A review on optimization of cutting parameters for surface roughness in facing process using Taguchi method

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***Abstract*— The influence of cutting parameters in the facing process mainly affects the surface roughness and machining time of product. The growing competition for higher productivity with high quality surface finish has created the need of using high quality machining tool. The important cutting parameters in facing process mainly cutting speed, feed rate, depth of cut, spindle speed affect the surface roughness of the finished material. This paper reviews the optimization of cutting parameters in facing process using Taguchi method. A specially designed orthogonal array of Taguchi is used to investigate the effect of cutting parameters through the small number of experiments. Taguchi method is a powerful tool of optimization. ANOVA (Analysis of variance) is used to find out which input parameters significantly affect the performance characteristics. Signal to Noise (S/N) ratio is used to measure the variations of experimental data.**

Keywords: Facing, Surface Roughness, Taguchi Method, ANOVA, S/N Ratio

I. INTRODUCTION

Facing is a machining process used to obtain the desired dimension of metal. The main objective in present industrial era is to produce low cost quality product with required dimensions in an optimum time. Therefore the optimum cutting parameters are to be recognized first. In actual practice, there are many factors affect the surface roughness like cutting conditions (speed, feed and depth of cut), tool variables (tool material, nose radius, rake angle, cutting edge geometry, tool vibration, tool overhang, tool point angle etc.) and work piece variables (material, hardness and other mechanical properties etc.). Process parameter optimization is of great significance while looking into the process capability of any machining operation. Highly competitive market requires high quality products at minimum cost. Facing operation using a single point cutting tool has been one of the oldest and popular methods of metal cutting. Facing can be done on lathe machine or by using CNC (computer numerical control) machine. Taguchi method was developed for improving the quality of goods manufactured (manufacturing process development), later its application was expanded to many other fields in Engineering, such as Biotechnology etc. Professional statisticians have acknowledged Taguchi's efforts especially in the development of designs for studying variation.

II. SURFACE ROUGHNESS

Surface roughness and material removal rate plays a vital role in deciding about the productivity in global manufacturing. As far as turned components are concerned, better surface finish (low surface roughness) is important as it can reduce or even completely eliminate the need of further machining. Surface roughness often shortened to roughness, is a component of surface texture. It is quantified by the deviations in the direction of normal vectors of a real surface from its ideal form. If these deviations are large, the surface is rough; if they are small, the surface is smooth.

III. TAGUCHI METHOD

Taguchi method is statistical method developed by Professor Genichi Taguchi of Nippon Telephones and Telegraph Company Japan for the production of robust products. According to Taguchi, total loss generated by a product to the society after shipped is the quality of the manufactured product. Taguchi has used experimental design as a tool to make products more robust – to make them less sensitive to noise factors. Currently, Taguchi method is applied to many sectors like engineering, biotechnology, marketing and advertising. Taguchi developed a method based on orthogonal array experiments, which reduced "variance" for the experiment with "optimum settings" of control parameters. Hence, the optimal results can be achieved by implementing the combination of Design of Experiments (DOE) with optimization of control parameters. Signal-to-noise (S/N) ratio and orthogonal array are two major tools used in robust design. Signal to noise ratio, which is log functions of desired output measures quality with emphasis on variation, and orthogonal arrays, provide a set of well balanced experiments to accommodate many design factors at the same time.

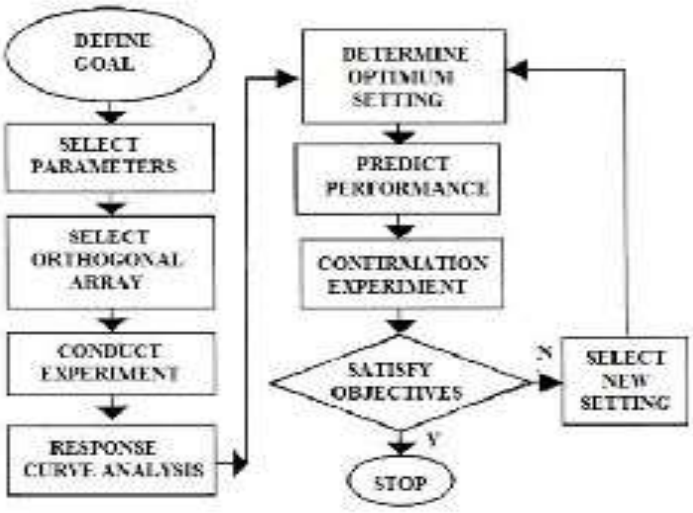

Fig. 1 Flow Chart of Taguchi Method

IV. LITERATURE REVIEW

Ankit Dogra, Hartaj Singh, Vishal Singh, Sunil Kumar [1] have analyzed that Taguchi Optimization technique pair with relational analysis has been adopted for evaluating parametric complex to carry out acceptable surface roughness lower is better of the material EN-8 steel during turning on a lathe trainer. After identify the optimal process parameters setting for turning operation. ANOVA is also applied for finding the most significant factor during turning operation. Cutting speed and depth of cut is found to be insignificant during ANOVA study.

Anshul Sen, Dr. Shailesh Dewangan et al [2] have discussed an application of the Taguchi method for optimizing the cutting parameters in turning operations. The Taguchi method provides a systematic and efficient methodology for the design optimization of the cutting parameters with far less effect than would be required for most optimization techniques. It has been shown that tool life and surface roughness can be improved significantly for turning operations.

Srinivas Athreya, Dr. Y. D. Venkatesh et al [3] have analyzed that the application of single characteristics optimization approaches for facing processes. These approaches utilized in many fields to optimize the single and multi performance characteristics efficiently. Facing is one of the most basic machining processes in traditional manufacturing process. Their control factors were cutting speed, depth of cut, feed rate, nose radius, coolant and accordingly the noise factors were vibration, raw material variation, machine condition, temperature and operator skill.

Sujit Kuman Jha et al [4] used Taguchi method to optimize cutting parameters during dry turning of aluminum with carbide tipped tool. The operation is performed on CNC that provides the power to turn the work piece at a given rotational speed and to feed to the cutting tool at specified rate and depth of cut.

Mr. Amar Kawale et al [5] have used the ANSYS for the analysis of single point cutting tool. All the angles, the tool signature, nose radius and also the tool wear. They checked the cutting forces, tool wear, temperature, stresses developed in SPCT during turning operation. They checked the different cutting forces during different depth of cuts.

L B Abhang et al. [6] focused on parametric investigation of turning process on EN-31 steel, investigated turning process parameters on steel. Experiments have been conducted using factorial design, to study the effect of machining parameters such as cutting speed, feed rate, depth of cut, tool nose radius and lubricant on surface roughness while turning En-31 steel. The Results have been analyzed by the variance technique and the F-test.

Mr. Balaji et al [7] Studied Optimization of Cutting Parameters in Drilling of AISI 304 Stainless Steel using Taguchi and ANOVA. The study deals with the effect of cutting parameters namely cutting speed, feed rate and helix angle on the tool life. The experiments were performed on drilling of AISI304 steel with carbide drill bits. Design of experiments was prepared according to Taguchi orthogonal array of L8 and experiments were performed with two levels of the cutting parameters. The effects of cutting parameters were analyzed by evaluating the amplitude of drill bit vibration and surface roughness. Taguchi and Analysis of Variance methods were used to identify significant cutting parameters affecting the drill bit vibrations and surface roughness.

Ch. Maheswara Rao et al [8] on his paper optimization of surface roughness in CNC turning using Taguchi method and ANOVA, studied the effect of cutting parameters (speed, feed and depth of cut) in CNC turning of AA7075 to achieve low surface roughness using tungsten carbide insert. The experiments were designed as per the Taguchi's L9 orthogonal array technique. Analysis of Variance (ANOVA) was performed to find the significance of the cutting parameters on the surface roughness.

Shivam Goyal et al [9] investigated experimental study of turning operation and optimization of MRR and surface roughness using Taguchi method. In this research work turning operation is performed on AISI 1020 mild steel. The experiments were performed by taking Cutting Speed, Feed Rate & Depth of cut as process parameters and got the optimized value of MRR & SR. An L9 orthogonal array, the S/N ratio are employed to the study the performance characteristics in the turning using carbide insert with a nose radius of 0.8mm.

Krishnakant et al [10] analyzed that an optimization of turning process by the effects of machining parameters applying Taguchi methods. EN24 steel is used as the work piece material for carrying out the experimentation to optimize the Material Removal Rate.

Sr. No.	Author	Year	W/P Material	Experimental run	Input	Output	Most significant
1	Ankit Dogra, Hartaj Singh et al	2016	EN- 8	27	Speed, feed, depth of cut	Tool wear rate	Spindle speed
2	Anshul Sen, Dr. Shailesh Dewangan et al	2016	AISI 4320	18	Cutting speed, depth of cut	MRR, surface roughness,	Cutting speed
3	Srinivas Athreya, Dr. Y. D. Venkatesh et al	2012	Mild Steel	27	Speed, feed, depth of cut	Surface finish	Cutting speed
4	Sujit Kuman Jha et al	2016	Aluminium	9	Spindle speed, feed, depth of cut, cutting speed	MRR	Cutting speed
5	Mr. Amar Kawale et al	2013	Mild steel	5	Depth of cut, cutting force	Temperature	Depth of cut
6	L B Abhang et al.	2014	En- 31 steel alloy	24	Cutting speed, feed rate, depth of cut, tool nose radius	Surface roughness	Feed rate
7	Mr. Balaji et al	2016	AISI 304 steel	8	Cutting speed, feed rate, helix angle	Surface roughness, and drill bit variation	Helix angle
8	Ch. Maheswara Rao et al	2016	Aluminium alloy 7075	9	Feed, cutting speed, depth of cut	Surface roughness	Feed & cutting speed
9	Shivam Goyal et al	2016	AISI 1020 mild steel	9	Depth of cut, feed, cutting speed	MRR & surface roughness	Depth of cut & cutting speed
10	Krishnakant et al	2012	EN 24 steel	27	Speed, feed, DOC	Surface roughness, MRR	speed

V. CONCLUSION

From the above literature review, we have found that most of the researchers have taken the controllable parameters as spindle speed, depth of cut, feed and cutting speed while keeping the other factors like nose radius, tool signature, coating thickness of cutting tool apart from the research. The common output factor are, surface roughness, material removal rate (MRR), tool wear rate (TWR), and cutting force. The result from this literature review is the surface roughness is highly dependent on cutting speed and feed rate while performing the operation while the least significant parameter is DOC.

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