A Literature Review on Optimization of Cutting Parameters of P20 Steel by using Taguchi Method for Minimizing Surface Roughness in End Milling Process

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Abstract—The Surface roughness is one of the most commonly used criteria to determine the quality of milled steel and it is affected by various cutting parameter such as depth of cut, cutting speed and feed rate. Surface roughness is an important parameter for quality of product such as aerospace, automobile and mold dies etc. Some standard tools and techniques are required for the analysis of cutting parameter to get the optimum results. Surface roughness contributes to better function or longer life span. It also contributes to abrasion resistance materials and good wear resistance. Hence Taguchi method or cutting parameter design approach is used. The aim of the project is to optimize the cutting parameter such as feed rate, depth of cut and cutting speed for End milling process of P20 steel. P20 steel which is used for making molds and dies requires excellent surface finish. This can be achieved by Taguchi method aiming to increase the surface finish and reducing production cost. Taguchi method is powerful tool to design a process. It can be used to find optimal condition for the operation. This optimized cutting parameter can be used for End milling process to achieve better surface finish.

Key words: Surface Roughness, Cutting Parameters, Quality Products, Taguchi Method, Mold Dies, P20 Steel, End Milling Process

I. INTRODUCTION

End milling is one of the most widely used metal removal process in industry and end milled surfaces are largely used to mate with other parts in die, aerospace, machinery design as well as in manufacturing industries. The end milling is mostly used in industries because it is versatile and efficient. The Mechanism of surface roughness formation is very dynamic, complicated, and process dependent. In end milling process single point milling cutter and multi point milling cutter are used. Quality and productivity are two major parameters in machining operations. Surface roughness is a quality indicator and also the last stage in controlling the machining performance and the operation cost. Surface finish is an important criteria of product quality.

Surface roughness has an impact on mechanical properties like corrosion resistance, creep life, fatigue behavior and stress concentration etc. Surface roughness is not only a quality indicator but also the last stage in controlling the machining performance and the operation cost. Surface roughness is a result of many factors such as cutting parameters, tool geometry, work piece material, chatter and cutting fluids. The Taguchi method is a simple and reliable method that is used to optimize the process parameter by decreasing the variation in time. Taguchi method used orthogonal array to minimize the effect of the uncontrolled factor. Taguchi method employed systematic approach to the robust design by increasing performance quality and decreasing the cost. Two major tools used to optimize the process parameter are signal to noise ratio and orthogonal array.

The selection of optimal cutting parameters is very important factor for every machining process in order to increase the quality of machined products, to decrease the machining costs and to increase the production rate. To be able for recognizing the process conditions through data processing of the feedback of the sensors and then choosing the suitable action based on the experience resulted from the learning process. The Surface roughness also depends the numerous attributes of parts, such as contact causing surface friction, wearing, light reflection, heat transmission, ability of distributing and holding a Lubricant, coating, or resistance fatigue.

II. LITRETURE VIEW

Pankaj Chandana et al [1], optimizes cutting parameters like rate of feed, cutting speed and depth of cut by using Taguchi approach. The experiment have been performed as per the combination of levels of different process parameters suggested by the L9 orthogonal array. After the experiment it was found that at the particular experiment the values of signal to noise ratios is less and that is final surface roughness because in the case of cutting parameters always we have consider smaller is better hence it is clarify that from that particular experiment the effect of depth cut is more significant to increase the surface finish comparing to the other factor like cutting speed and feed rate. B.Sidda et
[2]. Selected appropriate parameters for minimizing surface roughness that are nose radius, cutting speed, feed rate, axial depth and radial depth. Minimization of surface finish done by using of response surface methodology of DOE and for achieving the minimum surface roughness the experiment were conducted using taguchi L50 OR orthogonal Array and analysis done by using of analysis of variance. Here one more tool was used for optimizing the cutting parameters that is genetic algorithm. After completion all process form both tool we have found that the genetic algorithm has reduced surface roughness more precisely comparing to the other tool RSM. V. V. K Lakshmi et al [3], Was applied response surface methodology to developed the second order equation for optimizing the process parameter. Input Variable for reducing surface roughness are cutting speed, feed rate and depth of cut was considered. For achieving the minimum surface roughness the experiment were conducted using Response surface methodology with level factorial design and analysis done by using of analysis of variance. In this case output variable were surface roughness and material removal rate. After the experiment and analysis it was found that the feed rate and cutting speed to be a significant factor affecting the surface roughness. J. S Pang et al [4], Used the ORTHOGONAL ARRAY and S/N RATIO for analysing of cutting parameters that majorly affects in surface finish process such as cutting speed, feed rate and depth of cut by Taguchi method. The result of graph response and the analysis of variances shows best output, out of all the surface finish reading recorded during the experiment. Vikas Pare et al [5], used the particle swarm optimization (PSO) to optimize the cutting parameters or controllable parameters and result compare with genetic algorithm. Genetic algorithms that only used for combinatorial optimization but PSO used for both combinatorial and continuous optimization. After the analysis by both method that is genetic algorithms and Particle swarm optimization author got the better result in PSO in very short amount of time. Subramanian et al [6], developed mathematical for optimizing of cutting parameter like feed rate, cutting speed and depth of cut by used of the RSM. And after that optimize the parameter by used of ANOVA and for improving the result author used GA. Form the graph responses proved that the surface roughness improved by used of GA comparing to the ANOVA. G.M. Sayeed Ahmed et al [7], Used Regression analysis for validation of result. The mathematical model developed by using RSM. The cutting parameters consider here that is cutting speed, depth of cut and feed rate. For reducing vibration during machining process magneto rheological damping used that is improving the surface finishing, by this approach researcher analysed, reduction in cutting forces and result values of cutting coefficient from experiment notified that are very close to the predicted value hence this approach is acceptable. Surasit Rawangwong et al [8], the author used the factorial design for selection of orthogonal array method approach and ANOVA method used for analysing of variables. The major factor considered as cutting speed, feed rate and depth of cut, by used of regression analysis, the predicted value of absolute percentage error for surface roughness comes greater than the performed experiment value, hence it’s found that, the approach of regression analysis in surface roughness process very important, result from regression analysis experiment directly improved and increases the surface finish. Lohithaksha M. Maiyar et al [9], Optimize the cutting parameter of end milling process for Inconel 718 super alloy in this case taguchi orthogonal array with grey relational analysis tool used for experimental purpose. In the gray relational analysis they had selected material removal rate and surface finish for normalized value. Basically the largest normalized valve better the performance and after words it was compare with analysis of variance. After comparison it was found that Cutting speed most influence and significant factor for increasing surface finish. Surasit Rawangwong et al [10], by doing research using factorial design of experiment for deciding the orthogonal array or no f run. Here major parameter that consider feed rate, speed of cut and depth of cut respectively. The RSM used to developed equation and predict the mean absolute percentage error in case of roughness and also tool life. It was found that when equation used to confirm the research results. The MAPE obtained from equation that predictive is more comparing to the experiment hence it in acceptable. Hossein K.A et al[11], In this paper RSM used to developed the model for the first order and second order equation for predicting the cutting forces produced in End milling and to minimize the surface roughness. For the analysis purpose they had used MINITAB SOFTWARE. It was found that they had predicted range of values for the surface roughness and experimentally recorded value very close to it. Avinash A. Thakre et al[12], In this paper Applied taguchi method to optimize the cutting parameters of the 1040 MS on CNC machine L9 orthogonal Array used the four factor that is spindle speed, feed rate, depth of cut and coolant flow and three level for analysis purpose. It was found that the ANOVA used to determine the spindle speed and coolant flow which was the most significant factor to minimize the surface roughness. Etory Madrilles et al[13], used Taguchi method and S/N ratio is applied to determine the quantity characteristics. The S/N ratio never effect the means value if we used the standard deviation at the place of S/N ratio it effect the mean value. The parameter selected here feed rate, radial depth of cut and angle of contact. IT was found that the feed rate has significant effect on the surface roughness has significant effect. Mohamad Syahmi Shahrom et al[14], determine the effect lubrication condition on the surface roughness and also consider the three other controls parameter that in cutting speed, feed rate and depth of cut. By used of Taguchi method of Taguchi method of design of experiment all analysis done. It was found that after evaluating surface roughness tester minimum quantity lubricant produced better surface finish and the result shows that it was significantly reduces cost and environmental pollution. J.B. Saedona et al[14], used first order and second order mathematical equation developed. In the terms of cutting speed, depth of cut and feed by using response surface methodology. By using Taguchi method all the experiment performed. For Analysis the ANOVA is used. Here we optimized the tools life by using above technique and parameter. It was found that if we control the feed rate and cutting speed the life of the tool can be increased hence these two parameters has significant effect in the life of the tool. Reddy Sreenivasulu et al[15], consider only two cutting parameter that is feed rate and cutting speed to
investigation the tool wear. For the analysis the analysis of variance used here. We have to cut the metal sheet with different feed rate and cutting speed. It was found that the feed rate shows most significant effect on tool wear if it is increases the wear also increases. Aman agrwal al[16], used Taguchi design of approach to optimize cutting speed, feed rate ,depth of cut, nose radius and cutting environment. Material p = 20 steel with TIN coated tungsten carbide tool used. After the experiment and analysis by used of Anova (Analysis of variance) it was found that the cutting speed, feed rate and cutting environment in most significant parameter. Komson Jirapataraslip et al[17]. Consider only two cutting parameter that is feed rate and cutting speed to investigation the tool wear. For the analysis the analysis of variance used here. We have to cut the metal sheet with different feed rate and cutting speed. It was found that the feed rate shows most significant effect on tool wear if it is increases the wear also increases Vedat savat[18].In turn milling going to op-timize the cutting parameters that feed rate, depth of cut and cutting speed for minimizing the surface roughness. In turn milling work piece and tool both rotating for analysis and experiment purpose Genetic algorithms (GA) used. It was found that as depth of cut and feed rate increases the surface roughness also increases both are has significate effect on surface roughness.

III. METHODOLOGY

This section represent detailed project plan and its implementation carried out to assess the impact of machining and process related parameters. The following block diagram represent the proposal work pf the project in the ascending order.

A. Introduction

The response variable selected to achieve better machining performance is surface roughness. Machining process parameters used in the investigation are cutting speed, depth of cut and feed rate. In the present work, we apply the method of experimental design for the optimization of process parameters in machining. The aim of the project is to optimize the cutting parameters such as depth of cut, feed rate and cutting speed for the end milling process of P20 steel. This can be achieved by Taguchi method aiming to increase the surface finish and reducing production cost associated with the end milling process.

B. Material Selection

In this study work piece material P20 steel is selected. Its properties are as follows. The sample of P20 steel received in the form of cylindrical rod will be used.

<table>
<thead>
<tr>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>S</th>
<th>Cu</th>
<th>Mo</th>
<th>Ni</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>0.45</td>
<td>0.85</td>
<td>0.35</td>
<td>0.025</td>
<td>1</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Table 1: Composition of P20 steel.

C. Performing initial experiment

Initial experiment performed on surface finish factor. The outputs of results are satisfied. From output results many factors are noted e.g. depth of cut, feed rate, speed of cutting. It affects the surface finish in manufacturing process of products.

D. Experiment parameters and level

Three cutting parameters feed rate, depth of cut and spindle speed has been selected to study their effect on surface roughness. Three levels of parameter are used.

E. Design of Experiment using Taguchi (steps)

1) Identify the main function, Side effects, and failure mode
2) Identify the noise factors, testing conditions, and quality Characteristics.
3) Identify the objective function to be optimized
4) Identify the control factors and their levels
5) Select the orthogonal array matrix experiment
6) Conduct the matrix experiment
7) analyze the data, predict the optimum levels and Perfor-mance
8) Perform the verification experiment and plan the future Action.

F. Performing the Experiment

The End milling operation is to be performed on high speed milling machine. Surface roughness tester is also to be used to measure the surface roughness (Ra).Preliminary experiment is to be conducted before actual experiments by using one factor at a time approach. Vary one factor and keep the other two constant. If cutting speed is varied then feed rate and depth of cut can be kept constant and experiments can be performed and repeat the procedure by alternately varying feed rate and depth of cut , so that we get initial values for these factors and experiments can be done. If we are selecting three set of experiments which are giving excellent surface finish then these parameters can be used for the experimentation.

Performing straight end milling operation on specimens as per Taguchi orthogonal array involving combinations of process control parameters like spindle speed, feed and depth of cut and then measuring surface roughness after each experiment.
G. Statistical analysis of Data
Minitab 18 is to be used to design the experiment. Using Taguchi method the analysis can be done on Minitab 18 soft-ware. Signal to noise ratio analysis can be done to find opti-mum cutting parameters using this software. Regression analysis can be done to develop mathematical model to predict surface roughness for given value of said cutting parameters. The developed model can be validated through experiment.

H. Report writing
Finally the report writing is done for the Optimization of cutting parameters for surface roughness in End milling of P20 Steel.

IV. CONCLUSION
The data was collected for P20 steel. It requires good surface finish as it is used for making aerodynamic parts. Literature review has been done for P20 steel and many research papers were referred for the literature review. Therefore for the required surface finish there is requirement of optimization of the cutting parameters of P20 steel. It is used in making automobile parts and requires excellent surface finish. It was found that optimization of cutting parameters is necessary for machining of P20 steel. Then the experimental plan is developed for the optimization of P20 steel.

REFERENCES
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