A REVIEW ON OPTIMIZATION OF CYLINDRICAL GRINDING PROCESS PARAMETERS USING TAGUCHI METHOD

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Abstract -- In today's era of the manufacturing sector, not only producing the products with good quality along with dimensional accuracy and close tolerances is important but also it has to produce economically and in a short time. Hence selection of optimum process parameters becomes very crucial for machining processes. In this paper, a review is made on optimization of cylindrical grinding process parameters done by different researchers on different materials. All the researchers studied and selected some vital process parameters which heavily affect the output parameters of cylindrical grinding such as surface quality, MRR etc. and done experiments on specimens. Taguchi method is used for experimentation and to find the optimum parameters.

Keywords—Cylindrical grinding, MRR, Surface finish, Taguchi method, OA, RSM, ANOVA.

I. INTRODUCTION

In the manufacturing sector, producing products with good quality surface finish along with dimensional accuracy and close tolerances play an important role. To fulfill these requirements, several finishing processes are used such as burnishing, honing, lapping, and grinding. Cylindrical grinding is one of the important metal cutting processes used extensively for finishing operations of cylindrical objects such as shafts, axles, spindles, studs etc. Grinding process is mostly used in which surface quality and metal removal rate are considered as an output parameters. But these output parameters of grindings are influenced by several operating input parameters such as: (i) wheel parameters – type of abrasives, grain size, grade, structure, binder, shape and dimension; (ii) work piece parameters – mechanical properties, chemical composition, fracture mode; (iii) process parameters – wheel speed, depth of cut, table speed, feed, and dressing condition; (iv) machine parameters – static and dynamic characteristics, spindle system, and table system.

Hence in grinding operation, it is an important task to select appropriate input parameters for achieving high cutting performance. Usually, the desired cutting parameters are determined based on experience or by use of a handbook. However, this does not ensure that the selected parameters have optimal or near optimal cutting performance for a particular machine and environment.

II. METHODOLOGY

Different procedures have been used by researchers from time to time for the process of optimization. Taguchi method is an experimental method. It is effective methodology to find out the effective performance and machining conditions. Taguchi parameter design offers a simple, systematic approach and can reduce number of experiment to optimize design for performance, quality and manufacturing cost. Signal to noise ratio and orthogonal array are two major tools used in robust design. And collected the data after experiments for each factor/level combination and then analyzed using Analysis of Variance (ANOVA).

III. LITERATURE REVIEW

Sandip Kumar et al. [1] has studied the Taguchi method and was found that various input parameters of cylindrical grinding such as the work piece speed, grinding wheel speed and feed rate has more significant effect for surface roughness and depth of cut has least effect on Material removal rate of EN15 AM steel. A Taguchi L18 (21 x 33) orthogonal array, the signal to noise (S/N) ratio and the analysis of variance (ANOVA) were used for the optimization of cutting parameters. ANOVA results shows that work piece speed contributes maximum 38.95 % percentage contribution, grinding wheel speed contributes 14.85 %, feed rate contributes 12.85% and depth of cut has least contribution about 9.80% towards the material removal rate. And finally concluded the optimized parameters for material removal rate are grinding wheel speed 1800 rpm, work piece speed 155 rpm, feed rate 275 mm/rev and depth of cut .04 mm.

Naresh Kumar et al. [2] worked on cylindrical grinding of C40E steel is done for the optimization of grinding process parameters. During this experimental work input process parameters i.e. speed, feed, depth of cut are optimized by using Taguchi L9 orthogonal array. Analysis of variance (ANOVA) used for confirmation. And finally concluded that surface roughness is minimum at the 210 rpm, 0.11mm/rev feed, and 0.04mm depth of penetration.

M. Melwin Jagadeesh Shridhar et al. [3] analyzed optimal process parameters of cylindrical grinding to grind OHNS Steel (AISI 0-1) with high surface quality by conducting various experiments. In this work L9 orthogonal array was selected for three levels and three input parameters. The inputs parameters are considered in this 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 objective 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). Finally they has found that number of pass of grinding process play an important role for achieving larger metal removal rate in cylindrical grinding process and optimal parameter of OHNS steel rounds in cylindrical grinding process are 150rpm of wheel speed ,0.02 mm of depth of cut and 1 number of pass.

K. Mekala et al. [4] analyzed that an optimization of cylindrical grinding parameters of austenitic stainless steel rods (AISI 316) by Taguchi method to have maximum MRR with good surface quality. In this, Taguchi design of experiments of L9 orthogonal array was selected with 3 levels with 3 factors and output parameters of Metal removal rate are measured. After conducting experiment optimized by S/N ratio and analyzed by ANOVA and predicts Cutting speed is a dominating parameter of cylindrical grinding. The optimal process

parameters for AISI 316 austenitic stainless steel were found 560 m/min of cutting speed, 0.130 mm/rev of feed and 0.005 mm of depth of cut.

Lijohn P George et al. [5] conducted experiment to study the working of cylindrical grinding machine and effects of grinding process parameters on Surface roughness. The experiments are conducted on MILANO RICEN RUM 1 Cylindrical Grinding Machine with L9 Orthogonal array with input machining variables as work speed, depth of cut and hardness of material. In this EN 24, EN 31, EN 353 alloy steels are used. Surface roughness is measured using MITUTOYO Surf test SJ-400 surface roughness tester. He also formulated an empirical relationship between the surface roughness values and the input parameters. Taguchi parametric optimization is used for the optimization process. Then results are further confirmed by conducting confirmation experiments on ANOVA.

Kundan Kumar et al. [6] used Taguchi method to find optimal material removal and effect of process parameters of cylindrical grinding machine on mild steel work pieces. In this grinding parameters evaluated are cutting speed and depth of cut. An L9 orthogonal array, signal-to-noise (S/N) ratio and analysis of variance (ANOVA) are employed to analyze the effect of these grinding parameters. From his experiment, he derived optimal grinding conditions for selected quality characteristic, MRR are – Cutting speed 41.07 m/min, Depth of cut 0.020 mm and optimal material removal rate is 19.906mm3/s. Also he found the percentage contributions of the parameters from ANOVA are Cutting Speed 47.30%, Depth of Cut 4.40%. The percentage contributions of the parameters have revealed that the influence of the Cutting Speed is significantly larger than that of Depth of Cut.

Deepak Pal et al. [7] conducted experiments on universal tool and cutter grinding machine with L9 Orthogonal array with input machining variables as work speed, grinding wheel grades and hardness of material. The results reveals surface roughness (Ra).The predicted optimal values for Ra for cylindrical grinding process was 1.07 Ra. The results are further confirmed by conducting confirmation experiments.

Kirankumar Ramakantrao Jagtap et al. [8] has done the work on cylindrical grinding of AISI 1040 steel to find out optimal process parameters that will minimize the surface roughness and maximize the metal removal rate. Empirical models were developed using design of experiments by Taguchi L9 Orthogonal Array and the adequacy of the developed model is tested with ANOVA. For minimum surface roughness he found that the work speed was the most influencing factor for AISI 1040 work material followed by grinding wheel speed, number of passes and depth of cut. So, to achieve the minimum surface roughness of AISI 1040 steel, employ low depth of cut of 300 µm, highest work speed of 630 rpm with moderate number of passes 06 and high grinding wheel speed of 1910 rpm. And for metal removal rate, the most influencing factor was number of passes, second being depth of cut followed by grinding wheel speed and work speed. So, to achieve the maximum metal removal rate of AISI 1040 steel, employ higher depth of cut of 400 µ m, moderate work speed of 224 rpm with minimum number of passes of 03 and high grinding wheel speed of 1910 rpm.

M. Ganeshan et al. [9] used Taguchi method for prediction and optimization of Cylindrical Grinding Parameters for Surface Roughness. Experiments are conducted on 304 stainless steel material. Experiments were conducted by using Taguchi design of experiments of L9 orthogonal array with 3 levels with 3 factors and output parameter of Surface Roughness is measured. After conducting experiment, it is optimized by S/N ratio and analyzed by ANOVA and predicted that cutting speed is a dominating parameter of cylindrical grinding.

B. Dasthagiri et al. [10] done Optimization Studies on Surface Grinding Process Parameters on EN8 steel. He used the Taguchi method as well as RSM (Response surface methodology) for finding out optimal parameters. The orthogonal array selected to conduct the experiments was L27. MRR was calculated as the ratio of volume material removed from the work piece to the machining time. The surface roughness, Ra was measured in perpendicular to the cutting direction using Surface Roughness tester SJ-201 at 0.8mm cutoff value.

IV. CONCLUSION

In this paper, survey is done on optimization of cylindrical grinding process parameters on different materials. And from above survey it is clear that process parameters plays vital role in obtaining desired output in grinding process. In grinding process main output parameter is surface finish which is a value addition process. Selection of wrong process parameters not only hampers the surface quality but it increases the machining cost. Hence it is very important to select optimum process parameters to have good quality surface economically.

V. FUTURE SCOPE

From the above literature survey it is observed that most of the researches have done their research to find optimal parameters for better MRR and surface finish separately. Hence there is a scope to investigate optimal controlling parameters for combined output parameters i.e. MRR and surface finish. Also it is found that, research work on En24 steel is less even it has wide industrial applications. Thus there is a scope to study above mentioned unexplored areas.

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