European Journal of Material Sciences
Vol.4, No.3, pp.1-5, November 2017
Published by European Centre for Research Training and Development UK (www.eajournals.org)

MINIMIZATION COMPARISON OF SURFACE ROUGHNESS DRILLING VALUE OF MILD STEEL, STAINLESS STEEL AND BRASS: AN APPLICATION OF ONE-WAY ANOVA TECHNIQUE

O.A. Raimi[1] and B.A. Tanimola[2]

[1]Department of Mechanical Engineering, Federal University of Technology, P.M.B 704, Akure, Nigeria
[2]Mechanical Engineering Department, Rufus Giwa Polytechnic, P.M.B 1019, Owo, Nigeria

ABSTRACT: *The study investigated on minimization comparison of surface roughness drilling value of mild steel, stainless steel and brass using one-way analysis of variance (ANOVA) technique so as to check for significant difference between the workpiece in their value of surface roughness using the same process parameters irrespective of their material properties. The experimental data used in the comparison were conducted nine (9) times for each of the workpiece. The descriptive statistics and the Tukey post hoc test of the ANOVA revealed that there were no statistically significant differences between the minimization surface roughness value of mild steel, stainless steel and brass. The result implies that irrespective of the material properties of the workpiece under the same process parameters condition, there are equal significant variation of surface roughness on mild steel, stainless steel and brass. The study concludes that regardless of the material properties for machining investigation using the same parameters, it is possible to have the same quality effect of surface roughness in terms of it minimization target.*

KEYWORDS: Minimization, Comparison, Surface roughness, Drilling, ANOVA

INTRODUCTION

Comparison investigation of using the same process parameters to check for level of significant of mild steel, stainless steel and brass irrespective of their properties [1-3] in the minimization of surface roughness are rare. Most of the investigations done are based on the specific properties of a particular workpiece with their corresponding process parameters [4-9]. There should be need to compare the level of significance between mild steel, stainless steel and brass based on the same process parameters so as to know if there are significant difference between the workpiece or not in minimizing surface roughness while drilling. In the process parameters for minimization of surface roughness, [4] conducted an investigation on AISI P20 steel en milling using CNC end milling machine with 8 mm diameters fine type carbide tool with twin cutting tip for speed, feed rate and depth of cut based on Taguchi design. The result of the findings revealed that surface roughness was likely to reduce when speed was 3000 rpm and the feed rate was 1000 mm/min and depth of cut 0.8 mm. Also, in the application of Taguchi method for minimizing the surface roughness in turning polyamide PA-6, [5] employed four cutting parameters which are cutting speed, feed rate, depth of cut and tool nose radius and their interactions on average surface roughness and analyzed the parameters based on Taguchi orthogonal array.

Print ISSN: 2055-8112(Print), Online ISSN: 2055-8120(Online)

The findings revealed that the combination of low levels of the cutting parameters was beneficial for minimizing average surface roughness. In the minimization of surface roughness in turning operation by using Taguchi method, [6] employed speed, feed, depth of cut, tool nose radius and shim materials and found that spindle speed, feed and depth of cut has significant effect on surface roughness and the tool nose radius and shim material (Aluminium) is less effect on surface roughness. In proposing an optimization strategy suitable for milling operation to achieve optimum cutting conditions based on the criterion of the energy consumed and minimization of surface roughness during milling, [7] solved the problem of energy consumed in milling by an optimization method chosen which is done according to different requirements in the process of roughing and finishing under various technological constraints. However, in the discussion of the use of Taguchi and response surface methodologies for minimizing the surface roughness in turning of discontinuously reinforced Aluminium composites, [8] adopted a matrix test conditions for cutting speed, feed rate, steam pressure and a constant depth of cut. The findings revealed that the most significant machining parameter for surface roughness is steam pressure followed by feed. Ref. [9] investigated the effect of cutting parameters on tool vibration and surface roughness of EN-31 tool steel using response surface methodology. The experimental results showed that feed rate is the most dominating parameters affecting surface finish, whereas cutting speed is the major factor affecting tool vibration. This present study will carry out a comparative study between the surface roughness value of mild steel, stainless steel and brass under the same process parameter conditions so as to know if there is any significant difference between the values of the considered workpiece or not.

METHODOLOGY

En8 mild steel, SS304 stainless steel and MS58 brass of dimension 200 mm by 80 mm with a thickness of 1.5 mm are the workpiece used in the investigation. A manually operated vertical pillar drilling machine of METALIK PK203 model with a speed range between 75 rpm and 3200 rpm which is driven by a motor of 1.5 kW was used for the machining operation using High Speed Steel (HSS) as the cutting tool. The drilling experiment was conducted nine (9) times each for the considered workpiece using speed (1400 rpm, 1500 rpm & 1700 rpm), feed (0.11 mm/rev, 0.18 mm/rev & 0.75 mm/rev), depth of cut (0.25 mm, 0.50 mm & 0.75 mm) and drill bit (6 mm, 8 mm & 10 mm). A coupling ultrasonic thickness meter of TM-8810 Model was used to measure the surface roughness values of the workpiece after drilling as shown on Table 1. Comparison of the result of the surface roughness of the workpiece was done using one-way ANOVA method with the aid of statistical package for social sciences (SPSS) version 17.0 as shown on Table 2, Table 3 and Table 4.

RESULTS AND DISCUSSIONS

Table 1: Surface roughness value of the considered workpiece

Test No.	Surface Roughness Value (µm)		
	Mild Steel	Stainless Steel	Brass
1	6.78	7.16	7.22
2	7.38	7.44	7.92
3	8.59	6.91	7.56
4	6.82	5.91	8.16
5	7.87	5.48	9.02
6	3.96	4.62	5.3
7	9.02	7.04	8.71
8	7.3	7.2	6.3
9	6.4	7.3	5.77

Table 2: The distribution of surface roughness value in mild steel, stainless steel and brass

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Mild Steel	9	7.1244	1.4638	0.4879	5.9992	8.2497	3.9600	9.0200
Stainless Steel	9	6.5622	0.9872	0.3291	5.8034	7.3211	4.6200	7.4400
Brass	9	7.3289	1.2980	0.4327	6.3312	8.3266	5.3000	9.0200
Total	27	7.0052	1.2597	0.2424	6.5069	7.5035	3.9600	9.0200

Table 3: One-way ANOVA comparing surface roughness value in mild steel, stainless steel and brass

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.8370	2	1.4185	0.89	0.43
Within Groups	38.4177	24	1.6007		
Total	41.2547	26			

Print ISSN: 2055-8112(Print), Online ISSN: 2055-8120(Online)

Table 4: Tukey HSD Post-Hoc for surface roughness value in mild steel, stainless steel and brass

	(I) Workpiece	(J) Workpiece	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Upper Bound	Lower Bound
Tukey HSD	Mild Steel	Stainless Steel	0.5622	0.5964	0.6192	-0.9272	2.0517
		Brass	-0.2044	0.5964	0.9375	-1.6939	1.2850
	Stainless Steel	Mild Steel	-0.5622	0.5964	0.6192	-2.0517	0.9272
		Brass	-0.7667	0.5964	0.4168	-2.2561	0.7228
	Brass	Mild Steel	0.2044	0.5964	0.9375	-1.2850	1.6939
		Stainless Steel	0.7667	0.5964	0.4168	-0.7228	2.2561

There were no statistically significant differences between surface roughness values in mild steel, stainless steel and brass as determined by one-way ANOVA having F-test result of 0.89 with corresponding p-value of 0.43 as shown on Table 3. A Tukey post hoc test for surface roughness value of mild steel, stainless steel and brass revealed that they were not statistically significant based on their values of surface roughness as shown on Table 4. The Tukey post hoc test revealed no statistically significant of mild steel surface roughness value after taking stainless steel $(6.56 \pm 0.99\mu m, p = 0.619)$ and brass $(7.33 \pm 1.30\mu m, p = 0.938)$ value. There was also no statistically significant of stainless steel surface roughness value after taking the mild steel $(7.12 \pm 1.46\mu m, p = 0.619)$ and brass $(7.33 \pm 1.30\mu m, p = 0.417)$ value. There was also no statistically significant of brass surface roughness value after taking mild steel $(7.12 \pm 1.46\mu m, p = 0.938)$ and stainless steel $(6.56 \pm 0.99\mu m, p = 0.417)$ value.

CONCLUSION

Comparative test on surface roughness drilling value of mild steel, stainless steel and brass using one-way ANOVA approach revealed that there were no statistically significant differences between the surface roughness values of the considered workpiece despite using the same process parameters in the investigation irrespective of their material properties. This result implies that irrespective of the investigated workpiece using the same process parameters, there are equal quality effects of surface roughness value in drilling mild steel, stainless steel and brass. This however revealed that different material can produce the same quality effect of surface roughness in terms of their minimization target.

Print ISSN: 2055-8112(Print), Online ISSN: 2055-8120(Online)

REFERENCES

[1] Igelegbai, E., & Alo, O., (2015). Investigation of mechanical properties and microstructure of brass alloys obtained from recycled copper and zinc metals. *International Journal of Scientific & Engineering Research*, 6(9), 799-806

[2] Sekunowo, O.I., Adeosun, S.O., & Ojo, O.E., (2014). Mechanical properties enhancement of conventional mild steel for fastener application. *International Journal of Engineering and Technology*, 4(5), 325-332

[3] Ismail, N.M., Khatif, N.A.A., Kecik, M.A.K.A., & Shaharudin, M.A.H., (2016). The effect of heat treatment on the hardness and impact properties of medium carbon steel. *IOP Conf. series: Materials Science and Engineering*, (114) 012108, doi: 10.1088/1757-899X/114/1/012108

[4] Khan, W., & Raut, N., (2016). Optimization of end milling process parameters for minimization of surface roughness of AISI P20 steel. *Asian Journal of Science and Technology*, 7(4), 2777-2787

[5] Lazarevic, D., Madic, M., Jankovic, P., & Lazarevic, A., (2011). Surface roughness minimization of polyamide PA-6 turning by Taguchi method. *Journal of Production Engineering*. 15(1), 29-32

[6] Nachimuthu, A.K., (2013). Minimization of surface roughness in CNC turning using Taguchi method. *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*, 8(1), 47-49

[7] Belloufi, A., Abdelkrim, M., Bouakba, M., & Rezqui, I., (2017). Minimization of energy and surface roughness of the products machined by milling. *IOP Conf. Series: Materials Science and Engineering*, (227) 012016, doi: 10.1088/1757-899X/227/1/012016

[8] Shetty, R., Pai, R., Kamath, V., & Rao, S.S., (2008). Study on surface roughness minimization in turning of DRACs using surface roughness methodology and Taguchi under pressured steam jet approach. *ARPN Journal of Engineering and Applied Sciences*, 3(1), 59-67

[9] Bhogal, S.S., Sindhu, C., Dhami, S.S., & Pabla, B.S., (2015). Minimization of surface roughness and tool vibration in CNC milling operation. *Journal of Optimization, Hindawi Publishing Corporation*, ID: 192030, 1-13, http://dx/doi.org/10.1155/2015/192030

Print ISSN: 2055-8112(Print), Online ISSN: 2055-8120(Online)