Survey of Optimization of Machining Parameters for Face Milling Operation

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Abstract— The main goal of the manufacturing industry is to manufacture a low/moderate production cost, high quality & better surface finish product in short time. For this achievement a lot of efforts & research work is carried out to determine the optimum parameters such as speed, feed, depth of cut, cutting tool material etc., and their influence is to be studied to obtain better surface finish. Influencing machining parameters may be two, three or four. Wide study was carried out for optimization of machining parameters for face milling operation. Many author designed experiment by using Taguchi method, response surface methodology and factorial design, And used many optimization techniques to optimize the response parameters, like Taguchi, response surface method. Less work carried out on Genetic algorithm technique and ant colony optimization.

Key words: MRR, CNC Milling Machine, Face Milling Operation

I. INTRODUCTION

The optimization of various processing parameters of a CNC milling machine effectively determines some critical process control factors/parameters or combinations of such parameters who will establish a close relation with the desired output of a machine. By considering all above, in this project, a new & basic approach is taken to study & analyze the relative significance of factors/parameters & their special combinations using suitable standard Experimental Design Methodology Method and Suitable analysis software. After determining the relative significance; it can be simple to understand the factors/parameters or their special combinations to be changed to increase process efficiency & output characteristics of CNC milling machine. As the product appearance, texture, surface finish plays a key role for machining processes and from the conclusions studied from different case studies & project work, it will be obvious to shift the focus towards the improvement in surface finish. Thus useful for the small, medium & large scale industries. The selection of optimal cutting parameters is a very important issue for each machining machine in order to enhance process efficiency & output characteristics of CNC milling machine which further leads towards an influence on surface quality of machining products. Thus to improve the process efficiency & output characteristics of CNC milling machine it is very important & necessary to optimize the various processing parameters of CNC milling machine.

II. LITERATURE SURVEY

Balinder Singh et.al [1] studied the significance of the processing parameters on the surface roughness of the EN24 Steel material for milling process by CNC milling machine, with carbide End Mill cutting tool. The main processing parameters are spindle speed, feed rate and depth of cut. All the experiments trials, planning and analysis were executed using Taguchi design of experiment. With the reference to optimization of parameters, the conclusions obtained are as follows. For optimum surface roughness value (Ra) feed rate contributed 87.29%, cutting speed contributed only 1.58% and depth of cut contributed 0.003%.

Sukhdev S. Bhogal et.al [2] studied the influence of machining parameters on the surface roughness of EN-31 die steel material for milling process by CNC milling machine with tungsten carbide tool. The main processing parameters are spindle speed, feed rate and depth of cut are optimized by response surface methodology. The optimum cutting parameters are investigated & analyzed for minimum surface roughness value and tool vibration in this experiment. The experimental results obtained are as follows. Cutting speed = 143.6 m/min, feed = 0.1 mm/tooth, and depth of cut = 1.25mm which resulted in surface roughness of 0.189 and tool vibration of 17.772. The validity of the model has been checked by conducting conformity test with maximum error of 4.3%.

M.R. Soleymani Yazdi et.al [3] In his work conduct the experiment to study the influence of machining parameters on the surface roughness (Ra) and material removal rate (MRR) Of 6061-T6 Aluminum material for face milling process by CNC vertical milling machine with a Ø 60 mm four-flute face-milling cutter with grade 1C28M40 inserts. The main processing parameters are spindle speed; feed rate and depth of cut are optimized by (Response Surface Methodology)-RSM & (artificial neural networks)-ANN method of optimization. The experimental results are as follows. The speed and feed rate are the most significant factors in surface roughness model. The depth of cut and feed rate and their interaction are significant factors in the material removal rate model. The MLP network and RSM provide a very good process modeling. In addition, the former provided the better data coverage value. The excellent accuracy (nearly null error) of the RSM optimization procedure is observed during rough machining and finishing.

Amit Joshi et .al[4] investigated the influence of process parameters on the material removal rate of aluminum cast heat-treatable alloy for end milling process by CNC Milling machine with a HSS end mill Tool using Taguchi methodology and Single to Noise ratio Analysis .The main processing parameters are spindle speed, feed rate, and depth of cut. To analyse the effect of milling parameters on MRR signal to noise ratio and analysis of variance (ANOVA) is employed.The result of ANOVA indicates that the proposed mathematical model can describes the performance within the limiting factors. From an experimental study the optimal set of process parameters also have been predicted to maximize the material removal rate (MRR)

The conclusions of an experimental study were as follows; Taguchi's robust design method is suitable to analyze the metal cutting problem. Conceptual S/N ratio and

Pareto ANOVA approaches for data analysis gives similar conclusion. Among the processing parameters, High feed rate (80 mm/min), high depth of cut (0.4mm) and high spindle speed (1000RPM) lead to higher value of resultant Material removal rate for the respective, specific test range. The depth of cut is the most dominant factor for material removal rate out of others two factors The optimal value of MRR using ANOVA analysis is 9.166mm3/min.

The optimal settings for the parameter spindle speed (A), feed rate (B) & depth of cut(C) are A2B2C3 i.e., spindle speed and federate are at second level and depth of cut is at third level.

Dr. G. Karuppusami et.al [5] Studied the effect of machining parameters on the surface roughness of mild steel for face milling process by CNC milling machine with three zinc coated carbide tool. . The main processing parameters are no of passes, spindle speed, feed rate and depth of cut has been analyzed using Taguchi technique and Genetic algorithm. It has been observed that, Taguchi's orthogonal array provides a large amount of information for a small amount of experimentation. All the four parameters are predominantly contributing to the response and all have been considered. Optimum machining parameter combination has been found through Taguchi technique and fine tuned with Genetic algorithm. Results of both techniques have been compared and optimum machining parameter combination setup has been suggested for minimum surface roughness. The experimental results obtained are as follows. The surface roughness evaluated through Taguchi technique is 0.975 µm with 4.308 % error from the predicted value and for genetic algorithm it is 0.88 µm with 4.625 % error from the predicted value.

Mandeep Chahal [6] studied the effect of process parameters on the Surface Roughness of Hot die steel H-13 for end milling process by CNC Milling machine with a solid carbide four flute type end mill tool using Taguchi technique and Single to Noise ratio Analysis .The main processing parameters are spindle speed, feed rate, and depth of cut. These processing parameters are evaluated to study their effect on surface roughness using L-9 standard orthogonal array. Signal –to-Noise (S/N) ratio ,Analysis of variance (ANOVA) and various plots were generated using MINITAB software and the significance of these input parameters on SR was studied. The conclusions of an experimental study were as follows; Taguchi's robust design method is suitable to analyze the metal cutting problem. In an experimental study for end milling, increase in spindle speed, decrease in feed rate and increase in depth of cut will decrease the SR within respective, specified test range. Low feed rate (0.08mm/tooth), high depth of cut (0.3mm) and high spindle speed (2500RPM) are optimized parameters for surface roughness for the respective, specific test range. The feed rate is the most dominant & influencing factor for surface roughness.

R.N.Nimase et. al [7] studied the effect of processing parameters on the surface roughness of Al-7075 material for CNC end milling process by CNC milling machine with four flute, 10mm diameter tungsten carbide tool. From S/N ratio graphs ,it has been observed that optimal setting values of machining parameters for low surface roughness obtained are 2500 rpm(for spindle speed), 240 mm/min(for feed rate) and 2.0 mm(for depth of cut). It is observed from S/N ratio table that feed rate has more effect, spindle speed has moderate effect and depth of cut has less effect on surface roughness. A confirmation test is carried out by using ANOVA which shows that feed the rate has more contribution 46.36%, spindle speed has moderate contribution 34.78% and depth of cut has less contribution\

Avinash A. Thakre et.al [8] studied the effect of processing parameters on the surface roughness of 1040 MS material for CNC face milling process by CNC milling machine using carbide inserts, using Taguchi's Technique. The main processing parameters are spindle speed, feed rate, and depth of cut and coolant flow. To analyse the effect of milling parameters on the surface roughness the analysis of mean & variance technique is employed.

It is observed from main effect plots of S/N ratios & of means of (Ra) that coolant flow has more effect (60.69% contribution) in controlling the surface roughness followed by spindle speed. During an experimentation the optimal parameters are obtained for surface roughness are as follows. Spindle speed=2500 r.p.m, feed rate=800 mm/min, depth of cut=0.8 mm & coolant flow=30 lit/min. For this combination obtained surface roughness value is 0.357 µm.

Lohithaksha M Maiyar et. al[9] studied the significance of machining parameters on the surface roughness of Inconel 718 super alloy material for end milling process by CNC milling machine with uncoated tungsten carbide tool using Taguchi design approach.The main processing parameters are cutting speed, feed rate and depth of cut. The optimum cutting parameters are investigated & analyzed for minimum surface roughness value and material removal rate in this experiment. A grey relational grade obtained from the grey relational analysis is used to solve the end milling process with the multiple performance characteristics. The analysis of variance (ANOVA) is also applied to identify the most significant factor. Additionaly, confirmation tests were performed to make a comparison between the experimental results and developed model. The experimental results obtained are as follows. For an experimental study, Rey relational analysis is an effective optimization tool for machining of Inconel 718 alloy in End milling. Optimal cutting parameters for the machining process lies at 75m/min for cutting velocity,0.06 mm/tooth for feed rate and 0.4 mm for depth of cut.AS there is a 64.8%increase in material removal rate and at the same time a 9.52% decrease in surface roughness. This encourages applying the grey concept for optimizing multi response processing with multiple factors. Analysis of variance shows that the cutting velocity is the most significant machining parameter followed by feed rate affecting the multiple performance characteristics with 56.88% and 34.64% influence respectively.

Nitin Agarwal [10] studied the effect of process parameters on the Surface Roughness of Aluminum alloy material for face milling process by CNC Milling machine with HSS milling cutter.The main processing parameters are spindle speed, feed rate, and depth of cut. An experimental study and analysis consists of machining of 36 specimens of Aluminium alloy in a CNC milling machine with HSS tool, further SJ 201 surface roughness tester has been used to determine Ra values of all specimens, then an Multiple regression model has been developed & evaluated by means of significant different between predicted Ra value 7 the

actual Ra values with the help of t-test. The significant conclusions of an experimental study were as below. Spindle speeds, feed rate, depth of cut are the input variables, to calculate surface roughness value. Among these the depth of cut has been established as most influencing parameter, followed by feed rate & spindle speed-test is used to test & analyse the prediction ability of the model. It has been observed that there is no significant different between the mean Ra values of theoretical & experimental data at 5% level of significance. When the spindle speed increases for lower feed rate, the surface roughness decreases & for higher feed rates, the surface roughness changes As the depth of cut affects the quality of the surface roughness considerably for a given feed rate, the increase in feed rate increases the surface roughness. For lower depth of cut, the feed rate increases with surface roughness.

III. CONCLUSION

From the study of various literatures, it has to be found that many researchers have investigated the influence of processing parameters on the variety of materials for milling operations by CNC milling machine with different methods of optimizations. The processing parameters are cutting speed, feed, depth of cut, no of passes, coolant used & No of flutes for milling tool. As the literatures have generally discussed the influence of the processing parameters and their combinations on the process efficiency and output characteristics of the CNC milling machine for different engineering materials, this has given us the basic idea of material selection procedure-"contribution of an experimental material in industrial applications". As a Hot Work Tool Steel (H) is an important material having great contribution in various industrial applications, like tools manufacturing, casting dies, extrusion dies, forging dies & hot blanking,etc this material should be considered as a sample Work piece material for an experimentation purpose. Plan to do an experimental research work which will show the influence of different input machining parameters like cutting speed, feed rate, depth of cut on output parameter - surface roughness value(Ra).

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