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INFLUENCE OF BURNESHING PARAMETER ON SURFACE CHARACTRISTICS FOR ALUMINUM ALLOY

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Abstract

Burnishing is a cool working process in which plastic misshapening happens by applying a weight through a hard and smooth ball or roller on metallic surfaces. It is a finishing and strengthening methodology. Improvements in surface finish and surface hardness is genuine concern in organizations for achieving distinct advantage. Roller cleaning is a frigid working technique which conveys a fine surface wrap up by the planetary upset of hardened disturbs more than a depleted or turned metal surface.The nature of burnishing machined parts is altogether influenced by different parameters utilized as a part of the procedure. The point of present work is to study the four parameters of the roller burnishing process, such as number of passes, force, feed rate, and burnishing speed. Their impact on two reactions such as surface hardness and surface roughness of the test examples may contemplate. Outline of examinations are utilized to inspect the relationship between one or more reaction variables and an arrangement of quantitative exploratory variables or components. These systems are frequently utilized after recognized the critical controllable variables and to discover the element choice that enhances the reaction.

Keyword: roller burnishing process, parameter of burnishing, surface roughness, surface hardness

I. Introduction

Machined surface by ordinary process, for example, turning furthermore, processing have natural anomalies and imperfections like device marks and scratches that cause vitality dissemination (frication) furthermore, surface harm (wear). To beat these difficulties, traditional completing procedures, for example, pounding, sharpening, and lapping have been customarily utilized. Notwithstanding, subsequent to these routines basically depend on chip evacuation to accomplish the craved surface complete, these machining chips may create additional surface scraped spot and geometric resilience issue particularly if directed by untalented administrators. As needs be, shining procedure offers an alluring post-machining option because of its chip less furthermore, moderately basic operations.During late years, extensive consideration has been paid to the post-machining metal completing operations, to shape the external layer, for example, shining procedure which enhances the surface qualities by plastic twisting of the surface layer.

Burnishing is considered as an cold working procedure, varying from other cold working, surface treatment procedures, for example, shot peening and sand impacting, and so on in that it delivers a decent surface completion and additionally affects leftover compressive burdens at the metallic surface layers. Likewise, burnishing recognizes itself from chip-framing completing procedures, for example, honing, grinding, super-finishing and lapping which affect remaining tractable burdens at the machined surface layers. Additionally, burnishing is monetarily alluring, since it is a straightforward and modest procedure, obliging less time and ability to get a superb surface finish.

Adjacent to creating a decent surface finishing, the burnishing process has extra favorable circumstances over other machining procedures, for example, improve hardness, corrosion resistance and fatigue life as a consequence of creating compressive remaining anxiety. An extensive order of polishing devices and their application has been given by Shneider. A writing overview demonstrates that work on the polishing procedure has been conducted by many researchers and the processimprove also the properties of the parts , e.g. higher wear resistance expanded hardness, surface quality and expanded most extreme remaining push in compression. The parameters influencing the surface completion are: ball material, number of passes, burnishing force, feed rate, depth of cut, workpiece material, and lubrication. It is important to locate an ideal procedure condition fit for delivering coveted surface quality and hardness. Notwithstanding, this enhancement ought to be performed in such a path, to the point that all the targets ought to satisfy at the same time.

The Taguchi system is extremely prevalent for understanding enhancement issues in the field of production engineering. The technique uses a very much adjusted trial outline (permits a predetermined number of trial runs) called orthogonal array design, and sign to-noise ratio (S/N ratio), which serve as target capacity to be upgraded (maximized) inside of the exploratory space.

The present research, an L'25 Taguchi standard orthogonal array was selected for the design of experiments. Since the numbers of factors are four with five levels, therefore the most suitable Taguchi orthogonal array for the experiment was L'25 array. Since this is a main effects array, the interactions among the factors are spread more or less equally among the columns. Additionally analysis of variance (ANOVA) was also utilized to examine the most significant factor for the surface roughness and surface hardness in burnishing process.

II. Experimental work

Aluminum alloy 6351 was used as a test material. This material was selected because of now day new research trend is focused on non-ferrous metal and aluminum alloy 6351 is widely used in aircraft, aerospace and automobile components. The chemical composition in weight percent and mechanical properties are shown in table. The material was received in the form of rod.

Component	weight(%)
Si	0.930
Mn	0.530
Cr	0.020
Cu	0.060
Ti	0.020
V	0.010
Fe	0.170
Zn	0.030
Mg	0.660
Al	97.560

Table-1 Chemical composition of aluminum 6351

Properties	Result
Yield strength (MPa)	150
Tensile strength (MPa)	250
Hardness-rockwell	95
Shear strength (MPa)	200
Modulus of elasticity (GPa)	70
Elongation	20%
Fatigue strength	90

Table-2 mechanical properties of aluminum 6351

Single roller hard carbide tool was used for burnishing. The experiments were performed on DX 150 CNC lathe. The tool was mounted on the CNC turret. Dry turning and burnishing were used in all the experiment work. Mitutoyo SJ-201 PR portable model surface roughness tester was used to measure the surface roughness of the work piece. Surface hardness of the work piece was measured by mitutoyo HR-521(L) surface hardness tester.

- **Planning for experiment**

The specimens for surface roughness and hardness are machinedby CNC lathe machine by using roller burnishing process. As per Taguchi approch total twenty fiveexperiments are conducted for each test as shown in Table . Here Minitab 15 software was used for Taguchi method.

Sr. No.	Control factor	Level				
		1	2	3	4	5
1	burnishing speed	100	200	300	400	500
2	feed (rev/min)	0.06	0.12	0.18	0.24	0.30
3	burnishing force	5	10	15	20	25
4	number of pass	1	2	3	4	5

Table-3Selected burnishing Process parameters and levels

The specimens for surface roughness and hardness are machinedby CNC lathe machine by using roller burnishing process. As per Taguchi L'25 orthogonal array total twenty fiveexperiments are conducted for each test as shown in Table-4 Here Minitab 15 software was used for Taguchi method.

Sr No	Speed	Feed	Force	No of passes

1	100	0.06	5	1
2	100	0.12	10	2
3	100	0.18	15	3
4	100	0.24	20	4
5	100	0.30	25	5
6	200	0.06	10	3
7	200	0.12	15	4
8	200	0.18	20	5
9	200	0.24	25	1
10	200	0.30	5	2
11	300	0.06	15	5
12	300	0.12	20	1
13	300	0.18	25	2
14	300	0.24	5	3
15	300	0.30	10	4
16	400	0.06	20	2
17	400	0.12	25	3
18	400	0.18	5	4
19	400	0.24	10	5
20	400	0.30	15	1
21	500	0.06	25	4
22	500	0.12	5	5
23	500	0.18	10	1
24	500	0.24	15	2
25	500	0.30	20	3

TABEL-4 experimental plan as per Taguchi L_{25}

III. Experimental result and analysis

The main objective of this work is the investigation of the effect of the stated parameter of the roller burnishing process on the work piece material characteristic

Sr. No.	Speed	Feed	Force	No. Of Pass	SR	Hardness
1	100	0.06	5	1	1.6	102
2	100	0.12	10	2	1.08	100
3	100	0.18	15	3	0.87	101
4	100	0.24	20	4	0.93	96
5	100	0.3	25	5	1.95	95
6	200	0.06	10	3	0.8	108
7	200	0.12	15	4	1	107
8	200	0.18	20	5	1.48	108
9	200	0.24	25	1	1.38	85
10	200	0.3	5	2	1.13	84
11	300	0.06	15	5	1.05	115
12	300	0.12	20	1	1.22	112
13	300	0.18	25	2	1.18	95
14	300	0.24	5	3	1.04	92
15	300	0.3	10	4	1.06	90
16	400	0.06	20	2	0.77	103
17	400	0.12	25	3	0.94	101
18	400	0.18	5	4	1.68	103
19	400	0.24	10	5	1.09	98
20	400	0.3	15	1	1.47	79
21	500	0.06	25	4	1.33	109
22	500	0.12	5	5	1.74	108
23	500	0.18	10	1	1.77	90
24	500	0.24	15	2	1.13	86
25	500	0.3	20	3	0.7	84

Table-5 experimenatal result

- **Analysis of variance (ANOVA)**

The purpose of the analysis of variance (ANOVA) is to investigate which burnishing parameters significantly affect the performance characteristics.

Factors	DOF	Sum of squares	Variance (mean square)	Variance ratio (F)	Percentage contribution (P)
Speed (A)	4	0.170496	0.042624	1.18535	0.061931

Feed (B)	4	0.282776	0.070694	1.9659 61	0.1
Force (C)	4	0.614896	0.153724	4.2749 8	0.2
No. Of Pass (D)	4	1.397176	0.349294	9.7136 74	0.5
Error	08	0.287672	0.035959	1	0.1
Total	24	2.753016			

Table-6 Summary of ANOVA calculation for Surface Roughness

Factors	DOF	Sum of squares	Variance (mean square)	Variance ratio (F)	Percentage contribution (P)
Speed (A)	4	84.16	21.04	1.75479 6	0.0361 67
Feed (B)	4	1630.9 6	407.74	34.0066 7	0.7008 97
Force (C)	4	42.96	10.74	0.89574 6	0.0184 62
No. Of Pass (D)	4	472.96	118.24	9.86155 1	0.2032 52
Error	08	95.92	11.99	1	0.0412 21
Total	24	2326.9 6			100

Table-7 Summary of ANOVA calculation for Surface Hardness

- **Main Effect plots for Surface Roughness**

The relation between all the process parameters of burnishing process like burnishing speed, feed, force, number of passes and surface roughness of burnishing processed parts are shown in Figure-1

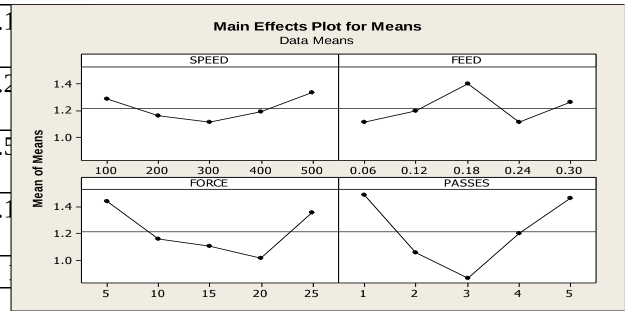

Figure: 1 Effect of burnishing speed, feed, force, number of passes on surface roughness

- **Effect of burnishing speed on surface roughness**

The surface finish in the burnishing process was found to reduce with increase in the speed, after certain level of speed the surface finish was increase. At lower speeds ,roller material and the work piece material will adhere and cause damage of surface, but at higher speeds, less time is available for contact and chance for adherence will be less and less damage on the surface. At lower speeds the possibility for adhesion between roller material and work material is less due to presence of coating. But at higher speed the coating was not having much influence on the performance namely the surface finish of the components.

- **Effect of feed on surface roughness**

The influence of the feed rate on the surface roughness is firstly increase with an increase in feed and then it starts to increase slightly with a further decrease in burnishing feed. This may be due to the change of the contact area between the roller and work piece, which is dependent on the burnishing parameters especially at very low feed and low forces.

- **Effect of burnishing force on surface roughness**

The effect of burnishing force on surface roughness of roller-burnished aluminum specimen. The surface roughness decreases with the increase in burnishing force to a minimum value after which it starts to increase.

- **Effect of number of passes on surface roughness**

The effect of the number of tool passes on surface roughness of roller-burnished aluminum .the surface roughness reaches a minimum value with increase in the number of burnishing tool passes, after which it starts to increase with further increase in the number of passes.

- **Main Effect plots for hardness**

The relation between all the process parameters of burnishing process like burnishing speed, feed, force, number of passes and surface hardness of burnishing processed parts are shown in Figure

Figure: 2 Effect of burnishing speed, feed, force, number of passes on surface hardness

- **Effect of burnishing speed on surface hardness**

Hardness increase with increase in speed up to 300 RPM and further gets decreases either increases in speed. It's due to possible chattering of the burnishing tool and the increase in temperature, which increases the possibilities of material transformation between the burnishing ball work pieces interfaces start to have a decisive effect.

- **Effect of feed on surface hardness**

Hardness decreases with increasing feed. When feed rate is low the distance between successive traces will be small.

- **Effect of burnishing force on surface hardness**

Hardness increase up to 20Kgf force and start decreases beyond it. As this force increases, the penetration depth of the ball inside the metallic surface will be increased, leading to a smoothing-out of the metallic surface, until this surface starts to show some deterioration, the latter being caused by the flaking of the surface due to the high work-hardening induced into the surface by the increase in the amount of plastic deformation as the burnishing force increases.

- **Effect of number of passes on surface hardness**

Hardness increases with increasing in number of passes. Similarly to the effect of burnishing force, after a particular number of passes, the surface layer becomes highly work-hardened, causing flaking to occur.

IV. Conclusion

Important conclusions from this study are summarized below.

The analysis of variance revealed that the burnishing speed, feed, banishing force and number of passes all are the influential parameters on surface roughness and surface hardness, but feed and number of passes are the main factors that contribute much more in surface roughness and surface hardness than burnishing speed and burnishing force.

Hardness increase with increase in speed up to 250 RPM and further gets decreases either increases in speed. It's due to possible chattering of the burnishing tool and the increase in temperature, which increases the possibilities of material transformation between the burnishing ball work pieces interfaces start to have a decisive effect.

The influence of the feed rate on the surface roughness is firstly increase with an increase in feed and then it starts to increase slightly with a further decrease in burnishing feed. This may be due to the change of the contact area between the roller and work piece, which is dependent on the burnishing parameters especially at very low feed and low forces.

Hardness decreases with increasing feed. When feed rate is low the distance between successive traces will be small.

The effect of burnishing force on surface roughness of roller-burnished aluminum specimen is that surface roughness decreases with the increase in burnishing force to a minimum value after which it starts to increase.

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