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A Review on Parametric Optimization of Surface Roughness & Material Remove Rate of AISI D2 Steel Using Turning

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ABSTRACT
In order to produce any product with desired quality by machining, proper selection of process parameters is essential. This can be accomplished by Full Factorial method. The aim of the present work is to investigate the effect of process parameter on surface finish and material removal rate (MRR) to obtain the optimal setting of these process parameters and the analysis of variance is also used to analysis the influence of cutting parameters during machining. L27 experimental will run based on an orthogonal array of full factorial method. Additionally the analysis of variance (ANOVA) will also apply to identify the most significant factor. During the experimental process parameters such as speed, feed and depth of cut are used to explore their effect on the surface roughness (Ra) of the work piece. This work will present an experimental investigation of influence of the three most important machining parameters of Speed, Feed and Depth of Cut on surface roughness during turning of AISI D2 steel. In this work AISI D2 steel work pieces are turned on conventional all gear lathe by using carbide tool.

Keywords - Full Factorial Method, Machining Parameters, Surface Roughness, Material Removal Rate (MRR), ANOVA Analysis

I. INTRODUCTION

A Lathe is a machine tool used principally for shaping pieces of metal, wood, or other materials by causing the workpiece to be held and rotated by the lathe while a tool bit is advanced into the work causing the cutting action. Lathes can be divided into three types for easy identification: engine lathe, turret lathe, and special purpose lathes. Some smaller ones are bench mounted and semi-portable. The larger lathes are floor mounted and may require special transportation if they must be moved. Field and maintenance shops generally use a lathe that can be adapted to many operations and that is not too large to be moved from one work site to another.

Turning is a machining process in which a cutting tool, typically a non-rotary toolbit, describes a helical tool path by moving more or less linearly while the workpiece rotates. The tool's axes of movement may be literally a straight line, or they may be along some set of curves or angles, but they are essentially linear (in the nonmathematical sense). Usually the term "turning" is reserved for the generation of *external* surfaces by this cutting action, whereas this same essential cutting action when applied to *internal* surfaces (that is, holes, of one kind or another) is called "boring". **Fig. 1** shows the turning operation.

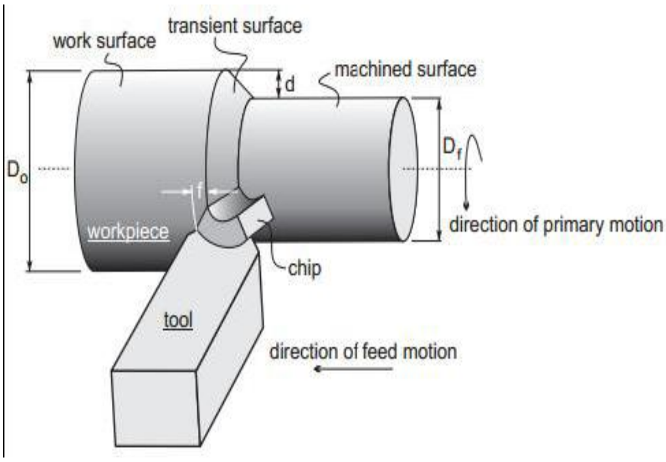

Fig.1. Turning Operation

Cutting speed in turning V in m/s is related to the rotational speed of the workpiece by the equation;

$$V = \pi DN$$

Where D is the diameter of the workpiece; N is the rotational speed of the workpiece. The three primary factors in any basic turning operation are speed, feed, and depth of cut.

In our project we are going to use AISI D2 tool steel which also known as HCHC tool steel. The chemical composition of AISI D2 tool steel is given in below Table 1.

Table 1. Chemical Composition

Carbon	1.55%
Silicon	0.30%
Manganese	0.35%
Chromium	12.00%
Molybdenum	0.75%
Vanadium	0.90%

AISI D2is recommended for tools requiring very high wear resistance, combined with moderate toughness (shock-resistance).AISI D2can be supplied in various finishes, including the hot-rolled, pre-machined and fine machined condition. Forming Dies, Punches, Forming Rolls, Knives, Slitters, Shear blades.

II. LITERATURE REVIEW

There are many articles are published on parametric optimization. Not all the articles are directly related to our work, especially, those articles which were focused on computational work. Many articles addressed experimental and theoretical optimization processes discussed. In this subsection, we are going to discuss only those articles (experimental and/or theoretical work) which are directly related to current work.

M. Kaladhar et al. (2011) investigate the effects of process parameters on surface finish and material removal rate (MRR) to obtain the optimal setting of these process parameters on AISI 304 steel. The Analysis Of Variance (ANOVA) is also used to analyze the influence of cutting parameters during machining. The results revealed that the feed and nose radius is the most significant process parameters on work piece surface roughness. However, the depth of cut and feed are the significant factors on MRR.[1]

Muammer Nalbant et al. (2007) investigate the effects of machining of AISI 1030 steel (i.e. orthogonal cutting) uncoated, PVD- and CVD-coated cemented carbide insert with different feed rates, cutting speeds by keeping depth of cuts constant without using cooling liquids has been accomplished. The surface roughness effects of coating method, coating material, cutting speed and feed rate on the work piece have been investigated. In this experimental study, an ANN-based prediction mechanism which removes the necessity of regression analysis has been presented. The conclusion shows that there is a negative relationship between the average surface roughness and cutting speed of coated cemented carbide cutting tools. Increasing the cutting speed reduces the average surface roughness. In the case of uncoated cemented carbide cutting tools there is parallel relationship between the cutting speed and average surface roughness value. Increasing the cutting speed also increases the average surface roughness. [2]

Anil Gupta et al. (2011)presents the application of Taguchi method with logical fuzzy reasoning for multiple output optimization of high speed CNC turning of AISI P-20 tool steel using TiN coated tungsten carbide coatings. The machining parameters (cutting speed, feed rate, depth of cut, nose radius and cutting environment) are optimized with considerations of the multiple performance measures (surface roughness, tool life, cutting force and power consumption). Taguchi's concepts of orthogonal arrays, signal to noise (S/N) ratio, ANOVA have been fuzzified to optimize the high speed CNC turning process parameters through a single comprehensive output measure (COM). It can be concluded that middle level of cutting speed and nose radius and lower level of feed and depth of cut yield the optimal result. Cryogenic environment is the most favorable condition out of three cutting environments. [3]

B FNIDE et al. (2010) investigate the application of response surface methodology for determining statistical models of cutting forces in hard turning of AISI H11 hot work tool steel. The work piece is machined by a mixed ceramic tool (insert CC650 of chemical composition 70%Al2O3+30%TiC) under dry conditions. Based on 33 full factorial design, a total of 27 tests were carried out. Mathematical models were deduced by software Minitab (multiple linear regression and response surface methodology) in order to express the influence degree of the main cutting variables such as cutting speed, feed rate and depth of cut on cutting force components. The results indicate that the depth of cut is the dominant factor affecting cutting force components. The feed rate influences tangential cutting force more than radial and axial forces. The cutting speed affects radial force more than tangential and axial forces. [4]

Sukumar et al. (2012) investigate the effects of machining parameter on CNC turning of martensitic stainless steel using RSM(Response surface methodology) and GA(Genetic algorithm). The results obtained from RSM are R-Sq obtained was 99.9% which indicates that selected parameters (speed, feed, depth of cut) significantly affect the response (surface roughness). [5]

Yansong Guo et al. (2012) investigate the effects of an approach which incorporates both energy consumption and surface roughness is presented for optimizing the cutting parameters in finish turning. Based on a new energy model and a surface roughness model, derived for a given machine tool, cutting parameters are optimized to accomplish a precise surface finish with minimum energy consumption. The analysis reveals that a two-step approach in determining the optimal cutting parameters for finishing turning operations for minimal energy consumption, by guaranteeing a specified surface roughness. [6]

Gaurav Bartarya et al. (2012) investigate effect of cutting parameters on cutting force and surface roughness during finish hard turning AISI52100 grade steel. A full factorial design of experiments procedure was used to develop the force and surface roughness regression models, within the range of parameters selected. The regression models developed show that the dependence of the cutting forces i.e. cutting, radial and axial forces and surface roughness on machining parameters are significant, hence they could be used for making predictions for the forces and surface roughness. The predictions from the developed models were compared with the measured force and surface roughness values. To test the quality of fit of data, the ANOVA analysis was undertaken. It has been conclude that Depth of cut was found to be the most influential parameter affecting the three cutting forces followed by the feed. Cutting speed was least significant in case of axial and radial force models but was not significant forthe regression model of cutting force. For the surface roughness predictions, the model developed from the analysis was found insignificant. [7]

Suleiman Abdulkareem et al. (2011) investigate of the influence of the three most important machining parameters of depth of cut, feed rate and spindle speed on surface roughness during turning of mild steel. In this study, the design of experiment which is a powerful tool for experimental design is used to optimize the machining parameters for effective machining of the work piece. Box Behnken experimental design method as well as analysis of variance (ANOVA) is used to analyze the influence of machining parameters on surface roughness height Ra. Using multiple linear regressions, mathematical models correlating the influence of machining parameters on the surface roughness Ra during the machining process were developed. The result shows that the feed rate is found to be the most important parameter effecting Ra, followed by cutting speed while spindle speed has the least effect. [8]

R.A. Mahdavinejad et al. (2011) investigate paper the optimize turning parameters of AISI 304 stainless steel. Turning tests have been performed in three different feed rates, cutting speeds with and without cutting fluid. A design of experiments (DOE) and an analysis of variance (ANOVA) have been made to determine the effects of each parameter on the tool wear and the surface roughness. It is being inferred that cutting speed has the main influence on the flank wear and as it increases, the flank wear decreases. The feed rate has the most important influence on the surface roughness and as it decreases, the surface roughness also decreases. Also, the application of cutting fluid results in longer tool life and better surface finish. [9]

Pragnesh. R. Patel(2012) investigate the effects of different cutting parameters (Cutting Speed, feed rate, Depth of cut) on surface roughness and Power Consumption in turning of 6063 AL alloy TiC (MMCs). PCD tool was used as wear resistive tool in order to achieve desire surface finish. Full factorial Design in design of experiment was adopted in order to planning the experimental runs. Analysis of Variance was used to investigate percentage Contribution of Each process parameters on output Response. Results show that feed rate is significant parameter, which affect on surface roughness; and Cutting Speed is effective parameter which affect on power consumption. [10]

Kamal Hassan et al. (2012) investigates the effects of process parameters on Material Removal Rate (MRR) in turning of C34000.The effect of parameters i.e Cutting speed, feed rate and depth of cut and some of their interactions were evaluated using ANOVA analysis with the help of MINITAB 16 @ software. And it has been conclude that The Material removal rate is mainly affected by cutting speed and feed rate. The conclusion shoes that with the increase in cutting speed the material removal rate is increases & as the feed rate increases the material removal rate is increases. [11]

III. CONCLUSION

A From the above literature survey we find that there are many research done on optimization techniques for process parameter for surface roughness and material removal rate. But I found that there are very few research done on AISI D2 tool steel so we want to do research on this material. We like to use gray relational analysis for optimization.

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