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Optimization of Milling Process Parameters using Taguchi Parameter Design Approach

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Abstract

Manufacturing industries try to make high great products at decrease price to remain competitive within the market. The merchandise can be made the use of numerous production methods, including machining, etc. Milling is many of the most common machining processes used to make planar surfaces with faster material elimination and good floor first-rate.

The vital objective of the technology of steel reducing is the solution of realistic issues associated with the green and particular removal of metal from work piece. It has been diagnosed that the dependable quantitative predictions of the numerous technological overall performance measures, preferably in the form of equations, are critical to broaden optimization techniques for deciding on slicing situations in procedure making plans. In this thesis experiments conducted to improve the floor end pleasant of aluminum alloy 6061 work piece by way of the use of carbide device, insert cutter, HSS and by using Taguchi's approach including L9 orthogonal array. A series of experiments can be accomplished by means of various the milling parameters spindle speed, feed price and depth of reduce. The spindle speeds are 800rpm, 1000rpm and 1200rpm. The feed charges are 150mm/min, 200mm/min and 250 mm/min. Depth of cut is zero.5mm and 1.0mm and 1.Five mm. Taguchi method is used to observe the impact of process parameters and establish correlation some of the reducing speed, feed and depth of reduce with recognize to the primary machinability component, surface end. Validations of the modeled equations are proved to be well within the settlement with the experimental statistics.

1. INTRODUCTION:

Milling system is one of the critical machining operations. In this operation the paintings piece is feed in opposition to a rotating cylindrical tool. The rotating device includes more than one slicing edges (multipoint slicing device). Normally axis of rotation of feed given to the work piece Milling operation is prominent from other machining operations on the premise of orientation between the device axis and the feed route; however, in other operations like drilling, milling, and so forth. The tool is fed inside the path parallel to axis of rotation. The reducing tool utilized in milling operation is known as milling cutter, which consists of more than one edge known as teeth. The system device that plays the milling operations by means of producing required relative motion between paintings piece and tool is referred to as milling machine. It provides the desired relative motion below much managed situations. These situations might be mentioned later in this unit as milling velocity; feed fee and intensity of reduce. Normally, the milling operation creates aircraft surfaces. Other geometries also can be created by way of milling system. Milling operation is considered an interrupted slicing operation enamel of milling cutter enter and go out the paintings all through every revolution. This interrupted cutting movement topics the tooth to a cycle of effect force and thermal surprise on each rotation. The tool fabric and cutter geometry ought to be designed to bear the above said situations. Depending upon the positioning of the device and paintings piece the milling operation may be categorized into different sorts.

Fig 1: Vertical Milling Machine

2. LITERATURE REVIEW

ANIL CHOUBEY optimized “Optimization of gadget parameters of CNC Milling device for moderate metal using Taguchi layout and Single to Noise ratio Analysis” [1]. Balinder Singh minimized “Optimization of Input Process Parameters in CNC Milling Machine of EN24 Steel” [2]. N. Gopikrishna and M. Shiva Chander determined the surface roughness in the paper “Determining the Influence of Cutting Fluid on Surface Roughness during Machining of EN24 and EN8 steel by using CNC Milling Machine”. [3]. G., Krishna studied and investigated “Selection of Optimum Process Parameters in High Speed CNC End-Milling of Composite Materials Using Meta Heuristic Techniques – a Comparative Study Pare”. [4]. B. Satish Kumar and N. Gopikrishna made an investigation in “optimization of turning process parameters, on EN 9 carbon steel using grey relational analysis”. [5]. G. Petropoulos, I. Ntziantzias, C. Anghel, made observations in “A predictive model of slicing forces in milling the usage of Taguchi & response floor strategies” [6]. C. Tsao, in his paper, “Grey–Taguchi technique to optimize the milling parameters of aluminum alloy”, studied parameters. [7].

3. METHODOLOGY

Taguchi Method

Taguchi Method is evolved via Dr. Genichi Taguchi, a Japanese first-class management representative. The method explores the idea of quadratic exceptional loss function and uses a statistical degree of overall performance referred to as Signal-to Noise (S/N) ratio. The S/N ratio takes both the imply and the variability into account. The S/N ratio is the ratio of the imply (Signal) to the usual deviation (Noise). The ratio depends at the high-quality characteristics of the product/technique to be optimized. The general S/N ratios normally used are as follows: - Nominal is Best (NB), Lower the Better (LB) and Higher the Better (HB).In this assignment the experiments are designed with the assist of taguchi L9 orthogonal array. The software program used for DOE (Design of test) is Minitab18. The mission incorporates many procedures that are described one after the other within the methodology respectively.

Input parameters and their levels

Selected input Parameters

Table 1: Process parameters

PROCESS PARAMETERS	LE VEL1	LEVEL2	LEVEL3
CUTTING SPEED(rpm)	800	1000	1200
FEED RATE (mm/rev)	150	200	250
DEPTH OF CUT(mm)	0.5	1.0	1.5

4. EXPERIMENTAL INVESTIGATION

The experiments are done on the CNC milling machine with the following parameters:

CUTTING TOOL MATERIAL –cemented Carbide Tool, HSS and insert cutter

WORK PIECE MATERIAL – aluminum 6061

FEED – 150mm/min, 200mm/min, 250mm/min

CUTTING SPEED – 800rpm, 1000rpm, 1200rpm,

DEPTH OF CUT – 0.5mm, 1.0mm, 1.5mm

EXPERIMENTAL PHOTOS:

Fig 2: CNC milling machine

Fig 3: Milling insert cutter

Fig 4: Carbide tool

Fig 5: HSS tool

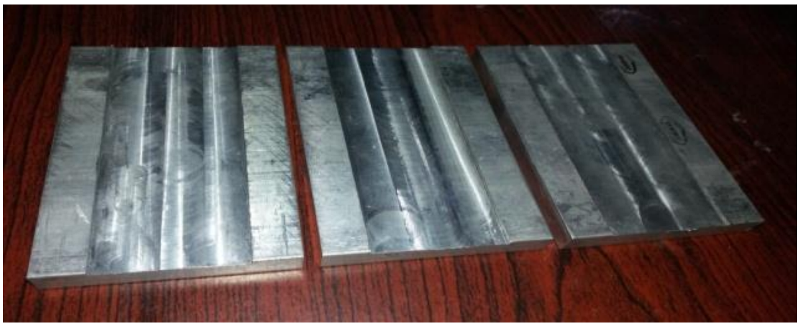


Fig 6: Work piece

Design of experiments (DOE)

For selected input parameters experiments are designed using Taguchi L9 orthogonal standard array. For this purpose software Minitab 17 is used

Table 2: Experiment Process Parameters

JOB NO.	SPINDLE SPEED (rpm)	FEED RATE (mm/min)	DEPTH OF CUT (mm)
1	800	150	0.5
2	800	200	1.0
3	800	250	1.5
4	1000	150	0.5
5	1000	200	1.0
6	1000	250	1.5
7	1200	150	0.5
8	1200	200	1.0
9	1200	250	1.5

5. EXPERIMENTATION

After design of experiment, 9 experiments are carried out in CNC vertical Face milling. After each experiment surface roughness is calculated. A quality characteristic for surface roughness is “larger is the better”.

Table 3: Surface Finish for cemented carbide tool

JOB NO.	SPINDLE SPEED (rpm)	FEED RATE (mm/min)	DEPTH OF CUT (mm)	Surface finish (R_a) µm
1	800	150	0.5	0.514
2	800	200	1.0	0.623
3	800	250	1.5	0.691
4	1000	150	0.5	0.912
5	1000	200	1.0	1.114
6	1000	250	1.5	1.253
7	1200	150	0.5	1.632
8	1200	200	1.0	1.412
9	1200	250	1.5	1.351

Table 4: Surface Finish for insert cutter

JOB NO.	SPINDLE SPEED (rpm)	FEED RATE (mm/min)	DEPTH OF CUT (mm)	Surface finish (R_a) µm
1	800	150	0.5	0.415
2	800	200	1.0	0.594
3	800	250	1.5	0.612
4	1000	150	0.5	0.834
5	1000	200	1.0	1.015
6	1000	250	1.5	1.123
7	1200	150	0.5	1.215
8	1200	200	1.0	1.129
9	1200	250	1.5	1.127

Table 5: Surface Finish for high speed steel

JOB NO.	SPINDLE SPEED (rpm)	FEED RATE (mm/min)	DEPTH OF CUT (mm)	Surface finish (R_a) µm
1	800	150	0.5	0.346
2	800	200	1.0	0.456
3	800	250	1.5	0.594
4	1000	150	0.5	0.731
5	1000	200	1.0	0.912
6	1000	250	1.5	1.005
7	1200	150	0.5	1.116
8	1200	200	1.0	1.015
9	1200	250	1.5	1.112

Metal Removal Rate:

$$MRR = \frac{Vol.Removed}{CT} = \frac{L*W*t}{CT} = W*t*f_m \text{ where,}$$

W= width of cut (mm), t= depth of cut

f_m=feed rate

Table 6: Evaluated Material removal rate

MRR (cm^3/min)
1
2
3
1.33
2.67
3.33
1.67
3.3
5

5.1 INTRODUCTION TO TAGUCHI TECHNIQUE

- Taguchi defines Quality Level of a product because the Total Loss incurred through society because of failure of a product to carry out as preferred whilst it deviates from the added goal performance ranges.
- This consists of prices associated with poor performance, running fees (which adjustments as a product a long time) and any added fees due to dangerous side results of the product in use.
- Taguchi Methods
- Help corporations to perform the Quality Fix!
- Quality problems are due to Noises in the product or technique system
- Noise is any unwanted effect that will increase variability
- Conduct vast Problem Analyses
- Employ Inter-disciplinary Teams
- Perform Designed Experimental Analyses
- Evaluate Experiments the usage of ANOVA and Signal-to noise strategies
- Defining the Taguchi Approach
- Noise Factors Cause Functional Variation
- They Fall Into Three "Classes"
  - –1. Outer Noise – Environmental Conditions
  - –2. Inner Noise – Lifetime Deterioration
  - –3. Between Product Noise – Piece To Piece Variation
- The Point Then Is To Produce Processes Or Products The Are ROBUST AGAINST NOISES

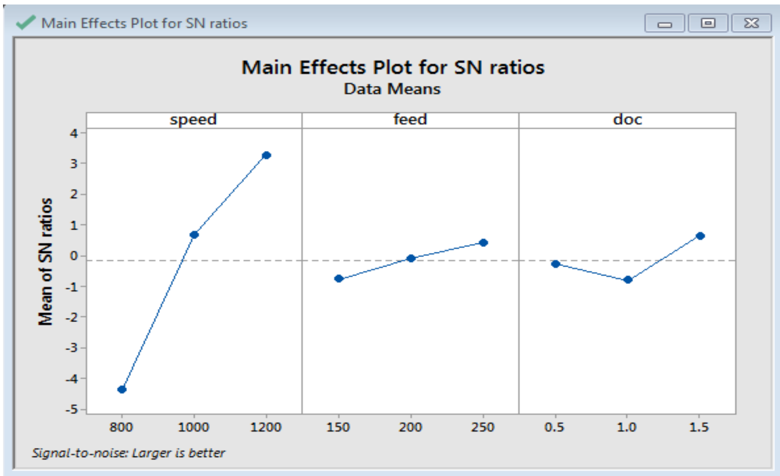
6. RESULTS &DISCUSSION

Table 7: Results table of Surface Finish for carbide

Worksheet 1 ***

↓	C1	C2	C3	C4	C5	C6	C7
	speed	feed	doc	surface	surface1	SNRA1	MEAN1
1	800	150	0.5	0.514	0.520	-5.73063	0.5170
2	800	200	1.0	0.623	0.612	-4.18829	0.6175
3	800	250	1.5	0.691	0.684	-3.25488	0.6875
4	1000	150	1.0	0.912	0.904	-0.83854	0.9080
5	1000	200	1.5	1.114	1.112	0.92989	1.1130
6	1000	250	0.5	1.253	1.243	1.92408	1.2480
7	1200	150	1.5	1.632	1.631	4.25174	1.6315
8	1200	200	0.5	1.412	1.405	2.97506	1.4085
9	1200	250	1.0	1.351	1.350	2.60989	1.3505

Graph 1: Effect of signal to noise ratio

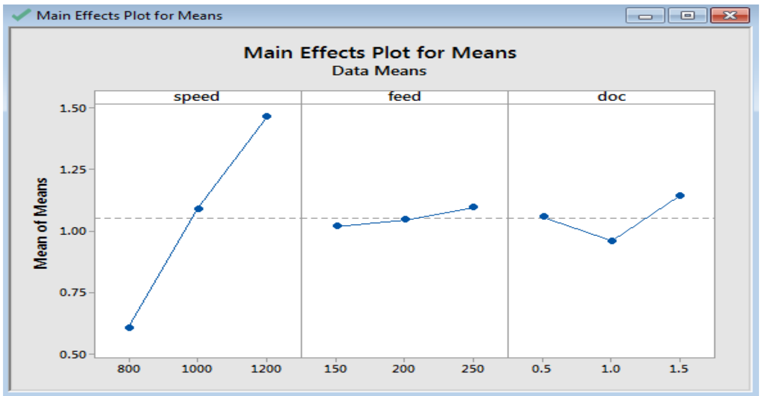


Response Table for Signal to Noise Ratios

levels	**Spindle speed**	**Feed rate**	**Depth of cut**
1	-4.39	-2.323	-0.279
2	1.23	-0.09	-0.805
3	2.27	0.42	0.641

To get better surface finish, the optimal parameters are spindle speed – 1200rpm, feed rate – 250mm/min and depth of cut – 1.5mm.

Graph 2: Effect of signal to noise ratio



7. CONCLUSION

In this thesis an attempt to utilize Taguchi optimization approach to optimize slicing parameters during excessive pace milling of aluminum alloy using cemented carbide reducing device.

The slicing parameters are cutting velocity, feed charge and intensity of reduce for milling of labor piece aluminum alloy6061. In this paintings, the most efficient parameters of reducing pace are 800 rpm, 1000rpm and 1200rpm, feed charge are 150mm/min, 200mm/min and 250mm/min and intensity of cut are 0.5mm, 1.0mm and 1.5 mm. Experimental paintings is carried out by way of thinking about the above parameters. Cutting forces, surface end and slicing temperatures are established experimentally.

Milling experiments could be performed to enhance the surface finish pleasant of aluminum alloy paintings piece through the usage of carbide ,insert cutter, HSS and with the aid of the usage of Taguchi's method which include L9 orthogonal array.

By observing the experimental effects via taguchi, the following conclusions may be made:

After completing the project it can be observed that optimal value of surface finish is obtained at third level of Spindle Speed and it was 1200rpm, third level of Feed Rate and it was 250mm/min and third level of Depth of Cut and it was1.5mm.

After completing the project it can be observed that optimal value of material removal is obtained at third level of Spindle Speed and it was 1200rpm, second level of Feed Rate and it was 200mm/min and second level of Depth of Cut and it was1.0mm.

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