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EFFECT OF VARIATION IN MAGNESIUM COMPOSITION ON TURNING OF ALUMINIUM ALLOY Al6463

Prof. Amardeepak[1], Dr. Narayana B Doddapattar[2]

[1]Research Scholar, Department of Mechanical Engineering, SSIT, Tumkur, Karnataka,(India)

[2]Professor, The Oxford College of Engineering, Bengaluru, Karnataka, (India)

ABSTRACT

The present research work aims at determining the variation in surface roughness and tangential forces when the Magnesium percentage is varied in Aluminium alloy Al6463 during turning operation. The alloy was cast using a resistance furnance for 16 different compositions and two sets of 16 specimen were prepared. These specimens were first machined to a standard size and then the experiment was conducted for the required parameters. The results obtained show that the increase in percentage composition does not necessarily increase or decrease the surface roughness and the tangential force generated during turning.

Keywords: Aluminium alloy, Magnesium, Turning.

I. INTRODUCTION

Majority of industrial applications [1] of machining are in metals. Although the metal cutting process has resisted theoretical analysis because of its complexity, the application of these processes in the industrial world is widespread. Machining processes are performed on a wide variety of machine tools. Metal cutting processes can be viewed as consisting of independent input variables, dependent variables, and independent-dependent interactions or relationships. The engineer or machine tool operator has direct control over the input variables and can specify or select them when setting up the machining process. Turning is a machining process for generating external surfaces of revolution by the action of a cutting tool on a rotating work piece, usually in a lathe. Turning is the major operation in a machining sequence discussed in this research work.

A lathe is a machine tool which rotates the work piece on its axis to perform various operations such as cutting, knurling, drilling, thread cutting etc. with tools that are applied to the work piece to create an object which has symmetry about an axis of rotation. Lathes are used in woodturning, metalworking, metal spinning, Thermal spraying, parts reclamation, and glass-working. Aluminium alloys can be machined rapidly and economically. Because of their complex metallurgical structure, their machining characteristics are superior to those of pure aluminium. The micro-constituents present in aluminium alloys have important effects on machining characteristics. The literature survey indicates that, in machinability studies investigations, statistical design of experiments is used quite extensively. Statistical design of experiments refers to the process of planning the experiment so that the appropriate data can be analysed by statistical methods, resulting in valid and objective conclusions.

This research work is a preamble to the current research work being conducted based on Taguchi technique and Design of Experiments. This work helps in understanding the nature and effect of the composition at different levels.

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 was varied from a low value of 0.5% to a maximum of 0.875% with an increment of 0.025%. this variation in composition gave us 16 samples to be tested for the behaviour under turning operation. Table 1 gives the variation in composition and the cutting parameters used in the present work. Using this configuration, turning operation was performed and the tangential force generated during the operation was measured.

TABLE 1: Cutting parameters for measurement of tangential forces

Exp No	% C	Speed	Depth of Cut	Exp No	% C	Speed	Depth of Cut
1	0.500	310.000	0.250	9	0.700	310.000	0.250
	0.500	500.000	0.500		0.700	500.000	0.500
	0.500	775.000	0.750		0.700	775.000	0.750
	0.500	1200.000	1.000		0.700	1200.000	1.000
2	0.525	310.000	0.250	10	0.725	310.000	0.250
	0.525	500.000	0.500		0.725	500.000	0.500
	0.525	775.000	0.750		0.725	775.000	0.750
	0.525	1200.000	1.000		0.725	1200.000	1.000
3	0.550	310.000	0.250	11	0.750	310.000	0.250
	0.550	500.000	0.500		0.750	500.000	0.500
	0.550	775.000	0.750		0.750	775.000	0.750
	0.550	1200.000	1.000		0.750	1200.000	1.000
4	0.575	310.000	0.250	12	0.775	310.000	0.250
	0.575	500.000	0.500		0.775	500.000	0.500
	0.575	775.000	0.750		0.775	775.000	0.750
	0.575	1200.000	1.000		0.775	1200.000	1.000
5	0.600	310.000	0.250	13	0.800	310.000	0.250
	0.600	500.000	0.500		0.800	500.000	0.500
	0.600	775.000	0.750		0.800	775.000	0.750
	0.600	1200.000	1.000		0.800	1200.000	1.000

6	0.625	310.000	0.250	14	0.825	310.000	0.250
	0.625	500.000	0.500		0.825	500.000	0.500
	0.625	775.000	0.750		0.825	775.000	0.750
	0.625	1200.000	1.000		0.825	1200.000	1.000
7	0.650	310.000	0.250	15	0.850	310.000	0.250
	0.650	500.000	0.500		0.850	500.000	0.500
	0.650	775.000	0.750		0.850	775.000	0.750
	0.650	1200.000	1.000		0.850	1200.000	1.000
8	0.675	310.000	0.250	16	0.875	310.000	0.250
	0.675	500.000	0.500		0.875	500.000	0.500
	0.675	775.000	0.750		0.875	775.000	0.750
	0.675	1200.000	1.000		0.875	1200.000	1.000

One set of work pieces were used for machining under varying speed and depth of cut with feed remaining constant as shown in table 2. These parameters are used for machining each work piece and measuring its tangential forces. Another set of work pieces are used for turning under the same cutting parameters (speed = 1500 RPM, feed = 0.1 mm/rev, DoC = 0.75 mm, Insert = TNMG 0.4 mm). the results of the second set of experiments are given in table 4.

TABLE 2: Cutting parameters for measurement of tangential forces

Speed (RPM)	310	500	775	1200
DoC (mm)	0.25	0.5	0.75	1.00

The measurement of surface roughness was done after the tangential forces were measured.

III. RESULTS AND DISCUSSIONS

After the experiments were conducted, the tangential forces and the surface roughness values were obtained which are given in table 2.

TABLE 3: Tangential forces measured during turning operation

Exp No	Tangential force		Exp No	Tangential force	
	Ft(kg.f)	N		Ft(kg.f)	N
1	40.000	392.264	9	43.000	421.684
	59.000	578.589		61.000	598.203
	98.000	961.047		96.000	941.434
	105.000	1029.693		125.000	1225.825

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2	43.000	421.684	10	41.000	402.071
	61.000	598.203		64.000	627.622
	97.000	951.240		95.000	931.627
	124.000	1216.018		162.000	1588.669
3	39.000	382.457	11	39.000	382.457
	65.000	637.429		63.000	617.816
	101.000	990.467		95.000	931.627
	129.000	1265.051		135.000	1323.891
4	44.000	431.490	12	43.000	421.684
	62.000	608.009		61.000	598.203
	96.000	941.434		97.000	951.240
	108.000	1059.113		127.000	1245.438
5	45.000	441.297	13	38.000	372.651
	58.000	568.783		66.000	647.236
	96.000	941.434		96.000	941.434
	116.000	1137.566		141.000	1382.731
6	42.000	411.877	14	40.000	392.264
	67.000	657.042		68.000	666.849
	95.000	931.627		98.000	961.047
	115.000	1127.759		152.000	1490.603
7	40.000	392.264	15	39.000	382.457
	64.000	627.622		69.000	676.655
	93.000	912.014		98.000	961.047
	118.000	1157.179		134.000	1314.084
8	44.000	431.490	16	43.000	421.684
	63.000	617.816		69.000	676.655
	96.000	941.434		101.000	990.467
	146.000	1431.764		140.000	1372.924

TABLE 4: Surface roughness measured during turning operation

Exp No	Surface Roughness			Exp No	Surface Roughness		
	Ra	Rz	Rq		Ra	Rz	Rq
1	2.185	13.033	2.701	9	1.408	11.053	1.832
2	1.309	9.416	1.657	10	1.093	6.753	1.333
3	2.176	15.833	2.789	11	1.404	9.972	1.787

4	1.125	8.515	1.390	12	1.132	8.824	1.404
5	1.345	10.770	1.810	13	1.232	9.449	1.619
6	1.219	8.625	1.543	14	1.091	7.397	1.345
7	1.297	8.775	1.609	15	1.162	7.897	1.435
8	1.157	8.433	1.437	16	1.115	7.457	1.385

Figure 1 shows a graphical representation of the tangential force values obtained during turning of aluminium alloy Al6463. Each experiment consisting of different composition values are plotted against the previously set cutting parameters as shown in table 2. It also shows that the %C of 0.5 Mg is seen to generate the lowest tangential force at very high speed and depth of cut. The %C of 0.725 gives the highest tangential forces under the same high speed and depth of cut.

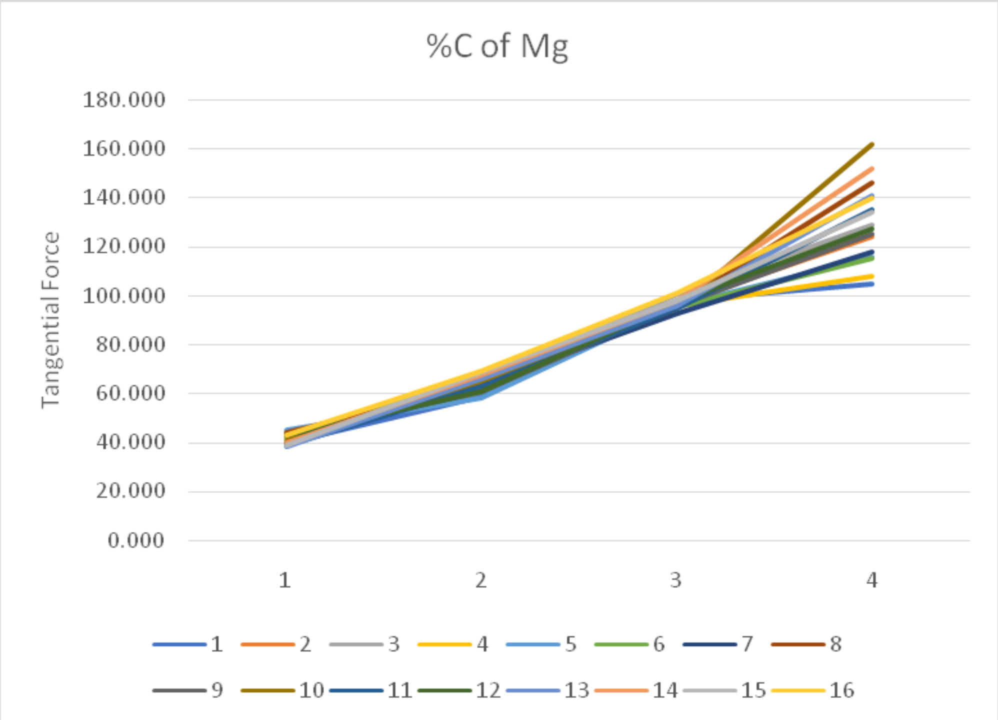

FIGURE 1: Graphical representation of tangential forces measured for turning on Al6463

Figure 2 shows a graphical representation of the surface roughness values obtained after machining a second set of work pieces with varying %C Mg. The figure shows that the maximum surface roughness is obtained for a 0.5%C of Mg with a value of 2.185 µm. Minimum surface roughness is seen during machining of 0.875%C of Mg with a value of 1.115 µm. Other experimental values vary in the beginning to a great extent but tend to normalize after a %C of 0.625. It shows that the higher %C of Mg in Al6463 reduces the variation in surface roughness and gives a constant value.

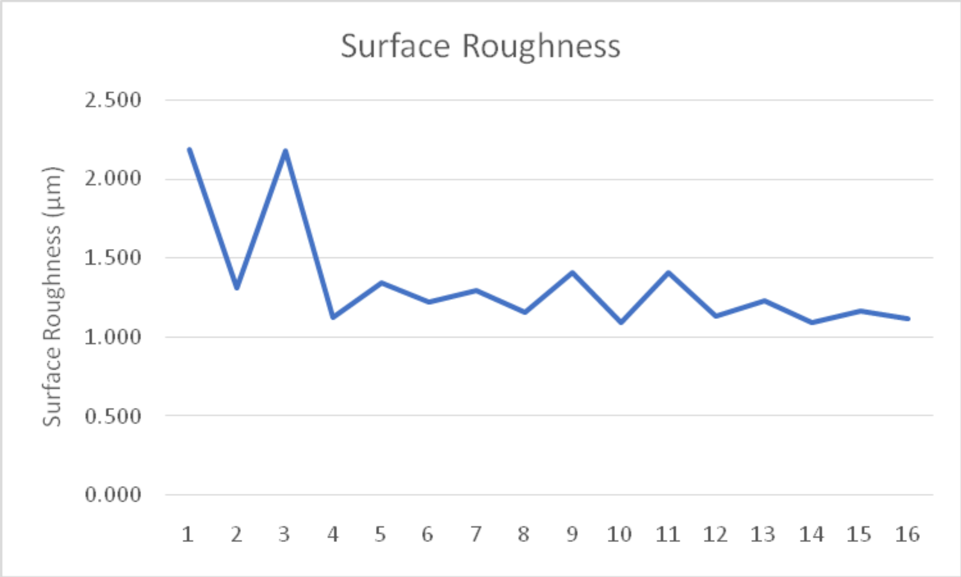

FIGURE 2: Graphical representation of Surface roughness measured for turning on Al6463

IV.CONCLUSIONS

Two sets of 16 pieces of Al646 were cast with different %C of Mg to conduct two sets of experiments and for measurement of tangential forces and surface roughness. One set of experiments were conducted under a range of speeds and depth of cuts keeping the feed constant. The tangential forces were measured for these experiments and recorded. A second set of experiments were conducted for the 16 work pieces under constant cutting parameters. The second set was used to measure surface roughness of the workpieces after turning operation.

The tangential forces measured from the first set of experiments were recorded and they show that the lowest composition gives the lowest tangential force. From the second set of workpieces used for measuring surface roughness show that the lowest %C of Mg in A6463 gives a high roughness value and the highest %C of Mg gives low roughness value.

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