MAT JOURNALS

Journal of Industrial Engineering and Advances
Volume 2 Issue 2

Optimization of Turning Parameters of AL-Alloy 6082 using Taguchi method – A Review

Ravi Aryan[1], Francis John[2]
Assistant Professor,
Sharda University, Greater Noida, India
E-mail Id - raviaryan3793@gmail.com

Abstract

This experiment reviews the optimization of cutting parameters for surface roughness & material removal rate in the turning process to obtain the optimal setting for the process parameters and analysis of variance is used to analysis the influence of cutting parameters while machining. Orthogonal array is also been used and prepared to obtain the optimal levels and to analyse the effect of each turning parameters. The S/N ratio is been calculated to structure the ANOVA table and study the performance characteristics in turning process. ANOVA analysis gives the contribution percentage of every process parameter. The number of experiments are to be obtained using full factorial design for optimal result.

Keywords: *ANOVA, Taguchi technique, Signal-to- Noise ratio, AL 6082, MINITAB, Turning process.*

INTRODUCTION

The turning operation is a machining operation performed on metals that is used widely in various industries working on metal cutting. The machining parameters selected for a turning operation is an important procedure in order to achieve high performance.

Surface roughness is a term considered as a product quality index that is used to measure the surface finish of a product. As better as the surface finish, we can get the improved strength properties. The best parameter to judge the quality of turned product is surface roughness which is very important for a product.

Surface roughness is one of the most commonly used criteria to determine quality of a turned surface. Surface roughness gives product a longer life, strength properties & affects the functional properties like friction, heat transmission, light reflection properties, etc. Production cost of an individual product is also get affected by surface roughness. As we try to minimize the surface roughness, we can accomplish towards the optimal parameters by optimizing some of the cutting parameters.

LITERATURE SURVEY

Rajpoot, Bheem Singh, et al. [1] used RSM to find the effect of cutting speed, feed and depth of cut on surface roughness and MRR while turning of AA6061. He does to find out the effect of every factor individually on surface roughness face centered design based on RSM. At three different points, the surface roughness is measured[1-5]. In Design Expert 8.0.4.1 software, the results of 20 experimented samples were examined methodically to get the surface roughness & MRR. ANOVA was performed to analyze the regression model which was developed for evaluating surface roughness for an accuracy of 95%. Both surface roughness and MRR are found to be significant factors amongst the three cutting parameters[6-10].

Bala Raju, J., et al. [2] studied the effect of cutting speed, feed and depth of cut while turning mild steel and aluminum by using HSS tool which was done to get better surface finish and to decrease power requirement. 2k factorial techniques were

used to carry out the experiments. ANOVA was used to carry out the effect of cutting parameters and multiple regression analysis was used to develop cutting forces Feed was found to be significant factor effecting on both surface roughness and cutting force[11-15].

Hakim et al. [3] analyzed the effect of machining parameter on cutting force component in hard turning of AISI T15 high speed steel. The cutting force during the turning of the alloy steel was affected by the type of the chip produced[16-20].

Lawal et al. [4] evaluated the effect of cutting fluids on cutting force components in turning of AISI 4340 steel using Taguchi method. The results showed that cutting speed and cutting fluid were significant factors on cutting force measurements.

Sachin C Borse [5] he was focused on optimizing turning parameters based on the Taguchi method to minimize the surface roughness and maximize the metal removal rate by using SAE 52100 steel with carbid Inserts[21-26]. Results of this study indicate that the feed rate is mostly influencing the surface roughness of the machined surface.

Deore Dhiraj Rajendra, Prof. Radha R [6] used Taguchi method for optimization of machining parameters for minimum cutting forces on EN 19 steel. Through ANOVA it is found out that Depth of cut is the significant factor for thrust force, and feed rate is the significant factor for feed force.

Lodhi, B. K. and Shukla, R. [7] experimented to optimize the surface roughness & material removal rate during machining of AISI 1018 alloy with Titanium coated carbide inserts. Spindle speed, feed rate & depth of cut were the input parameters. The experiment was performed in CNC Lathe machine using L9 orthogonal array. Surface roughness & material removal rate were obtained at the lowest and highest level respectively. ANOVA was used to obtain the most significantly effecting factor which was spindle speed for surface roughness & material removal rate with 75.295% & 78.173% respectively.

Mohan, R., et al. [8] analysed the cutting speed, feed rate & depth of cut to get the minimum surface roughness. The work piece material used in the experiment was AISI 52100 steel alloy (bearing steel) & cutting tool was Carbide inserts with nose radius 0.80. L9 orthogonal array was used for machining. Feed rate was found to be most significantly effected on surface roughness by ANOVA analysis.

Paramasivam et al. [9] studied the optimization of cutting speed, feed rate & depth of cut on surface roughness & material removal rate for EN24 steel based on regression analysis. Spindle speed is the significant factor over surface roughness & material removal rate.

Narayana Reddy et al. [10] analyses the machining parameters for 20MnCr5 steel in CNC horizontal lathe. The study of performance characterstics were by S/N ratio & ANOVA. L9 orthogonal array was used to design the experiment. Cutting speed, feed rate, depth of cut & hardness of tool were input parameters on output parameters like surface roughness & material removal rate.

Koura, M. M., et al. [11] inspected the cutting speed, feed rate & depth of cut on surface roughness during turning of mild steel by Carbide inserts using Artificial Neural Network. Total 27 were performed in dry condition using full factorial design. 19 out of 27 experiments were used for training and rest 8 for validation. The error calculated was 5.4%. in conclusion, they

found the increase in feed rate increases surface roughness & increase in cutting speed decreases surface roughness.

TAGUCHI METHOD

The Taguchi method is used for producing high quality product at minimum cost. This method is a conventional method. This method designs the experiment in an efficient & effective manner and analyse the process influencing parameter in lesser time. It is a modified method in design and analysis compared to traditional design and is widely used in making quality improvements. This is performed or done to find the suitable combination of parameters with the varying responses.

Taguchi method is a powerful tool to design optimization for quality. It is used to find the optimal cutting parameters such as cutting speed, feed rate, depth of cut and nose radius, etc. as the overall cost can be reduced. This experiment gives some background of optimization technique applied to various turning processes for improving surface roughness and material removal rate.

The objective of parameter design is to optimize the settings of the process parameter values for improving the performance characteristics and to identify the product parameter values.

SIGNAL TO NOISE RATIO

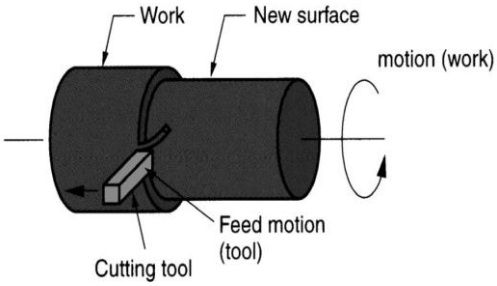
Signal-to-noise ratio is a measure used in science and engineering that compares the level of a desired signal to the level of background noise. It is defined as the ratio of signal power to noise power, expressed in decibels.

The Taguchi method uses a loss function to determine the quality characteristics. Loss function values are also converted to a signal-to-noise ratio (η). In general, there are three different quality characteristics in S/N ratio analysis, namely "Nominal is the best", "Larger is the better" and "Smaller is the better". For each level of process parameters, signal-to-noise ratio is calculated based on S/N analysis. The optimal level of the process parameters is the level having highest S/N ratio.

TURNING OPERATION ON LATHE

The turning operation is a basic metal machining operation that is used widely in industries dealing with metal cutting. In a turning operation, a high-precision single point cutting tool is rigidly held in a tool post and is fed past a rotating work piece in a direction parallel to the axis of rotation of the work piece at a constant rate and unwanted material is removed in the form of chips.

This operation is carried out in a Lathe Machine either manually under an Operator's supervision. There are two types of motion in a turning operation. One of the cutting motion which is the circular motion of the work and other is the feed motion which is the linear motion given to the tool. The basic turning operation with the motions involved is shown in Figure below-



METHODOLOGY

For getting accurate results, various types of analysis methods such as Taguchi methods, Regression Analysis etc. are used then ANOVA is performed for analysis. His methods focus on the effective application of engineering strategies rather than advanced statistical techniques. In this experiment, Taguchi is used to evaluate the effect of input parameters on the responses of the turning

of AA6082. The Taguchi philosophy and its associated experimental design method have been extensively used in the manufacturing environment to improve production processes.

For analysis, MINITAB 17 is used in the experimental work. The performance and percentile contribution of individual parameters to be done by Surface Roughness, MRR and Machining Time is measured with the help of S/N ratio & ANOVA.

FACTORS & PARAMETERS

There are three cutting parameters that are used to find the optimal conditions by turning process are -

- Spindle Speed
- Flank Angle
- Depth of Cut

The factors that can get affect by the cutting parameters in this experiment are –

- Surface Roughness
- Material Removal Rate
- Machining Time

CONCLUSION

Minitab 17 statistical software has been used for the analysis of the experimental work. This Minitab software studies the experimental data and provides the calculated results of signal-to-noise ratio. The objective of the present work is to minimize machining time and maximize the MRR in turning process optimization. The effect of different process parameters on material removal rate and machining time are to be calculated and plotted as the process parameters. The average value of S/N ratios has to be calculated to find out the effects of different parameters and as well as their levels. The use of both ANOVA technique and S/N ratio approach makes it easy to analyse the results and reach to the conclusion.

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