A Review on Optimization of Machining Parameters in Cylindrical Grinding Process

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Abstract— **The selection of optimum process parameters is crucial for machining processes. In this paper, a review of machining process parameters for different materials is done in cylindrical grinding. Machining of different materials is done by different researchers using cylindrical grinding.Various input parameters: wheel parameters such as abrasives, grain size, grade, etc. and work parameters such as: work speed, depth of cut, number of passes, feed rate, etc. are studied by researchers. This is revealed from the various research works that the above said parameters plays a vital role in achieving optimum value of MRR and Surface finish in cylindrical grinding process.**

Keywords—Cylindrical grinding, MRR, Surface finish, Taguchi, RSM.

I. INTRODUCTION

In modern manufacturing industry, the main objective is to manufacture low cost, high quality parts within short time. Machining is a major manufacturing process of nearly every product of the modern civilization. Main machining operations are turning, drilling, thread cutting, milling, grinding etc. Among them grinding has been employed in manufacturing for more than 100 years. It is a manufacturing process involved with material removal, and frequently the last operation performed on a workpiece. The applications of grinding are mainly for making products requiring a high degree of accuracy and precision. Final shape and finish depends on this operation; so, it is a very important process in order to meet stringent specifications and tolerances for the output job. The cylindrical grinder is one of the most important and most common grinding machines. Cylindrical grinders are used on the workpiece that are symmetrical about an axis of rotation.

The productivity depends on material removal rate (MRR). It is desirable to get high MRR without scarifying the quality. In case of grinding the MRR should be such that it does not affect the surface roughness. The material removal rate depends on the process parameters in machining operation, and in grinding also. Good surface roughness values and high MRR may obtain through process optimization, which needs a deep knowledge of the phenomena, mainly concerning the relationship between the process parameters and output characteristics.

II. LITERATURE REVIEW

Many investigators have suggested various methods to explain the effect of machining parameter on material removal rate and surface roughness in cylindrical grinding process.

M. Melwin Jagdish, [1] carried out study on cylindrical grinding of OHNS steel rounds. The input parameters considered in the experimental study are work speed, depth of cut and number of passes and response parameter is metal removal rate (MRR) during cylindrical grinding process. Higher metal removal rate is the main objectives of this machining process. The different machining parameters of OHNS steel of cylindrical grinding process are optimized by signal to noise ratio and analyzed by Analysis of variance (ANOVA’s).

The main objective was to show the knowledge of grinding process can be utilized to predict the grinding performance and achieve optimal operating process parameters.

A.Experimental Setup

- Work material: OHNS die steel in the form of round with 25 mm diameter and length 70 mm. There were 9 experiments conducted with different machining parameters to determine optimal solution of cylindrical grinding process.

Levels- Low, Medium and High
Factors- Work Speed, Depth of cut and Number of pass
Response Parameters- Metal removal rate

- Cylindrical grinding parameters:

1) Minimum and maximum work speed taken is 150 rpm and 350 rpm.
2) Minimum and maximum Depth of cut taken is 0.02 and 0.06 mm.
3) Three number of pass.

After conducting the experiment the optimum parameter for metal removal rate of cylindrical grinding process of OHNS steel were 150 rpm of work speed, 0.02 mm of depth of cut and 1 number of pass from the conducted experiments which gave the value of 0.061789 Gms/Sec of MRR.

B.Conclusion

- Number of pass is a dominating parameter of metal removal rate (MRR) of cylindrical grinding process of OHNS steel rounds.
- OHNS steel produces good surface finish during cylindrical grinding process with optimum grinding parameters.
- The work speed, Depth of cut and Number of passes are dependable parameters of larger metal removal rate of cylindrical grinding process on OHNS steel rounds.

Suleyman Neseli, [2] applied combined Response surface methodology (RSM) and Taguchi methodology (TM) to determine optimum parameters for minimum surface roughness (Ra) and vibration (Vb) in external cylindrical grinding. The three input parameters were workpiece revolution, feed rate and depth of cut the outputs were vibrations and surface roughness. Second to minimize wheel vibration and surface roughness, two optimized models were developed using computer aided single objective optimization. The experimental and statistical results revealed that the most significant grinding parameters for surface roughness and vibration is work piece revolution followed by depth of cut.

This paper shows how response surface and orthogonal arrays can be used in a series of grinding experiments to achieve a high performance. The Taguchi and Response surface methodology are used to predict the wheel vibrations and surface roughness in the external grinding of hardened AISI 8620 steel.

A. Experimental Setup

- Work material: AISI 8620 steel in the form of round with stepped diameter 40 mm for the length of 50 mm and 60 mm diameter for the remaining length of 350 mm. There were 27 experiments conducted with different machining parameters to determine optimal solution of cylindrical grinding process.

- Cylindrical grinding parameters:

1) Minimum and maximum depth of cut taken is 0.01 mm and 0.1 mm.

2) Minimum and maximum feed rate 0.2 mm and 0.6 mm.

3) Minimum and maximum work revolution 175 rpm and 275 rpm.

After conduction of the experiment the optimum results to minimize wheel vibrations were determined to be 0.01 mm depth of cut, 0.249 mm feed with work piece revolution of 175 rpm which gave the value of Vb 1.089 mV/g. For surface roughness the optimum condition was determined to 0.01 mm depth of cut, 0.2 mm feed with workpiece revolution of 275 rpm which gave the value of Ra 0.145µm.

B.Conclusion

- Using the Taguchi and Response surface methodology showed that the depth of cut and workpiece revolution were the dominant factors that influenced the wheel vibration and surface roughness.
- The surface roughness increases with increase in depth of cut and feed rate. If depth of cut and feed rate are increased and work revolution is decreased the surface roughness increases.
- Thus for lowest surface roughness value minimum depth of cut, minimum feed rate and maximum work revolution are the idle conditions.

V. Saravana Kumar, [3] the experiment was conducted on micrometric grinding machine using L9 orthogonal array with input parameters as depth of cut, work speed, feed rate and coolant flow rate. By analyzing the above values optimum surface roughness is obtained by conducting a series of experiments. The developed model in this paper can be used by the different manufacturing firms to select right combination of machining parameters to achieve an optimal Surface Roughness (Ra). The main objective of this project is analyze effect of various process parameters in machining of SS 410 for obtaining required surface roughness. In order to optimize these values Taguchi method is used.

Taguchi method uses a special design of orthogonal arrays to study the entire parameter space with a small number of experiments only. A loss function is then defined to calculate the deviation between the experimental value and the desired value. Taguchi recommends the use of the loss function to measure the performance characteristic deviating from the desired value. The value of the loss function is further transformed into a signal-to-noise (S/N) ratio. Usually there are three categories of the performance characteristic in the analysis of the S/N ratio, that is, the lower-the-better, the higher-the better, and the nominal- the-better. The S/N ratio for each level of process parameters is computed based on the S/N analysis. Regardless of the category of the performance characteristic, the larger S/N ratio corresponds to the better performance characteristic. Therefore, the optimal level of the process parameters is the level with the highest S/N ratio.

A. Experimental Setup

- Work material: SS410 in the form of round with diameter 24 mm and length of 150 mm.

- Cylindrical grinding parameters:

1) Minimum and maximum depth of cut taken is 0.02 mm and 0.1 mm.

2) Minimum and maximum feed rate 7.33 mm/s and 15.40 mm/s.

3) Minimum and maximum work revolution 80 rpm and 320 rpm.

4) The coolant used was Cim cool 602 in the ratio of 1:30 with the flow rate between 0.088 L/s to 0.276 L/s.

After conduction of the experiment it was observed that 0.02 mm depth of cut, 15.40 mm/s feed with work piece speed of 160 rpm and flow rate of 0.276 L/s were the optimum conditions which achieved the surface roughness which gave the Ra value of 0.28µm.

B.Conclusion

- The S/N ratio analysis depicts that when depth of cut is minimum with increase in feed Ra value decreases.
- The value of surface roughness increases drastically at high work speed.
- When the work speed is maximum and feed is minimum the Ra value is high or the surface finish is poor.
- At higher work speed and higher coolant flow rate better surface finish can be attained.

Karanvir Singh, [4] in this experimental work, the effect of input parameters like grinding wheel speed, work-piece speed, abrasive grain size, depth of cut, concentration of cutting fluid, and number of passes has been found on the surface roughness of cylindrical grinded AISI 4140 steel. The other parameters like feed rate, diameter of work-piece, coolant flow rate, etc. are kept constant. Three levels of each variable have been selected except wheel speed. Two levels of wheel speed have been taken. Heat treated AISI 4140 steel is selected as the work-piece material. The experiment is designed by using Taguchi's L18 orthogonal array. The effect of all the input parameters on the output responses have been analyzed using analysis of variance (ANOVA).

Plots of S/N ratio have been used to determine the best relationship between the responses and the input parameters, in other words, optimum set of input parameters for minimum surface roughness is determined.

A. Experimental Setup

- Work material: AISI 4140 steel in the form of round rod. AISI 4140 is used in manufacturing of axles, conveyor parts, spindles, shafts, etc.

- Cylindrical grinding parameters:

1) Minimum and maximum depth of cut taken is 15 µm and 25 µm.

2) Minimum and maximum grain size 36 mesh/inch and 60 mesh/inch.

3) Minimum and maximum workpiece speed 250 rpm and 710 rpm.

4) Minimum and maximum grinding wheel speed 2100 rpm and 2640 rpm.

5) Concentration of cutting fluid in % 3 to 5.

After conduction of the experiment it was observed that the minimum surface roughness obtained was 0.34 µm which is obtained at grinding wheel speed of 2640 rpm, work piece speed of 710 rpm, grain size 46, depth of cut 15 µm, concentration of cutting fluid 5 % and number of passes 2. While the maximum surface roughness obtained is 0.56 µm at grinding wheel speed of 2640 rpm, work piece speed of 250 rpm, grain size 60, depth of cut 25 µm, concentration of cutting fluid 5 % and number of passes 3.

B.Conclusion

- It has been found that depth of cut and work piece speeds are the most significant parameters.
- The variables like grinding wheel speed, grain size, concentration of cutting fluid and number of passes are not significant.
- The depth of cut is found to be most significant for surface roughness and the grinding wheel speed is found to be least significant parameter because it shows negligible change of response with change in levels.
- The surface roughness decreases when depth of cut was increased.

II. CONCLUSION AND FUTURE SCOPE

From the above literature survey we find that there are many researches done on optimization techniques for process parameter like surface roughness and material removal rate separately. But I found that there are very few researches done on combined output parameters of surface roughness and material removal rate which can be done using response surface methodology by considering the input parameters like work speed, wheel speed, depth of cut and number of passes.

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