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OPTIMIZATION OF HOT MACHINING PROCESS PARAMETERS FOR EN24 MATERIAL

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Abstract

In the modern world, there is a need of materials with very high hardness and shear strength in order to satisfy industrial requirements. So many materials which satisfy the properties are manufactured. Machining of such materials with conventional method of machining was proved to be very costly as these materials greatly affect the tool life. So to decrease tool wear, power consumed and increase surface finish Hot Machining can be used. Here the temperature of the work piece is raised to several hundred or even thousand degree Celsius above ambient, so as to reduce the shear strength of the material. Various heating method has been attempted, for example, bulk heating using furnace, area heating using torch flame, plasma arc heating, induction heating and electric current resistance heating at tool-work interface. The experiment is conducted on conventional lathe. The temperature is controlled by a infa-rate thermometer and flame heating system. The statistical analysis is done by Taguchi method. Taguchi designs provide a powerful and efficient method for designing products that operate consistently and optimally over a variety of conditions. The primary goal is to find factor settings that minimize response variation, while adjusting (or keeping) the process on target. A process designed with this goal will produce more consistent output. A product designed with this goal will deliver more consistent performance regardless of the environment in which it is used.Taguchi method advocates the use of orthogonal array designs to assign the factors chosen for the experiment. The L9 orthogonal array of a Taguchi experiment is selected for four parameters (speed, feed rate, depth of cut and temperature) with three levels (low, medium, and high) in optimizing the hot machining turning parameters on lathe. The signal-to-noise (S/N) ratio, analysis of variance (ANOVA) and grey relational analysis were employed to the study the performance characteristics in the turning of EN24 material. Form the experiment it is found that temperature is most effective parameter for surface roughness and tool wear, while cutting speed is most effective parameter for material removal rate.

Key Words- *EN-24, ANOVA, MRR, SR*

I. INTRODUCTION

In the modern world, there is a need of materials with very high hardness and shear strength in order to satisfy the industrial requirements. So many materials which satisfy the properties are manufactured. Machining of such materials with conventional method of machining was proved to be very costly as these materials greatly affect the tool life. So to decrease tool wear, power consumed and increase surface finish Hot Machining can be used. Here the temperature of the work piece is raised to several hundred or even thousand degree Celsius above ambient, so as to reduce the shear strength of the material. Various heating method has been attempted, for example, bulk heating using furnace, area heating using torch flame, plasma arc heating, induction heating and electric current resistance heating at tool-work interface.

It is difficult to obtain good surface finish and longer tool life while working with materials having high strength, corrosive resistance, toughness, and wear resistance in conventional machining. In order to circumvent the above problem, optimized cutting parameters and proper selection of cutting tools are to be employed. The high operating temperature in hot turning process imparts softness on the material under investigation, which eases the machining process and further reduces the high cost of changing and sharpening cutting tools. Softening of the work piece in hot machining is a more effective method than strengthening the cutting tool in conventional machining.

II. Methodology

Experimental investigation is done through design of experiments and the parameter influence and interaction effect on speed, feed rate, depth of cut and temperature.

III. Work Piece and Electrode Material

EN 24 is the work material which is a low alloy medium carbon steel used for large size parts which requires high strength and toughness. The electrode material is copper.

IV. Characteristics

This nickel-chromium-molybdenum alloy possesses increased ductility and toughness and much deeper harden ability. EN 24 is ideal for all highly stressed parts in the most severe conditions because of its high fatigue strength. It has good wear resistance and used in both elevated and low temperature environments. Typical applications include aircraft landing gear, power transmission gears and shafts and other structural parts, high strength machine parts, heavy-duty shafting, high tensile bolts and studs, gears, axle shafts, crankshafts, boring bars and down-hole drilling components.

V. Experimental Setup

A BAGA machinery make conventional lathe is the machine used to carry out this experiment. The input parameters considered for process speed, feed rate, depth of cut and temperature. Weight of work piece and electrode is measured using electronic weighing scale before and after machining to measure material removal rate and electrode wear rate. Mathematical models are developed on the basis of experimental data. The table 1 shows the EDM input parameters and their levels.

Table 1: Input parameters and their level

Control Variable	Cutting speed (m/min)	Feed (mm/rev)	Depth of cut (mm)	Temperature (℃)
Level-1	31	0.05	0.5	50℃
Level-2	75	0.1	1	100℃
Level-3	120	0.15	1.5	200℃

VI. Measurement Procedure

An electronic weighing scale is used to measure the weight of work piece before and after trial. The digital timer is used to measure the period of trial in minutes. SURFCORDER, a surface roughness measuring instrument is used to measure the surface roughness Ra in terms of µM.

VII. Measurement of MRR

$$MRR = \frac{(Wi - Wf)x1000}{7.8xt} \; mm3/_{min}$$

Where Wi = weight of work piece in grams before trial
Wf= weight of work piece in grams after trial
t = period of trial in minutes
7.8= Density of steel in gms/cc

VIII. Mathematical Modeling

Mathematical models are developed on the basis of experimental data. The experimental planning is done based on Design of Experiments.

Design of Experiments (DOE) is a method used to obtain useful information about a process by conducting only minimum number of experiments. Each controllable variable can be set on Lathe machine at three consecutive levels and hence the design consisting of 9 experiments based as shown in fig

IX. Experimental Results

Table 2: Experimental Results

Sr. No	Speed (m/min)	Feed (mm/rev)	Depth of cut (mm)	Temperature (℃)	Machining Time (min.)	Initial Dia. (mm)	Dia. After (mm)
1	31	0.05	0.5	50	9.82	47	46
2	31	0.1	1	100	4.89	46	44
3	31	0.15	1.5	200	3.27	45	42
4	75	0.05	1	200	4.10	46	44
5	75	0.1	1.5	50	2.44	45	42
6	75	0.15	0.5	100	1.36	47	46
7	120	0.05	1.5	100	2.52	45	42
8	120	1	0.5	200	1.26	47	46
9	120	0.15	1	50	0.98	46	44

X. Analysis of Experimental Results

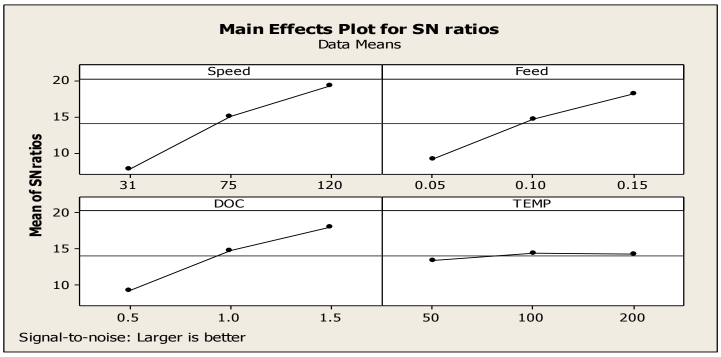
Material Removal Rate (MRR)-

The main effects plot of material removal rate verses cutting speed, feed rate, depth of cut and temperature, which is generate form the value of S/N ratio of material removal rate as per Table 5.4 in Minitabe-17 statistical software is useful to find out optimum parameter value for response variable. The graph generate by use of Minitab-17 statistical software for material removal rate is shown in figure

Table 3: Analysis of Variance for MRR

Level	SPEED	FEED	DOC	TEMP
1	7.825	9.178	9.295	13.375
2	14.974	14.683	14.749	14.399
3	19.258	18.196	18.012	14.282
Delta	11.433	9.018	8.717	1.024
Rank	1	2	3	4

Figure 1: Main Effect plot for MRR



Tool Wear (TWR) –

In this the observe value of Tool wear is transform in S/N ratio values to find out the optimum combination of parameters for response variable. In Tool wear “smaller is better" is objective characteristic, so the maximization of the quality characteristic is interested and it can be expressed by use of equation. The analyzed value of S/N ratio by use of Minitab 17 statistical software for Tool wear is shown in Table.

Table 4 Analysis of Variance for SR

Level	SPEED	FEED	DOC	TEMP
1	27.47	31	30.46	25.63
2	30.54	29.63	29.67	28.51
3	30.52	27.90	28.40	34.40
Delta	3.08	3.10	2.06	8.76
Rank	3	2	4	1

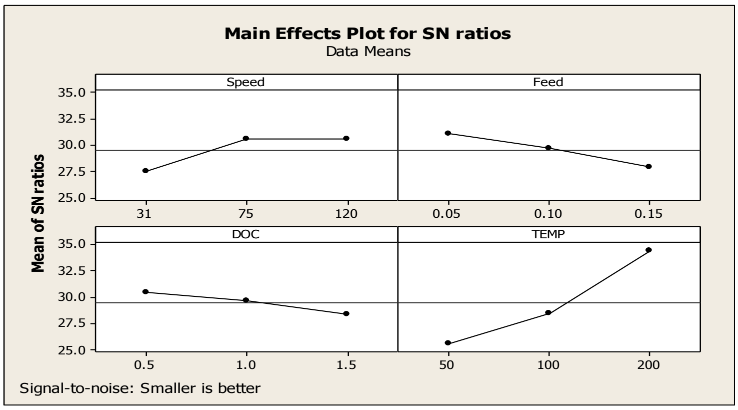


Figure 2: Main Effects Plot for TWR

XI. Conclusion

From Table.5.5, it is show that the value of delta for each parameter A, B, C and D are 11.433, 9.018, 8.717 and 1.024 for material removal rate. From delta value of each parameter it is conclude that for material removal rate the most effective parameter is Cutting speed followed by Feed rate, Depth of cut and Temperature.

From Table.5.7, it is show that the value of delta for each parameter A, B, C and D are 3.08, 3.10, 2.06 and 8.76 for tool wear. From delta value of each parameter it is conclude that for tool wear the most effective parameter is Temperature followed by Feed rate, Cutting speed and Depth of cut.

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XII. Reference

1. Adeel H. Suhail, N. Ismail, S.V. Wong and N.A. Abdul Jalil,"Optimization of Cutting Parameters Based on Surface Roughness and Assistance of Workpiece Surface Temperature in Turning Process" American Journal of Engineering and Applied Sciences 3 (1), (2010), pp.- 102-108
2. E. Daniel Kirby, Zhe Zhang, Joseph C. Chen and Jacob Chen, "Optimization surface finish in a turning operation using the taguchi parameter design method", International Journal Advance Manufacturing Technology, 30, (2006), pp.-1021-1029.
3. G.S.Kainth, Dey B.K., An experimental investigation into cutting forces and chip- tool interface temperature for oblique hot machining of EN 24 steel, Bulletin Cercle Etudes des Métaux, (1980), pp-22.1-22.7.
4. Ketul M. Trivedi and Jayesh V. Desai, "An experimental investigation to optimize the process parameters of AISI 4340 steel in hot machinig", International journal for scientific research & development, March (2014), Vol. 2, Issue 03, pp.-1542-1545.
5. K. A. Patel, S. B. Patel and K. A. Patel, "Performance evaluation and parametric optimization of hot machining process on EN-8 material", International journal for technological research in engineering, June (2014), Volume 1, Issue 10, pp.-1265-1268.
6. K.P. Maity and, P.K. Swain, "An experimental investigation of hot-machining to predict tool life", Journal of materials processing technology 198, (2008), pp. 344–349.

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