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Optimization of Drilling Process Parameters: A Review

Amarnath R. Mundhekar[#1], Subhash R. Jadhav[*2]
[#]*Mechanical Engineering Department, Karmaveer Bhaurao Patil college of Engineering & Polytechnic, Satara.

Abstract— Drilling is one of the widely used machining processes for various purposes. Now a days it is frequently used in automotive, aircraft and aerospace and dies or mold industries, home appliances, medical and electrical equipment industries. Thus, it needs to be cost effective along with the assurance of the quality specifications within the experimental limit. In today's rapidly changing circumstances in manufacturing industries, applications of optimization techniques in metal cutting processes is essential for a manufacturing unit to respond efficiently to severe competitiveness and the increasing demand of quality product in the market. Optimization methods in metal cutting processes, considered being a very important tool for continual improvement of output quality in products & processes [13]. This paper reviews the various literatures on the optimization of drilling process by studying the influence of various drilling parameters (spindle speed, feed rate, drill diameter, drill point angle, etc.) on the performance parameters (surface roughness, material removal rate, thrust force, etc) during drilling process.

Keywords— Drilling process, Optimization, Surface roughness, Thrust force, Material removal rate.

I. INTRODUCTION

Drilling is a most common machining process that uses multi tooth cutting tools called drills or drill bits to cut or enlarge a hole of circular cross-section in solid materials.

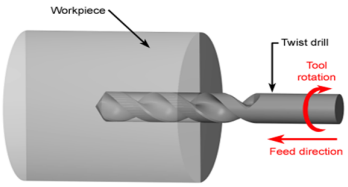

Fig.1 Drilling Process

Drilling involves the creation of holes that are right circular cylinders. The drill bit is a rotary cutting tool, often called multipoint cutting tool. The drill bit is pressed against the workpiece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the workpiece, cutting off chips from the hole as it is drilled. The chips must exit through the flutes to the outside of the tool. As can be seen in the fig. 1, the cutting front is embedded within the workpiece, making cooling difficult. The cutting area can be flooded, coolant spray mist can be applied, or coolant can be delivered through the drill bit shaft.

A drill bit enters the workpiece axially and cuts a blind hole or a through hole with a diameter equal to that of the tool (i.e. drill) as shown in Fig. 2. A drill bit is a multi-point tool and typically has a pointed end. A twist drill is the most commonly used but other types of drill bits, such as a centre drill, spot drill, or tap drill can be used to start a hole that will be completed by another operation.

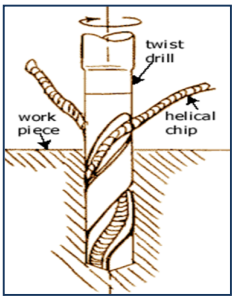

Fig. 2 Cross Section of a hole being cut by a Twist Drill

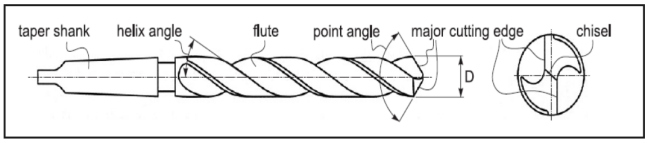

Fig. 3 Cross Section of a Twist Drill

A drill consists of two main cutting edges-the chisel edge and the cutting lips as shown in fig. 3. The chisel edge extrudes into the workpiece material and contributes substantially to the thrust force. The cutting lips cut out the material and produce the majority of the drilling torque and thrust. The chips are formed along the cutting lip and moved up following the drill helix angle.

II. LITERATURE REVIEW

M.A. Amrana. et.al. [1] investigates the effects of drilling parameters such as spindle speed, feed rate and drill diameter on the surface roughness and surface texture of drilled hole by applying RSM. From One factor plot analysis found that the most significant 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. [2] 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. [3] 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. [4] 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. [5] 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. [6] 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. [7] 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. [8] 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. [9] 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. [10] 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. [11] presents optimization of machining parameters- Spindle speed, Feed rate & Cone radius ratio for thermo – mechanical form drilling of Aluminium 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. [12] 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. [13] 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.

C.C. Tsao. et.al. [14] 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 on Taguchi 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. [15] 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. [16] 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 fibre 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.

III.PROPOSED WORK

From the study of literature on Optimization of drilling process with various workpiece materials, it has been found that the various cutting process parameters such as spindle speed, feed rate affects the material removal rate [4,10] and the surface roughness is mostly affected by spindle speed, feed rate, type of drill & drill diameter[1], [4], [7]-[15] and Most of the researchers have used response surface methodology for the optimization of drilling process [1]-[3], [5]-[7], [12], [13]. And in case of (AISI 1040) EN 08 as workpiece material, optimization of the drilling process is carried out with spindle speed, feed rate,

type of drill, cutting environment as input parameters and surface roughness, torque, cutting force, material removal rate & power as output parameters [8]-[10].Though the effects of drill diameter, material thickness and the drill point angle on, surface roughness and material removal rate is considered in case of glass fibre reinforced plastic (GFRP) as a workpiece material it is not considered in case of as workpiece material AISI 1040 (EN 08). Hence, Problem statement can be stated as, To correlate the Input parameters- Spindle speed, Feed rate, Drill diameter, Drill point angle & Material thickness with Output parameters- Surface roughness, Material removal rate & Drilling time in case of Steel AISI 1040 (EN 8) as workpiece material by using Response surface method for analysis & Desirability function for multi response optimization.

IV. CONCLUSIONS

In this paper the survey is done on Optimization of drilling process with various workpiece materials by studying the references by scholars correlating the relationship between the input process parameters and the output responses in order to optimize the process parameters so that the desired values of performance parameters are obtained and hence making the drilling process cost effective along with the assurance of the quality specifications within the experimental limit through optimization as it supports continuous improvement of output quality of products and process through modelling and determination of optimal cutting conditions. The proposed work shows that we are supposed to determine the region of critical process control factors such as drill diameter, material thickness and the drill point angle (which are not yet considered with En 08 material) leading to desired output or responses with acceptable variations that will ensure a low cost of manufacturing through optimization. Thus, it contributes to manufacturers to face the challenge of higher productivity and quality of the product.

V. ACKNOWLEDGMENT

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REFERENCES

[1] M.A. Amrana,, S. Salmah, N.I.S. Hussein, R. Izamshah, M. Hadzley, Sivaraos, M.S. Kasim, M.A. Sulaiman (2013), “Effects of machine parameters on surface roughness using response surface method in drilling process”, The Malaysian International Tribology Conference 2013, MITC2013, Procedia Engineering 68 (2013), PP : 24 – 29.

[2] Murthy B.R.N., Lewlyn L.R. Rodrigues and Anjaiah Devineni, “Process Parameters Optimization in GFRP Drilling through Integration of Taguchi and Response Surface Methodology,” Research Journal of Recent Sciences, ISSN 2277-2502, Vol. **1(6),** 7-15, June (2012).

[3] S. Madhavan, S. Balasivanadha Prabu, “Experimental investigation and Analysis of Thrust Force in Drilling of Carbon Fibre Reinforced Plastic Composites using Response Surface Methodology, International Journal of Modern Engineering Research (IJMER), ISSN: 2249-6645, Vol.2, Issue.4, July-Aug. 2012 pp-2719-2723.

[4] Yogendra Tyagi, Vedansh Chaturvedi, Jyoti Vimal, “Parametric Optimization of Drilling Machining Process using Taguchi Design and ANOVA Approach,” International Journal of Emerging Technology and Advanced Engineering, (ISSN 2250-2459, Volume 2, Issue 7, July 2012).

[5] S Jayabal & U Natarajan “Influence of cutting parameters on thrust force and torque in drilling of E-glass/Polyester composites”, Indian Journal of Engineering & Materials Sciences, Vol. 17, December 2010, pp. 463-470.

[6] Godfrey C. Onwubolu, Shivendra Kumar, “Response surface methodology-based approach to CNC drilling operations,” Journal of Materials Processing Technology Vol.171 (2006) 41–47.

[7] Erol Kilickap & Mesut Huseyinoglu & Ahmet Yardimeden, “Optimization of drilling parameters on surface roughness in drilling of AISI 1045 using response surface methodology and genetic algorithm,” Int J Adv Manuf Technol (2011) 52:79–88, DOI 10.1007/s00170-010-2710-7.

[8] P.Venkataramaiah, G.Vijaya Kumar and P. Sivaiah, “Prediction and analysis of multi responses in drilling of EN8 steel under MQL using ANN-Taguchi approach,” Elixir Mech. Engg. 47 (2012) 8790-8796 , ISSN:2229-712X.

[9] Dr.P.Venkataramaiah, G.Vijaya Kumar, “Design of Optimum ANN for Prediction of response parameters in drilling of En8 steel Under MQL environment,” International Journal of Emerging Technology and Advanced Engineering. (ISSN 2250-2459, Volume 2, Issue 5, May 2012).

[10] N. Keerthi, Dr. Syed Altaf Hussian, “Modelling And Analysis Of Machining Characteristics Of En-8 Steel In Drilling Process,” International Journal of Engineering Research & Technology (IJERT), Vol. 2 Issue 11, November – 2013, ISSN: 2278-0181.

[11] Indumathi V. Diwakar Reddy & G. Krishnaiah, “Optimization of machining parameters using Desirability Function Analysis and ANOVA for thermo-mechanical form drilling,” International Journal of Industrial Engineering & Technology (IJIET) ISSN(P): 2277-4769; ISSN(E): 2278-9456 Vol. 4, Issue 1, Feb 2014, 19-26.

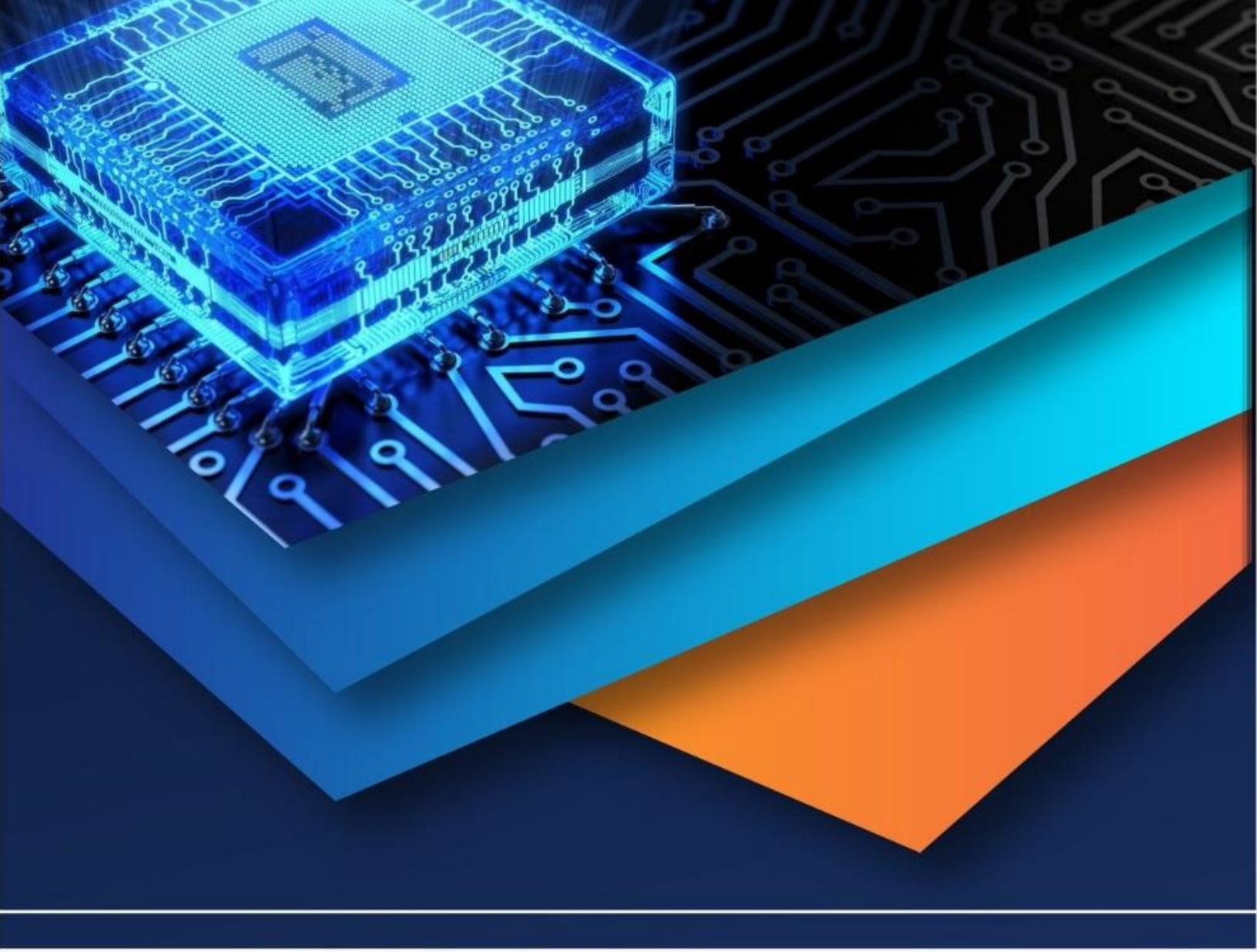
[12] A. Munia Raj, Sushil Lal Das and K. Palanikumarr, “Influence of Drill Geometry on Surface Roughness in Drilling of Al/SiC/Gr Hybrid Metal Matrix Composite”, Indian Journal of Science and Technology, Vol 6 (7), July 2013, ISSN: 0974-6846.

[13] Kapil Kumar Goyal, Vivek Jain, Sudha Kumari, “Prediction of Optimal Process Parameters for Abrasive Assisted Drilling of SS304”, Elsevier, Procedia Materials Science 6 (2014), 1572 – 1579.

[14] C.C. Tsao, H. Hocheng, “Evaluation of thrust force and surface roughness in drilling composite material using Taguchi analysis and neural network”, Elsevier, Journal of Materials Processing Technology 203 (2008), 342–348.

[15] J.Pradeep Kumar, P.Packiaraj, “Effect of drilling parameters on surface roughness, tool wear, material removal rate and hole diameter error in drilling of OHNS”, International Journal of Advanced Engineering Research and Studies, Vol. I/ Issue III/April-June, 2012/150-154, E-ISSN2249–8974.

[16] Uwe Heisel, Tobias Pfeifroth, “Influence of Point Angle on Drill Hole Quality and Machining Forces when Drilling CFRP”, Elsevier, Procedia CIRP 1 (2012) 471 – 476.



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