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TAGUCHI METHOD

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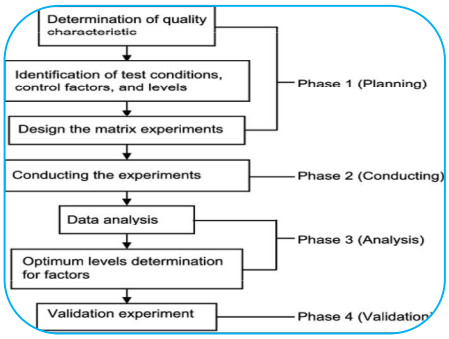
ABSTRACT-



Metal cutting process is the most complex process which has numerous factors contributing towards the quality of the finished product. Turning is one among the material cutting process in which quality of the finished product depends substantially upon the machining parameters similar as speed, depth of cut, feed rate, type of coolant and inserts used etc. also the work piece material plays a vital part in metal cutting process. In turning process achieving a good surface quality and minimum cutting forces are the most significance. It involves numerous process parameters which directly or indirectly impact the surface roughness and cutting forces of the product in common. A precise knowledge of these optimum parameters would grease to reduce the machining costs and ameliorate product quality. In this project turning of Steel SM45 work piece sample of propeller shaft and carbide insert tool will be performed on lathe machine. SM45 steel is used as the work piece material for carrying out the trial to optimize the Material Removal Rate. The bars will be use of Diameter 50 mm and length 300 mm. There will be three machining parameters i.e. Spindle speed, Feed rate, Depth of cut. Different trials will be accomplished by varying two parameters and keeping other one fixed. Taguchi orthogonal array is designed with three levels of turning parameters with the help of software Minitab 18. Nine trials are performed and material removal rate(MRR) is calculated. Taguchi system focuses the significance of studying the response variation using the signal – to – noise(S/ N) ratio, performing in minimization of quality characteristic variation due to ungovernable parameter. The material removal rate was considered as the quality characteristic with the conception of" the larger the- better". The S/ N ratiovalues for larger the- better are calculated with the help of software Minitab 18. The MRR values measured from the experiments and their optimum value for maximum material removal rate are corelated.

KEYWORDS: *propeller shaft, Material removal Rate, Minitab, surface roughness testing machine, S/ N ratio.*

INTRODUCTION

Turning is the utmost introductory machining processes. The part is rotated while a single point cutting tool is moved parallel to the axis of rotation. Turning can be done on the external face of the part as well as internally(boring). The starting material is generally a work piece generated by other processes similar as casting, forging, extrusion, or drawing. Turning can be done in two ways whether manually, in a traditional form of lathe, which generally requires nonstop supervision by the operator

or by using a Computer- controlled and automated lathe which doesn't require nonstop supervision. In turning operations, vibration is a frequent problem, which affects the result of machining, in particular, the tool wear. Vibration can be defined as an object being constantly displaced at a veritably high frequency. In turning process, three types of mechanical vibrations are present. They're free, forced and self-excited vibrations. They do due to lack of dynamic stiffness/ rigidity of machine tool system comprising tool, tool holder, work piece and machine tool. Machining vibrations, also called as chatter, correspond to the relative movement between the work piece and cutting tool. These vibrations affect typical machining processes, similar as turning, milling and drilling. Relative vibration breadth between the work piece and cutting tool influences the tool life. Cutting tool and tool holder shank are subordinated to dynamic excitation due to the distortion of the work material during the cutting operation. The dynamic relative motion between the cutting tool and work piece will affect the quality of the machining,in particular, thesurface finish. likewise, the tool life is correlated with the amount of vibration. In turning, the presence of tool vibration is a major factor which leads to poor surface finish, cutting tool damage, increase in tool wear and inferior noise. With the production and productivity adding in ultramodern society, the manufacturing energy consumption is increased with enhancing the energy extremity and global warming(1). According to International Energy Agency(2), manufacturing is responsible for nearly1/3 of the global energy consumption and 36% of carbon dioxide emissions (3). adding energy price and requirement to ameliorate energy effectiveness are the severe challenges faced by ultramodern manufacturing enterprises. Increase in manufacturing production is characterized by technological development, which is driven by increased competitiveness. Machining processes must thus also undergo changes in order to meet market conditions in order to guarantee the anticipated quality, reduce production costs, and increase productivity.

INTRODUCTION TO TAGUCHI METHODOLOGY

Taguchi Method was proposed by Genichi Taguchi, a Japanese quality management adviser. The method explores the concept of quadratic quality loss function and uses a statistical measure of performance called signal to noise(S/ N) ratio. Taguchi method is generally used in an analysis that uses several factors. When the total factors have been further than two, the number of experiments also will increase, and the result will be used Taguchi method. Taguchi method is a system of cost driven quality engineering that emphasizes on the effective operation of engineering strategies rather than advanced statistical technique. It includes both upstream and shop floor quality engineering. Upstream styles efficiently use small scale experiments to reduce variability and find cost effective, robust designs for large scale production and the marketplace. Shop floor ways give cost based real time methods for monitoring and maintaining quality in product. Taguchi method allow a company to fleetly and accurately acquire technical information to design and produce low cost, highly reliable products and processes. Its most advanced operations allow masterminds to develop flexible technology for the design and product of families of high-quality products, greatly reducing research, development and delivery time. The DOE with Taguchi approach is divided into three main phases

1. Planning phase,
2. Conducting phase, and
3. Analysis phase

PROBLEM STATEMENT:

Machining a work piece is itself a self-sufficient statement which means to get the rough work piece in a desired shape and size with the desired surface finish. The end product or the finished component of desired dimensions can be achieved by various methods and one must choose the most suitable method for the job which is cost and time efficient. Choosing such a method or changing a predetermined method is known as optimization. Machine optimization involves the determination of efficient machining parameters such as cutting speed, feed rate and depth of cut in process planning stage. It directly impacts the production economics of machining processes in terms of meeting the

minimum production cost, minimum production time, maximum production rate, and maximum production profit objectives.

The turning process in an automobile industry plays an important role in the production department, which in turn contributes to the profit of the industry. To get the better results from the machining process it is important to know the contribution level of different cutting parameters like speed of spindle, rate of feed and depth of cut to the machine. This study aims to determine and analyze the effect of the cutting tool edge geometry and cutting parameters (speed, feed, depth of cut) on surface roughness in turning of Steel SM45C work piece sample of propeller shaft.

OBJECTIVES:

1. To Develop Taguchi model for experimentation.
2. To analyze the effect of process parameters viz. speed, feed depth of cut for surface roughness.
3. To find optimum combination of parameters in order to get the minimum surface roughness
4. To statistically analyze the response parameters.
5. Measure Surface roughness of work piece samples.
6. Experimental testing and correlating results.

LITERATURE REVIEW

Jakhale Prashant P, Jadhav B. R. studied higher value of surface roughness generates on the machining parts and due to rework or scrap results into increase in cost and loss of productivity. Surface roughness is a major factor in modern Computer Numerical Control (CNC) turning industry. optimization researches for CNC finish turning were either accomplished within certain manufacturing purposes, or achieved through various equipment operations. Therefore, a general optimization of surface roughness is deemed to be necessary for the most of manufacturing industry. In this paper author investigate the effect of cutting parameters(cutting speed, feed rate, depth of cut) and insert geometry(CNMG and DNMG type insert) on surface roughness in the high turning of alloy steel. The experiments have been conducted using L9 orthogonal array in a TACCHI lathe CNC turning machine. The optimum cutting condition was determined by using the statistical methods of signal-to-noise (S/N) ratio and the effect of cutting parameters and insert type on surface roughness were evaluated by the analysis of variance (ANOVA) [1]

Youcef ABIDI mentioned in paper hard machining is a process that has become highly recommended for replacing grinding in the manufacturing industry. This is due to its ability to machine complex shapes with reduced production costs by reducing the machining time and being an ecological process. Three technological parameters determine the quality and productivity generated from this process: cutting vibration, surface roughness and tool wear. Therefore, the analysis of the correlation between them is very important. Also mentioned neutralize the effect of cutting parameters, a combination of parameters such as cutting speed, feed rate and depth of cut to be used in the experimental tests is selected from the literature based on a quality-productivity optimum performance. The novelty of this work lies in the fact that we consider the cutting vibration as a response generated the during cutting process and not as a variable affecting the other technological parameters. This was rarely studied in previous researches [2]

Martoni took the topic of "Analysis and Repair of Latitude Sledge Lathe GHB-1340G". For the process of improving latitude slashes so that the composer can be reused to make improvements in the latitude slashes. After that, the composer conducts an experiment by turning the work piece sample. The next stage after testing the work piece samples by making a reduction, holes, and threads obtained a good, smooth, and even turning. The machine does not experience damage or problems anymore and can be used for a good turning process. [3]

Ng Chin Fei represent determining the optimal processing parameter is routinely performed in the plastic injection moulding industry as it has a direct and dramatic influence on product quality and costs. Taguchi method has been employed with great success in experimental designs for problems with multiple parameters due to its practicality and robustness. Improvements are to be expected by

integrating the practical use of the Taguchi method into other optimization approaches to enhance the efficiency of the optimization process. The review will shed light on the standalone Taguchi method and integration of Taguchi method with various approaches including numerical simulation, grey relational analysis (GRA), principal component analysis (PCA), artificial neural network (ANN), and genetic algorithm (GA). All the features, advantages, and connection of the Taguchi-based optimization approaches are discussed. [4]

Melesse Workneh Wakjira mentioned in research paper to analyze the machinability of CSN 12050 carbon steel bars using carbide insert tool in order to utilize the optimum cutting parameters by employing Taguchi approach. Experiments have been performed under dry cutting condition using an optimization approach according to Taguchi's L9 (34) orthogonal arrays; signal-to-noise ratio tests are designed. Analysis of variance (ANOVA) was performed to determine the importance of machining parameters on the material removal rate (MRR). The results were analyzed using signal-to-noise ratios (S/N); 3D surface graphs, main effect graphs of mean, and predictive equations are employed to study the performance characteristics. [5]

Mahesh Gopal studied DSS material was very difficult to perform machining operations due to high austenite, nitrogen content, alloy composition, high strength, work hardening rate and toughness. High hardness required high cutting force which tends to reduce machinability characteristics such as tool wear, surface finish, low MRR, etc. This review article researcher provided an overview of the research conducted during last one decade by the researchers and the optimization methods used to examine the machinability characteristics of DSS to predict surface unevenness wear in tool, machinability, MRR and chip volume ratio. Furthermore, this article indicated an efficient means of machining behavior, future scope and the fruitful methodology for the successful machining of duplex stainless steel. [6]

Arun Kumar Parida concluded Results of the main effects plot indicate that depth of cut is the most influencing parameter for MRR but cutting speed is the most influencing parameter for surface roughness and feed is found to be the least influencing parameter for both the responses. The confirmation test is conducted for both MRR and surface roughness separately. Finally, an attempt has been made to optimize the multiresponses using technique for order preference by similarity to ideal solution (TOPSIS) with Taguchi approach. [7]

Ahmet Hasçalık mentioned in his paper thesis the effect and optimization of machining parameters on surface roughness and tool life in a turning operation was investigated by using the Taguchi method. The experimental studies were conducted under varying cutting speeds, feed rates, and depths of cut. An orthogonal array, the signal-to-noise (S/N) ratio, and the analysis of variance (ANOVA) were employed to the study the performance characteristics in the turning of commercial Ti-6Al-4V alloy using CNMG 120408-883 insert cutting tools. The conclusions revealed that the feed rate and cutting speed were the most influential factors on the surface roughness and tool life, respectively. The surface roughness was chiefly related to the cutting speed, whereas the axial depth of cut had the greatest effect on tool life. [8]

Xianzhen Huang studied in this paper, dynamic model of regenerative chatter in turning process is established to predict the limited cutting width and derive the stability lobe diagram. This study addresses the influences of uncertain factors on the turning process, and a reliability based optimization model is established to obtain optimal turning parameters. In the optimization model, the maximum material removal rate is taken as the objective function and the reliability of turning stability, surface precision, and cutting power is defined as the constraint function. The sequential optimization and reliability assessment (SORA) is utilized to solve the optimization model. Finally, a discussion of the practical application of this method is presented. [9]

T. Tamizharasan mention the Effect of turning parameters on chip generation during machining aluminum composite is studied in this work. Turning of Al–4%Cu–7.5%SiC composite material prepared through powder metallurgy procedure was chosen as the work piece, machined using uncoated carbide insert TNMG 120404. Chips produced during machining were studied by measuring the thickness and were used along with uncut chip thickness to determine the chip thickness ratio.

99.85% pure aluminum was added with 4% volume fractions of copper and with silicon carbide particulates of 7.5%. To visualize the distribution of reinforcement phases in matrix, scanning electron microscope is used. Taguchi's methodology of design of experiments was adopted for designing a L9 (Latin square) orthogonal array for experimental investigation, and from analysis of variance, cutting speed influencing the formation of chip by 64.13%, continuing with depth of cut by 35.26%, was identified. Confirmation test accomplished with ideal conditions produces a better chip condition. [10]

Pardeep Saini carries out investigation on the impact of end milling parameters has been attempted for rough and finish machining conditions. Two case studies taken for study (a)rough machining i.e., 100% weightage to material removal rate (MRR) (b) finish machining i.e., 80% weightage to surface roughness, and only 20% weightage to MRR have been investigated. Full factorial design with 3-factors at 3-level each has been used as the design matrix for conducting the milling experiments. Taguchi-based grey relational analysis(TGRA) has been adopted for the bi-objective optimization for finish machining. The significance of process parameters has been checked with analysis of variance (ANOVA). [11]

H. Akkus investigated the consistency between the results obtained from the turning operation. To this end, Ti 6Al-4V alloy work piece was machined using CNC lathe. In addition, surface roughness (Ra), vibration, and energy consumption values were determined through turning. Experimental results were then analyzed statistically. Response Surface Method (RSM) and grey relational analysis were employed for statistical analysis. According to RSM analysis, grey relational analysis, and ANOVA and regression analysis, the feed rate was found the most Effective parameter that negatively affects surface roughness, energy consumption, and vibration. Finally, the steps involved in conducting grey relational analysis and the process of obtaining the results were examined. [12]

Gap in Literature

The above literature review clearly indicates that the study of feed, speed and depth of cut on cutting force and surface roughness has been very active since the past several decades, but there has been a continuous need to extend this study for the different combinations of tool and work material. The literature review also shows that there is not much of work undertaken with mixed lathe machine tool and Steel SM45C, even though it is a widely used combination owing to its industrial applications. Input parameters preferred - speed, feed rate, depth of cut, coolant used, and Output parameters preferred- surface roughness, MRR, tool etc. Material preferred - Steel SM45C

CONCLUSIONS

Following conclusion can be drawn from above review study.

- Taguchi method is originated on performing assessment or experiments to test the compassion of a set of response variables to a set of control parameters (or independent variables) by in view of experiments in "orthogonal array" with an aim to get the optimum set of the control parameters and it can be applied in turning process of propeller shaft .
- In the various research paper, turning process of Mild steel and Aluminum are studied to find out the factors causing high surface roughness in it. The reduction of surface roughness was done by optimizing the control variables or factors affecting the output. Taguchi method is the best accessible method to optimize the factors and together with the help of analysis of variance the optimum control factors are also found out.

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