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A Review on Optimization of Process parameter of Drilling Process for Hastelloy C 276

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Abstract: The growing need for miniaturization of systems necessitates the production of components with higher dimensional accuracy. Nickel base super alloy Hastelloy C 276 have excellent mechanical and chemical properties at low and intermediate temperature range, it has been widely used in petroleum, chemical processing and paper-puls industries. Among all traditional machining processes, drilling is one of the most important metal cutting operations, comprising 33% of all metal cutting operations. Dimensional accuracy (Surface roughness and Circularity) of drilled hole is influenced by input conditions, material of the work piece or tool and condition of the machine. Among these parameters cutting speed, feed and point angle have significantly affected the Surface roughness and Circularity.

Keywords: Circularity, Cutting Speed, Feed, Point angle, Super alloy, Surface roughness.

I. INTRODUCTION

Nickel based super alloy Hastelloy C 276 (US designation N10276) consist of nickel, molybdenum, chromium and iron, is high temperature and precipitate hardening alloy. It is widely used high temperature applications such as petroleum, chemical processing and paper and pulp industries. Alloy C 276 produced by vacuum induction melting or Argon Oxygen Decarburization (AOD) refining. It is maintains outstanding properties in extreme heat, holding strength and resisting oxidation. Also it has high fatigue resistance.

Drilling is a conventional cutting process that uses a drill bit to cut or enlarge a hole of circular cross-section in solid materials. Drill bit have cutting edges to removing the material from component in the form of chip. Generally, it is considered as expensive method. In spite of the advancement in scientific technology the demand for economically produced holes, drilling operation still remain a complex and difficult operation. There are number of problem occurred in drilling process. This include: unwanted thrust force which leads to reduced drill life; drill fracture; burr formation in metals, and vibration that affect surface finish and dimensional accuracy. Thus, the hole quality becomes a serious concern.

Conventional machining of hard material (e.g. super alloys) is difficult due to lower thermal conductivity produce high cutting temperature and requirement higher thrust force. Due to higher thrust force it will lead to vibration and temperature which leads to lower surface finish and hole quality. So, it is challenges to select the appropriate cutting parameters such as cutting speed, feed rate, point angle, drill diameter.

II. LITERATURE REVIEW

M.A. Amran et al., 2013 had carried out experiments to investigates the effects of drilling parameter such as spindle speed (270 to 2000rpm), feed rate (78 to 228mm/min) and drill diameter (2.5 to 5 mm) on the surface roughness and surface texture of drilled hole of aluminium's alloy work piece (150 mm x 50 mm x 9 mm). The cutting tool used was twist drill high speed steel (HSS). End of experiment found that the most significant parameter was spindle speed followed by drill diameter and feed rate. Thus, surface roughness decreased when increasing the spindle speed, and drill diameter, but for feed rate it is decrease up to some limit after that it is increases. The minimum surface roughness measured for the hole was 1.06 µm at combination of 2000 rpm spindle speed, 78 mm/min feed rate and 2.5 mm drill diameter. While the maximum surface roughness of 2.59 µm was measured at the combination of 250 rpm spindle speed, 153 mm/min feed rate and 3.5 mm drill diameter.

Gaurav Chaudhary et al., 2014 had conducted experiment to examine the effect of drilling parameter on Metal matrix composites (197mm ×108mm× 20mm) [2]. The response parameters considered are MRR, oversize and surface roughness. The tests are performed for different dry cutting speed (110 to 960 rpm) and feed rate (0.250 to 0.17 mm/rev) and point angle (110 to 120). Drills with titanium nitride Coated and uncoated were used to cut holes in 20mm thick. It is found that the feed rate is the most significant machining parameter used to predict the surface roughness in response surface methodology. Finally concluded that better surface finish and optimum MRR for the specific test are different, use of high cutting speed (960 rpm), low feed rate (0.075 mm/rev) and low point angle 110° are to be preferred to obtain better surface finish and material removal rate for the specific test.

H. Siddhi Jailani et al., 2015 had carried out experiments to measure the micro structural characterization, hardness and drilled hole quality in terms of surface roughness, diameter error and roundness error were studied on Al-Si alloy and Al-Si alloy - fly ash composites. The drilling experiments were conducted by drilling holes in Al-Si alloy and Al-Si alloy - fly ash composites in a drilling machine (Alto) with twist drills of M2 grade high speed steel (HSS) of 8 mm diameter were used in this investigation. The drilling studies were conducted at speeds of 500 to 1000 rpm and feeds of 0.05 to 0.15 mm/rev under dry conditions. At the end of investigation, concluded that speed is most affecting parameter followed by feed and fly ash %. Diameter error and roundness error increased with increasing speed, feed and fly ash content.

A. Navanth et al. 2013 had carried out experiments were performed on AI 2014 alloy block (100mm x50mm x12mm) for drilling operation using HSS twist drills under dry cutting conditions to obtain minimum surface roughness (Ra) and hole diameter using the Taguchi technique. The cutting tool (point angle: 90), spindle speed (200 to 300rpm) and feed rate (0.15 to 0.36 mm/rev) were selected as control factors. Finally justified that for optimum value of surface roughness at highest spindle speed, lowest feed rate and highest helix angle pair and that of hole diameter lowest spindle speed, highest feed rate and lowest helix angle pair are used.

B.M. Umesh had et al. 2014 conducted experiment on Al-Si3N4 composite materials, using automatic drilling machine with HSS tool. The input process parameters are % volume of Si3N4 (0 to 10%), speed (360 to 680 rpm), feed (0.095 to 0.285 mm/rev), diameter of drill bit (6 to 10 mm), and machining time (30 to 90 sec). The response variables measured for the analysis are surface roughness, circularity and cylindricity. Finally, concluded that minimum diameter of drill bit (6mm) is required to minimize the dimensional deviation. Relatively higher cutting speed and lower feed rate are required to obtain good surface finish. Cutting speed has the highest effect on circularity and feed rate has largest influence on surface finish and cylindricity.

Ahmet Taskesen et al., 2013 had carried out experiments for drilling on boron carbide (B4C) reinforced metal matrix composites (MMCs) produced by powder metallurgy. HSS, TiAlN coated and uncoated cementite carbides drills were used under dry cutting conditions. The drilling parameters such as feed rate (0.1 to 0.3mm/rev), spindle speed (1500 to 2500 rev/min), drill material and wt.% of B4C particles were optimized based on multiple performance characteristics including thrust force, torque and surface roughness. According to experimental results, the thrust force increased with B4C fraction and feed rate but decreased with spindle speed. Better surface finish was achieved with coated carbide tools and poor surface quality was obtained with HSS tools. The effect of cutting speed on surface roughness depends on B4C content and this effect might be neglected when B4C particle content was about 25%.

Kapil Kumar Goyal et al., 2014 had carried out experiments to optimization of cutting parameters for improving surface finish of stainless steel SS304 in the abrasive assisted drilling of SS304 with supply of abrasive slurry consisting of silicon carbide abrasives of 1250 mesh size has been studied. The slurry concentration has been varied from 20-30% by weight. The drilling parameters including spindle speed (345 to 740 rpm), feed rate (32.5 to 78 mm/min), and slurry concentration (20 to 30%) are optimized using multiple performance characteristics for surface roughness. At finally, concluded that feed rate and spindle speed are the most significant factors which affect the surface roughness but an overall improvement of approximately 11% in the surface roughness has been investigated with the aid of abrasive slurry. Out of all selected parameters, speed and feed were significantly affecting the surface roughness of stainless steel SS304 in comparison to the slurry concentration.

Mohamed Elajrami et al., 2013 had conducted experiment to study and analyze the effects of drilling parameters on hole quality in aluminum alloy 2024-T3 with the help of vertical milling machine [8]. Six variables are considered as input parameter is: rotational speed of the bit, feed rate, the length and the state of the bit, the use of lubricant and the use of a pilot hole analyze the hole quality (surface roughness and hole-conicality). From experiments concluded that Low value of surface roughness corresponds to a high rotational speed and to a low feed rate. The bit state affects the roughness surface of the hole. The lubricant use reduces the roughness value to approximately 53%. New bit reduce the roughness values 3 to 4 times compared to a worn one. The use of pilot hole improved hole quality.

J. Prasana et al., 2014 had carried out experiments on small-hole dry drilling in Ti–6Al–4V (0.4 mm thickness) using twisted carbide drill bits of 0.4 mm diameter by conventional dry drilling. The Taguchi's experimental design and Analysis of Variance (ANOVA) techniques have been implemented to understand the effects, contribution, significance and optimal machine settings of process parameters, namely, spindle speed (2000 to 5000rpm), feed rate (5 to 15 mm/min) and air pressure (2 to 6 bar). The performance characteristics of the small hole drilling were evaluated through thrust force, overcut, circularity and taper. The outcome of this research reveals that spindle speed and air pressure have the most significant impact on the dimensional accuracy of the hole; spindle speed and feed rate controls the thrust force.

J. Pradip Kumar et al., 2012 had conducted experiments to investigate the effects of drilling parameters such as cutting speed (5 to 8 m/min), feed (0.15 to 0.25 mm/rev) and drill tool diameter (10 to 15 mm) on surface roughness, tool wear by

weight, material removal rate and hole diameter error in drilling of OHNS material using HSS spiral drill on DECKEL MAHO-DMC 835V machining center. The outcome of this research reveals that feed and speed are important process parameters to control surface roughness, tool wear, material removal rate and hole diameter error.

Arshad Noor Siddiquee et al. 2014 had conducted experiments to optimizing deep drilling parameters using Taguchi method on AISI 321 Steel for minimizing surface roughness. The experiments were conducted on CNC lathe machine using 10mm solid carbide cutting tool. The effect of cutting parameters such as cutting fluid (water soluble mineral oil), speed (300 rpm, 400 rpm, 500 rpm), feed (0.03 mm/s, 0.04 mm/s, 0.05 mm/s) and hole-depth(25 to 35 mm) are analyze to measure the surface roughness. The outcome of these experiments reveals that except hole-depth, cutting parameters such as speed, feed, and cutting fluid mainly influenced the surface roughness. The percentage contributions of speed, cutting fluid, feed and hole-depth are 27.02 %, 25.10%, 22.99% and hole-depth 14.29% respectively.

V. Baghlani et al., 2013 had carried out experiments to investigate the effect of ultrasonic vibration amplitude (3 to 10 μm), spindle speed (355 to 710 rpm) and number of steps (1×50 to 5×10mm) to drill each hole on machining force and surface roughness using Electro Discharge Machining (EDM) on Inconel 738LC super alloy (25 mm ×25 mm ×50 mm) with depth-to-diameter ratio of 10. Optimized conditions and results predicted using Taguchi method. Results show that increasing material removal rate makes drilling more difficult and increases forces and surface roughness. Furthermore by using more steps for each hole and lower spindle speed can improve drilling conditions which leads to reduction of thrust force and surface roughness.

Tamil Selvan et al., 2014 had conducted experiments to optimize the process parameters of Drilling in Ti-TiB Composites using Taguchi Technique. The effect of cutting parameters such as spindle speed (600 to 1000 rpm), feed rate (0.05 to 0.08 mm/rev), process (Spark Plasma Sintering, Hot Isostatic Pressing and Vacuum Sintering process), and drilling tool material (Solid carbide, Diamond coated high speed steel, Cobalt coated high speed steel) are analyze to measure thrust force, overcut, circularity and taper. The outcome of this research reveals that spindle speed and feed rate have the most significant impact on the dimensional accuracy of the hole, spindle speed and feed rate controls the thrust force. Drilling tool material, process influences less contribution on drilling of Ti-TiB composites.

Turgay Kivak et al., 2012 had carried out experiments to investigate the effect of cutting parameters on the hole quality (circularity and hole diameter) and tool wear during the drilling of super alloy Inconel 718 (100mm x 100mm x 10mm) with coated and uncoated carbide drills of 5 mm diameter using JOHNFORDVMC 550-7.5 kW CNC vertical machining centre under dry cutting conditions by drilling blind holes of 8 mm depth and employing four different cutting speeds (10.5 to 17.5 m/min) and three different feed rates (0.051 to 0.1 mm/rev) [14]. Taking into consideration the hardness distribution around the drilled hole, the holes were placed at equal distances from each other as much as possible. Minimum 6 points were measured to obtain the hole diameter and roundness error measurements at a certain depth of the hole. It was observed that there was a decrease of tool performance and hole quality at high cutting speed and feed rate combinations. A serious increase in tool wear was observed when increasing cutting speed.

III. CONCLUSION

From the literature survey found that most of researchers are carried out experiment using various tools, methods, and parameter and observed the effect of various responses during drilling. Also found research gap that very few researchers are carried out worked on nickel base super alloy hastelloy C 276 with conventional drilling and very few researchers consider the effect of point angle on surface roughness and hole quality. From above paper observed that spindle speed and feed has significant effects on surface roughness and hole quality. Feed also affects thrust force.

IV. REFERENCES

[1] M.A. Amran, S. Salmah, N.I.S. Hussein, R. Izamshah, M. Hadzley, Sivaraos, M.S. Kasim, M.A. Sulaiman, "Effects of machine parameters on surface roughness using response surface method in drilling process". Procedia Engineering, 68, pp.24 – 29, *2013*.

[2] Gaurav Chaudhary, Manoj Kumar, Santosh Verma, Anupam Srivastav, **"**Optimization of drilling parameters of hybrid metal matrix composites using response surface methodology". Procedia Materials Science, 6, pp. 229 – 237, 2014.

[3] H Siddhi Jailani, A Rajadurai, B Mohan, T Sornakumar, **"**Evaluation of drilled hole quality of Al-Si alloy/fly ash composites produced by powder metallurgical technique". Indian Journal of Engineering & Materials Sciences, 22, pp.414-420, 2015.

[4] A.Navanth, T. Karthikeya Sharma, **"**A study of taguchi method based optimization of drilling parameter in dry drilling of al 2014 alloy at low speeds". International Journal of Engineering Sciences & Emerging Technologies, 6, pp.65-75, 2013.

[5] B.M. Umesh Gowda, H.V. Ravindra, H.R. Gurupavan, G. Ugrasen, G.V. Navin Prakash, "Optimization of process parameters in drilling Al-Si3N4 metal matrix composite materials using taguchi technique". Procedia Materials Science, 5, pp.2207 – 2214, 2014.

[6] Ahmet Taskesen, Kenan Kütükde**, "**Experimental investigation and multi-objective analysis on drilling of boron carbide reinforced metal matrix composites using grey relational analysis". Measurement, 47, pp.321–330, 2013.

[7] Kapil Kumar Goyal, Vivek Jain, Sudha Kumari**, "**Prediction of Optimal Process Parameters for Abrasive Assisted Drilling of SS304". Procedia Materials Science, 6, pp. 1572 – 1579, 2014.

[8] Mohamed Elajrami, Houcine Milouki, and Farouk B. Boukhoulda, "Effect of Drilling Parameters on Hole Quality". International Journal of Mining, Metallurgy & Mechanical Engineering, 1, pp. 2320-4052, 2013.

[9] J. Prasanna, L. Karunamoorthy, M. Venkat Raman, Sai Prashanth, D. Raj Chordia, **"**Optimization of process parameters of small hole dry drilling in Ti–6Al–4V using Taguchi and grey relational analysis". Measurement, 48, pp.346–354, 2014.

[10] J.Pradeep Kumar, P.Packiaraj, 2012, "Effect of drilling parameters on surfaceroughness, tool wear, material removal rateand hole diameter error in drilling of OHNS". International Journal of Advanced Engineering Research and Studies, 1, pp.150-154, 2014.

[11] Arshad Noor Siddiquee, Zahid A. Khan, Pankul Goel, Mukesh Kumar,Gaurav Agarwal, Noor Zaman Khan, **"**Optimization of Deep Drilling Process Parameters of AISI 321 Steel using Taguchi Method". Procedia Materials Science, 6, pp. 1217 – 1225, 2014.

[12] V. Baghlani, P. Mehbudi, J. Akbari, M. Sohrabi, "Ultrasonic assisted deep drilling of Inconel 738LC super alloy". Procedia CIRP, 6, pp. 571 – 576, 2013.

[13] Tamilselvan, Raguraj, "Optimization of Process Parameters of Drilling in Ti-TiB Composites using Taguchi Technique". International Journal on Mechanical Engineering and Robotics, 2, pp. 2321-5747, 2014.

[14] Turgay Kivak, Kasım Habali, Ulvi Seker, "The effect of cutting parameters on the hole quality and tool wear during the drilling of Inconel drilling of Inconel 718". Gazi University Journal of Science, 2, pp.533-540, 2012.