A Review on Various Approach for Process Parameter Optimization of Burnishing Process and TAGUCHI Approach for Optimization

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Abstract— The aim of this paper is review for different optimization methods used for process parameter optimization of roller burnishing process and Taguchi approach used for process parameter optimization for various processes. The quality of burnishing processed parts are highly depends upon various process parameters of burnishing process. Hence optimization of burnishing process parameters is necessary in order to improve the quality of parts. The purpose of this paper is to explore the reviews for various optimization methods used for process parameter optimization of burnishing process and application of Taguchi approach for design of experiments.

Key words: burnishing process, Optimization and Taguchi approach

I. INTRODUCTION

The competition in the world market for manufactured the product has intensified tremendously in recent years. It has become important the quality of product is to be good as possible for achieving competitive advantage. The quality of burnishing processed parts is affected by various process parameter used in this process. There is a need for optimizing the process parameters both from technological and economic point of view. Optimization of process parameters helps to finding out the correct adjustment of parameter which improves the quality of the product. Taguchi method is powerful tool for optimization of process design. The primary advantages for design of experiments using Taguchi's technique include simplification of experimental plan and feasibility of study of interaction between different parameters.

II. PROBLEM FORMULATION

In today's competitive market the quality of parts like surface finish, mechanical strength, hardness etc. is most important things to satisfy and attract the customers. In the burnishing process the quality of the parts is highly depends upon the various process parameters of the process. For that, process parameter optimization of burnishing process should be carried out. It will improve the quality of functional parts. There are different methods of optimization of process parameter like factorial design, Taguchi method, central composite design; response surface methodology etc. From these different methods of optimization, Taguchi approach is more powerful technique. Currently high quality of the parts with low cost and in shorter time period is the demands from the users. This is the big challenge so it is necessary to optimize the process parameter of respective machines.

III. LITERATURE SURVEY

Optimization of process parameters helps to finding out the Correct adjustments of parameters which improve the quality of products. Review of various approaches which is used by other researchers for process parameter optimization of burnishing process is discussed in this section.

Mayank K Patel et al. (2012) have conducted the experiments in order to optimize burnishing process parameters for batter surface quality. They have selected burnishing process parameters such as burnishing speed, burnishing feed, force and frequency for the study purpose. The experiments were planned on the basis of response surface methodology technique for statistical design of experiments. The experiments were conduct on M.S. (C-20) material. The analysis of variance was employed to find out which parameter is most significant over performance characteristics. After the experimental work they have found that at the combination of 90 rpm speed, 0.127 mm/rev feed, 20 Kgf burnishing force and 40 HZ frequency the lowest experimental surface roughness (1.05 µm) was achieved. [1]
Pravindrababu et al. (2012) have studied the effect of various burnishing parameters on the surface characteristics, surface micro structure and micro hardness. For the experimental purpose EN series steel and brass material was selected. The burnishing parameters considered for the studies were burnishing speed, burnishing force, burnishing feed and number of passes. They have employed Taguchi technique in their investigation to identify the optimal burnishing parameters on surface roughness. After the experimental work they have conclude that the optimal speed, force and feed for minimum roughness are 535 rpm, 200 N, 0.063 mm/rev for EN 8 and 355 rpm, 200 N, 0.095 mm/rev for EN 24 and EN 31 alloy steel material. They have also suggest that the aluminum alloy shows the best surface finish in the second pass and maximum burnishing depth happen to occur in first pass of brass. [2]

Nikunj K. Patel et al. (2013) have investigated the impact of burnishing speed, burnishing force and number of pass of the tool on the surface qualities and tribological properties. To determine influence of each process parameters, several tests were carried out. Taguchi's designs of experiments were employed to conduct the experiments. ANOVA applied with the aim to find optimize value for enhancing the surface quality and hardness economically. For the experiments purpose Al alloy 6351-T6 was selected as a work piece material. After the experimental work and analysis they have conclude that the surface finish is increase with increase in the speed and decrease with increase in burnishing force. They have suggest that the optimum roller burnishing parameters for aluminum 6351-

T6 were the combination of the burnishing force 20 kgf, feed 0.50 mm/rev, number of passes 3 and burnishing speed 250 rpm. [3]

P. S. Kamble et al. (2012) have used internal roller Burnishing tool to burnish the drilled holes. Speed, feed and number of passes have been varied by using Taguchi method to examine surface finish and micro hardness. ANOVA analysis is carried out to find out most significant burnishing process parameters among all. They have selected EN 8 material which is use as a plain carries in planetary type gear box to carry the planetary gears. After the experimental works they have conclude that the surface roughness is decrease with increase in feed and speed. But with increase in number of passes the surface roughness is increase. They have also found that the maximum micro hardness is achieved at lower feed rate and minimum number of passes. Surface roughness from 2.44 µm to 0.13 µm was achieved. [4]

C. S. Jawalkar et al. (2009) has conducted the experiments to find optimize value for enhancing the surface quality and hardness economically in roller burnishing process. They have considered the input parameters of roller burnishing process are spindle speed, tool feed, number of passes and lubricants. The surface roughness and micro hardness were main response variables. The commonly used industrial material EN 8 is selected as a work piece for experimental purpose. Taguchi's standard L9 orthogonal array was used as for design of experiments. ANOVA analysis was applied to find out most significant roller burnishing process parameters. After the experimental work they have conclude that the number of passes, feed and spindle speed contribute maximum for surface roughness in burnishing for EN 8 material. Number of passes and speed contribute maximum percentage in surface hardness for burnishing of EN 8 due to hard hardening effect. [5]

SUNDARARAJAN P.N. et al. (2009) have selected roller burnishing tool to perform roller burnishing process on aluminum 63400 materials under different parameters and different burnishing orientations. The impact of burnishing force, burnishing feed, number of passes and step over the surface roughness and surface hardness are investigated. They have selected Taguchi's L27 standard orthogonal array for conducting the experiments. ANOVA analysis was applied to check the effects of parameter on performance characteristics. From the analysis of results in roller burnishing using conceptual S/N ratio approach, they have concluded that the in burnishing process use of burnishing force (1200 N), burnishing feed (200 mm/min) and number of passes (3) are recommended to obtain batter surface finish. They have also found that burnishing force 1200 N yields the highest improvement in surface hardness. [6]

IV. TAGUCHI APPROACH FOR OPTIMIZATION

The Taguchi method is a well-known technique that provides systematic and efficient methodology for design optimization. Design of experiment using Taguchi's technique includes simplification of experimental plan with minimum experiments.

S. Shaji et al., (2003) have investigated the possibility of using graphite as lubricating medium to reduce the heat generated at the grinding zone in surface grinding. They have studied the effect of parameters such as speed; feed, in feed and mode of dressing on the performance characteristics of surface finish and force developed. Factors and their levels selected for the study is indicate in Table 3.Total nine experiments were carried out by using Taguchi's standard L9 orthogonal array design (Table 4) to find out the effects of parameters on force developed and surface quality. After the experimental work optimum condition has been found out and they observed that the result obtain in the conventional coolant grinding is in a good agreements with the results obtained graphite assisted grinding. It has been observed that with the graphite application, the tangential force and surface roughness are lower compare to those in conventional grinding. [7]

Ulas et al., (2007) were developed, artificial neural network (ANN) and regression model to predict surface roughness in abrasive water jet machining (WAJM). They have consider machining parameters such as traverse speed, water jet pressure, standoff distance, abrasive grit size and abrasive flow rate. They have used Taguchi's design of experiments in order to collect the surface roughness values. Analysis of variance (ANOVA) was used to check the validity of regression model. At the end of the study, both the ANN and regression analysis results were comparing with experimental data. They studied that both the models ANN and regression presents a good agreement with the experimental data. Based on the ANOVA (Table 2), the most dominant parameter on the surface roughness was found as water jet pressure. Abrasive flow rate and standoff distance were less effective on surface roughness, while effect of abrasive grit size can be negligible [8].

D. Chakradhar et al., (2011), have investigated the effect and parametric optimization of process parameters for electrochemical machining of EN-31 steel. The process parameters consider are electrolyte concentration, feed rate and applied voltage and are optimize with considerations of multiple performance characteristics including material removal rate, over cut, cylindrical error and surface roughness. They used Taguchi's standard L9 orthogonal array design for performing experiments. They performed the ANOVA to get the contribution of each parameter on the performance characteristics. After the experimental works they found that the best combination of process parameters are electrolyte concentration at 15%, feed at 32 mm/min and voltage at 20 V. From the results they have conclude that the material removal rate can be maximize and the over cut, cylinder city error and surface roughness can be minimized through this method [9].

Anoop et al., (2008) have optimized the efficiency of pulsed ND: YAG laser for the laser surface structuring of porous alumina ceramic. The laser processing parameters like the pulse width, repetition rate and the scanning speed were evaluated. The Taguchi's standard L9 orthogonal arrays were used to identify the combination of process parameters for optimize physical attribute of the ceramic. ANOVA is carried out to identify the processing parameters that contributed the most to minimize the porosity and maximize the grain size. After the experimental work they

have conclude that the pulse repetition rate was the most significant factor in minimizing the inter dendritic porosity while the scanning speed played a vital role in increasing the grain size [10]

V. CONCLUSION

From the above reviews we can conclude that optimization of burnishing parameters is necessary to achieve higher quality parts and Taguchi's approach is versatile tool for process design optimization. The Taguchi's tool such as orthogonal array, signal to noise ratio, factor effect analysis (ANOVA) is most effective to get the contribution of each parameter and to determine significant parameters which affect the performance characteristic respectively. There are different optimization methods but as shown in above reviews researchers got better results with Taguchi's approach because of it can be provide systematic, efficient and simplification of experimental plan with minimum experiments so the time and cost are reduced concerned with manufacturing.

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