Advancement of drilling process parameters using taguchi method for 6082AA material

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Abstract- *A progression of investigations was done on aluminum material using carbide twisted drills on drilling 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 ideal setting of interaction boundaries was finished by utilizing taguchi strategy combined with the attractiveness capability investigation (DFA). From the results it is found that speed is the most impacting factor. The ideal mix of cycle boundaries for multi-reaction esteem is acquired at speed of 2000 rpm, feed of 400 mm/min, profundity of cut of 12 mm and drill size of 13mm.*

Keywords- Dilling Machine, Taguchi, OA, and DFA.

I. INTRODUCTION

It is designed for drilling small holes at high speeds in light jobs. High speed and hand feed are necessary for drilling small holes. The base of the machine is mounted either on a bench or on the floor by means of bolts and nuts. It can handle drills upto 15.5mm of diameter. The drill is fed into the work purely by hand. The operator can sense the progress of the drill into the work because of hand feed. The machine is named so because of this reason. A sensitive drilling machine consists of a base, column, table, spindle, drill head and the driving mechanism.

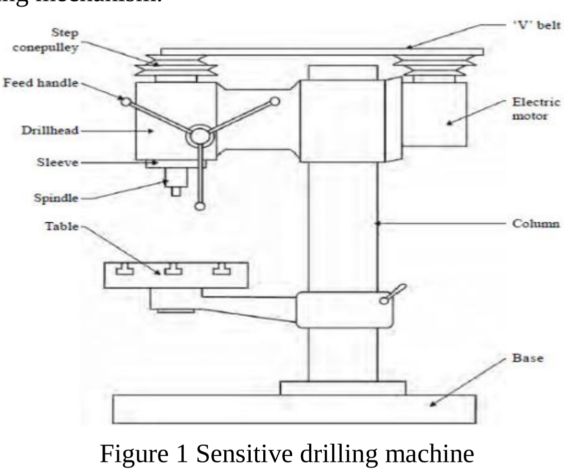

Figure 1 Sensitive drilling machine
Figure 1: ANSYS Simulation workflow

II. LITRATURE REVIEW

Yogendra tyagi et al. (2021) researched the impact of cutting boundaries of cutting apparatus, cutting pace and feed rate on boring of AISI 316 hardened steel. Tests were finished on CNC vertical machine utilizing Taguchi L16 symmetrical cluster. Covered and uncoated M35 HSS wind boring apparatus were involved under dry condition for this reason. Investigation of change was finished to draw the impacts of the control factors. It was observed that cutting apparatus was the main element on surface harshness and feed rate was the main component on push force.

Adamn Çiçeak et al. (2012) explored the impact of profound cryogenic and cutting boundaries on surface unpleasantness as well as roundness blunder in boring of AISI 316 austenitic pure. Cutting apparatuses, cutting paces and feed rate was taken as control factors. M35 turn bore were utilized for doing the investigation. L8 symmetrical exhibit was utilized and different relapse investigation was performed to figure out prescient condition of surface harshness. An affirmation try has showed Taguchi technique exactly streamlined the boring boundaries in penetrating AISI 316 steel.

Readdy Srinivasulu et.al. investigated the effect of cutting limits, for instance, cutting rate, drill instrument expansiveness perpetually feed on surface finishing of OHNS material using HSS contorting drill. L18 balanced bunch, S/N extent, ANOVA and Backslide assessment has been used to focus on the effect of exhausting limits on surface disagreeableness regard. Preliminary data was destitute down using MINITAB 15 and it was found that speed and feed plays most decision factors on surface brutality, instrument wear, material clearing rate.

J.Pradeep Kumar et.al. worked on enhancement of surface unpleasantness in penetrating of Al 6061 utilizing Taguchi plan strategy and fake brain network technique. Cutting pace, feed rate, drill width, leeway point and point were taken as cutting boundaries and HSS turn bore as an instrument. L27 symmetrical exhibit, ANOVA, S/N proportion was utilized to concentrate on the impacts of the control factors. ANOVA examination showed cutting velocity, feed rate, drill width, freedom point and point all were huge on surface unpleasantness. The ideal settings for harshness are found at speed 800 rpm, feed rate .3 mm/fire up, drill width 10 mm, point 1180, leeway point 40 individually.

M Sandeep et al. (2017) have done an experimental investigation on boring of Austenitic stainless Steel (AISI 316) using Taguchi L9 array. Speed of spindle, 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 found on optimization of drilling parameters using the Taguchi technique. L9 orthogonal array has been used to bore on EN-24 steel blocks. Uncoated M32 HSS contort drill was utilized under dry condition. Cutting velocity, feed rate and profundity of opening were taken as interaction boundary. S/N proportion was utilized to gain ideal influence variables and they observed that cutting pace was the vitally critical elements on surface harshness and the apparatus life.

B.Shivapragash, K. et al. investigate the optimization of the process parameters speed of spindle, 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 symmetrical cluster has been utilized and ideal settings found for better surface completion at shaft speed (1000 rpm), feed rate (1.5 mm/fire up), profundity of cut 6 mm.

Arshad Noor Siddiquee et al. . focused on advancing boring boundaries like cutting liquid, speed, feed and opening profundity in penetrating AISI312 material. Tests were finished in CNC machine utilizing strong carbide cutting device. Taguchi L18 symmetrical exhibit has been utilized for the investigation. Motion toward commotion ratio(S/N), investigation of change (ANOVA) were utilized to figure out the impacts of cutting boundaries on surface unpleasantness. It has been tracked down that in presence of cutting liquid, speed 500 rpm, feed .04 mm/sec, opening profundity 25 mm were the ideal incentive for surface unpleasantness. Anova examination showed that speed was the main component followed by cutting liquid, feed and opening profundity for surface unpleasantness esteem.

Vishwajeet. N et al. (2015)[12] focused in optimizing drilling parameters such as cutting speed, feed and point angle for sharpened 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 (ANOVA) 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.

Sateesh Rau. U et.al. (2014)[13] 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. Analysis of variance (ANOVA) 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. 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.

Sreenivasa Readdy et al. researched the effect of cutting boundaries, for example, cutting velocity, point and feed rate on surface harshness in penetrating of AL 6463 material. HSS boring apparatus was utilized and the analysis was finished in CNC penetrating machine utilizing Taguchi L9 symmetrical exhibit. Motion toward clamor proportion (S/N), investigation of fluctuation (ANOVA) has been utilized to figure out the ideal boring boundary. It was found that Cutting velocity, feed rate and point assumes critical part on surface harshness during penetrating activity of AL6463 material.

II. METHODOLOGY

There are various procedures for advancement of result attributes and to acquire ideal worth yet from all the streamlining strategies, Taguchi's strategy for trial configuration is straight forward and east to apply to many designing issues. It tends to be utilized to rapidly limit the extent of an examination project or to recognize issues in an assembling cycle from the information currently in presence. Likewise, the taguchi technique permits the examination of a wide range of boundaries without a restrictively high measure of trial and error.

Taguchi Method

A deliberate factual way to deal with item and interaction improvement has created by Dr. Genichi Taguchi. The procedure stresses moving the quality issue upstream to the plan stage and zeroing in on avoidance of deformities by process improvement. Taguchi has put extraordinary accentuation on the significance of limiting variety as the essential method for working on quality. Taguchi characterizes the quality level of an item to be the complete misfortune caused by society because of the disappointment of the item to convey the normal exhibition and because of hurtful symptom of the item, including the working expense. In the idea some misfortune is undeniable from the time an item is served to the client and more modest misfortune gives helpful items.

Procedure of Desirability Function Analysis (DFA)

STEP 1: Calculate the individual desirability (di) for the corresponding responses using the formula proposed by Derringer and Suich. There are three forms of the desirability functions according to the response characteristics.

Nominal-the-best: The value of ŷ is required to achieve a particular target T. when the ŷ equals to T, the desirability value equals to 1; if the departure of ŷ exceeds a particular range from the target, the desirability value equals to 0, and such situation represents the worst case.

$$d_i = \begin{cases} \left(\frac{\hat{y} - y_{min}}{T - y_{min}}\right)^s, & y_{min} \le y \le T, s \ge 0 \\ \left(\frac{\hat{y} - y_{min}}{T - y_{min}}\right)^t, & T \le y \le y_{min,} T \ge 0 \\ 0 & \end{cases}$$

Where the ymax and ymin represent the upper and lower tolerance limits of ŷ and s and t represent the indices.

IV. EXPERIMENTAL DETAILS

Work Material and Drills

In the present work the drills are made on a plate of aluminum alloy 6082-T6 having 25 mm thickness shown in the figure 4.1 using carbide twist drills (11mm and 13mm size with 4 flutes) shown in the figure. Aluminum alloy 6082 is a medium strength alloy with excellent corrosion resistance. The addition of a large amount of manganese controls the grain structure which in turn results in a stronger alloy. AA 6082 is typically used for

- Highly stressed applications
- Trusses
- Bridges
- Cranes
- Transport applications
- Ore skips
- Beer barrels
- Milk churns

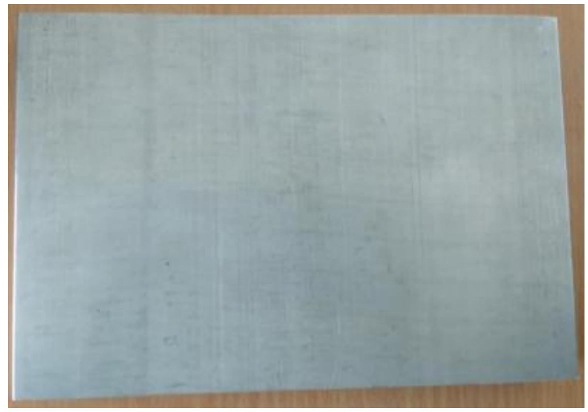

Figure 4.1. AA6082 Plate

Measurement of Surface Roughness after Machining

After conducting the experiments the machined surface was measured at three different positions using roughness measuring instrument SJ-210 as shown in the figure 4.4 and the average surface roughness (Ra) values is recorded in microns.

Figure 4.4. SJ-210 Surface Tester

Result and Discussion-

In The present work a series of experiments were carried out on AA6082 material using carbide twisted drills on Drilling machine. Speed, feed, depth of cut and drill sizes are considered as the process parameters and Volume of material removal rate (VMRR) and surface roughness (Ra) are considered as the output characteristics. In this chapter the experimental results and their analysis using desirability function analysis (DFA) and analysis of variance (ANOVA) methods has been discussed.

ANOVA Results

Analysis of variance (ANOVA) is a method of apportioning variability of an output response to various inputs. The purpose of statistical ANOVA is to investigate which design parameter significantly affects the performance characteristics. This is accomplished by separating the total variability of the composite desirability value, which is measured by sum of the squared deviations from the total mean of the composite desirability value into contributions by each machining parameter and the error. the contributions of the process parameters are speed of 42.68, feed of 20.36, depth of cut of 16.70 and drill size of 0.020 respectively. Hence, it is clear that the speed is the high influencing factor on the multi response value called composite desirability index and followed by feed, depth of cut and drill size respectively.

V. CONCLUSION

The experiments also show that uncoated carbide tools are more suitable compared to uncoated HSS for producing high-quality holes, resulting in the formation of less built-up edges when drilling aluminium alloys. Moreover, the aluminium alloy Al2024 produced better results in terms of hole quality due to its good machinability compared with aluminum alloys Al6061

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.

VI. FUTURE SCOPE

- To development of sensors for the smart drilling system: The smart drilling system requires sensors that are capable of detecting and measuring the following:
- Conditions at the drill bit: Sensors are needed for in situ measurement of pressure (including pore pressure), temperature, permeability, mineralogic and chemical composition of the rock and heterogeneities, borehole fluid composition (at the part-per-million level for environmental applications), stress state, and rock strength.

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