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A review of optimization on turning process parameters for surface roughness in dry and wet condition of AISI 1045 steel using Taguchi method

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ABSTRACT

The challenge of recent machining industries is reduced lead time and increase production rate in order to maintain their competitiveness. The mechanical manufacturing industries are regularly challenged for achieving higher productivity and high-quality products in order to remain competitive. The desired shape, size and finished ferrous and non- ferrous materials are conventionally produced by turning the preformed blanks with the help of cutting tools that moved past the work piece in a machine tool. Among various cutting processes, turning process is one of the most fundamental and most applied metal removal operations in a real manufacturing environment. This literature review compiles different work presented on optimization of process parameters and concludes the most significant cutting parameters and most frequently used optimization techniques for improving surface finish. The cutting parameters like Cutting speed, Feed rate and Depth of cut are taken into consideration.

Keywords: *Productivity, Surface Roughness, Turning, Cutting Parameters.*

1. INTRODUCTION

Turning is the removal of metal from the outer diameter of a revolving cylindrical work piece. Turning is used to reduce the diameter of the work piece, usually to a specified dimension, and to produce a smooth finish on the metal. Cutting speed, feed rate, depth of cut, tool-work piece material, tool geometry and coolant conditions are the turning input parameters which highly affect the response variables. In CNC turning, various response variables like surface roughness, material removal rate, chip methodology etc. are involved. It is necessary to increase tool life, to improve surface finish, to reduce the cutting force in turning operations through an optimization study. Among these all, surface roughness and material removal rate play the most important role in the performance of a turning process. The settings of turning parameters depend on the experience of operators. It is difficult to achieve the greatest performance of a machine because there are so many adjustable machining parameters. In order to minimize these machining problems, there is a need to find optimum cutting conditions for CNC turning.

2. LITERATURE REVIEW

Pytlak (2010) built up a multi-criteria optimization procedure for the hard turning of hardened 18 HGT steel. CBN inserts geometry was utilized. The model considered the accompanying parameters depth of cut, feed and cutting speed. Optimization criteria were minimizing manufacturing cost time per part and resultant cutting force in a machining operation. Weighted objectives technique and Modified distance method were utilized to create Pareto sets of arrangements. To guarantee low production cost and low benefits of cutting forces a various leveled strategy was utilized.

Sieben, B., Wagner, T. and Biermann, D. 2010) Utilized design and analysis of computer experiments (DACE) for the experimental testing in hard turning process of AISI 6150 steel. PCBN tool was utilized for this reason. The distinctive parameters chose were feed, depth of cut and cutting speed. The DACE strategy can be utilized to demonstrate complex non-linear factors.

D. Mittal, M.P. Garg, R. Khanna; (2011) researches the impact of process parameters in turning of Titanium grade 2 on a conventional lathe. Three parameters to be specific spindle speed, depth of cut and feed rate are varied to contemplate their impact on material removal rate and tool failure. The tests are conducted utilizing one factor at any given moment approach. In addition, a few random experiments are likewise conveyed to examine the phenomenon of tool failure. The examination uncovers that material removal rate is specifically impacted by all the three process parameters. However, the effect of spindle speed and feed rate is more compared to the depth of cut. The optimum range of input parameters has been sectioned as the ultimate result for completing further research.

S. Pahda, S. M Sharma, N. Malhotra; (2011) examined surface roughness by considering the cutting parameters like cutting speed, feed rate and depth of cut. The CNC turning machine is utilized to conduct tests on EN-8 steel with 150 mm length and 35 mm diameter. Taguchi technique has been utilized for designing and optimization of the investigation. Besides, Minitab 16 software is additionally being utilized to conduct ANOVA test to predict the significance level for individual parameter and it has been found that the cutting speed is most critical parameter contributing towards surface roughness followed by the depth of cut. The relevance of these results finally checked by performing the confirmatory experiment as proposed by the Taguchi technique.

S.Khrais, A.M. Hassan, A. Gazawi; (2011) build up a multiple regression models for surface roughness as a function of cutting parameters during the turning of flame hardened medium carbon steel with TiN-Al2O3-TiCN coated inserts. A trial design of work signal-to-noise ratio (S/N) were utilized to relate the impact of turning parameters to the work piece surface finish using Taguchi technique. The impacts of turning parameters were considered by utilizing the investigation of analysis of variance (ANOVA) technique. Assessed parameters were feed, cutting speed, and depth of cut. It was discovered that the most significant interaction among the considered turning parameters was between the depth of cut and feed. The average surface roughness (Ra) came about by TiN-Al2O3-TiCN coated inserts was around 2.44 µm and the minimum value was 0.74 µm. Also, the regression model could foresee values for surface roughness in the examination with test within a limit.

U. K. Yadav, D. Narang, P.S. Attri; (2012) examined the impact and optimization of machining parameters (cutting speed, feed rate and depth of cut) on surface roughness are investigated. An L'27 orthogonal array, analysis of variance (ANOVA) and the signal-to-noise (S/N) ratio are utilized as a part of this investigation. Three levels of machining parameters are utilized and tests are done on STALLION-100 HS CNC machine. The optimum value of the surface roughness (Ra) turns out to be 0.89. It is additionally presumed that feed rate is the most noteworthy factor influencing surface roughness took after by depth of cut. Cutting speed is the minimum noteworthy factor influencing surface roughness. Cutting speed is the least significant factor with the help of confirmation experiments.

M. V. Ramana, A. V. Vishnu, G. K.M. Rao, D.H. Rao; (2012) analyzed experimentally and optimization of process parameters for surface roughness in turning of Ti-6Al-4V composite under dry, flooded and Minimum Quantity Lubrication (MQL) conditions utilizing Taguchi's robust design methodology and development of prediction models for surface roughness using multiple regression analysis. The results have been compared among dry, flooded and MQL conditions and it uncovers that MQL indicates better execution and change in a decrease of surface roughness contrasted with dry and flooded lubricant conditions. From Analysis of Mean (ANOM), it is watched that MQL is appropriate at higher suitable at a higher depth of cut with dry and flooded lubricant conditions. It is seen from ANOM that under MQL condition uncoated tool indicates better execution contrasted with the CVD and PVD coated tools, though CVD coated tool demonstrates better execution for dry and flooded lubricant conditions contrasted with uncoated and PVD coated tools. It is likewise seen from the ANOVA that, feed rate has a significant commitment to optimizing the surface roughness.

B Kumaragurubaran, P Gopal (2013) done experimental work considering turning parameters on EN-9 steel with various cutting parameters like cutting speed, feed and depth of cut incredibly affected by response parameters like surface roughness and metal removal rate. For the most part surface roughness were examined utilizing L9 orthogonal array utilizing Taguchi's design of experiments with various cutting parameters of EN-9 of turning parameters and optimized by S/N ratio analyzed by Analysis of variance (ANOVA's).

Yacov sahijpaul, Gurpreet Singh (2013) studied the impact of controlled cutting parameters namely cutting speed, feed rate, depth of cut, cutting fluid concentration and two cutting fluids with different base oils on surface roughness (Ra) of EN8 or AISI 1040 steel during turning process by applying design of experiments, custom design method, analysis of variance, leverage plots and desirability profiling using JMP software to optimize surface roughness during wet CNC turning process. The examination suggested that feed rate has the most significant impact on surface roughness (Ra) and value of surface roughness does not fundamentally contrast for two different cutting fluids used.

Sachin C Borse (2014) presented the optimization of surface roughness & material removal rate in the dry turning of SAE52100 steel. Carbide inserts were utilized for machining of SAE 52100 to examine impacts of process parameters [Cutting speed (S), Feed (F) and depth of cut (d)]. These models can be viably used to foresee the surface roughness (Ra) and material removal rate of the workpiece. The big challenge of the Micro, small& medium ventures in India is for accomplishing excellent items with expanded efficiency. Paper presents work of an examination of turning process parameters on SAE 52100 material, for optimization of surface roughness, material removal rate. The analysis is done by considering three controllable info factors in particular cutting speed, feed rate, and depth of cut. The design of experiment and optimization of surface roughness, material removal rate is carried out by using Taguchi L9 orthogonal array.

R. Rajamanickam, K.Thanasekaran, G .Prabu, S.Gopal (2015) studied the cutting of MS material using lathe machine by Taguchi approach. Taguchi technique is utilized to formulate the experimental design. A Taguchi L9 design of experiment (DOE) will be applied and analysis of variance (ANOVA) will complete determining the effect of process parameters on process performance. To analyze the effect of each parameter on the machining characteristics and to predict the optimal choice for each parameter, such as speed, feed, depth of cut. It will found that these parameters affect machining qualities such as surface roughness and metal removal rate test is conducted to validate the test result.

Aswathy V G, Rajeev N, Vijayan K (2015) researched the effects of machining parameters, particularly tool nose radius, on surface finish, material removal rate (MRR) roundness error during the wet turning of Ti-6Al-4V. The selection of Ti-6Al-4V is because of the reason that it offers a special mix of high quality, light weight and erosion protection which have made it an essential material in aviation applications. In his examination, the investigation is done based on Taguchi method of optimization and the experimental design and further investigation completed with the assistance of Minitab16. The outcomes acquired from the investigation is approved with numerical programming PYTHON.

Saurabh Singhvi, M.S.Khidiya, S.Jindal, M.A.Saloda (2016) examined the machinability of mild steel in turning process perform on a conventional lathe machine. Two parameters like tool rake edge and feed are varied to investigate their effect on material removal rate. An attempt has been made to show the response variable utilizing Taguchi and ANOVA investigation. Taguchi L9 orthogonal array is utilized for experimental design.

Amritpal Singh, Harjeet Singh (2016) reviewed the effects of different process parameters, for example, cutting speed, depth of cut and feed rate on the response parameters, for example, surface roughness, material removal rate and chip reduction coefficient. Through this investigation principle cutting parameters which influence the turning task are talked about.

Lavish Sharma, Jai Prakash Sharma, Nitin Sharma (2016) inspected how the surface roughness of composite steel EN47 is influenced by hard turning. Tests were conducted on the CNC machine using different cutting parameters. The surface was assessed regarding surface roughness. Tests demonstrated that hard turning gives the good surface finish. Process parameters (insert radius, cutting speed, depth of cut and feed rate) are utilized as input parameters. Taguchi method is implemented to find the optimum cutting parameters for surface roughness (Ra) in hard turning. The L9 orthogonal array, signal to noise ratio and analysis of variance has been utilized to study the performance characteristics in turning of alloy steel EN 47 utilizing carbide inserts (TNMG 160408-FMTN8135).

Siva Surya Mulugundam, Shalini Manchikatla, Sridhar Atla (2017) optimized the material removal rate and surface roughness in machining of EN19 steel using ANOVA. The impact and contribution of cutting parameters such as cutting speed, feed rate and depth of cut are assessed through dry and wet machining utilizing ANOVA. The Minitab software is utilized to form the design of experiments with the L9 orthogonal array. The values of the material removal rate (MRR) and the surface roughness (SR) are calculated. The results of this examination demonstrate that the depth of cut and cutting speed has the most critical impact on MRR and SR for dry machining and the depth of cut for wet machining.

Jitender Sharma, Ajay Kumar Agarwal (2017) reviewed the surface roughness of the machined parts is a standout amongst the most significant product quality characteristic which alludes to the deviation from the nominal surface. Surface roughness assumes an essential part in numerous applications, for example, exactness fits, latch openings, stylish necessities and parts subject to weariness loads. Surface roughness forces a standout amongst the most critical constraints for the determination of cutting parameters and machine tools in the development of a process.

S. Nandha Kumar, R. Shanmuga Prakash (2017) done the experimental work; the machining process is done in CNC machine by using the ceramic cutting tool. The essential cutting parameters to be specific cutting velocity, feed and Depth of cut are chosen for machining of martensitic stainless steel 416. The optimal range of cutting parameters are chosen for martensitic stainless steel 416 preceding the experimental machining process is done to guarantee the less effort in accomplishing optimal parametric combinations. By changing the range of the cutting parameter, the machining attributes (Surface roughness, cutting force) are estimated. Taguchi method is analyzed with the help of Minitab software. Finally, confirmation tests were completed for the optimal machining parameters to ensure the reliability of the experimental results obtained previously.

B. Padma, B. Satish Kumar, N. Gopikrishna (2017) examined the optimization of the machining process parameters for the turning of EN 9 carbon steel (it is a carbon steel, otherwise called 070m55, accessible in distances, flats, squares, and plates – it can be used for gears, sprockets and cams) on the lathe machine utilizing a combination of the Taguchi and the Gray Relational Analysis to yield a minimum cutting forces and expected minimum surface roughness. Process parameters are as the rotational speed, a feed, the depth of cut and a selected cutting fluid. The tests which are directed according to the Taguchi experimental designs and the L9 orthogonal array were completed in the analysis. The Analysis of variance (ANOVA) has been utilized to assess the most impact of processing parameters which were brought about the test. The results indicate that the depth of cut is an important factor in that influencing a cutting force and the surface roughness evaluated by the feed, a speed, and the cutting fluid.

P. G. Inamdar, N. S. Bagal, V. P. Patil (2017) optimized the surface roughness in conventional turning operation utilizing Taguchi Method for the material medium carbon steel EN8. In this work cutting speed, feed rate and depth of cut are taken as execution parameters to accomplish better surface roughness. Taguchi Method is utilized to acquire the main parametric effect on the surface roughness utilizing 3 levels and 3 factors. The L9 orthogonal array is utilized to plan the trials. Likewise, analysis of variance

(ANOVA) was done with the significance factor of 95%. After the experimentation, it was discovered that cutting speed has a more affected surface roughness in traditional turning process than feed rate and depth of cut.

3. CONCLUSION

Literature depicts that a lot of work has been done by a number of authors for modeling, simulation and parametric optimization of surface roughness and material removal rate in turning process using different process parameters, different cutting tools, and different cutting condition. A review of journal articles published between 2001 and 2017 yields studies that vary in scope and level of analysis, yet with reliable great outcomes. Some further developed investigations used cutting force, power consumption, material removal rate, or tool life as response factors at the same time with surface roughness. The authors additionally show clear and useful correlations between at any rate some of their control parameters and the response. These investigations did well to productively decide the parameters combinations important to minimize surface roughness of the turned surface.

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