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Optimization of Machining Parameters for Carbon Steel

Mr. Akash Bajpai
SR institute of management and technology, Lucknow
akashbajpaihr@gmail.com

Abstract:

The objective of the present work is to optimize process parameter such as the material removal rate and surface roughness on work piece Carbon Steel-ASTM A514. The research contributions are classified into methodology for investigation and analysis, input processing conditions and response variables. The Taguchi Method is used to find out the optimum parameter. With a full factorial design of 3 cutting parameters with 3 levels each onto CNC Drilling machine.

Keywords

Taguchi's Method, CNC drilling, EN-9, MRR, Ra, Process Parameters,
Minitab-17.0 software & S/N Ratio

"1. Introduction"

Headings Drilling is a machining operation by which holes are produced or enlarged in a work piece with the help of fluted end cutting tool called drill.

Drilling is done by forcing a rotating drill into a stationary job as on a drilling machine or by forcing stationary drill in a rotating work piece as on a lathe. The Drilling machines are most commonly used in an all small and medium scale sector for metal removal operation. So that Drilling machine optimizes the quality and productivity of simultaneously.

Impact of drilling parameter such as speed (700, 900, and 1100) in rpm Feed rate (0.3, 0.4, and 0.5) mm/rev .The diameter of drill bit is 12 mm and tool angle is fixed 1180.

"2. Taguchi Method"

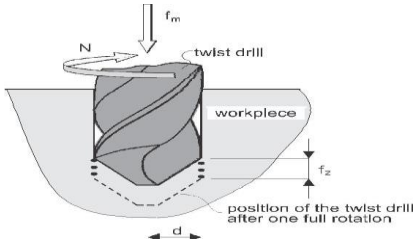
In this section we deal with the philosophy and experimental design principles devised by Genichi Taguchi, a Japanese engineer whose ideas in quality engineering have been used for many years in Japan. Quality engineering has the objective of designing quality into every product and corresponding process. It directs quality improvement efforts upstream from the manufacturing process to the design phase and is therefore referred to as an offline quality control method.

Level	Spindle Speed (RPM)	Feed Rate mm/rev.	Depth of cut (mm)
1	1	1	1
2	1	2	2
3	1	3	3
4	2	3	1
5	2	2	2
6	2	1	3
7	3	3	1
8	3	1	2
9	3	2	3

Standard L9 (3^2) Orthogonal array used in Taguchi Method

"3. Research Methodology"

In this experimental setup used for conducting the experiments by using single point cutting tool on ' Automatic High Speed Drill Machine' and CNC Drill Machine.



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"4. Cutting tool or drilling operations"

Tool Geometry

Cutting tools, geometry depends mainly on the properties on the too material and the work material. For signal point, the most important angles sure the rake angle and the end side relief angles**.**

Flank

The surface on a drill Point which extends behind the lip to the following.

Heel

The edge formed by the intersection of flute surface and the body clearance.

Lip Clearance angle

The angle formed by the flank and face at right angle to the drill axis. The angle is normally measured at the periphery of the drill. Lip clearance is the relief that is ground to the cutting edges in order to allow the drill to enter the metal without interference.

Chemical composition of material used

Chemical composition of ASTM A514 Carbon steel

Elements	Percentage %
Carbon	0.25-0.30%
Manganese	0.95-1.20%
Sulfur	0.45%
Phosphorous	0.05%

Chemical composition of En-8D steel

Constituents	Compositions
Carbon	0.36 -0.44
Silicon	0.10-0.40
Manganese	0.6- 1.00 max
Sulphur	0.050 max
Phosphorous	0.050 max

Mechanical properties

Mechanical properties of ASTM A514

Tensile stress	330 MPa
Hardness. No	201-255 HB
Yield Stress	207MPa
Elastic Modulus (GPa)	160-200
Elongation (%)	16
Poisson's Ratio	0.25-0.30
Density (×1000 kg/m^3)	7.7-8.03

Design of experiment

The experimental set-up consist of an .Automatic High speed Drilling machine and CNC Drilling Machine, an ASTM A514/ En-8D with Length of 120mm width of 50 mm and thickness of 10mm.

Result and discussion

The Material removal rate and surface roughness was recorded and analyzed using MINITAB-17.0 software for creating graphs and plots for the results which makes it easier to understand the effect of the parameters on the responses. Minitab is the advanced statical software, which is used for scientific applications, particularly in design and analysis of experiment.

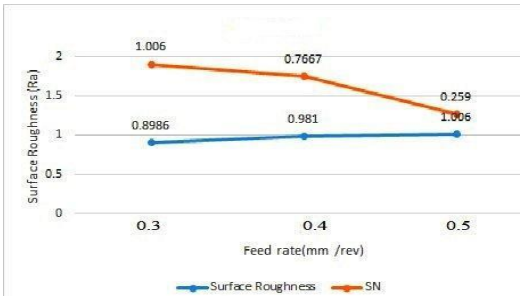
S. No	Spindle speed (RPM)	Feed Rate (mm/rev.)	MRR (gm/min)	Ra (µm)
1	700	0.3	19.61	0.924
2	700	0.4	22.64	0.907
3	700	0.5	29.74	0.865
4	900	0.5	38.27	0.833
5	900	0.3	22.39	0.818
6	900	0.4	30.59	0.856
7	1100	0.4	33.63	1.180
8	1100	0.3	28.05	0.907
9	1100	0.5	46.79	1.320

Experimental Result and Corresponding S/N ratio for ASTM A514

Formula Based Calculation

SN ratio for feed rate (mm/rev.)

Level	Feed rate (mm/sec.)	Surface roughness Ra	S/N Ratio
1	0.3	0.8986	1.0688
2	0.4	0.9810	0.0766
3	0.5	1.0060	0.2591



Surface Roughness Vs Feed rate and S/N ratio

Conclusions

Taguchi method has been used to determine the optimum machining condition to the performance of

drilling hole in carbon steel-ASTM –A514 based on the results presented here. We can conclude that, the Spindle speed and feed rate of drilling machine tool mainly effects the Surface Roughness and material removal rate.

After studying the results and discussions the following conclusions were made in the present work:

1. Surface roughness is based on smaller is better for S/N ratio. Cutting speed has greater effect than feed rate and depth of cut
2. The minimum surface roughness(Ra) of 0.82µm was obtained corresponding to: Vc =900RPM & Feed=0.3mm/rev
3. From the graph of S-N ratio it can be observed that optimal value of surface finish is obtained at second level of cutting speed, first level of feed rate and second level of depth of cut.

From the graph of S/N ratio can be observed that optimal value of MRR is 46.79gm/min at Vc=1100RPM and Feed=0.5mm/rev.

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