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OPTIMIZATION OF PROCESS PARAMETERS OF HIGH SPEED MILLING FOR PHOSPHOR BRONZE

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ABSTRACT

Every day scientists are developing new materials and for each new material, we need economical and efficient machining and it is also predicted that, Taguchi method is a good method for optimization of various machining parameters as it reduces the number of experiments. In the present work, by using taguchi approach the End milling of EN-31 steel alloy is carried out in order to optimize the milling process parameters and to minimize the surface roughness. This paper deals with optimization of selected milling process parameters, i.e. Speed, Feed rate, Depth of cut and coolant flow Taguchi orthogonal array is designed with three levels of milling parameters and different experiments are done using L9 orthogonal array, containing four columns which represents four factors and nine rows which represents nine experiments to be conducted and value of each parameter was obtained. The nine experiments are performed and surface roughness is calculated. The Signal to Noise Ratio (S/N) ratio of predicted value and verification test values are valid when compared with the optimum values. It is found that S/N ratio value of verification test is within the limits of the predicted value and the objective of the work is full filled.

1.0 INTRODUCTION

The objective of this project work is to find out the set of optimum values for the selected control factors in order to reduce surface roughness using Taguchi's robust design methodology and to develop the prediction models for surface roughness considering the control factors. In the present work, Taguchi method is used to determine the optimum cutting milling parameters more efficiently. Four control factors viz. cutting speed, feed rate, depth of cut and coolant flow are investigated at three different levels. The work piece material used is EN-31 steel alloy. Taguchi method is used to optimize the process parameter i.e. surface roughness using signal-to-noise ratio for milling process of the work piece materials. Experiments are carried out using L9 (34) orthogonal array.

Milling process:

Milling is the process of removing extra material from the work piece with a rotating multi-point cutting tool, called milling cutter. The machine tool employed for milling is called milling machine. Milling machines are basically classified as vertical or horizontal.

Computer numerical control

Numerical Control is the automation of machine tools that are operated by precisely programmed commands encoded on a storage medium, as opposed to controlled manually via hand wheels or levers, or mechanically automated via cams alone. Most NC today iscomputer numerical control (CNC), in which computers play an integral part of the control. In modern CNC systems, end-to-end component design is highly automated using computer-aided design (CAD) and computer-aided manufacturing (CAM) programs

Advantages of NC systems over manual methods of production:

Better control of the tool motion under optimum cutting conditions.

- Improved part quality and repeatability.
- Reduced tooling costs, tool wear, and job setup time.
- Reduced time to manufacture parts.
- Reduced scrap.
- Better production planning and placement of machining operations in the hand of engineering.

Problem definition

Advanced materials exhibit very excellent technical properties. However, the high cost of both raw materials and processing reduce their uses. Alternatively advanced machining process such as CNC flame Cutting is normally used. Advanced material such as MS nickel-base alloys, titanium alloys and stainless steel can be used as the work piece in this type of cutting. A torch in which temperatures as high as 30,000°C are achieved by injecting aflame gas tangentially into an electric arc formed between electrodes in a chamber; the resulting vortex of hot gases is emerges at a very high speed through a hole in the negative electrode, to form a jet for welding, spraying of molten metal, and cutting of hard rock or hard metals.

2.0 LITERATURE REVIEW

Abdulkareem, S., Khan, (2011) The Last forty years there is tremendous research in machining and development in technology. With increase in competition in market and to attain high accuracy now a days the non-conventional machining are become lifeline of any industry. One of the most important non-conventional machining methods is CNC flame Machining. It has high accuracy, finishing, ability of machining any hard materials and to produce intricate shape increases its demand in market

Aggarwal, V., Khangura, (2015) Mild steel and stainless steel are difficult to machine in traditional machining method. Wire cut electrical discharge machining (WEDM), a hybrid manufacturing technology which enables machining of all engineering materials. This research article deals with the investigation on optimization of the process parameters of the wire cut EDM of mild steel and stainless steel. Material removal rate, surface roughness, were studied against the wire cut EDM process parameters, such as pulse on, voltage and wire feed rate.

3.0 METHODOLOGY

Traditional experimental design methods are very complicated and difficult to use. Additionally, these methods require a large number of experiments when the number of process parameters increases. In order to minimize the number of tests required, Taguchi experimental design method, a powerful tool for designing high quality system, was developed by Taguchi. This method uses a special design of orthogonal arrays to study the entire parameter space with small number of experiments only.

Various cycles:

- turning
- milling
- Measurement

Figure: FANUC control LCD

Milling Process:

Milling is the process of removing extra material from the work piece with a rotating multi-point cutting tool, called milling cutter. The machine tool employed for milling is called milling machine. Milling machines are basically classified as vertical or horizontal. These machines are also classified as knee-type, ram-type, manufacturing or bed type, and planer-type. Most milling machines have self-contained electric drive motors, coolant systems, variable spindle speeds, and power-operated and table feeds. The three primary factors in any basic milling operation are speed, feed and depth of cut. Other factors such as kind of material and type of tool materials have a large influence, of course, but these three are the ones the operator can change by adjusting the controls, right at the machine.

Surface Roughness

Surface roughness is an important measure of product quality since it greatly influences the performance of mechanical parts as well as production cost. Surface roughness has received serious attention for many years and it is a key process to assess the quality of a particular product. Surface roughness has an impact on the mechanical properties like fatigue behavior, corrosion resistance, creep life, etc

Figure: Surface Roughness

Table: Chemical composition of the materials

Chemical composition of mild steel(AISI 1015)		Chemical composition ofstainless steel(AISI 202J1)	
Elements	Percentage	Elements	percentage
Carbon	0.17	Carbon	0.15
Silicon	0.39	Manganese	7.5

Manganese	0.75	Phosphorus	0.06
Sulphur	0.04	Cr	16
Phosphorus	0.04	Ni	4
Ferrous	Rest	Ferrous	Rest

Taguchi method

Optimization of process parameters is the key step in the Taguchi method to achieve high quality without increasing cost. However, originally Taguchi method was designed to optimize single performancecharacteristics. According to Taguchi method, the S/N ratio is the ratio of Signal to Noise where signal represents the desirable value and noise represents the undesirable value. The response Ra and Kf reported in Table, which is used to calculate the Signal to Noise Ratio (S/N) using the equation. The experimental results are now transformed into a signal-to-noise (S/N) ratio. Since surface roughness and kerf width is desired to be at minimum, so Lower the Better characteristic is used for S/N ratio calculation. The optimal setting would be the one which could achieve lowest S/N ratio.

$$S/N_{LB} = -10 \times \log\left(\frac{1}{r}\sum_{i=1}^{r} y_i^2\right)$$

Where S/NLB is the Signal to noise ratio (Lower the better), yi – output characteristic (Ra) and r no of trials.

4.0 RESULTS

Cutting is the separation of a physical object, or a portion of a physical object, into two portions, through the application of an acutely directed force. An implement commonly used for cutting is the knife or in medical cases the scalpel. However, any sufficiently sharp object is capable of cutting if it has a hardness sufficiently larger than the object being cut, and if it is applied with sufficient force. Cutting also describes the action of a saw which removes material in the process of cutting.

Turning - A single-point turning tool moves axially, along the side of the work piece, removing material to form different features, including steps, tapers, chamfers, and contours. These features are typically machined at a small radial depth of cut and multiple passes are made until the end diameter is reached.

Figure: Turning process of bronze material

Facing - A single-point turning tool moves radially, along the end of the workpiece, removing a thin layer of material to provide a smooth flat surface. The depth of the face, typically very small, may be machined in a single pass or may be reached by machining at a smaller axial depth of cut and making multiple passes.

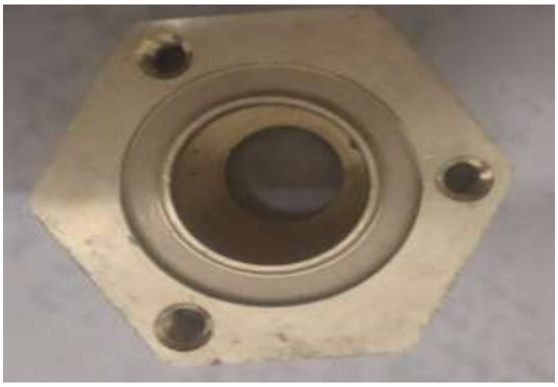
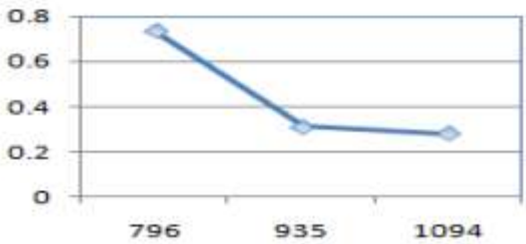
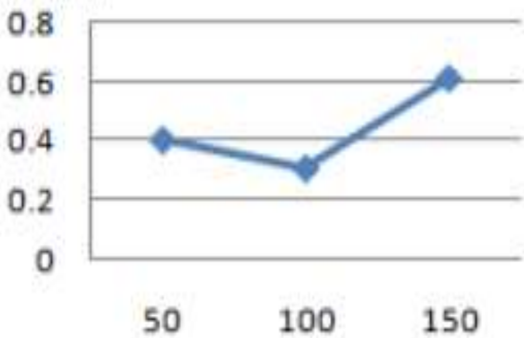


Figure: Facing of the material

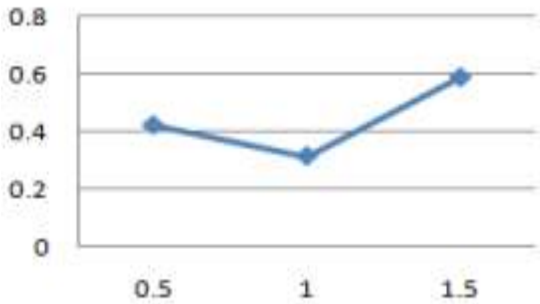
Effect of cutting parameters on surface roughness



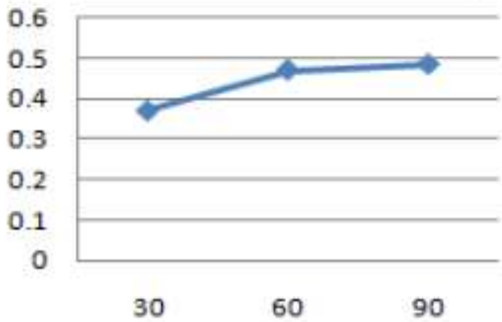
From Fig No, it is observed that, the surface roughness is high at low speed and certainly decreasing from moderate cutting speed to low speed conditions. the surface roughness is high at small depth of cut and certainly decreasing from small depth of cut to moderate depth of cut conditions, but again from moderate to high depth of cut, the surface roughness increases.



Graph:Surface Roughness v/s Feed Rate



Graph: Surface Roughness v/s Depth of Cut



Graph: Surface Roughness v/s Coolant Flow

It is observed that, the surface roughness is low at low coolant flow and certainly increasing from low coolant flow to moderate coolant flow conditions, and again from moderate to high coolant flow, the surface roughness increases. This can be explained by the reason that, surface roughness increases due to temperature, stress and wear at tool tip increases.

Material quality checking grinding process :

Round corner square bars are delivered in the as rolled stage. These bars have rounded edges the radius is approximately,15% of the side length. Round Corner Square Bars are available in standard size ranging from 20 mm to 160 mm.

Figure: Different turning operations of bronze material

CONCLUSION:

Present work is concerned with determining the optimum settings of process parameters for single as well as multi response optimization during EDM of high carbon high chromium steel on the basis of taguchi approach and utility concept. The L25 OA was used for experimental planning. In the first stage (single response) optimal settings of process parameters were obtained individually so as to obtain optimum values for MRR, SR and KW respectivelyThe effect of process parameters cutting speed, Feed, Depth of cut and Tool Hardness on response Characteristics MRR and Surface roughness were studied on 20MnCr5 steel alloy in CNC Turning. The relationship between cutting parameters (cutting speed, feed, depth of cut and hardness of cutting tool) and the performance measures (surface roughness and material removal rate) are expressed by multiple regression equation which can be used to estimate the expressed values of the performance level for any parameters levels. ANOVA suggests that cutting speed is the most significant factor and feed is most insignificant factor for surface roughness and cutting speed is the most significant factor and tool hardness is the most insignificant factor for MRR when the coolant is ON.ANOVA suggests that cutting speed is the most significant factor and feed is most insignificant factor for surface roughness and cutting speed is the most significant factor and feed is the most insignificant factor for MRR when the coolant is OFF.

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