A Review on Cutting Parameters of Drilling Operation

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Abstract: Drilling is process of making the cylindrical hole on a work piece. The cylindrical hole size is varying in range of small to large. Several types of drill bits like H.S.S., carbide tool etc. are used for drilling operation in industries. The drilling operation is affected by various parameters like cutting speed, feed rate, depth of cut, coolant etc. The various experiments have been done on CNC drilling machine, VMC drilling, micro drilling (Drill Ø<1mm). There are various materials like steel, composite material (like C.F.R.P., AL alloy), brass, white cast iron being used for analysis of drilling operation. There are so many worked has been carried out for optimization the drilling parameter for improvement of drilling process. Still there is a scope to work considering specific machine like pneumatic feed drilling process. In pneumatic drilling machine, effect of pneumatic pressure with others control parameters on material removal rate (MRR) and drill tool machining time would be analyzed.

Keywords: Drilling, Pneumatic Feed Drive, H.S.S., MRR

I. INTRODUCTION

In the bottle neck situation of market, machining industries are concentrated on achieving the high quality in terms of workpiece dimensional accuracy, surface finish, less tool wear and less production cost. Drilling is process of making hole on solid body with help of multipoint cutting tool. Drilling is one of most common metal removing method used in various filed like aerospace industries, automobile, structural and so on. Although several hole making process like laser beam, electron beam, ultrasonic machining, abrasive jet machining have improved in the manufacturing industries, conventional drilling have its own importance. Drilling is required simple set up during operation. The basic objective of drilling operations is to generate holes at minimum cost consistent with the required quality levels. The attainment of this straight forward objective can present challenges to those responsible for establishing and maintaining efficient production operation. The broad applicability of drilling results in a large variation in customer requirements, materials, tolerances, lot sizes and shop facilities that, in turn, preclude simplified solution.

1) Types of drilling process:
Several operations are related to drilling, most of them illustrated in the figure 1.1. The different drilling operation are used for specific application and purpose. All the drilling process almost similar to each others as we can see from the figure 1.1. For this various operation various types of drill tool are used. The drill tool geometry is changed as per operations.

2) Types of drill tool:
Drilling machines of different capacity and configuration are basically used for originating cylindrical holes and occasionally for enlarging the existing holes to full or partial depth. But different types of drills are suitably used for various applications depending upon work material, tool material, depth and diameter of the holes.

General purpose drills may be classified as;

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

• According to size:
  - Large twist drills of diameter around 40 mm
  - Micro drills of diameter 25 to 500 μm
  - Medium range (most widely used) diameter ranges between 3 mm to 25 mm.

• According to number of flutes:
  - Two fluted – most common
  - Single flute – e.g., gun drill (robust)
  - Three or four flutes – called slot drill

• According to helix angle of the flutes:
  - Usual – 20° to 35° – most common
  - Large helix : 45° to 60° suitable for deep holes and softer work materials
  - Small helix : for harder / stronger materials
• Zero helix: spade drills for high production drilling micro-drilling and hard work materials.

**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

**According to shank:**
• Straight shank – small size drill being held in drill chuck
• Taper shank – medium to large size drills being fitted into the spindle nose directly or through taper sockets

**According to specific applications:**
• Centre drills : for small axial hole with 60° taper end to accommodate lathe centre for support
• Step drill (and sub land drill: for small holes with two or three steps.
• Half round drill, gun drill and crank shaft drill (for making oil holes).
• Ejector drill for high speed drilling of large diameter holes
• Taper drill for batch production.
• Trepanning tool: for large holes in soft materials.
• Brad Point or Wood Bits: used to drill hole in wood.
• Glass or Tile Bits :- for Glass and tiles drilling

### II. LITERATURE REVIEW

For the development of new technique, operation, process or methodology, it is very important to make detail study on existing technique, operation, process or methodology and to understand the same for elimination of problems related to them. The section covers the work investigated by several researchers for parameters that affects drilling operation. The parametric study has been taken out by authors to reduce the tool wear, to improve the surface roughness and accuracy of drilled holes. Different authors have experimented on different material with different tool characteristics. This study can be helpful for improving the quality of hole and reduces tool breakages in manufacturing industry. Drilling is material removal process to make round holes. The sizes of holes are varying from very small to large size. Reference[1] Leszek Kundla have studied the drilling process that used for making the small holes (Dia less then 1 millimeter).Drilling of small holes is complex and intricate process. For drilling small holes, it is necessary to use precision machine. They have reviewed that feed motion execution is defined the successful drilling. or drilling of micromoles with preventing against the breakage of tool is not possible without special feed drive realizations. For proper drilling, feed stroke is divided into sections. From this study, they concluded that feed drives, method of feed and its execution are the most effecting parameters to minimizing the risk of drill breakage, to improve the hole quality and production cycle time. Drilling wear is major parameters in any manufacturing industry that uses the drilling process. In automated manufacturing system detection of drill tool wear is carried out by Tool Condition Monitoring system. Reference [2] Issam Abu Mahfoz presented the research on tool wear comparison with two different method of TCM. One is the multi layer feed – forward neural network and other one is back propagation training algorithm for twist drill tool wear. The algorithm utilizes vibration signature analysis for collecting the information of machining process. The purpose of study is to identify the TCM system that will more lead to economical and efficient drilling tool usage. Five experiments are being carried out to collect different tool wear data. From this author demonstrates that vibration signals analysis is effective and useful TCM system for drill wear detection and classification. Reference [3] Azlan, Azuddin, & Abdullah have presented the effect of drilling parameter such as spindle speed, feed rate and drilling tool size on material removal rate (MRR), surface roughness, dimensional accuracy and burr. They have used HSS drill tool to do the micro drilling process on brass material. Drill tool diameter is taken from 0.5 to 1 mm to perform the experiment with three different levels of speed and feed. The results were analyzed using microscope and surface roughness device. Comparatives analysis has been done between surface roughness, MRR and accuracy of drilled holes by experimentation. From the result, the surface roughness are mostly influenced by spindle speed and feed rate. As the spindle and feed rate increases, the surface roughness will decrease. The tool diameter gives less influence on the value of surface roughness. The value of MRR is decreased when the tool diameter, spindle speed and feed rate are decreases. As drilling tool diameter, feed rate and spindle speed increase the dimensional accuracy of drilled hole will decrease. The increment of spindle speed and feed rate value mostly will affect the tool wear and size of burr on the edge of drilled holes.

Reference [4] Ramji, Narasimha, Krishna, have experimented on drilling process characteristics of white cast iron material using non-treated, cryogenically treated and tempered carbide tipped drills. The tungsten carbide drill tool is used for performance of drilling. They have conducted the experiments at various levels of cutting speed; feed, to analysis tool conditions on thrust, torque and surface roughness of drilled holes. Taguchi’s Orthogonal Array technique is used to generate the experiment lay out. SEM, ANOVA and Grey Taguchi relational method are used for analysis the experimental result. Thus, this study presented that Cryogenic treatment of the carbide drills [(CT) and (CTT2)] proved better than the non-treated ones in terms of
less thrust force, torque and better surface finish in drilling of white cast iron specimens.

Reference [5] Kadam Shirish, M. G. Rath, have experimented the effect of the input machining parameters like cutting speed, feed rate, point angle and diameter of drill bit on CNC milling machine under dry condition. The change in chip load, torque and machining time are obtained through series of experiments according to central composite rotatable design to develop the equations of responses. They have carried out experiment using commercially available single layer Titanium Aluminum Nitride (TiAlN) and HSS tool. Drilling is done on the workpiece of T105CR1 EN31 steel material. ANOVA analysis is taken to confirm the validity and correctness of the established mathematical models for in depth analysis of effect of finish drilling process parameters on the chip load, torque, and machining time.

Reference [6] Ugur Köklü, have studied the effect of the mechanical properties of aluminum alloys against drilling process. Taguchi experimental method is used to find the effect of cutting speed, feed rate and the drill diameter on burr height and surface roughness of drilling holes. The work piece materials like Al-2024, Al-7075 and Al-7050 were selected for experiments. The ANOVA and S/N ratio were employed to analyze the effect of the drilling parameters. The results of the statistical analysis indicated that feed rate and cutting speed minimize significantly both the height of the exit burrs and the surface roughness.

Reference [7] Archit Shrivastava , was described that optimum working condition for HSS drill bit which shows that cryogenic Treated tool is better than non treated tool using Taguchi analysis method.

Reference [8] Ramazan & Adem had performed the experiment to optimize the cutting parameters on drill bit temperature in drilling. The work piece material is Al 7075 and drill tool is the uncoated and Firex coated carbide drills in the experiment. The optimization of the cutting parameters was carried out by Taguchi method with L18 orthogonal array. The cutting speed, feed rate and cutting tool are selected as control factors. Taguchi design method exhibit a good performance in the optimization of cutting parameters on drill bit temperature measurements. In addition, the empirical equations of drill bit temperatures were derived by using regression analysis. From ANOVA they founded that the most significant factor in affecting the drill bit temperature was the feed rate having a percentage contribution of 56.15%.Taguchi design method, Regression Analysis was able to provide the minimum cost and time in the manufacturing engineering applications.

Reference [9] Mustafa Gunay , Emre Yucel, were aimed to optimize the cutting conditions for the average surface roughness(Ra) obtained during turning process. The machining of high-alloy white cast iron (Ni-Hard) at two different hardness levels (50 HRC and 62 HRC) were performed at the CNC lathe using ceramic and cubic boron nitride (CBN) cutting tools. Cutting speed, feed rate and depth of cut were chosen as control parameters of experiment. Taguchi L18 orthogonal array was used to design of experiment. Optimal cutting conditions was determined using the signal-to-noise (S/N) ratio which was calculated for Ra according to the “the-smaller-the-better” approach. The effects of the cutting parameters and tool materials on surface roughness were evaluated by the analysis of variance. The statistical analysis indicated that the parameters that have the biggest effect on Ra for Ni-Hard materials with 50 HRC and 62 HRC are the cutting speed and feed rate, respectively.

III. CONCLUSION

Although modern metal removing process, including ultrasonic machining, electron beam machining abrasive jet machining have improved in manufacturing industry, conventional drilling is still one most importance machining process. There are so many work carried out by the researchers on drilling operation and parameters that affects drilling operation. They have investigated that drilling operation may affected by several parameters like cutting speed ,feed rate , tool geometry ,tool angle ,application of different lubrication , coating on tool. This all parameters affect the tool wear or tool life, surface roughness of drilled hole, productivity and accuracy of hole. Still there is a scope to work on drilling operation with pneumatic feed drive automatic application and can perform the parametric study on it. Pressure of pneumatic drive can be taken as control parameter to find out effect of on MRR, tool wear rate , production time and etc.

REFERENCES


