EFFECT OF VARIATION IN COMPOSITION ON WEAR AND COMPRESSION OF ALUMINIUM ALLOY Al6463

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ABSTRACT

The wear and compression behaviour of varying the Mg and Si composition in Al6463 aluminium alloy was studied in this research work. Wear and compression behaviour are studied for Mg variation (0.5 to 0.875%) and Si variation (0.2 to 0.575%) individually. These specimens were first machined to a standard size and then the experiment was conducted for the required parameters. The results show that lowest wear rate was obtained for the highest composition of Mg and lowest Si percentage.

Keywords: Aluminium alloy, Magnesium, Silicon, wear rate, compression.

I INTRODUCTION

Traditionally, the machinability of materials involves tool life, cutting forces, productivity or chip formation, with less attention paid to particle emission. In this work, the authors address the machinability of aluminium alloys from several points of view, including cutting forces, chip formation and segmentation and metallic particle emission. The main properties which make aluminium a valuable material are lightweight, strength, recyclability, corrosion resistance, durability, ductility, formability and conductivity. Due to this unique combination of properties, the variety of applications of aluminium continues to increase.

The analysis of the data during manufacturing by using suitable statistical designs is of high importance for precise evaluation to be obtained from the process. Design and methods such as factorial design, response surface methodology and Taguchi methods are now widely in use in place of one-factor-at-a-time experimental approach which is time consuming and exorbitant in cost. Lalwani et al., [1] studied the effect of cutting parameters in turning on cutting forces and surface roughness. Dickinson, Grieve et al., and Fischer and Elrod developed a turning model in which tool nose radius and feed rate are taken into account but cutting speed is ignored. Thomas et al., used built up edge formation occurring during dry turning mild carbon steel and a full factorial design, taking into account the three-level interactions between the independent variables. Yang and Tarng [3] have conducted study on optimal cutting parameters using Taguchi method in turning. Nian et al. [7]

investigated the optimization of CNC turning operations by Taguchi method with multiple performance characteristics. Lin et al., developed an objective network model to estimate the surface roughness and cutting forces. Wang et al.,[9] investigated the effect of tool nose vibration on surface roughness during turning theoretically and experimentally.

Surface finish is one of the most important quality characteristics in manufacturing industries which influences the performance of mechanical parts as well as production cost. In order to improve the product quality and efficiency in machining, recently, there has been intensive computation focusing on surface roughness at international level. This computation can be observed in turning processes especially in aerospace and automotive industry by increasing the alternative solution for obtaining better surface roughness. A good quality turning surface can lead to improvement in strength properties such as fatigue strength, corrosion resistance and thermal resistance. In addition, the final surface roughness also affects several function attributes of parts like friction, wearing, light reflection, heat transmission, coating and ability of distributing and holding a lubricant. According to Kromanis, A. and Krizbergs, the quality of surface plays a very important role in functionality of produced part. Therefore, it is necessary to develop methods, which can be used for the prediction of the surface roughness according to technological parameters.

II EXPERIMENTATION

The aluminium alloy was cast using the basic compositions and a variation of one of the compositions that have a significant effect on the properties of the alloy. Magnesium percentage was varied from 0.5% to 0.875% with a variation of 0.125% and Silicon percentage was varied from 0.2% to 0.575% with a 0.125%. All the specimen were prepared for the ASTM standard and the experimentation was conducted. The general composition of Al6463 is shown in Table 1.

2.1 Wear test

Table 2 gives the experimental details for after varying the magnesium composition.

TABLE 1: Chemical Composition 6463 Aluminum Alloys In Weight Percentage

Weight%	Al	Si	Fe	Cu	Mn	Mg	Zn	Other Each	Others Total
6463	Bal	0.20 / 0.60	0.15 max	0.20 max	0.05 max	0.45/0.90	0.05 max	0.05 max	0.15 max

TABLE 2: Initial data for wear test of Mg% varied Al6463 alloy

Specimen	Load	Initial weight	Peripheral diameter
	kg	gms	mm
0.500%	0.5	1.579E-02	30
	1	1.578E-02	30
	1.5	1.576E-02	30
0.625%	0.5	1.447E-02	30

	1	1.440E-02	30
	1.5	1.437E-02	30
0.750%	0.5	1.525E-02	40
	1	1.523E-02	40
	1.5	1.520E-02	40
0.875%	0.5	1.448E-02	40
	1	1.448E-02	40
	1.5	1.448E-02	40

The experimentation was conducted with varying load of 0.5, 1, 1.5 kg with a peripheral distance of 30mm for 0.5% and 0.625% and 40mm for 0.75% and 0.875%.

TABLE 3: Initial data for wear test of Si% varied Al6463 alloy

Specimen	Load	Initial weight	Peripheral diameter
	kg	gms	mm
0.200%	0.5	1.432E-02	40
	1	1.432E-02	40
	1.5	1.432E-02	40
0.325%	0.5	1.600E-02	40
	1	1.599E-02	40
	1.5	1.599E-02	40
0.450%	0.5	1.593E-02	45
	1	1.592E-02	45
	1.5	1.592E-02	45
0.575%	0.5	1.438E-02	45
	1	1.436E-02	45
	1.5	1.434E-02	45

The experimentation was conducted with varying load of 0.5, 1, 1.5 kg with a peripheral distance of 40mm for 0.2% and 0.325% and 45mm for 0.45% and 0.575%.

2.2 Compression test

The compression test was conducted on a 40-ton Universal Testing Machine with a load increment of 2 tons. The specimen was prepared with the dimensions 12.7 X 25.4 mm. The deformation and stress was noted and the stress-strain graph was plotted for the results.

III RESULTS AND DISCUSSIONS

3.1 Wear test

Table 4 gives the experimental results for wear test conducted on the aluminium alloy Al6463 with Mg% variation. Figure 1 gives the graphical representation of the experimental values shown in table 4. It shows that the alloy with Mg% 0.625% shows the maximum wear at 0.5kg and reduces when the load is increased. Also, it shows that the Mg% of 0.875% gives the least wear at 1kg load and increases the wear rate when the load is increased.

TABLE 4: Wear rate of Al6463 with Mg% variation

Specimen	Load (kg)	%wear	Wear rate
0.500%	0.5	6.333E-02	6.37E-09
	1	1.267E-01	1.27E-08
	1.5	1.269E-01	1.27E-08
0.625%	0.5	4.838E-01	4.46E-08
	1	2.083E-01	1.91E-08
	1.5	2.784E-01	2.55E-08
0.750%	0.5	1.311E-01	9.55E-09
	1	1.970E-01	1.43E-08
	1.5	1.974E-01	1.43E-08
0.875%	0.5	2.762E-02	1.91E-09
	1	1.381E-02	9.55E-10
	1.5	2.763E-02	1.91E-09

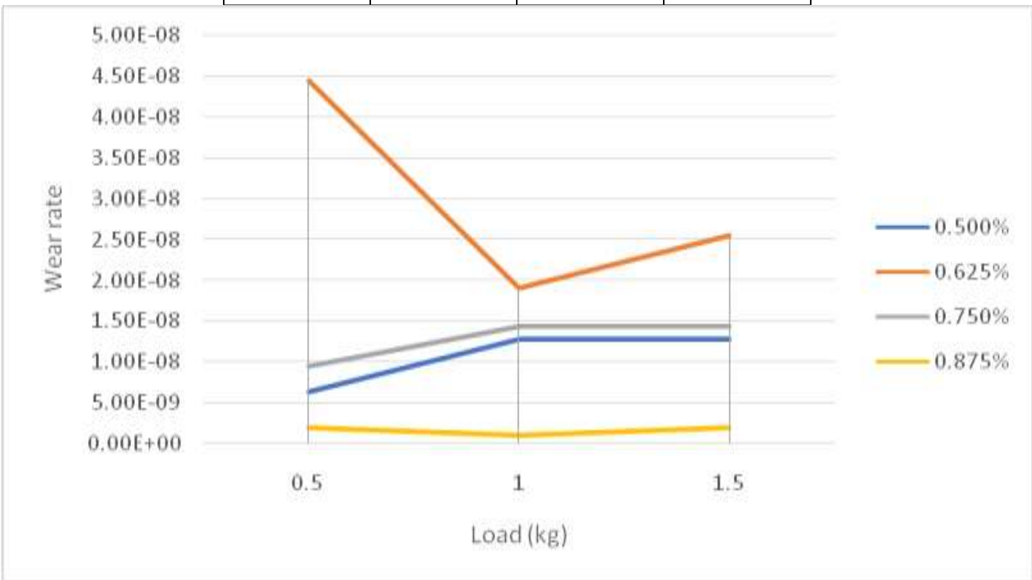

FIGURE 1: Graphical representation of wear rate vs load on Al6463 with Mg% variation

Table 5 gives the experimental results for wear test conducted on the aluminium alloy Al6463 with Si% variation. Figure 2 gives the graphical representation of the experimental values shown in table 5. It shows that the alloy with Si% of 0.45% shows the maximum wear at 1.5kg and reduces when the load is decreased. Also, it shows that the Si% of 0.325% gives the least wear at 1.5kg load and increases the wear rate when the load is decreased.

TABLE 5: Wear rate of Al6463 with Si% variation

Specimen	Load (kg)	%wear	Wear rate
0.200%	0.5	6.333E-02	6.37E-09
	1	1.267E-01	1.27E-08
	1.5	1.269E-01	1.27E-08
0.325%	0.5	4.838E-01	4.46E-08
	1	2.083E-01	1.91E-08
	1.5	2.784E-01	2.55E-08
0.450%	0.5	1.311E-01	9.55E-09
	1	1.970E-01	1.43E-08
	1.5	1.974E-01	1.43E-08
0.575%	0.5	2.762E-02	1.91E-09
	1	1.381E-02	9.55E-10
	1.5	2.763E-02	1.91E-09

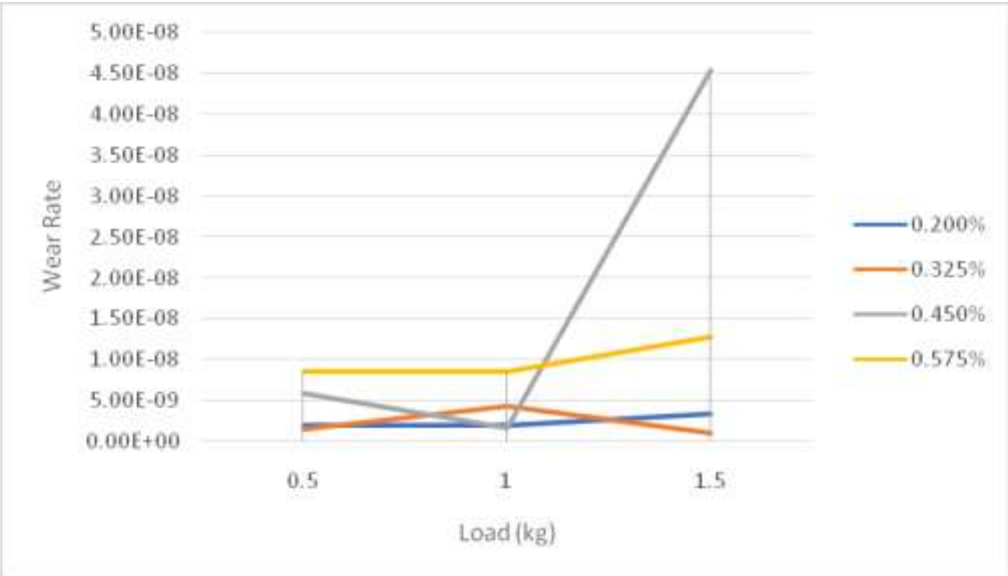

FIGURE 2: Graphical representation of wear rate vs load on Al6463 with Si% variation

3.2 Compression test

TABLE 6: Stress-Strain values obtained for Al6463 with Mg variation under compression test

Load	0.5% Mg		0.625% Mg		0.75% Mg		0.875% Mg	
kN	**Stress (MPa)**	**Strain**	**Stress (MPa)**	**Strain**	**Stress (MPa)**	**Strain**	**Stress (MPa)**	**Strain**
2.000	15.353	0.028	15.042	0.050	14.980	0.054	14.856	0.063
4.000	30.582	0.033	29.836	0.058	29.463	0.072	29.463	0.072

6.000	45.500	0.041	44.567	0.063	43.635	0.085	43.822	0.081
8.000	59.921	0.054	59.175	0.067	57.434	0.100	58.180	0.085
10.000	73.968	0.067	73.347	0.076	70.860	0.114	71.793	0.100
12.000	88.016	0.076	87.270	0.085	83.914	0.129	85.033	0.114
14.000	100.945	0.095	100.510	0.100	96.159	0.149	97.899	0.129
16.000	112.382	0.124	112.879	0.119	107.409	0.176	109.399	0.155
18.000	123.073	0.155	123.633	0.149	118.039	0.204	119.717	0.187
20.000	131.154	0.204	131.776	0.198	126.181	0.251	129.911	0.215
22.000	138.799	0.251	139.483	0.245	134.013	0.296	138.799	0.251
24.000	145.450	0.303	145.450	0.303	140.975	0.344	145.450	0.303
26.000	150.299	0.366	149.491	0.373	147.066	0.396	151.107	0.358
28.000	154.028	0.435	152.288	0.451	152.288	0.451	155.769	0.419

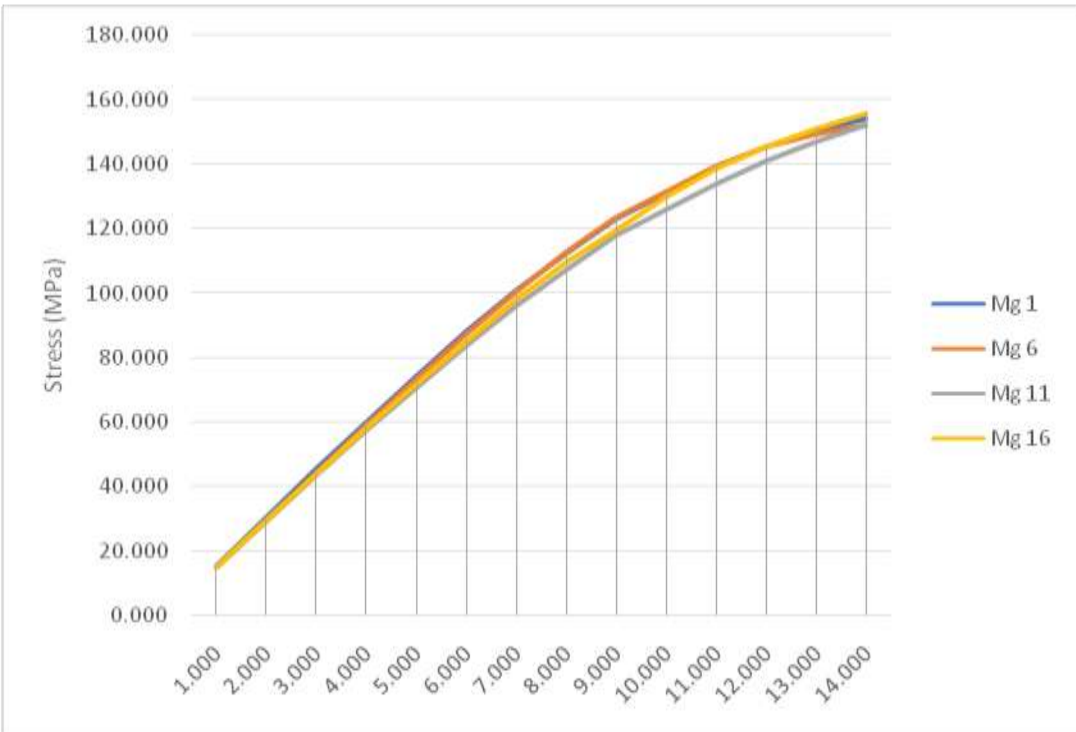

FIGURE 3: Graphical representation of Stress on Al6463 with Mg% variation

TABLE 6: Stress-Strain values obtained for Al6463 with Si variation under compression test

Load	0.2% Si		0.325% Si		0.45% Si		0.575% Si	
kN	Stress (MPa)	Strain	Stress (MPa)	Strain	Stress (MPa)	Strain	Stress (MPa)	Strain
2.000	15.167	0.041	15.664	0.008	14.669	0.076	15.602	0.012
4.000	30.085	0.050	31.203	0.012	29.090	0.085	30.831	0.024
6.000	44.754	0.058	46.619	0.016	43.449	0.090	45.500	0.041
8.000	58.752	0.075	61.661	0.024	57.186	0.104	60.169	0.050

10.000	72.725	0.085	76.455	0.033	70.860	0.114	73.658	0.072
12.000	85.778	0.104	90.627	0.045	83.914	0.129	86.524	0.095
14.000	98.769	0.119	103.991	0.063	96.159	0.149	98.769	0.119
16.000	110.393	0.144	114.371	0.104	106.912	0.181	108.901	0.160
18.000	119.717	0.187	122.514	0.160	118.039	0.204	118.039	0.204
20.000	128.668	0.227	129.911	0.215	126.181	0.251	126.181	0.251
22.000	134.697	0.289	134.697	0.289	133.330	0.303	133.330	0.303
24.000	139.483	0.358	138.737	0.366	138.737	0.366	138.737	0.366
26.000	143.834	0.427	142.218	0.443	143.834	0.427	144.642	0.419
28.000	146.196	0.512	143.586	0.539	147.066	0.503	148.807	0.485

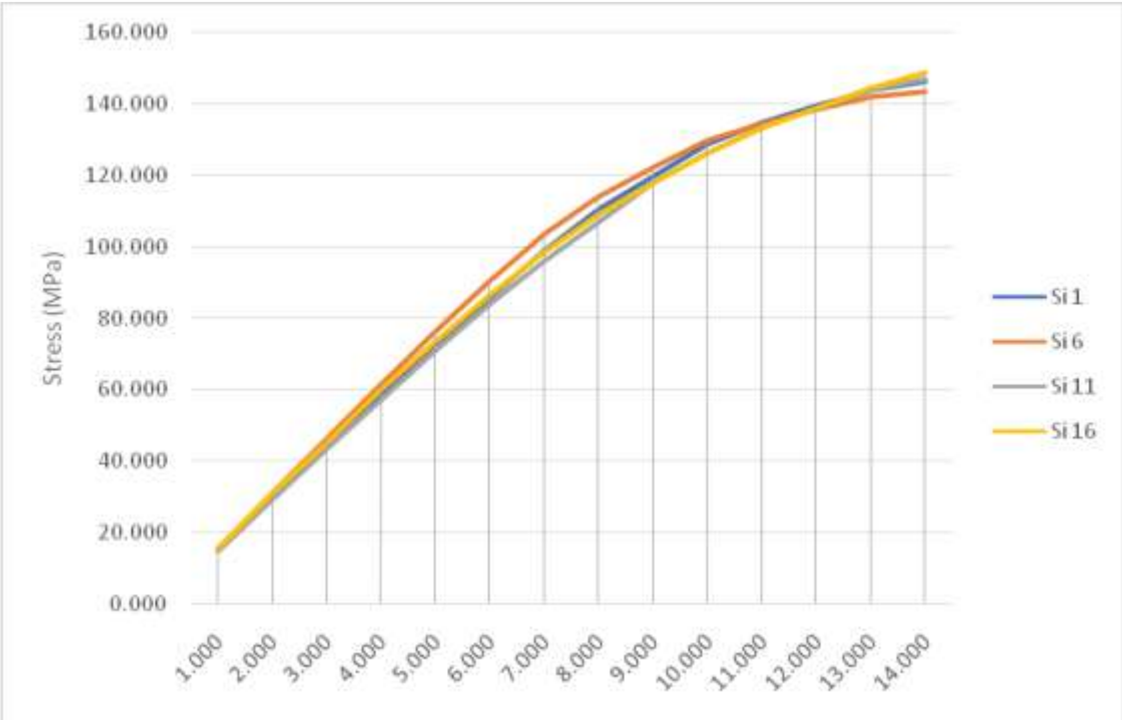

FIGURE 4: Graphical representation of Stress on Al6463 with Si% variation

IV CONCLUSIONS

The wear test and compression test were conducted on the aluminium alloy Al6463 with varying percentages of Mg and Si. The specimen were prepared as per the standards for the test and experimentation was conducted. The following conclusions can be drawn from the experimental values.

- The wear rate calculated for the Mg% of 0.625 gives the maximum wear at lower loads than on larger loads.
- The wear rate graphs change direction after a certain load indicating the significance of the loads applied on the material.
- The wear rate calculated for Si% of 0.45% gives maximum wear at higher loads than on smaller loads.

- The compression test performed on Al6463 with Mg% variation shows that the stress developed in all the specimen of the material will be similar at lower loads and increases as load increases.

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