ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 9 , September 2021

Effect of Cutting Variables on the Surface Finish of Dead Mild Steel (DMS)

Jewo O.A. , Ebojoh E.

Lecturer, Department of Mechanical Engineering, Petroleum Training Institute, Effurun, Delta State
Lecturer, Department of Production Engineering University of Benin, PMB 1154, Benin City, Nigeria

ABSTRACT: An experimental study on the effect of cutting parameters (spindle speed, feed rate and depth of cut) on surface finish of dead mild steel (DMS) is presented. In machining operation, the quality of surface finish is an important factor in many turned workpiece; it either improves or reduces the value of a given machined component. In this study, the specimen was cut into required piece (50x200mm) and turning operation was done using a tungsten carbide tip tool. Graphical method was used to evaluate the effect of these cutting parameters. The result obtained show that feed rate of 0.20mm/min has the most effect on the surface finish. The combination of minimum depth of cut (0.25mm) and maximum constant spindle speed of 700rpm gave a minimum effect on the surface finish with Ra value of 1.1µm. However, spindle speed of 450rpm and depth of cut 0.25mm gave a maximum roughness value of 2.8µm.

KEY WORDS: Roughness value, Depth of cut, feed rate, Spindle speed,Mild steel

I.INTRODUCTION

Steel has a major influence in our lives, the cars we drive, the homes in which we live and countless other facts in between. Steel is used in the electric power line tower, natural gas pipelines, machines tools, military weapons and so on. Steel is by far the most important, multifunctional and most adaptable materials compared to other materials of its type. It has low production cost and it is environment friendly because it is recyclable. Steel production is 20 times higher as compared to production of all non- ferrous. Steel is widely used in manufacturing process to produce various products.Metal cutting on the other hand is an industrial process in which metal parts are shaped or removal of unwanted materials. It is one of the most important and widely used manufacturing processes in engineering industries. In metal cutting, the output quality is of great important. A significant improvement in output quality can be obtained by optimizing the cutting parameters. Optimization of parameters does not only improve output quality but also ensures low cost manufacturing.

Product quality is mostly dependent on the surface finish. Decrease of surface roughness quality also leads to decrease in product quality in the field of manufacturing, especially engineering, the surface finish can be a considerable factor which can affect the functioning of a component and possibly its cost. Surface roughness has been receiving attention for many years in the machinery industries. It is an important design feature in many situations such as arts subjects and fatigue loads, precision fits, farter holes, and so on.

II. SIGNIFICANCE OF THE STUDY

This study is to ascertain the cutting variable that has the least or most effect on the surface roughness of dead mild steel. This will ensure better quality product with good aesthetics characteristics.

III. LITERATURE SURVEY

A study on the correlation among the cutting parameters, surface roughness and cutting forces in turning process on Aluminium alloy where full factorial method was used to carryout experimental investigations and statistical analysis was performed using MINITAB 16 software[1]. The results of the study shows that feed rate affect surface roughness (70.35%) most while depth of cut (85.37%) being the most influencing parameter on cutting forces. Furthermore, in a recent studyfull factorial method was used to evaluate the effect of cutting variables on surface roughness during

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 9 , September 2021

turning of ASISI 304L alloy steel with coated carbide [2].The input variables used were cutting speed, feed rate and depth of cut. Minitab17 software was used to conduct analysis of variance test on the data. The result shows that feed rate has the most significant effect on surface roughness with 79.86% and the relationship between feed rate and cutting speed at constant depth of cut shows that as feed rate increase for every cutting speed, the surface roughness increases.

In the same vein, Vikram et al [3]carried out a study on the prediction of optimality and effect of machining parameters on surface roughness based on Taguchi design of experiments. This work focused on surface roughness produced in speed machining on lathe. Machining was carried out on AISI 1040 steel material using coated carbide inserts and high speed steel (HSS) tools. Spindle speed and feed rate were chosen as control factors.These control factors were adopted to analyze significance and contribution on the surface roughness of the machined parts. Taguchi method based on orthogonal Arrays was used to design the experiments. Analysis of variance (ANOVA) was then used to analyze the influences and contribution of the machining parameters on the surface roughness values based on F-Statistic Test. The result of this study from ANOVA test and % contribution evaluation show that spindle speed seemed to be very highly significant predominant factor in producing the surface roughness while machining with both type of tools. Also an investigation was carried outon the effect of cutting parameters (cutting speed, depth of cut and feed) in turning off mild steel and aluminium to achieve better surface finish and to reduce power requirement by reducing the cutting forces involved in machining [4]. The experimental layout was designed based on the 2^k factorial techniques and analysis of variance (ANOVA) was performed to identify the effect of cutting parameters on surface finish and cutting forces are developed by using multiple regression analysis. The coefficients were calculated by using regression analysis and the model is constructed. The model is tested for its adequacy by using 95% confidence level. By using the mathematical model the main and interaction effects of various process parameters on turning was studied.

The optimization of machining parameters based on surface roughness prediction for AA6061 using response surface method. The study includes the cutter flutes in addition to cutting speed, feed rate and depth of cut. Response Surface Model (RSM) was adopted to establish the relationship model between the surface roughness and the parameters using Minitab16 software [5]. The sensitivities of the surface roughness to the parameters were then analyzed based on analysis of variance (ANOVA). The result shows that cutter flutes has high significant influence on surface roughness followed by feed rate and depth of cut, while cutting speed has the less significant influence. Further an experimental study on the effect of cutting parameters on surface finish of stainless steel and aluminium was also conducted [6]. The study was carried out in order to find the optima control parameters that give the minimum surface roughness. In their work, the analysis of effect of process parameters; cutting speed, feed rate and depth of cut, were considered and graphical method was used to determine the parameters with the minimum effect on the surface finish of the specimen.

Some authors in theirresearch [7] showed that the factors that influence the surface roughness level of carbon steel material are spindle speed followed by feed rate and depth of cut. To get the result of smooth surface roughness with Ra value about 1.18 µm, setting parameter used is spindle speed 600 rpm, 130 m/min feed rate and 1.5 mm cutting depth. To obtain a rough surface roughness of about 6.25 µm, the setting parameters used are 400 rpm spindle speed, 240 m/min feed rate, and 1.0 mm cutting depth. Also [8] uses the combination of signal to noise and analysis of variance were used in this investigation, besides, the model adequacy examination was carried out through residual analysis. The cutting speed, feed rate and regression model were statistically significant for hardness, also a moderate increase of it was found. On the other hand, feed rate was statistically significant factor for surface roughness and, its lowest value for the lower feed rate and the medium cutting speed was observed. Besides, the 75 % of the data values are less than or equal to 3,2µm, therefore, the grinding operation could be avoided.The taguchi technique and the analysis of variance (ANOVA) were employed to investigate the effect of the turning parameters on Metal Removal Rate (MRR) and Tool Wear Rate (TWR). The LARGER THE BETTER signal to noise (S/N) ratio based on the Taguchi technique was applied for MRR while the LOWER THE BETTER S/N ratio was applied for TWR[9].

IV. METHODOLOGY

Material

The workpiece material used in this study is low carbon steel (dead mild steels), also known as black mild steel has a dark colour as the name implies and is different from bright mild steel due to its percentage carbon and it varies from 0.05-0.15%. It is used for making various components like sheets, ships, wire, or rod. This percentage of carbon gives

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 9 , September 2021

the dead mild steel the properties of ductility and formability. Table 1 shows the various composition of low carbon steel (www.matweb.com/searcg/datasheet.aspx accessed 2020)[10].

Table 1: Composition of Low Carbon Steel

Element	(%)
Aluminum, Al	0.0100 - 1.50
Boron, B	0.000500 - 0.00600
Carbon, C	0.00300 - 0.800
Chromium,Cr	0.200 - 10.0
Cobalt, Co	7.50 - 12.0
Copper, Cu	0.0200 - 1.50
Iron, Fe	63.0 - 100
Lead, Pb	0.150 - 0.360
Manganese, Mn	0.100 - 2.20
Molybdenum, Mo	0.0800 - 4.80
Nickel, Ni	0.0300 - 18.5

The specimen dimension used for dead mild steel material was 50mm diameter and 200mm length, this is done so as to maintain a ratio of cylindrical turning length to the initial diameter of workpiece at 4 in order to ensure the required stiffness of chuck/workpiece/cutting force (Lawal 2016).The cutting tool material used for the turning operation was carbide. Carbide tools are more expensive when compared to high speed steel (HSS), but last longer and can be much faster thereby proving more economical in the long run. Ajax lathe with maximum speed of 700 rpm was used for the turning operation and TM-8810 Coupling Ultrasonic Thickness Meter was used to test the surface roughness of the specimen.

Method

The experimental procedure was carried out in the following steps: The material specimens (DMS) were cut into required dimensions. The metal rod was mounted on the lathe chuck and secured appropriately and finally turning operation was then carried out with a tungsten carbide tip tool for the required number of runs. The turning process was done in the following three cases; keeping depth of cut and feed rate constant while spindle speed was varied; keeping spindle speed and depth of cut constant while feed rate was varied, and keeping feed rate and spindle speed constant while depth of cut was varied, Table 2 to Table 10 shows the setting parameters and the variations of the three parameters to be investigated.

Table 2: Constant Spindle speed and Feed rate with varied Depth of cut

S/N	Spindle speed (rpm)	Feed rate (mm/min)	Depth of cut (mm)
1	400	0.20	0.75
2	400	0.20	0.50
3	400	0.20	0.25

Table 3: Constant Spindle speed and Depth of cut with varied Feed rate

S/N	Spindle Speed (rpm)	Feed rate (mm/min)	Depth of Cut mm
1	400	0.20	0.75
2	400	0.22	0.75
3	400	0.24	0.75

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 9 , September 2021

Table 4: Constant Feed rate and Depth of cut with varied Spindle speed

S/N	Spindle Speed (rpm)	Feed rate mm/min	Depth Of Cut mm
1	400	0.2	0.75
2	450	0.2	0.75
3	700	0.2	0.75

Table 5: Constant Spindle speed and Feed rate with varied Depth of cut

S/N	Spindle Speed (rpm)	Feed rate mm/min	Depth of Cut mm
1	450	0.20	0.75
2	450	0.20	0.50
3	450	0.20	0.25

Table 6: Constant Spindle speed and Depth of cut with varied Feed rate

S/N	Spindle Speed (rpm)	Feed rate (mm/min)	Depth of Cut (mm)
1	450	0.20	0.75
2	450	0.22	0.75
3	450	0.24	0.75

Table 7: Constant Feed rate and Depth of cut with varied Spindle speed

S/N	Spindle Speed (rpm)	Feed rate mm/min	Depth of Cut (mm)
1	400	0.20	0.50
2	450	0.20	0.50
3	700	0.20	0.50

Table 8: Constant Spindle speed and Feed rate with varied Depth of cut

S/N	Spindle Speed (rpm)	Feed rate (mm/min)	Depth of Cut (mm)
1	700	0.20	0.75
2	700	0.20	0.50
3	700	0.20	0.25

Table 9: Constant Spindle speed and Depth of cut with varied Feed rate

S/N	Spindle Speed (rpm)	Feed rate (mm/min)	Depth of Cut (mm)
1	700	0.20	0.75
2	700	0.22	0.75
3	700	0.24	0.75

Table 10: Constant Feed rate and Depth of cut with varied Spindle speed

S/N	Spindle Speed (rpm)	Feed rate (mm/min)	Depth of Cut (mm)
1	400	0.22	0.50
2	450	0.22	0.50
3	700	0.22	0.50

Cutting process was performed to the desired length and diameter and set in the Ajax lathe with variation of spindle speed, feed rate and depth of cut see Plate 1. The measurement of roughness values for the various variations of the

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 9 , September 2021

three parameters of the test specimens was carried (see Plate 2 and Plate 3) using TM-8810 COUPLING ULTRASONIC THICKNESS METER resulting from the lathe process and recorded.


Plate1: Workpiece on lathe during turning operation


Plate 2: Surface tester on the surface of the workpiece


Plate 3: Measuring and reading roughness value

V. EXPERIMENTAL RESULTS

The following Figures presents the experimental results obtained for dead mild steel. Fig. 1 shows a graph of constant spindle speed of 400 rpm and feed rate of 0.2 mm/min it is observe that the value of Ra increases from 1.3µm to 2.0µm as the depth of cut reduces, also at constant spindle speed of 400 rpm and depth of cut of 0.75mm with varied feed rate, the Ra value increases to 2.0µm as shown in Fig. 2.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 9 , September 2021

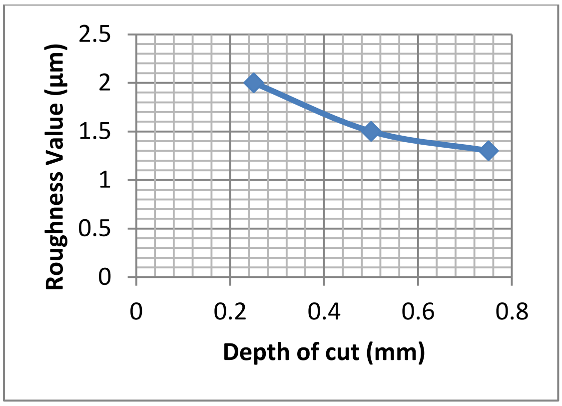

Fig. 1: Relationship of surface roughness with depth of cut

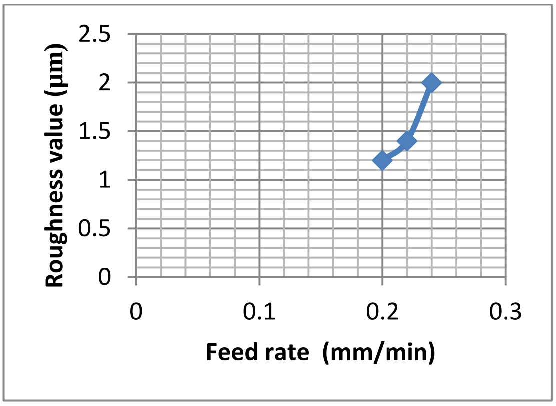

Fig. 2: Relationship of surface roughness with feed rate

Fig. 3 further shows that roughness value reduces from 1.3µm to 1.1µm as the spindle speed increases when the depths of cut and feed rate are held constant. Also it is observed in Fig. 4 that at constant spindle speed of 450rpm and feed rate 0.20mm/min with varied depth of cut was a fluctuation in the Ra value from 2.8µm to 1.8µm and 2.4µm as the depth of cut increases.

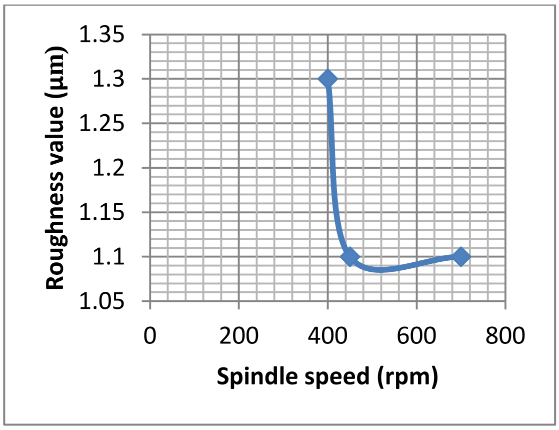

Fig. 3: Relationship of surface roughness with spindle speed

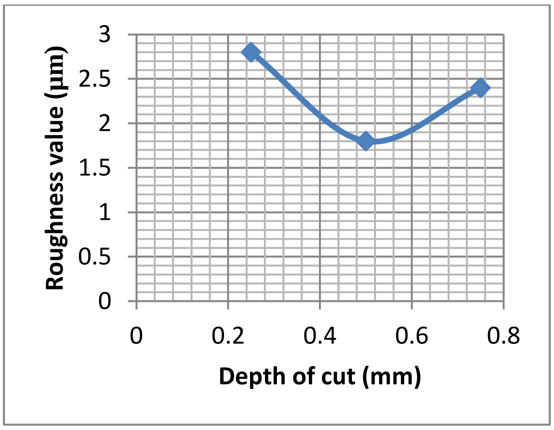

Fig. 4: Relationship of surface roughness with depth of cut

Fig. 5 is a plot of roughness value against feed rate. It is observed that as the feed rate increases from 0.2mm/min to 0.24mm/min there is a linear increase in the Ra value from 1.1µm to 2.0µm when the spindle speed and depth of cut are held constant. Again when the depths of cut and feed rate are held constant, with a varied spindle speed, it is seen that there is a drop of in the Ra value from 1.5 µm to 1.2 µm as shown in Fig. 6.

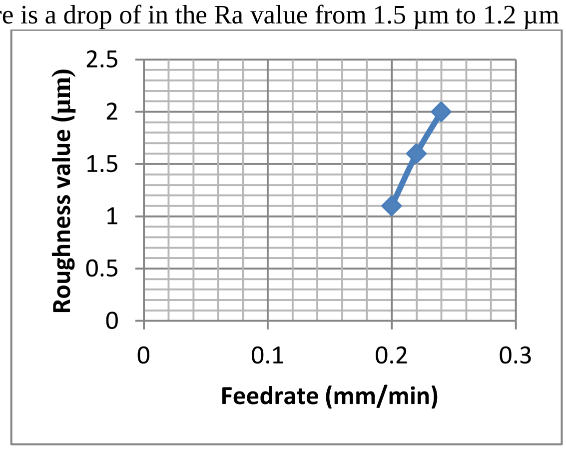

Fig. 5: Relationship of surface roughness with feed rate

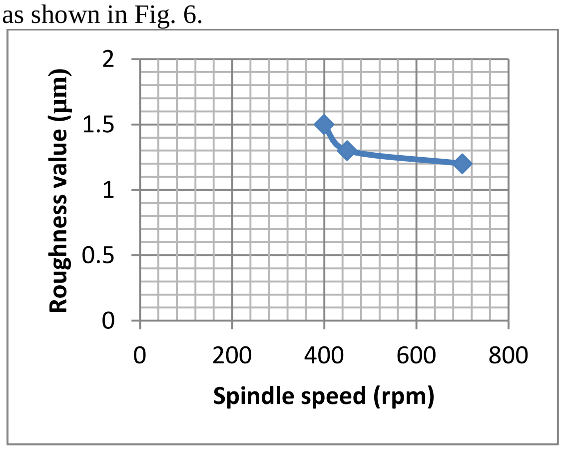

Fig. 6: Relationship of surface roughness with spindle speed

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 9 , September 2021

For a spindle speed of 700rpm held constant with feed rate of 0.20mm/min, Fig. 7 shows the effect of varied depth of cut in the machining parameters to roughness; that as the depth increases there is a corresponding increase in the Ra value. This is seen to rise from 1.1µm to 1.8µm. Furthermore when the speed remains at 700rpm and depth of cut held constant at 0.75mm and the feed rate varied it was observed that as it increases there is a drop in the Ra value and then rises again, this can be seen in the plot in Fig. 8.

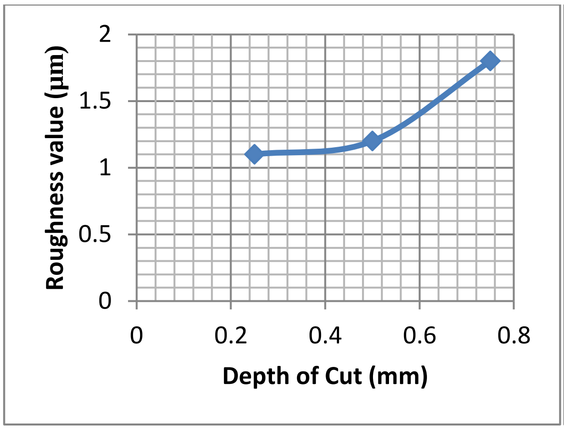

Fig. 7: Relationship of surface roughness with depth of cut

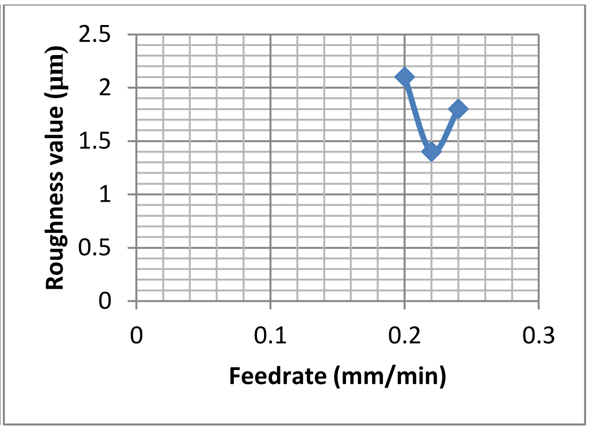

Fig. 8: Relationship of surface roughness with feed rate

Fig. 9 shows the relationship of spindle speed with roughness when depth of cut and feed rate are held at constant values. The plot shows a decrease in the surface roughness as the spindle speed increases.

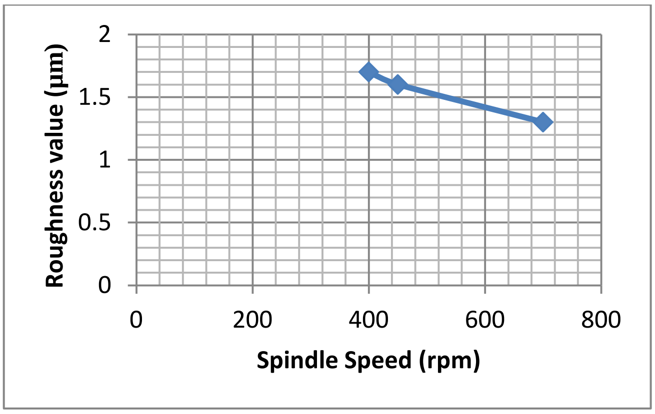

Fig. 9: Relationship of surface roughness with spindle speed

In Fig. 1, Fig.4 and Fig.7, the plot train shows the influence of the variation of depth of cut on the surface roughness of dead mild steel. Fig. 2, Fig. 5 and Fig. 8 shows the influence of the variation of feed rate on dead mild steel. Furthermore, Fig. 3, Fig. 6 and Fig.9 show the influence of the variation of spindle speed on dead mild steel. It is observed from the graphs that an increase in feed rate increases the roughness value, a higher spindle speed on the other hand with a minimum depth of cut results to a minimum roughness value.

VI. CONCLUSION

An experimental study on the effect of cutting variables on surface finish of mild steel has been carried out. The experiment was done by varying and combination of three cutting parameters which are; spindle speed, feed rate, and depth of cut. A conclusion was drawn that the minimum surface roughness in dead mild steel is obtained when there is a combination of maximum spindle speed (700rpm) with a minimum depth of cut of 0.20mm, while a minimum surface finish is obtained when the feed rate is high (0.75mm/min).

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 9 , September 2021

REFERENCES

[1] Jithin B.R, and BabuA.R. (2014), Correlation among the Cutting Parameters, Surface Roughness and Cutting Forces in Turning Process by Experimental Studies in the Preceding of 5th International and 26th all Indian Manufacturing Technology, Design and Research Conference (AIMTDR 2014), December 12th -14th, 2014, IIT Guwahati, Assan, Indian Pages 459-1 to 459 -6

[2] Lawal S.A. (2016), Effect of Cutting Variables on Surface Roughness in high speed turning of AISI 3041 steel using full Factorial Method, in the proceedings of National Conference of the Nigerian Institute of Mechanical Engineers, Uyo, Pages 1-6

[3] Vikram A.K., Narayana K.S., Kumar G.P., Skandha C., (2014), Prediction of Optimality and Effect of Machinery Parameters on Surface Roughness based on Taguchi Design of Experiment International Journal on Theoretical and Applied Research in Mechanical Engineering (IJTARME), vol 3, issue-3, page 2319-3182

[4] BalaRaju J, Leela Krishna J, Tejomurthy P. (2013)Effect And Optimization Of Machining Parameters On Cutting Force And Surface Finish In Turning Of Mild Steel And Aluminum. International Journal of Research in Engineering and Technology. Volume: 02 Issue: 11 pp. 135-141

[5] Yahya E., Ding G.F., Shing F.Q. (2015), Optimization of Machining Parameters based on Surface Roughness Prediction for AA6061 using Response Surface Method, American journal of Science and Technology, Vol 2, No 5, Pages 220-231

[6] Tulasiramarao B., Srinivas K., Ram R. P., Raveedra A., kumar B.V.R., (2013), Experimental study on the cutting parameters on surface finish obtained in CNC Turning Operation, International journal of Innovative Research in Science, Engineering and Technology Vol. 2, issued September 2013. Pages 4547-4555

[7] Sumardiyanto D., Susilowati S.E and Cahyo A.(2018), Effect of Cutting Parameter on Surface Roughness Carbon Steel S45C. Journal of Mechanical Engineering and Automation 2018, 8(1): 1-6

[8] Hernández-González, L. W., Dumitrescu, L., Quesada-Estrada, A. M. & Reyes-Camareno, R. (2020). Cutting parameters determination in milling of AISI 1045 steel.Revista Universidad y Sociedad, 12(6), 207-214.

[9] Mgbemena C, Mgbemena C, Etebenumeh G. and Ashiedu F.(2016), Effect of Turning Parameters on Metal Removal and Tool Wear Rates of AISI 1018 Low Carbon Steel Nigerian Journal of Technology (NIJOTECH) Vol. 35, No. 4, October 2016, pp. 847 – 854

[10] www.matweb.com/searcg/datasheet.aspx accessed 2020