REQUIREMENT OF OPTIMIZATION OF MACHINING PARAMETER FOR IMPROVING THE SURFACE FINISH OF MATERIALS – A REVIEW

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ABSTRACT

The purpose of this research paper is to analyze the techniques used in current scenario in order to optimize the surface roughness of various materials used in industries such as inconel, aluminum, cast iron, steels, alloy steels and stainless steels. Many research papers are studied and evaluated on the basis of problem definition, cutting parameters used, procedure opted and their conclusions. An attempt to generalize the dependency of surface finish on various cutting parameters is made in the conclusion of the paper.

Keywords: Taguchi, ANOVA, SEM & S/N Ratio, Surface Finish, Cutting Parameters Etc

I. INTRODUCTION

Surface finish is an important parameter in manufacturing engineering. It is a characteristic that could influence the performance of mechanical parts and the production costs.Increasing the productivity and the quality of the machined parts are the main challenges of metal-based industry. The ratio between costs and quality of products in each production stage has to be monitored and immediate corrective actions have to be taken in case of deviation from desired trend. [1].

Techniques such as Taguchi approach, Signal to noise ratio, ANOVA, genetic algorithms etc. are used to select cutting parameters of speed, depth of cut, feed, rake angles, nose radius, coolant pressure and concentration so as to obtain optimum value of these parameters for surface finish operation. Machining the materials with optimum cutting parameters increase surface finish and satisfies economy with minimum possible loss of material.

II. LITERATURE SURVEY

Many investigators have suggested various methods to explain the effect of process parameters on surface finish:

Prof. Bharat S Patel and Mr. Hiren Pal [2] investigated "Optimization of Machining Parameters for Surface Roughness in Milling Operation of aluminum". The machining was done on aluminum using milling machine and it was observed that the surface roughness for different cutting conditions such as speed, feed and depth of cut on Talysurf roughness testing machine. The findings include S/N ratios for each set of experiment and with the approach that level at which the S/N ratio is higher gives the optimum surface roughness obtained the required parameters and optimum surface finish.

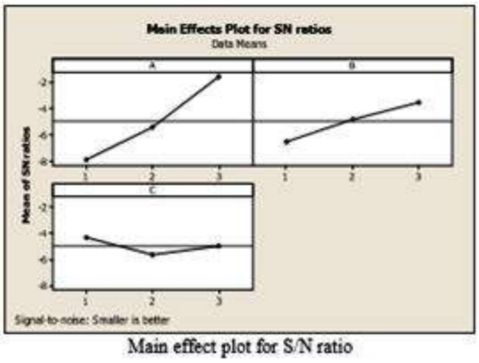

Figure 1: Main Effect Plot for S/N Ratio of Aluminum

MrJ.A.Ghani, Mr. K. Othman, Mr. M.N.A. Rahman, Mr. B.M. Deros and Mr. C.H.C.Haron [3] worked out on "Machined surface of FCD 700 ductile cast iron in a dry turning environment using carbide tools" The problem was to optimize the parameters of cast iron which actually was being changed due to stress transformation of the high carbon-retained austenite in the matrix into martensite. The machining trials were carried out on a Colchester model Tornado 600 CNC turning machine in a dry environment. The FCD700 (JIS) grade ductile cast iron with spherical graphite and ferrite was prepared in the form of round bar of dimensions D100mm x 160mm. Surface roughness was measured using a Mahrperthometer portable roughness tester, and the surface topography was captured using a Leica confocal microscope.

Following are the plots of the observations obtained in the experiment

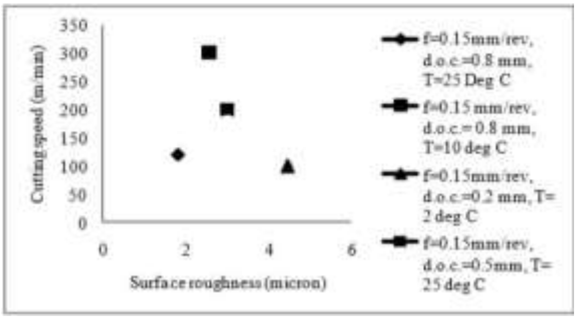

Figure2: Plot of Surface Roughness vs Depth Of Cut

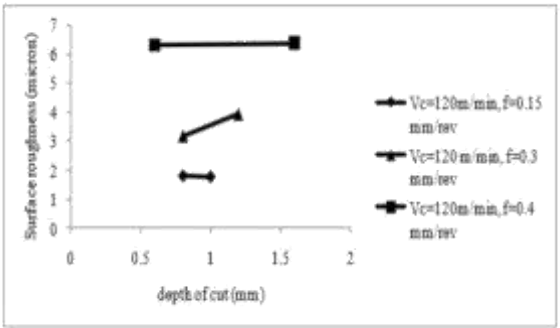

Figure 3: Plot of Cutting Speed vs Surface Roughness

It is found that surface roughness measured depends mainly on the feed rate and not on the depth of cut i.e. the value of Ra doubles when feed rate is doubled. The Ra obtained at a cooler air temperature of -2^0 C was lower than when cutting in a normal air environment. A high feed rate produced a coarser surface finish at the beginning of the cut, but as the tools became worn out the machined surface topography remained unaffected by the value of feed rate used.

MrTugrul ¨Ozel, MrTsu-Kong Hsu and MrErolZeren [4] studied "Effects of cutting edge geometry, Workpiece hardness, feed rate and cutting speed on surface roughness and forces in finish turning of hardened AISI H13 steel". Edge preparation, Workpiece hardness, Feed rate and Cutting speed was selected as process parameters. Longitudinal turning was performed on a rigid, high-precision CNC lathe. The cutting forces were measured with a three-component force dynamometer (Kistler Type 9121), the surface is measured on SEM and an analysis of variance (ANOVA) was conducted to identify statistically significant trends in the measured surface roughness and cutting force data. The following graph is obtained after plotting the observations:

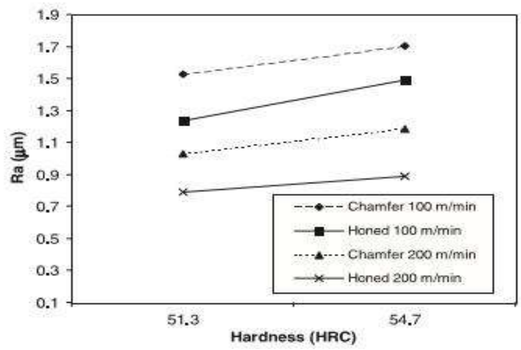

Figure 4: Interaction plot: Ra Vs HRC

It is found that the effect of cutting edge geometry on the surface roughness is remarkably significant. The cutting forces are influenced not only by cutting conditions but also the cutting edge geometry and Work piece surface hardness. Especially, honed edge geometry and lower Workpiece surface hardness resulted in better surface roughness. Cutting edge geometry, Workpiece hardness and cutting speed are found to be affecting force components. The lower Workpiece surface hardness and small edge radius resulted in lower tangential and radial forces.

Mr. Joseph Emmanuel and Mr Rahul Davis [5] worked upon "An Experimental Study of the Effect of Control Parameters on the Surface Roughness in Turning Operation of EN 353 Steel" with Cutting speed, doc, feed, rake angle and pressurized coolant jet pressure as variables. Using Taguchi approach L9 array was designed and then using S/N ratios and ANOVA optimization of cutting parameters for surface finish was done. At the end it was concluded that rake angle contributes the highest effect on surface roughness.

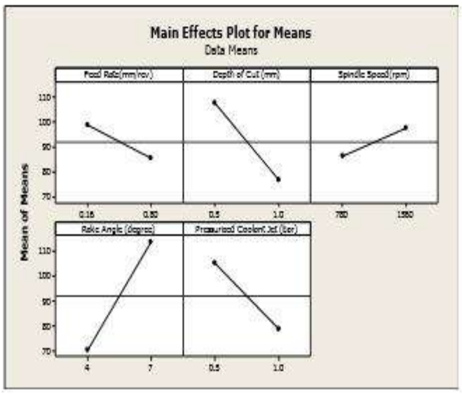

Figure 4: Combined Main Effect Plot for EN 353

Mr. Nikunj R Modh, Mr. G. D. Mistry and Mr. K. B. Rathor [6] workedon "An experimental investigation to optimize the process parameters of AISI 52100 steel in hot machining". They used the concept that softening of the work piece should be a better approach instead of increasing the quality of the cutter materials. Cutting speed, feed rate, depth of cut and temperature are the variables. The procedure includes L27 array and 3-level approach for design of experiment and then using S/N ratios and ANOVA results optimization of the parameters for surface finish was processed.

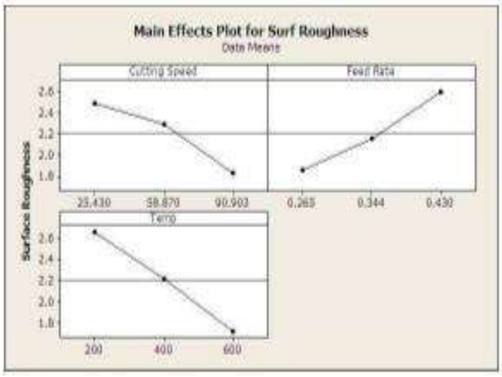

Figure 5: Main Effect Plot for Ra for AISI 52100

In this work it was found that hot machining process gives good surface finish at high cutting speed, high temperature and low feed rate. Hot machining is also beneficial in terms of low cutting force and feed force.

Mr. S. Thamizhmanii, Mr. B. Bin Omar, Mr. S. Saparudin and Mr. S. Hasan [7] worked on "Surface roughness analyses on hard Martensitic stainless steel 440C by turning". Feed, doc and nose radius were selected as the cutting parameters. Taguchi approach along with ANOVA for optimization was followed. It was concluded that it is always advisable to turn the hard Martensitic stainless steel at medium level cutting speed, high feed rate and high depth of cut. Turning at this parameter would also produce generation of heat and intensity may not be high which in turn affect flank wear. Using regression analysis they provided a general formula for surface roughness ($Ra = 0.032\ f^2/ R$).

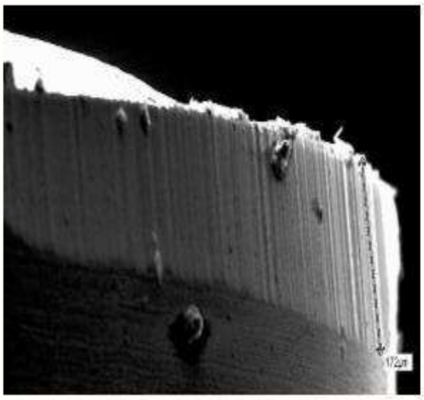

Figure 6: Tool Flank Wear at 225 Cutting Speed with Feed Rate of 0.125 and Doc of 1 mm

III. RESULTS

Following table is made after summarizing the results obtained from the papers:

IV. CONCLUSION

1. As per the table in which it is found that there are many researches done on optimization techniques for process parameter for surface roughness. This is a wide field of study.

2. Optimization of cutting parameters is a subjective research topic. There is no definite or general formula to predict surface finish for a set of parameters. Regression analysis provides some formulas but they are limited to individual experiments only not as a whole.

Table1: Summary of Results of Various Research Papers

SR. NO.	MATERIAL	OPTIMISED CUTTING PARAMETERS	MOST SIGNIFICANT PARAMETER	SURFACE FINISH
1	ALUMINIUM	SPEED=1200 RPM, FEED=200 mm/rev, DOC=0.75mm.	SPEED	R_a=1.46 µm
2	CAST IRON	SPEED=120m/min, FEED=0.15mm/rev, DOC=0.8 mm	FEED	R_a=1.8 µm
3	HARDENED AISI H13 STEEL	SPEED= 200 m/min, FEED=0.05mm/rev, HONED TOOL, HARDNESS= 51.3 HRC	TOOL GEOMETRY & SURFACE HARDNESS	R_a=0.4 µm
4	EN 353 STEEL	DOC=1.0 mm, FEED= 0.80 mm/rev, SPEED=1560rpm,RAKE ANGLE= 4°, COOLANT PRESSURE=1.0 bar	RAKE ANGLE	R_a=36.65 µm
5	AISI 52100 STEEL	CUTTING SPEED is 965 rev/min, DOC is 0.8 mm, FEED= 0.265 mm/rev & TEMP. is 600°C	FEED	R_a=1.3 µm
6	STAINLESS STEEL SS 440 C	SPEED= 225 m/min, FEED of 0.125 and 0.50 mm DOC.	FEED	R_a=23µm

3. In the experiments, most of the time feed& tool geometry became the prominent factor which influencedthe surface roughness most.

REFERENCES

[1] Turning parameter optimization for surface roughness of ASTM A242 type-1 alloy steel using taguchi method by JitendraVerma, Pankaj Agrawal and Lokesh Bajpai - International Journal of Advances in Engineering & Technology, March 2012. ISSN: 2231-1963.

[2] Optimization of Machining Parameters for Surface Roughness in Milling Operation by Prof. Bharat patel&MrHiren Pal -- International Journal of Applied Engineering Research, ISSN 0973-4562 Vol.7 No.11 (2012) © Research India Publications.

[3] Machined surface of FCD 700 ductile cast iron in a dry turning environment using carbide tools by J.A.Ghani, K. Othman, M.N.A. Rahman, B.M. Deros and C.H.C.Haron -- International Journal of Mechanical and Materials Engineering (IJMME), Vol.6 (2011), No.3, 362-366

[4] Effects of cutting edge geometry, Workpiece hardness, feed rate and cutting speed on surface roughness and forces in finish turning of hardened AISI H13 steel by TugrulOzel, Tsu-Kong Hsu, ErolZeren -- Int J AdvManufTechnol (2005) 25: 262–269 © Springer-Verlag London Limited 2004

[5] An Experimental Study of the Effect of Control Parameters on the Surface Roughness in Turning Operation of EN 353 Steel by Joseph Emmanuel, Rahul Davis -- IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 8, Issue 4 (Sep. - Oct. 2013),

PP 33-38 www.iosrjournals.org

[6] An experimental investigation to optimize the process parameters of AISI 52100 steel in hot machining by Nikunj R Modh, G. D. Mistry, K. B. Rathod -- International Journal of Engineering Research and Applications (IJERA) Vol. 1, Issue 3, pp.483-489 ISSN: 2248-9622

[7] Surface roughness analyses on hard martensitic stainless steel by turning by S. Thamizhmanii, B. Bin Omar, S. Saparudin and S. Hasan – journal of Achievements in Materials and Manufacturing Engineering volume 26 issue 2 February 2008