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Process Parameter Optimization Of CNC Milling Of En-31 Using Taguchi Technique

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Abstract: In processing activity, the work-piece is typically taken care of into a pivoting cutting device known as processing shaper. Similarly separated fringe teeth on the shaper interact with the work piece discontinuously and machine the work-piece. Processing machines are utilized to deliver parts having level just as bended forms. The present test examination on End Milling contemplates the cycle boundaries that are influencing the machining execution and efficiency of End Milling. A consolidated methodology is utilized for the streamlining of boundaries and execution attributes dependent on Taguchi strategy. The plan of investigations depends on Taguchi's L9 symmetrical cluster. The reaction table and reaction diagram for each degree of machining boundaries are gotten from Taguchi strategy to choose the ideal degrees of machining boundaries. In the current work, the machining boundaries are Feed Rate, Cutting Speed and Depth of Cut, which are upgraded for most extreme material evacuation rate (MRR), least Surface Roughness during end processing of EN-31.

Keywords: CNC, MRR, EN-31, Process Parameter

1. Introduction:

Processing is a multi-reason and perhaps the most helpful machining activities. End processing measure is quite possibly the most essential thing and regularly experienced material expulsion measures in assembling ventures including the vehicle and aviation area where the quality is a significant factor considered in the creation of spaces, pockets and shape/kicks the bucket. Processing machine is a machine instrument in which metal is taken out through a rotating shaper with numerous teeth, every tooth having a state of the art which eliminates metal from the work-piece. In processing activity, the work-piece is regularly taken care of into a turning cutting apparatus known as processing shaper. Similarly dispersed fringe teeth on the shaper interact with the work piece discontinuously and machine the work-piece. Processing machines are utilized to create parts having level just as bended shapes. Unpredictable shapes, which can't be delivered on other machine apparatuses, can be made on the processing machine. This machine is maybe close to the machine in significance [1]. Processing instrument is a vital and complex part in assembling. Parcel of study and analysis has done on processing device plan by numerous specialists and they are as yet dealing with it. Numerous perspectives like properties of the apparatus, surface harshness, edge sweep, cutting power, vibration, wear and so on are locked in with planning of processing device. Processing is a cycle of delivering level and complex shapes with the utilization of multitooth cutting apparatus (multi point cutting device), which is known as a processing shaper and the bleeding edges are called teeth. The hub of pivot of the slicing device is opposite to the heading of feed, either equal or opposite to the machined surface. The machine that customarily plays out this activity of processing is known as a processing machine. The most well-known cutting instrument utilized with an upward processing is an end-plant, which appears to be a squat turn drill with a smoothed end rather than a point. An end plant can cut a work piece 2 either in an upward direction, similar to a drill, or evenly utilizing the side of the end plant to do the cutting. This even cutting activity forces substantial parallel powers on the apparatus and the factory, so both should be inflexibly developed. By making a progression of level cuts across the outside of a work piece, the end plant eliminates layers of metal at a profundity that can be precisely controlled to around one huge number of an inch (.001").

2. Related Work:

Lately, investigates have investigated various approaches to work on the efficiency and appearance including some remarkable trial idea. Scientists have conveyed investigates various materials with various apparatuses in various conditions to discover the impact of different interaction boundaries of processing on the diverse execution measures. During an examination by Milon D. Selvam et al [2], they completed analyses on gentle steel to decide the impact of cycle boundaries on surface harshness and tracked down that the shaft speed was the most affecting boundary for it. The quantity of passes, profundity of cut and feed rate affected surface unpleasantness.

Neeraj Kumar et al [3] examined about the advancement strategies for CNC processing and introduced an outline of the streamlining methods for CNC processing. They talked about the methods to advance the cycle boundaries for different execution measures. They have additionally examined different boundaries under examination.

A trial study was led by Balinder Singh et al [4] on EN-24 steel for different arrangement of boundaries for example feed rate, cutting pace and profundity of cut. Their investigation

reasoned that the feed rate was the most affecting variable for both material expulsion rate and surface unpleasantness. The axle speed was second most ruling element for material expulsion rate and third for surface unpleasantness. The profundity of cut was least influencing boundary for material evacuation rate yet second for surface harshness.

In another investigation led by Piyush pandey et al [5] on gentle steel utilizing strong carbide device, they tracked down that cutting rate and feed were the most affecting boundaries for the distinctive presentation measures. C.M.

Vikas Pare et al [6] led investigates Al2O3 in addition to SiC metal framework composite to discover the impact of boundaries on surface harshness. Slicing speed was discovered to be the most compelling component for surface unpleasantness.

Amit Joshi et al [7] completed an exploratory examination on Aluminum combination. The examination reasoned that the profundity of cut was the most ruling boundary while feed rate and cutting pace were positioned second and third individually.

V. S. Thangarasu et al [8] did examination on Stainless Steel 304. It was presumed that the profundity of cut was the most crucial factor to further develop MRR and to diminish surface unpleasantness. Different boundaries that are axle speed and feed rate additionally have little impact on MRR and surface unpleasantness. The shaft speed was the second most ruling component for MRR and surface unpleasantness

Mandeep Chahal [9] conveyed an examination on solidified steel H-13 and tracked down that the feed rate was the most ruling element for surface harshness. While profundity of cut and axle speed have little impact on surface harshness of Hardened steel H-13.

3. Methodology:

Taguchi has developed a methodology for the application of designed experiments, including a practitioner's handbook. This methodology has taken the design of experiments from the exclusive world of statistician and brought it more fully into the world of manufacturing [28]. His contributions have also made the practitioner work simpler by advocating the use of fewer experimental designs, and providing a clear understanding of the variation nature and the economic consequences of quality engineering in the world of manufacturing. Taguchi introduces his approach, using experimental design for:

- Designing products/processes so as to be robust to environmental conditions;
- Designing and developing products/processes so as to be robust to component variation;
- Minimizing variation around a target value. This philosophy of Taguchi is broadly applicable. He proposed that engineering optimization of a process or product should be carried out in a three step approach i.e. system design, parameter design and tolerance design. In system design the engineer applies scientific engineering knowledge to produce a basic functional prototype design. In the product design stage the selection of the materials, components, tentative product parameter values etc. are involved. Since system design is an initial step, functional design may be far from optimum in terms of quality and cost.

The target of boundary configuration is to upgrade the setting of interaction boundary an incentive for further developing execution qualities and to recognize the item boundary esteems under the ideal cycle boundary esteems. Furthermore, it is normal that the ideal interaction boundary esteems got from the boundary configuration are heartless toward the variety of natural conditions and other commotion factors. Subsequently, the boundary configuration is the critical advance in Taguchi technique for accomplishing top caliber without expanding cost. Fundamentally, traditional boundary configuration created by Fisher is unpredictable and difficult to utilize particularly, countless analyses must be completed when the quantity of interaction boundaries increments. To tackle this assignment, the Taguchi technique utilizes an extraordinary plan of symmetrical clusters to contemplate the whole boundary space with few examinations as it were. A misfortune work is then characterized to ascertain the deviation between the exploratory qualities and wanted qualities. Taguchi suggests the utilization of the misfortune capacity to gauge the presentation trademark going amiss from the ideal worth. The worth of the misfortune work is additionally changed into a sign to-commotion (S/N) proportion. Generally there are three arrange of execution trademark in the investigation of the S/N proportion that is the lower-the-better, the higher-the-better, and the ostensible the – better. The S/N proportion for each degree of interaction boundary is PC dependent on the S/N investigation. Despite the class of the presentation trademark, the bigger S/N proportion compares to the better exhibition trademark. Thusly, the ideal level of the cycle boundary is the level with the most elevated S/N and ANOVA examination, the ideal mix of the interaction boundaries can be anticipated. At last, an affirmation analyze is led to confirm the ideal interaction boundaries got from the boundary plan. The Taguchi technique is received to get ideal machining execution in the pass on sinking.

1. Larger is better (maximum) : $S/NLB = -1 \log ((1/n) \Sigma (1/yi^2))$
2. Smaller is better (minimum) : $S/NSB = -1 \log ((1/n) \Sigma yi^2)$

4. Result and Discussion:

In present investigation, the experiments are conducted on a Vertical Milling machine of model Surya VF-3 CNC VS

manufactured by BFW. The material under study is EN-31 which had a measured hardness of 65 BHN. The machine specifications are shown in the table 4.1 below. Milling is the second most used machine after lathe machine. The material is removed in form of chips from the work-piece by the help of rotary cutter tool rotating at high velocity. The machine was available at Central Institute of Plastic Engineering and Technology, Lucknow. Figure 1 on the next page shows the SURYA VF 3 CNC VS milling machine.

Table 1: Technical Specification of Surya VF 3 CNC VS Milling Machine

Surya Vf3 Cnc Vs Milling Machine	
Model	VF 3 CNC VS
Table Size(Clamping Area)	106 mm X 315 mm
T-Slots No. / Width / Centre Distance	3 Nos. / 14 mm / 10 mm
Maximum Load on Table	30 Kg
Longitudinal Movement (X)	80 mm
Traverse Movement (Y)	35 mm
Vertical Movement (Z)	38 mm
Position Accuracy	± 0.01 mm
Repeatability	± 0.005 mm

Fig. 1: Surya VF 3 CNC VS Milling Machine

Fig. 2: CNC Panel of VF 3 CNC VS Milling Machine

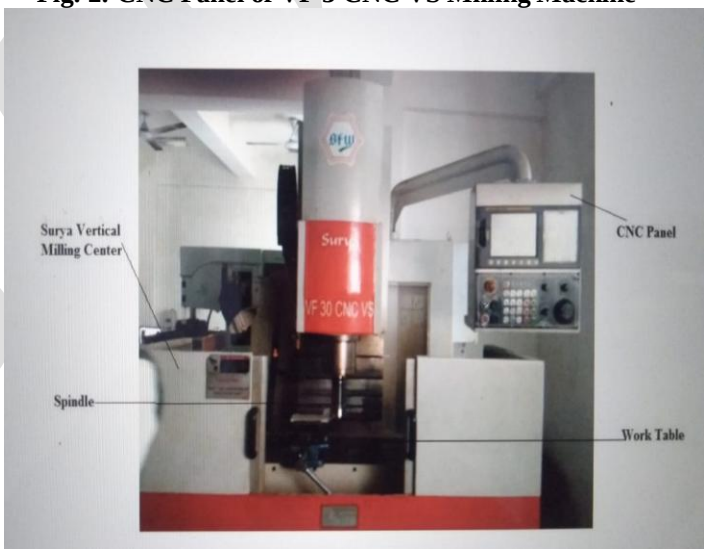

Fig. 3: Setup for Machining

4.1 Work Piece Material

The material used for this work is EN-31 of 50 mm X 50 mm X 10 mm. It is used in industries to manufacture Ball and Roller Bearings, Spinning tools, Beading Rolls, Punches and Dies. By its character this type of steel has high resisting nature against wear and can be used for components which are subjected to severe abrasion, wear or high surface loading.

Table 2 Properties of EN-31

Density (g/cm³)	**Melting point (°C)**	**Yield strength (MPa)**	**Elastic modulus (GPa)**	**Poisson's Ratio**	**Brinell Hardness**
7.80	1540	450	210	0.3	65

Table 3 Chemical composition of the workpiece material (EN-31) by weight

Material	Fe	Mn	Cr	C	Si
% Composition	95.6	0.75	1.42	1.70	0.53

5. Conclusion:

The present experimental investigation was conducted on Surya VF 3 CNC VS vertical milling machine using EN-31 as work piece and HSS as tool to analyze the effect of process parameters viz. feed rate, cutting speed and depth of cut on performance measures viz. material removal rate and surface roughness. The following conclusions were made on the basis of investigation is depth of cut is the most affecting parameter for material removal rate with a contribution of 90.77%. The material removal rate increases with increase in depth of cut. The material removal rate is highest at highest level of depth of cut.

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