Optimization of Process Parameters using Taguchi Method Coupled with Desirability Function Analysis (DFA)

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Abstract— In present days the manufacturers are facing the challenges in attaining the high productivity, quality and overall economy in the field of manufacturing by machining. Among all the machining processes available drilling is a major and common hole making process and it uses the drill bits to cut or enlarge the holes in solid materials such as wood or metal. The present work is to investigate the effect of the drilling process parameters on the multiple responses of Volume of material removal rate (VMRR) and surface roughness (Ra). A series of experiments were carried out on AA6082 material using carbide twisted drills on CNC machine. Speed, feed, depth of cut and drill sizes are considered as the process parameters and taguchi's standard L16 orthogonal array (OA) has been followed for conducting the experiments. The optimal setting of process parameters was done by employing taguchi method coupled with the desirability function analysis (DFA) and analysis of variance (ANOVA) methods. From the results, it is concluded that speed is the most influencing factor for the combined desirability index value. The optimal combination of process parameters for multi-response value is obtained at speed of 2000 rpm, feed of 400 mm/min, depth of cut of 12 mm and drill size of 13mm.

Keywords: Volume of Material Removal Rate (VMRR), Surface Roughness (Ra), Taguchi method, Desirability Function Analysis and ANOVA

I. INTRODUCTION

Drilling is a major and common hole making process, it uses the drill bits to cut or enlarge the holes in solid materials, such as wood or metal. Drilled holes are characterized by their sharp edge on the entrance side and the presence of burrs on the exit side (unless they have been removed). Also, the inside of the hole usually has helical feed marks. Drilling may affect the mechanical properties of the work piece by creating low residual stresses around the hole opening and a very thin layer of highly stressed and disturbed material on the newly formed surface. This causes the work piece to become more susceptible to corrosion and crack propagation at the stressed surface. A finish operation may be done to avoid these detrimental conditions. But in case of fluted drill bits, any chips are removed via the flutes. Chips may form long spirals or small flakes, depending on the material, and process parameters. The type of chips formed can be an indicator of the machinability of the material, with long chips suggesting good material machinability. Whenever possible the drilled holes should be located perpendicular to the work piece surface. This minimizes the drill bit's tendency to "walk", that is, to be deflected from the intended center-line of the bore, causing the hole to be misplaced. The tendency to walk is also preempted in various other ways, which include:

- Establishing a centering mark before drilling
- Center punching
- Spot drilling (i.e., center drilling)
- Spot facing, which is machining a certain area on a casting or forging to establish an accurately located face on an otherwise rough surface?

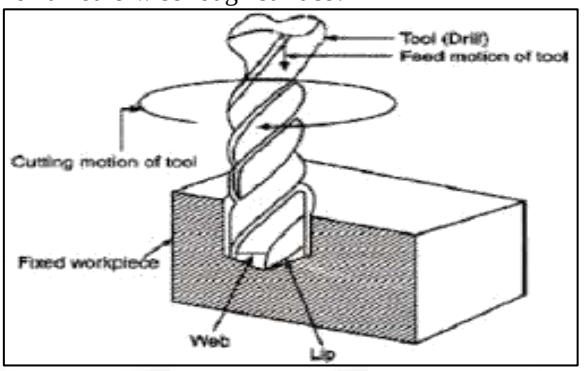

Fig. 1: Drilling parameters

- Constraining the position of the drill bit using a drill jig with drill bushings

Cutting fluid is commonly used to cool the drill bit, increase tool life, increase speeds and feeds, increase the surface finish, and aid in ejecting chips. Application of these fluids is usually done by flooding the work piece with coolant and lubricant or by applying a spray mist. Drilling is a preliminary step for many operations, such as reaming, tapping and boring. In the present era of globalization manufacturers are facing the challenges of higher productivity, quality and overall economy in the field of manufacturing by machining. To meet these challenges in a global environment, there is an increasing demand for high material removal rate (MRR) and also longer life and stability of the cutting tools. But high production machining with high cutting speed, feed and generates large amount of heat and temperature at the chip-tool interface which ultimately reduces dimensional accuracy, tool life and surface integrity of the machined component. This temperature needs to be controlled at an optimum level to achieve better surface finish and ensure overall machining economy.

Basically, the traditional experimental design procedures are too complicated and not easy to use. A large number of experimental works have to be carried out when the number of process parameters increases. To solve this problem, the Taguchi method uses a special design of orthogonal arrays to study the entire parameter space with only a small number of experiments. Using Taguchi technique optimum controllable parameter combinations are identified for each response. In view of the fact, that traditional Taguchi method cannot solve a multi-objective optimization problem; to overcome this limitation

Desirability Function Analysis has been coupled with Taguchi method in the present work. Desirability function analysis (DFA) had been most widely used in industries to optimize the multi response process characteristics into single response characteristics. The advantage of the DFA method is that many factors can be analyzed using less data. It does not involve complicated mathematical theory or computations like traditional approaches and thus can be employed by engineers without strong statistical background.

II. LITERATURE REVIEW

The works reported by various researchers are presented below.

M.A. Amrana. et.al.investigates the effects of drilling parameters such as spindle speed, feed rate and drill diameter on thesurface roughness and surface texture of drilled hole by applying RSM. From One factor plot analysis found that the mostsignificant parameter was spindle speed followed by drill diameter and feed rate and from experimental observations it was found that, surface roughness decreased when increasing the spindle speed, feed rate and drill diameter. There were interactions between all the parameter of spindle speed, feed rate and drill diameter in drilling process under investigation.

Murthy B.R.N. et.al. stated the effect of process parameters i.e. spindle speed, feed, drill diameter, point angle & material thickness on thrust force and torque generated during drilling of Glass Fibre Reinforced Polymer (GFRP) composite material through integration of Taguchi method and Response Surface Methodology & by using solid carbide drill bit. It was found that,Thrust force is significantly influenced by spindle speed, and they are inversely proportional. Higher the drill diameter, larger will be the thrust force and cutting torque required. Thrust force increases, whereas, cutting torque decreases with the increase in drill point angle. Both thrust force and cutting torque increase with the increase in feed rate and material thickness.

S. Madhavan. et.al. reports the effect of drilling parameters - Speed, Feed rate, drill type on thrust force during drilling of holes in Carbon Fibre Reinforced Plastic composite laminate using HSS, Solid Carbide (K20) and Poly Crystalline Diamond insert drills. Experiments were conducted by using Taguchi design of experiments and a model is developed to correlate the drilling parameters with thrust force using Response surface Methodology (RSM). Thrust force recorded for HSS drill was high when compared to Carbide. and there is tremendous increase in thrust force values for PCD. The thrust force generally increases as the speed increases but decreases further in the case of Carbide and PCD tool. Medium cutting speed and feed rate provides optimum thrust forces irrespective of the drills used.

Yogendra Tyagi.et.al. states the impact process parameters- Spindle speed, Feed rate and Depth of cut on Surface Roughness and Material Removal Rate for CNC drilling machine operation by using high speed steel Tool and by applying Taguchi methodology. It was observed that, as spindle speed increases there is increase in the MRR and the surface roughness initially decreases with increase in spindle speed while after some process there is increase in surface roughness. As there is increase in the feed rate there is decrease in both the MRR and the surface roughness. Initially there is decrease in MRR & the surface roughness with increase in depth of cut and after some process, there is increase in MRR and surface roughness with increase depth of cut.

S Jayabal. et.al. reports the influence of cutting parameters- spindle speed, feed rate & drill point angle on thrust force and torque in drilling of Glass Fibre Reinforced Composite. Experiments were conducted by using HSS twist drill and a mathematical model correlating the interactions of cutting parameters and their effect on thrust force and torque. Also it was found that the thrust force and torque both depends on the drill point angle, spindle speed & the feed rate, and both of them increase with increase in drill point angle and feed rate.

Godfrey C. Onwubolu. et.al. correlates the interactions of drilling parameters such as speed, feed rate and drill diameter & their effects on axial force and torque acting on the cutting tool through a mathematical model by means of response surface methodology with Sheet metal (Aluminium alloy bar) as workpiece material. It was found that, Drill axial force increases as drill size increases for a given speed and decreases as spindle speed increases for a given diameter. Also drill axial force increases as feed rate increases for a given diameter, while the drill torque varies non-linearly with all the control parameters.

Erol Kilickap. et.al. focuses study on the influence of machining parameters- cutting speed, feed rate, and cutting environment on the surface roughness obtained in drilling of AISI 1045. It was found that Minimum Surface roughness is obtained at lower cutting speeds, while it deteriorates as a feed rate is increased. Surface roughness was much better for the MQL condition than for the compressed air and dry drilling, also it increases under dry drilling

P.Venkataramaiah. et.al. focused on development of a neural network model to predict the multi-responses and to study the influence of drilling parameters- cutting speeds, feed rates, type of drill tool, cutting fluids on output parameters- Torque, cutting force, surface roughness, material removal rate and power for determining the optimum input parameters combination using Taguchi method. It was found that, Surface finish and torque are mostly affected by types of drill tools. Cutting force is mostly affected by cutting environment. Material removal rate is mostly affected by feed rate, with increase in feed rate there is decrease in MMR and Power is mostly affected by cutting speed

Dr.P.Venkataramaiah. et.al. reports the design of optimum ANN in a simple way to predict the responses- surface roughness, material removal rate, torque, cutting force, power of drilling process while drilling of En 8 with coated tools. The proposed ANN model can be used in optimization of cutting process for efficient and economic production by forecasting torque, cutting force, MRR, power and surface roughness in drilling operations.

N. Keerthi et.al. states the impact process parameters- Spindle speed, feed rates, type of drill tool, cutting environment on performance parameters- material removal rate, surface roughness, Torque, cutting force, & power during the drilling of En 8 steel. In the present work, Taguchi method is combined with ANN for effective data representation in wide range with low experimental cost, to

predict responses in drilling of En 8. From ANOVA it was observed that torque and surface roughness is mostly affected by feed and cutting force, material removal rate & power is mostly affected by spindle speed.

Indumathi V. et.al. presents optimization of machining parameters- Spindle speed, Feed rate & Cone radius ratio for thermo – mechanical form drilling of Aluminum sheet (AA1100) with tungsten carbide tool using desirability function analysis (DFA). The spindle speed (Percentage contribution, P = 27.59%) is the more significant machining parameter for affecting the multiple performance characteristics form drilling process. High spindle speed, high feed rate and high cone ratio – optimum machining condition are obtained.

A. Munia Raj. et.al. investigates the drilling of Al/Sic/ Graphite hybrid composite material (Al6061) with Spindle speed, Feed rate, Drill diameter & type of drill as input parameters and surface roughness as performance parameter by using Response surface methodology. It was found that minimum surface roughness could be achieved at higher spindle speed, lower feed rate and low or moderate drill diameter.

Kapil Kumar Goyal. et.al. presents the optimization of cutting parameters - Spindle speed, Feed rate, and Slurry concentration in order to improve the surface finish of stainless steel SS304 in the abrasive assisted drilling RSM has been adopted for planning of experiments and ANOVA has been used to find the contribution of process parameters and the interaction among them. It was observed that the surface roughness of drilled surface significantly improves through the use of abrasive particles. The speed and feed significantly affects the surface roughness of SS304 in comparison to the slurry concentration and an overall improvement of 10.81% was observed in surface finish by using the abrasive slurry instead of only coolant.

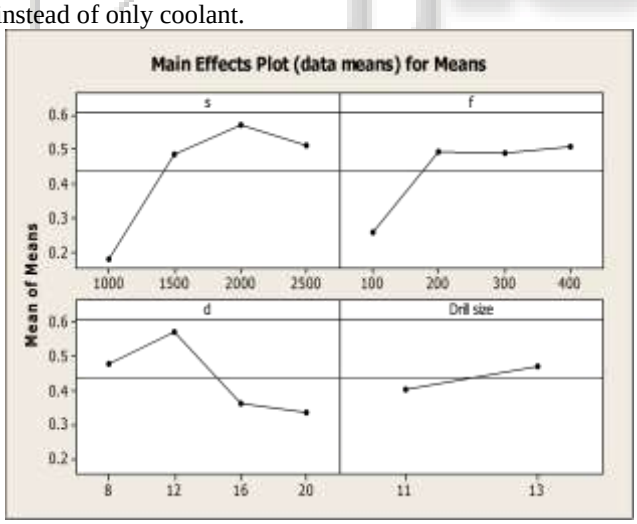

Fig. 2: Main Effect Plot for Means of D_g

C.C. Tsao. et.al. predicts and evaluates the thrust force and surface roughness in drilling of composite material using candle stick drill & by considering the drilling parameters - feed rate, spindle speed and drill diameter. The approach is based onTaguchi method and the artificial neural network. Feed rate and the drill diameter are found to be the most significant factors affecting the thrust force, while the feed rate and spindle speed are seen to have the largest contribution to the surface roughness. It was found that Radial basis function network (RBFN) seems to be more effective than multi-variable regression analysis.

J.Pradeep Kumar. et.al. utilizes taguchi method to investigate the effects of drilling parameters- cutting speed, feed rate and drill diameter on surface roughness, tool wear by weight, material removal rate and hole diameter error in drilling of OHNS material using HSS spiral drill. It was found that, Feed rate and Spindle speed are important process parameters to control surface roughness, tool wear, material removal rate and hole diameter error. Suitable combination of cutting speed and feed rate should be used so as to reduce the variations that can affect the quality of the holes that are drilled on OHNS material

Uwe Heisel. et.al. investigates the influence of the point angle of a drill tool and increased cutting speeds on machining forces and drill hole quality (delamination, fraying, burr formation) while drilling of Carbon fiber reinforced plastic (CFRP) material and found that, With increase in drill point angle there is increase in feed forces but almost similar drilling torques, while improved drill hole qualities at the entrance (especially fraying and delamination) and increase in cutting speeds result in elevated feed forces and decrease in drilling torques while the drill hole quality remains almost unaffected.

In the study conducted by Turgay Kıvak and Gurcan Samtas, the effect of drilling parameters on surface roughness and thrust force were investigated. A number of drilling experiments were conducted using the L16 orthogonal array on a CNC vertical machining center. The experiments were performed on AISI 316 stainless steel blocks using uncoated and coated M35 HSS twist drills under dry cutting conditions. Analysis of variance (ANOVA) was employed to determine the most significant control factors affecting the surface roughness and thrust force. The cutting tool, cutting speed and feed rate were selected as control factors. After the sixteen experimental trials, it was found that the cutting tool was the most significant factor on the surface roughness and that the feed rate was the most significant factor on the thrust force. The results of the confirmation experiments showed that the Taguchi method was notably successful in the optimization of drilling parameters for better surface roughness and thrust force. As a result of experimental trials performed using the Taguchi OA, it was found that the cutting tool was the most significant factor affecting the surface roughness with a percentage contribution of 39.14%, and that the feed rate was the most significant factor affecting the thrust force with a percentage contribution of 82.77%

In another similar work by YogendraTyagi, and Vedansh Chaturvedi, described the Taguchi technique for optimization of surface roughness in drilling process. In this the drilling of mild steel with the help of CNC drilling machine operation with Tool use high speed steel by applying Taguchi methodology has been reported. The Taguchi method is applied to formulate the experimental layout to ascertain the Element of impact each optimum process parameters for CNC drilling machining with drilling operation of mild steel. AL9 array, Taguchi method and analysis of variance (ANOVA) are used to formulate the procedure tried on the change of parameter layout. The available material study in focuses optimization of CNC Drilling machine process parameters to provide good surface

finish as well as high material removal rate (MRR).The surface finishing and material removal rate have been identified us quality attribute and are assumed to be directly related to productivity. The selection of optimal machining parameters i.e., spindle speed, depth of cut and feed rate) for drilling machine operations was investigated in order to minimize the surface roughness and to maximize the material removal rate. This paper has discussed the feasibility of machining Mild Steel by drilling machine with a HSS Tool. We can conclude that, the Spindle Speed of drilling machine Tool mainly affects the Surface Roughness. The Feed Rate largely affects the Material Removal Rate.

In another work by A. Navanth, T. Karthikeya Sharma, described the Taguchi technique for optimization of surface roughness in drilling process. The experiments were performed on AI 2014 alloy block using HSS twist drills under dry cutting conditions. The measured results were collected and analyzed with the help of the commercial software package MINITAB16. Analysis of variance (ANOVA) was employed to determine the most significant control factors affecting the surface roughness and hole diameter. The cutting tool, spindle speed and feed rate were selected as control factors. The main and interaction effect of the input variables on the predicted responses are investigated. The predicted values and measured values are fairly close. It was identified that a spindle speed of 300 rpm, point angle & Helix angle of 1300/200 and a feed rate of 0.15 mm/rev is the optimal combination of drilling parameters that produced a high value of s/n ratios of hole roughness. And also identified that a spindle speed of 200 rpm, point angle & Helix angle of 900/150 and a feed rate of 0.36 mm/rev is the optimal combination of drilling parameters that produced a high value of s/n ratios of Hole Diameter.

Yogendra Tyagi, Vedansh Chaturvedi, et al. (2012) investigated the effect of cutting parameters spindle speed, feed rate and depth of cut for maximizing material removal rate and minimizing surface roughness in drilling mild steel. Taguchi L9 orthogonal array is used. Results are analyzed using Taguchi DOE software. They concluded that spindle speeds affects most surface roughness and feed rate largely affects Material removal rate.

M Sundeep, M Sudhahar, et al. (2014) have done an experimental investigation on drilling of Austenitic stainless Steel (AISI 316) using Taguchi L9 array. Spindle seed, feed rate and drill diameter was taken as process parameter. It was found that spindle speed plays the most dominating role in surface finish as well as Material removal rate in drilling.

Kadam Shirish, M. G. Rathi (2013) focused on optimization of drilling parameters using the Taguchi technique. L9 orthogonal array has been used to drill on EN-24 steel blocks. Uncoated M32 HSS twist drill was used under dry condition. Cutting speed, feed rate and depth of hole were taken as process parameter. S/N ratio was employed to get optimal control factors. They found that cutting speed was the main significant factors on surface roughness and the tool life.

Turgay Kıvak , Gurcan Samtas,et al. (2012) investigated the effect of cutting parameters cutting tool, cutting speed and feed rate on drilling of AISI 316 stainless steel. Experiments were done in CNC vertical machine using Taguchi L16 orthogonal array. Coated and uncoated M35 HSS twist drill bit were used under dry condition for this purpose. Analysis of variance was done to draw the effects of the control factors. It was found that cutting tool was the most significant factor on surface roughness and feed rate was the most significant factor on thrust force

Adem Çiçek, Turgay Kıvak,et al. (2012) investigated the effect of deep cryogenic and cutting parameters on surface roughness as well as roundness error in drilling of AISI 316 austenitic stainless. Cutting tools, cutting speeds and feed rate was taken as control factors. M35 twist drill bit were used for doing the experiment. L8 orthogonal array was used and multiple regression analysis was performed to find out predictive equation of surface roughness. A confirmation experiment has showed Taguchi method precisely optimized the drilling Parametersin drilling AISI 316 steel

A. Navanth, T. Karthikeya Sharma (2013) focused on optimization of drilling parameter for minimum surface roughness and hole diameter by using Taguchi methodology. Al 2014 material and HSS twist drill bit has been taken for performing experiment. L18 orthogonal array has been used and the result obtained were analyzed in MINITAB 16 .Analysis of variance (ANOVA) was used to find out the optimal factors from cutting tool, spindle speed and feed rate. Optimal values are spindle speed 300 rpm, point angle and helix angle 1300/200and feed rate.15mm/rev for minimum roughness.

J.Pradeep Kumar, P.Packiaraj (2012) investigated the effect of cutting parameters such as cutting speed, drill tool diameter feed and feed on surface finish of OHNS material using HSS spiral drill. L18 orthogonal array, S/N ratio, ANOVA and Regression analysis has been employed to study the effect of drilling parameters on surface roughness value. Experimental data was analyzed using MINITAB 13 and it was found that speed and feed plays most dominating factors in surface roughness, tool wear, material removal rate.

Reddy Sreenivasulu (2014) focused on optimization of surface roughness in drilling of Al 6061 using Taguchi design method and artificial neural network method. Cutting speed, feed rate, drill diameter, clearance angle and point angle were taken as cutting parameters and HSS twist drill bit as a tool. L27 orthogonal array, ANOVA, S/N ratio was employed to study the effects of the control factors. ANOVA analysis showed cutting speed, feed rate, drill diameter, clearance angle and point angle all were significant on surface roughness. The paper shows Optimal settings for roughness are speed 800 rpm, feed rate .3 mm/rev, drill dia 10 mm, point angle 1180, clearance angle 40

B.Shivapragash, K. Chandrasekaran ,et al.(2013) studied optimization of the process parameters spindle speed, feed rate, depth of cut to investigate their influence in drilling composite Al-TiBr2. Taguchi method with grey relational analysis was used to optimize the factors. L9 orthogonal array has been used and optimal settings found for better surface finish were spindle speed (1000 rpm), feed rate (1.5 mm/rev), depth of cut 6 mm

Nalawade P.S. and Shinde S.S. (2015) optimizes the cutting parameters speed, depth of cut, feed and type of tool to get better Surface Finish and Hole Accuracy in dry Drilling of EN-31 material. Taguchi L9 orthogonal array, S/N ratio, ANOVA, Regression analysis was done to find out the

optimal settings. Optimal settings for surface roughness were Cutting speed (30 m /min), feed (.2 mm/min), type of tool (HSS uncoated).

Sathish Rao U And Lewlyn .L.R. Rodrigues (2014) have made an attempt to study the effect of spindle speed, feed rate, drill diameter, fiber orientation on tool wear during drilling GFRP components in dry condition. HSS drill bit was used for the experiment. Taguchi L9 orthogonal array has been used. S/N ratio, ANOVA, regression analysis was used to find out the optimal settings. It has been found that speed, feed rate , drill diameter has significant effect on tool wear.

Nisha Tamta, R S Jadoun (2015) analyzed theeffect of spindle speed, feed rate, drilling depth on drilling Aluminium alloy 6082 with the help of CNC machine. Taguchi L9 orthogonal array was used to perform the experiment. Signal to noise ratio (S/N), analysis of variance (ANOVA) were used to analyze the effects drilling parameters on surface roughness. For analyzing statistical software MINITAB-15 has been used. It has been found that spindle speed 3000 rpm, feed rate 15 mm/min, drilling depth 9 mm were the optimum value. According to the paper drilling depth was the most significant factor for surface roughness followed by spindle speed.

Srinivasa Reddy, S. Suresh,et al. (2014) investigated the impact of cutting parameters such as cutting speed, point angle and feed rate on surface roughness in drilling of AL 6463 material. HSS drill bit was used and the experiment was done in CNC drilling machine using Taguchi L9 orthogonal array. Signal to noise ratio (S/N), analysis of variance (ANOVA) has been employed to find out the optimal drilling parameter. It was found that Cutting speed, feed rate and point angle plays significant role on surface roughness during drilling operation of AL 6463 material.

Arshad Noor Siddiquee, Zahid A. Khan,et al. (2014) focused on optimizing drilling parameters such as cutting fluid, speed, feed and hole depth in drilling AISI312 material. Experiments were done in CNC lathe machine using solid carbide cutting tool. Taguchi L18 orthogonal array has been used for the experiment. Signal to noise ratio(S/N), analysis of variance (ANOVA) were used to find out the effects of cutting parameters on surface roughness. It has been found that in presence of cutting fluid, speed 500 rpm, feed .04 mm/sec, hole depth 25 mm were the optimum value for surface roughness. Anova analysis showed that speed was the most significant factor followed by cutting fluid, feed and hole depth for surface roughness value.

Vishwajeet N. Rane, Ajinkya P.Edlabadkar,et al. (2015) focused in optimizing drilling parameters such as cutting speed, feed and point angle for resharpened HSS twist drill bit on hardened boron steel using Taguchi method. L16 orthogonal array has been used to perform the experiment in a double spindle drilling machine.Analysis of variance was employed to find out effects of control factors on surface roughness. It was found that point angle was the main significant factor for tool wear and feed rate for surface roughness.

Sumesh A S. et. al. -has conducted experiment using Taguchi technique to obtain minimum surface roughness (Ra).for validation ANOVA Software is used. Experiments were performed on cast iron using HSS twist drills. A number of drilling experiments were conducted using the L9 orthogonal array on a radial drilling machine , it is observed that the variation in drilling parameters are optimized with respect to multiple performances in order to achieve a good quality of holes in drilling. Finally variation in parameter it was identified that a spindle speed of 80 rpm, drill diameter of 4mm and a feed rate of 0.1 mm/rev is the optimal combination of drilling parameters that produced a high value of S/N ratios of hole roughness.

Yogendra Tyagi et.al has studied on drilling of mild steel with the help of CNC drilling machine, with tool high speed steel, to optimize various process parameters using Taguchi method and L9 array, taguchi method and analysis of variance (ANOVA) are used. Finally it is found that, the Spindle Speed of drilling machine Tool mainly affects the surface roughness and the Feed Rate largely affects the MRR.

Nisha Tamta et.al. - has conducted experiment to optimize the drilling machining process for Surface roughness (Ra). The drilling parameters were chosen as Spindle speed, Feed rate and Drilling Depth. L9 orthogonal array used to conduct the experiments. Signal to noise (S/N) ratio and analysis of variance (ANOVA) is used to analyze the effect of the drilling parameters on material. Optimization of parameters is done by Taguchi method using statistical software MINITAB-15. Finally it is conclude that optimum parameter combination for the minimum Surface roughness (Ra) are, Spindle speed 3000 (rpm), Feed rate 15(mm/min.) and Drilling Depth 9 (mm) ,the ANOVA and S/N ratio showed that Drilling Depth is obtained as the most significant factor for Ra followed by Spindle speed.

Kunal Sharma et. al. -has conducted experiment to study the performance characteristics of AISI 304 stainless steel using CNC drilling process, with input parameters spindle speed, feed rate and point angle, to get minimum surface roughness and minimum ovality. Experiments are conducted based on Taguchi L16 orthogonal array by taking point angle, drill diameter, feed rate and spindle speed at two levels. The Taguchi based signal-to-noise ratio analysis is used to obtain the relation between the machining parameters and performance characteristics. The feed is the most effective parameter and that the small variation in feed will show large increase in surface roughness.

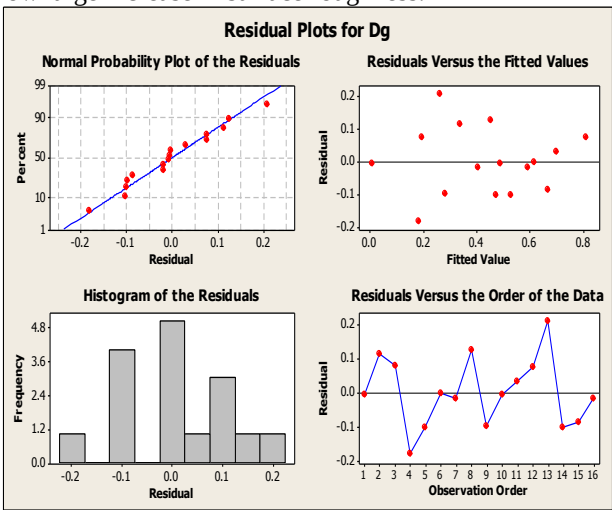

Fig. 3: Residual Plots for D_g

S.V. Alagarsamy et. al.- used Taguchi method to study the effects of drilling parameters such as cutting speed,

feed and depth of cut on surface roughness and material removal rate in drilling of Aluminum alloy 7075 using HSS spiral drill. Orthogonal arrays, the signal- to -noise ratio, the analysis of variance are used to analyze the effect of drilling parameters on the quality of drilled holes and experiment results are collected and analyzed using statistical software Minitab16. ANOVA software is used to study the most significant control factors August 2017, Volume 4, Issue 08 JETIR (ISSN-2349-5162) JETIR1708006 Journal of Emerging Technologies and Innovative Research (JETIR) www.jetir.org 26 affecting the surface roughness and material removal rate and it is concluded that the depth of cut has significant role to play in producing higher material removal rate and cutting speed has significant role to play for producing lower surface roughness.

Arshad Noor Siddiqueea et.al. - has conducted experiment on CNC lathe machine using solid carbide cutting tool on material AISI 321 austenitic stainless steel, to optimize deep drilling parameters with the help of Taguchi method for minimizing surface roughness. The cutting parameters such as cutting fluid, speed, feed and hole-depth considered. Taguchi L18 orthogonal array used as design of experiment. To determine which machining parameter significantly affects the surface roughness the signal-to-noise (S/N) ratio and the analysis of variance (ANOVA) is used. Results revealed that the machining done using cutting fluid, at a speed of 500 r.p.m. with a feed of 0.04 mm/s and hole-depth of 25 mm is the optimum condition. The results of ANOVA indicated that all four cutting parameters significantly affected the surface roughness with maximum contribution from speed (27.02%), followed by cutting fluid (25.10%), feed (22.99%), and hole-depth (14.29%).

Yogendra Tyagi et. Al- has conducted experiment to study the optimization of drilling of mild steel with the help of CNC drilling machining operation with tool use high speed steel by using taguchi method and signal-to-noise ratio applied to find optimum process parameter for CNC drilling machining. L9 orthogonal array and analysis of variance (ANOVA) are used to study the performance characteristics of machining parameter (spindle speed, feed, depth) to achieve good surface finish and high material removal rate (MRR). Results obtained by taguchi method and signal-to-noise ratio match closely with (ANOVA) and the feed are most effective factor for MRR. And spindle speed is the most effective factor for surface roughness.

A.Navanth et.al. -has conducted experiment to optimization of drilling parameters using Taguchi technique to obtain minimum surface roughness (Ra) and hole diameter on conventional drilling machine, and number of drilling experiments were conducted using the L18 orthogonal array. The material used is AI 2014 alloy block using HSS twist drills under dry cutting conditions and measured results are analyzed with the help of MINITAB16 and Analysis of variance (ANOVA).To determine the most significant control factors affecting the surface roughness and hole diameter. It concludes that a spindle speed of 300 rpm, point angle & Helix angle of 1300/200 and a feed rate of 0.15 mm/rev is the optimal combination of drilling parameters that produced a high value of s/n ratios of Hole roughness. And also find that a spindle speed of 200 rpm, point angle & Helix angle of 900/150 and a feed rate of 0.36 mm/rev is the optimal combination of drilling parameters that produced a high value of s/n ratios of Hole Diameter.

M.A. Amran et. al . -has conducted experiment on effects of drilling parameter such as spindle speed, feed rate and drill diameter on the surface roughness and surface texture of drilled hole using response surface method (RSM),and concluded that the appropriate combination of spindle speed, feed rate and drill diameter is very important for drilling process. And also found that the parameters that affects surface roughness is spindle speed followed by drill diameter and feed rate. The minimum and maximum surface roughness is 1.06 µm and 2.59 µm respectively.

Arya Yashvardhan et. Al -has studied Signal to Noise Ratio to determine the main effects, significant factors and optimum machining condition to the performance of finishing operation in mild steel. And it is conclude that, the Spindle Speed of finishing machine Tool mainly affects the surface roughness and the Feed Rate largely affects the MRR.

Reddy et al. proposed a goal-programming approach in Taguchi's methodology for optimizing three responses (outer diameter, height and pull-out force) in a certain injection-molding process involving seven factors at two levels. This method is too difficult to be understood by any engineer with limited statistical skills and knowledge and therefore it is difficult to use on the shop floor. R. K. Roy ('Multiple criteria of evaluations for designed experiments', unpublished) proposed a simple and pure engineering methodology called overall evaluation criteria (OEC) for optimization of multiple responses. The methodology assigns a relative weight to each quality characteristic based on team or group consensus, which is again subjective in nature and therefore the relative weight varies from company to company. This will bring some risk to the calculations of OEC and therefore is not widely accepted for tackling multi-response problems in industrial experiments.

Derringer and Suich made use of modified desirability functions which measure the designer's desirability over a range of response values. They have utilized the modified desirability function approach for the development of a tyre tread compound which involves four responses (abrasion index, modulus, elongation at break and hardness) and three factors or independent variables. The method increases the complexity of the computational process and therefore cannot be so easily understood by the engineering fraternity.

III. CONCLUSIONS

From the experimental, Desirability Function Analysis (DFA) and ANOVA the following conclusions can be drawn

- The optimal combination of process parameters for the multi objective function is obtained at speed of 2000 rpm, feed of 400 mm/min, depth of cut of 12 mm and drill size of 13 mm.
- ANOVA results of composite desirability concluded that the Speed is the high influencing factor and followed by feed, depth of cut and drill size respectively.
- The normal probability and the constant variance assumptions of ANOVA are verified from the residual plots of composite desirability (D_g).

– This Desirability function analysis (DFA) method is very simple in calculations and can be apply for any industrial multi-objective problems effectively.

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