July 2016

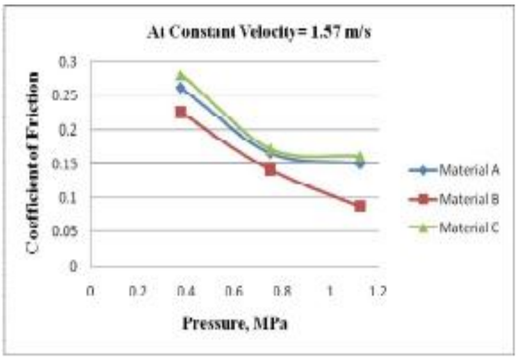

Fig 4: *coefficient of friction v/s pressure (At constant V= 1.57 m/s)*

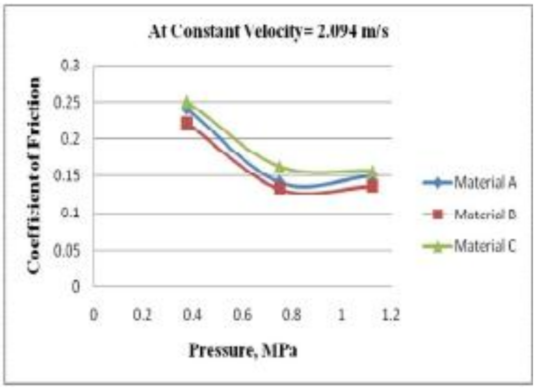

Fig 5: *coefficient of friction v/s pressure (At constant V= 2.094m/s)*

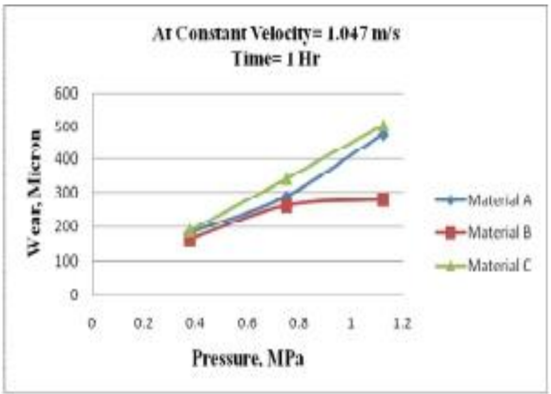

Fig 6: *Wear loss V/s pressure (At constant V= 1.047m/s)*

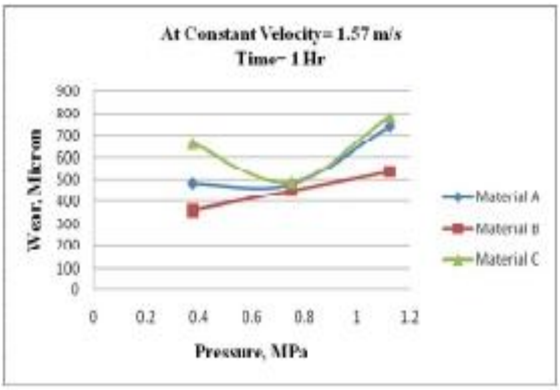

Fig 7: *wear loss v/s pressure (At constant V= 1.57m/s)*

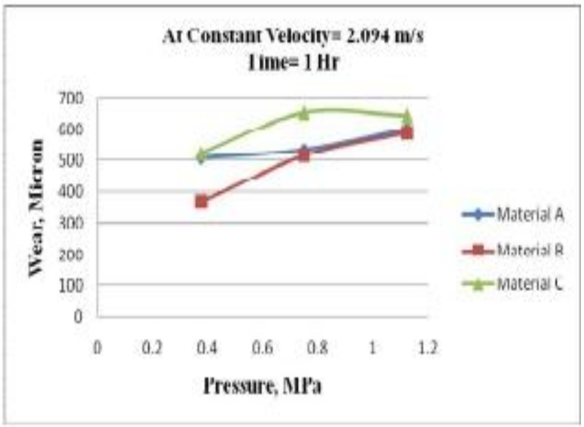

Fig 8: *wear loss v/s pressure (At constant V= 2.094m/s)*

3.3 Comparison of measured and predicted wear

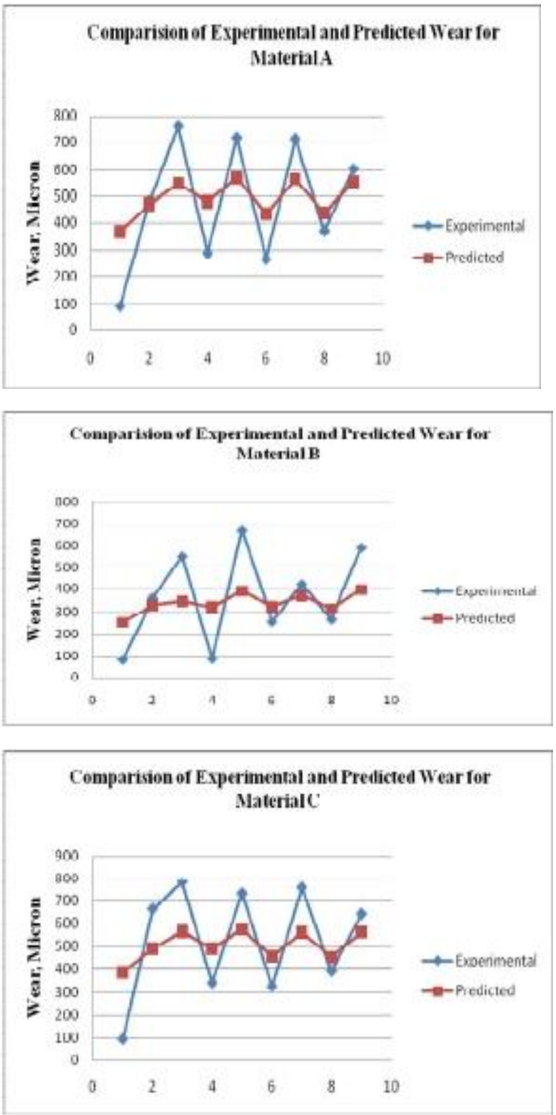

Fig 9: *comparisons of measured and predicted wear*

From fig. 9 it is observed that the average percentage error of measured and predicted wear for material B is less.

4. COCLUSION

1. The hardness and both tensile and compressive strengths of the Al-25Zn-2Cu-0.4Mn based alloys increased with increasing silicon content, but thetrend reversed for the ones with more than 2.5% Si. Amongst the as cast alloys, the highest wear resistance was obtained with the Al-25Zn-2Cu-0.4Mn-2.5 Si Alloys.

2. The highest wear resistance was obtained with the 25 Zn-2Cu-0.4Mn-2.5Si alloy.

3. The lowest coefficient of friction was obtained with the 25Zn-2Cu-0.4Mn-2.5Si Alloy.

REFERENCES

[1] Ahmet trunk, Mehmet durman E, sabriKayali."The effect of manganese on the microstructure and mechanical properties of zinc-aluminium based ZA-8 Alloy", J Mater Sci(2007)42:8298-8305.

[2] Miroslav Babic, Slobodan BranislavJeremic."The influence of heat treatment on the sliding wear behavior of a ZA-27 alloy", Tribology international 43 (2010)16-20

[3] S.Zeki Azakh, Temelsavas-kan, "An Examination of friction and sliding wear propertiesof Zn-40Al-2Cu2Si alloy in case of oil cut off",Tribology international 41(2008)9-16

[4] B.K.Prasad, "Dry sliding wear response of zinc based alloy over a range of test speeds and load: a comparative study with cast iron", Tribology letters, vol.25,No2,February 2007(2007

[5] TemelSavaskan, ZekiAzakili, "Aninvestigationof lubricated friction and wear properties of Zn-40Al-2Cu-2Si alloy in comparison with SAE 65 bearing bronze wear 264"(20080920-928.

[6] B.K.Prasad, S,das,O.P. Modi, A.K.Jha,R.Dasgupta and A.H.Yegneswaran "Wear response of a Zn base Alloy in the presence of SIC particleReinforcement: Acomparative study with a copperbase Alloy",JMEPEG(1997) 1169-1175

[7] B.K.Prasad, A.H.Yegneswaran, "Influence of the nature of micro constituents on the tensile properties of aZinc based Alloy and leaded-tin bronze at different strain rates and temperature", Journal of materials science 32(1997)1169-1175

[8] Yasin Alemdag, Temelsavas-kan, "Mechanical and tribological properties of Al-40Zn-Cu alloys"Tribology international42(2009)176-182

[9] Temel Savas, kan, osman Bican, Yasin Alemdag. "Developing aluminium-Zinc- based a new Alloy for tribological applications", JMater Sci(2009)44:1969-1976

[10] Osman Bican, TemelSavas,Kan,"Influence of the test conditions on the lubricated friction and wear behavior of Al-25Zn-3Cu Alloy",Tribol Lett(2010)37:175-182