International Journal of
Emerging Research in Management &Technology
ISSN: 2278-9359 (Volume-6, Issue-3)

Research Article | **March 2017**

The Process Parameters of Drilling Process:- A Review

[1]Kulvinder Garg, [2]Jatinder Singh, [3]Bharat Bhushan
[1, 2]Assistant Professor, ME Deptt, Malout Institute of Management and Information Technology, Malout, Punjab, India
[3]M.Tech (ME) Student, ME Deptt, Malout Institute of Management and Information Technology, Malout, Punjab, India

Abstract:

Drilling is a metal cutting machine process used to create hole of circular cross section by employing a drill bit. The circular cross section holes size varying in range of small to large.Several types of drill bits like H.S.S., carbide tool, TiN and TiAlN coated carbide and HSS twist drill etc. are used for drilling process in industries. The drilling operation is affected by various input parameters like cutting speed, feed rate, depth of cut, cutting fluid, drill diameter, point angle etc. The various experiments have been done on CNC drilling machine.There are various materials like steel, composite material (like C.F.R.P, ALalloy), and MMC being used for analysis of drilling operation.

Keywords: HSS, CNC, MMC

I. INTRODUCTION

Drilling is a metal cutting machine process used to create hole of circular cross section by employing a drill bit. In drilling, the drill bit is rotating and penetrating into the work piece .For getting high quality at low price there is urgent requirement to realize the suitable cutting parameters that depends on work piece material, tool material, tool dimension etc. The cutting parameters selected for each process are cutting speed, feed rate, depth of cut, cutting fluid, tool diameter etc. For designing high quality work accurately and effectively, the Taguchi method is very basically used in optimization. The basic diagram to show the drilling process is given below :-

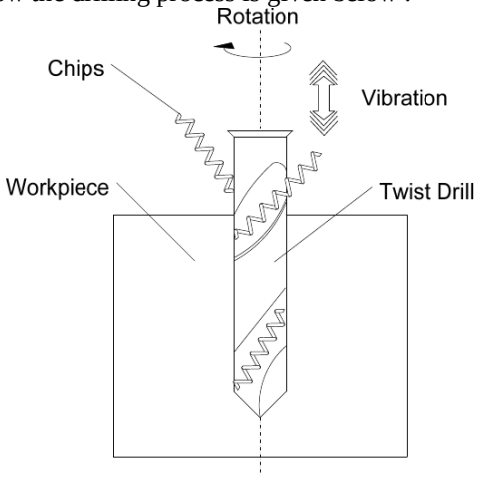

Fig.1 Drilling Process [2]

1.1 Types of Drilling process :- There are Several operations related to drilling, most of them shown in the figure 1.1.The different drilling operation are employed for different application and purposes. All the drilling process are almost similar to each others as we can see from the figure 1.1.

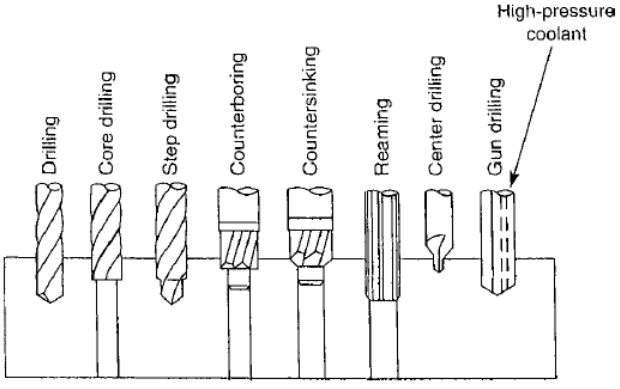

Fig.1.1 Various Drilling Processes [5]

1.2 Drill bit and Its geometery:- Drill bit is a tool which is used to create hole in the work piece almost always of circular cross-section. Drill bits come in variety of sizes and shape and can create different types of holes in different materials. For creating holes, drill bits are attached to a drill, which powers them to cut through the work piece, typically by rotation. The drill will hold the upper end of a bit called the **shank** in the chuck. Drill bits come in standard sizes and shapes.

Drill bit geometry has several characteristics:

1.2.1 Angle of twist :- The spiral (or rate of twist) in the drill bit manage the rate of chip removal. A fast spiral (high twist rate or compact flute) drill bit is used in high feed rate applications under low spindle speeds, where removal of a large quantity of chips is required. Low spiral (low twist rate or stretched flute) drill bits are used in cutting applications where high cutting speeds are used in the beginning , and where the material has a tendency to trouble on the bit or otherwise block the hole like aluminum or copper.

1.2.2 Point angle:- The point angle or the angle formed at the tip of the bit, is selected by the material the bit will be working on. Tough materials require a larger point angle and softer materials require a sharper angle. The correct point angle for the hardness of the material effects wandering, chatter, hole shape, and wear rate.

1.2.3 Lip angle:-The lip angle determines the amount of support provided to the cutting edge. A greater lip angle will cause the bit to cut more sharply under the equal amount of point pressure as a bit with a smaller lip angle. Both conditions can cause binding, wear, and sudden damage failure of the tool. The appropriate amount of lip angle clearance is calculated by the point angle. A very acute point angle has higher web surface area showed the work at any one time, requiring an aggressive lip angle, where a flat bit is highly sensitive to small changes in lip angle due to the small surface area supporting the cutting edges.

1.2.4 Length:- The length of a bit determines how deep a hole can be drilled, and also determines the rigidity of the bit and correctness of the resultant hole. While longer bits can drill deeper holes, they are more manageable meaning that the holes they drill may have an wrong location or drift from the planned axis. Twist drill bits are available in standard lengths, referred to as Stub-length or Screw-Machine-length (short), the more commonly used Jobber-length (medium), and Taper-length or Long-Series (long).

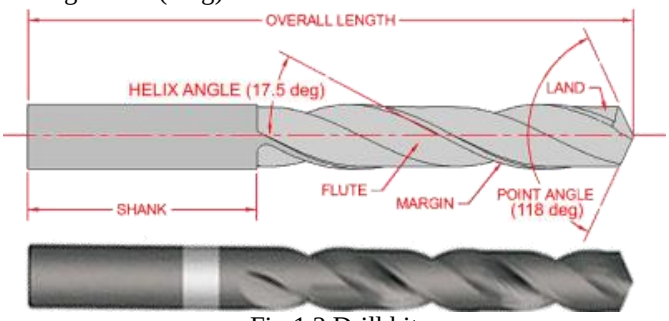

Fig.1.2 Drill bit

1.3. Types of drilling machines:- Drilling machines have a variety of capacity and configuration are usually used for creating cylindrical holes and occasionally for enlarging the existing holes to fully or partially. But different types of drills are used for various applications depending upon work piece material, tool material, depth and diameter of the holes.

General purpose drills may be classified as;

1.3.1 According to material:-

- High speed steel – most common
- Cemented carbides
  - Without or with coating
  - In the form of brazed, clamped or solid.

1.3.2. According to number of flutes:-

- Double flute – most commonly used
- Single flute – e.g., gun drill
- Three or four flutes – known as slot drill.

1.3.3. According to helix angle of the flutes:-

- Usual – 20^0 to 35^0 – most commonly used
- Large helix : 45^0 to 60^0 suitable for deep holes and softer work piece materials
- Small helix : for harder or tough materials.
- Zero helix: spade drills for high production drilling, micro-drilling and hard work materials.

1.3.4. According to length to diameter ratio:-

- Deep hole drill; e.g. crank shaft drill, gun drill etc.
- General type : L/D ≅ 6 to 10
- Small length : e.g. centre drill

1.4 Process parameters of drilling machine :- There are sevral process parameters of drilling machine which have to be obtimized. The brief description about main process parameters are given below:-

1.4.1 Cutting speed (V) :- It is the highest of the relative velocities of cutting tool or work piece. In drilling process, it is the speed of the cutting tool.

1.4.2 Depth of cut (D):- It is the vertical distance the cutting tool enters into the work piece.

1.4.3 Feed (F):- It is motion of the tool per revolution. It is the distance the tool travels in one revolution of the work piece and is given the units of mm/rev or in./rev.

1.4.4 Cutting fluid:- It is commonly used to cool the drill bit. It also enhance tool life, increase speeds and feeds, improve the surface finishing and helps in ejecting chips. Application of these fluids is usually done by gushing the work piece with coolant and lubricant or by applying a spray mist.

1.4.5 Surface roughness (SR):- Surface Roughness is a measure of the surface smoothness of a manufactured surface. It is the variation of the surface from a reference plane. Low variation from the reference line means low roughness. and high variation from reference line means more roughness. Optimal settings of the cuttings parameters are most important for obtaining low surface roughness.

1.4.6 Tool wear:- The tool wear is prolong concern to cutting tools, and state its slow failure due to continues operation. It is the tribological reaction between tool , new cut surface of work chip and will be under high temperature and pressure. Cutting tool is grinded at different angles to execute cutting operation effectively on various materials and in varying feed, speed and depth of cut . Tool life decreases with increase in tool wear. Tool wear cannot be avoided but can be minimized under different operating conditions.

1.4.7 Power required:- It is important to calculate the power required to drill the hole, because it lies under economical consideration. The power required must be at optimized level. If N= speed of drill in rev/minute, then work done/minute= $2\pi NT$ Newton meter. Therefore power required is given by equation:

Power= $2\pi NT/60000$ kW.

Where,

N= speed of drill in RPM

T= Torque in kg-m

II. LITERATURE REVIEW

In the study conducted by Reddy Sreenivasalu and Dr. Ch Srinivasa Rao [1], the influence of drilling parameters on surface roughness and the roundness error were studied in drilling of Al6061 alloy with High Speed Steel twist drill. The most favorable control factors for hole quality were find out using Taguchi grey relational analysis method. The Cutting speed, feed , drill diameter, point angle and cutting fluid mixture ratio were deliberated as the control factors. L18 orthogonal array was decided for experiment . Grey relational analysis was used to minimize surface roughness and the roundness errors.

Tyagi et al. [2] employed Taguchi method and studied the effects of machining parameters like spindle speed, feed and depth of cut on the surface roughness(SR) and material removal rate(MRR). And find out the results that the spindle speed of drilling machine tool mainly affects the surface roughness (SR) and the feed rate largely affects the material removal rate (MRR).

Koklu [3] studied the effect of the mechanical properties of aluminium alloys in drilling process by changing feed rate, cutting speed and the drill diameter on burr height and surface roughness with the help of Taguchi method. The results of the statistical analysis represents that feed rate and cutting speed to minimize both the height of the exit burrs and the surface roughness in a significant manner.

Tosun [4] worked on a statistical analysis of process parameters for surface roughness in drilling of Al/SiCp metal matrix composite. The experimental investigation were carried out under the fluctuating feed rate, spindle speed drill type, point angle of drill, and heat treatment conditions. The decided noticeable factors were the feed rate and tool category.

Kilickap et al. [5]concentrated on the effects of machining parameters such as cutting speed, feed rate and cutting circumstances on the surface roughness achieved in drilling of AISI 1045. The optimal parametric combination of the three control variables for the minimum surface roughness was achieved at 7.62 m/min cutting speed, 0.1 mm/rev feed rate, and Minimal quantity lubricant (MQL) cutting environment

Kurt et al. [6] enhanced the surface finish and hole diameter correctness in the dry drilling of Al 2024 alloy. They notice that the feed rate , cutting speed , and differently coated drills affect surface finish by 35.46 %, 6.15%, and 53.84 % and the depth of drilling, feed rate , cutting speed and differently coated drills affect the hole roundness errors by 8.18%, 74.09%, 6.04%, and 0.10% for the dry drilling of Al 2024 alloy.

Kurt et al. [7] studied the role of different coatings, point angles, cutting speeds and feed rates on the hole quality (hole size, surface roughness, roundness and radial deviation of created hole) in drilling of Al 2024 alloy. They concluded that using low cutting speed and feed rate .The best hole quality produced near the bottom of the drilled hole.

Archit Shrivastava [8] explained the optimum working condition for High Speed Steel drill bit which represents that cryogenic Treated tool is better than non cryogenically treated tool using Taguchi analysis method.

Dhavamani et al. [9] emphasized to find out the desirable machining condition for maximizing metal removal rate(MRR) and minimizing the surface roughness(SR) in drilling of Aluminum Silicon Carbide (AlSiC) by using suitable function approach. An effort was made to form a comprehensive mathematical model for comparing the interactive and higher order effects of different machining parameters using Taguchi technique. A multiple regression model was employed to represent relationship between input and output parameters and a multi-objective optimization method based on a Genetic Algorithm (GA) was employed to optimize the process.

Kadam Shirish, M. G. Rathi, [10] have examined the influences of the input machining parameters cutting speed, feed rate, point angle and diameter of drill bit on CNC milling machine under dry situations. The variations in

chip load, torque and machining time are achieved through series of experiments according to the central composite rotatable design to develop the equations of responses. They carried out some experiment using commercially available single layer Titanium Aluminum Nitride (TiAlN) and HSS tool. Drilling is done on the work piece of T105CR1 EN31 steel material. ANOVA analysis is taken to confirm the validity and accuracy of the established mathematical models for in depth analysis of effect of finish drilling process parameters on the chip load, torque, and machining time.

Shivapragash et al. [11] focused on multiple response optimization of drilling process for composite Al-TiBr2 to minimize the damage events occurring during drilling process. Taguchi method with grey relational analysis was employed to optimize the machining parameters with multiple performance characteristics in drilling of MMC Al-TiBr2 and found that the maximum feed rate, low spindle speed are the most important variables which affect the drilling process and the performance in the drilling process can be effectively improved by using this approach.

Haq et al.[12] implemented a new approach for the optimization of drilling parameters on drilling Al/SiC metal matrix composite with multiple responses based on orthogonal array with grey relational analysis. Experiments are carried out on LM25-based aluminum alloy reinforced with green bonded silicon carbide of size 25 μm. Drilling tests were carried out using TiN coated HSS twist drills of 10 mm diameter under dry condition. Drilling parameters like cutting speed, feed and point angle were optimized with the considerations of multi responses such as surface roughness, cutting force and torque.

Sureshkumar et al.[13] studied the performance of TiAlN coated and uncoated carbide drill bits. When drilling titanium alloy were studied on vibration, thrust force, torque, machine timing, burr size and surface roughness. In response, the experiments were conducted on CNC vertical milling machine with two factors and each factor consists of three levels. For experimentation, the limits of spindle speed and feed rate choice is depend on tool manufacturer suggestions. Including, the effects of spindle speed and feed rate on observed reactions were explored.

III. CONCLUSION

The conclusions can be drawn from this literature review on CNC drilling processes are given below:-

1. Taguchi method has been employed by various researchers to compute the main effects, important variables and more favorable machining conditions to achieve better performance parameters. The several performance parameters like tool life, cutting force, surface roughness and the overall production can be increased by important tools of Taguchi method.
2. Feed usually depends upon the following factors like desired finishing, Power available, state of machine and its drive etc. The Feed Rate largely affects the MRR
3. Surface roughness is determined by several factors including cutting parameters such as spindle speed, feed rate, depth of cut, Tool geometry, The material of the cutting tool, Machining condition etc. The Spindle Speed of drilling machine Tool mainly affects the SR
4. Grey relational analysis is mostly employed for checking the degree of relationship between series of grey relational grade. It is used by many researchers to optimizing the grey relational grade.
5. It is also observed that feed rate was the most effectible control parameter from all input parameters which influence the burr height. The cutting speed was the second parameter which influences the burr formation. The drill diameter has the less effect on burr height. For the surface roughness, cutting speed is a controllable parameter and after that feed rate and drill diameter, respectively. The optimal combination of the three control factors minimizing both the burr height and the surface roughness.
6. The uncoated drill bit produces the higher frequency of vibration at low spindle speed with mid-level of feed rate than coated drill bit. For most combination of spindle speed and feed rate the uncoated drill bit were recorded higher frequency of vibration. The higher thrust force occurred with uncoated drill bit with the combination of lower spindle speed and higher feed rate in differently higher torque take place with coated drill bit at the mid-level of spindle speed with the higher feed rate. TiAlN coated drill bit is not suitable for minimizing the burr dimensions. TiAlN coated drill bit is well suited for surface roughness when drilling SB 265 titanium grade 2 alloy than uncoated drill bit.

REFERENCES

[1] R.Sreenivasulu and S.Rao,"Application of grey relational analysis for surface roughness and roundness error in drilling of Al 6061 alloy", *International Journal of Lean Thinking* **, Volume 3,**Issue 2,[Dec2012],

[2] Y.Tyagi, V.Chaturvedi, and J.Vimal, "Parametric optimization of drilling machining process using Taguchi design and ANOVA approach".*International Journal of Emerging Technology and Advanced Engineering*, **Volume 2,** Issue 7, [July 2012].

[3] U.Koklu,"Influence of the process parameters and the mechanical properties of aluminum alloys on the burr height and the surface roughness in dry drilling", *Materials and technology*,46,Page no.103–108 [2012]

[4] G.Tosun," Statistical analysis of process parameters in drilling of AL/SICP metal matrix composite". *Int J AdvManufTechnol*,55: Page no. 477– 485 [2011].

[5] E. Kilickap, M.Huseyinoglu and A.Yardimeden. "Optimization of drilling parameters on surface roughness in drilling of AISI 1045 using response surface methodology and genetic algorithm". *Int J AdvManufTechnol*,52:Page no.79–88[2011].

[6] M.Kurt, Y.Kaynak and E.Bagci, " Evaluation of drilled hole quality in Al 2024 alloy". *Int J Adv Manuf Technol*, 37:Page no.1051–1060 [2008]

[7] M.Kurt, E.Bagci and Y.Kaynak, "Application of Taguchi methods in the optimization of cutting parameters for surface finish and hole diameter accuracy in dry drilling processes". *Int J Adv Manuf Technol*, 40 Page no.458–469[2009].

[8] A.Shrivastava, "Comparative Experimental Investigation for Reducing High Speed Steel Tool Wear Rate By Cryogenic Process",*International Journal of Scientific & Engineering Research,* , **Vol. 3**, Issue 9, [september2012].

[9] C. Dhavamani, and T. Alwarsami , "Optimization of machining parameters for aluminium and silicon carbide composite using genetic algorithm", *Procedia Engineering*, 38, page no..1994-2004,[2012]

[10] M.S. Kadam, S.SPathak , "Experimental Analysis and Comparative Performance of Coated and Uncoated Twist Drill Bit Dry Machining",*International Journal of Research in Mechanical Engineering and Technology* ,**Vol.1** Issue 1.[Oct. 2011]

[11] B.Shivapragash, K. Chandrasekaran, C. Parthasarathy, and M.Samuel, "Multiple response optimizations in drilling using Taguchi and grey relational analysis", *International Journal of Modern Engineering Research*, **Volume 3**, Issue2, Page no.765-768[2013].

[12] A.N.Haq, P.Marimuthu, and R.Jeyapaul, "Multi response optimization of machining parameters of drilling Al/Sic metal matrix composite using grey relational analysis in the Taguchi method" Int J Adv Manuf Technol , 37, Page no.250-255.[2008].

[13] B. Suresh kumar, V. Vijayan, N. Baskar, "Comparison of coated and uncoated carbide drill bits for drilling titanium grade 2 material" ISSN 1392-1207. MECHANIKA. **Volume 22**, Page no.571-575[2016]

[14] D. Priyanka, K. Aruna, Dr P. Venkata Ramaiah "Optimization of Process Parameters in Drilling of Hybrid Aluminium Metal Matrix Composite (AMMC)" *International Journal of Innovative Research in Science,Engineering and Technology (An ISO 3297: 2007 Certified Organization)* **Vol. 5**, Issue 6 [June 2016].

[15] V.Karthik &H.V. Puneeth," Tool Wear, Surface Roughness, and Power Requirement for Drilling Operation Using Uncoated and Coated HSS Tool" *Imperial Journal of Interdisciplinary Research (IJIR)* **Vol-2**, Issue-8, 2016 ISSN: 2454-1362, http://www.onlinejournal

