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Comparison of Parameters Non-Conventional Machining Process

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Abstract

The advancement in the technology has resulted in the development in the field of non-conventional machining process. The non-conventional machining process which includes those machining process in which there is no direct contact between the work piece and tool. Non-conventional machining process includes abrasive jet machining (AJM), Water Jet Machining (WJM), Abrasive Water Jet Machining (AJWM), Laser Beam Machining (LBM) and Electron Beam Machining (EBM). In this paper we will discuss the need for the selection of proper machining process for a metal. The paper will show the method and also the process for the comparison for the parameters of non-conventional machining process based on the common parameters like Feed rate, machining time.

Keywords: Non-Conventional Machining**,** AJM, AWJM, WJM, LBM, EBM, Grey Relational Analysis, Semi-finished, highly finished.

1. INTRODUCTION

With the advancement in the technology the non-conventional machining process has developed to become a better solution for the machining of various metals. The Non-conventional machining process provide a good solution to machining where there is requirement of high surface roughness or when there is requirement of machining of complex shapes. The non-conventional machining process also gives a good option for the machining of hard metals. The main characteristic of non-conventional machining process is that there is no direct contact between the tool and the work piece to be machined. The non-conventional machining process also called as the non-traditional machining process works on energies like mechanical, electrical, thermal, chemical, electrochemical and more. [1]

The mechanical process is based on the machining done using the high velocity of particle to strike the work piece for the machining. The thermal process is based on the removal of the material from the work piece by erosion or fusion or the vaporization of the metal.

The chemical process involves the removal of metal from the surface by some chemical reaction like formation of oxide etc. [1]. In spite of having so many benefits the selection of proper machining process for the given metal and shape is a difficult task and has to be done with proper research and analysis work.

The aim of the paper is to propose a process to compare the non-conventional machining process namely (AJM, AWJM, WJM, LBM and EBM) on the basis of three common parameters which are input Metal removal rate (MRR), surface roughness and Machining time and then analyze the result to find the best process for the machining of mild steel. The analysis is proposed by using Grey Relational Analysis on the results of the experiment performed. Grey Relational analysis provides grades to the parameters which can be used to determine the results.

Mentioned below are some examples of the comparison of Non conventional machining process.

1. Comparison of the Non Conventional Machining process based on the material.[1]

Table 1: Comparison based on the material.

Process	AJM	AWJM	ECM	EBM	LBM
Material					
Steel	F	G	G	F	F
Aluminum	F	G	F	F	F
Glass	G	G	NA	F	F
Plastic	F	F	NA	F	F

G- Good Machining

F- Fair

P- Poor Machining

NA- Not Able to Machine

2. Comparison of the Non Conventional Machining process based on the Shapes . [1]

Table 2: Comparison based on the Shape.

Process	AJM	ECM	EDM	EBM	LBM
Shape					
Small Holes	NA	NA	F	G	F
Deep Holes	P	G	F	P	P
Precision	P	F	G	P	P
Standard	F	G	G	P	P

G- Good Machining

F- Fair

P- Poor Machining

NA- Not Able to Machine

Theses comparisons have been done based on the physical property appearance of the results obtained in the experiment. All these results can be classified as the Qualitative comparison of the Non-conventional Machining process.

However it is important to find a Quantitative result for the comparison of the Non-conventional Machining process. This is because the quantities results help us analyze the results in a better way. Example the quantities results help us calculate the closeness of one process to another process in actual terms

In this Paper we will find out the ways to compare the Non-conventional Machining process. Based on the common parameters, the common parameters are the experimental results of the process which are common to all the process and can be compared into to obtain a result conclusion to determine which process is best suited for the material (Mild steel in our case).

The Common parameters in our case are

1. Surface Roughness (Ra & Rz)

2. Material Removal Rate (MRR)

The input parameter which we will vary to find out different results is feed rate.

For the comparison purpose we will consider only the Ra value for the surface roughness as it is most important as per industry point of view.

2. DETAILS EXPERIMENTAL

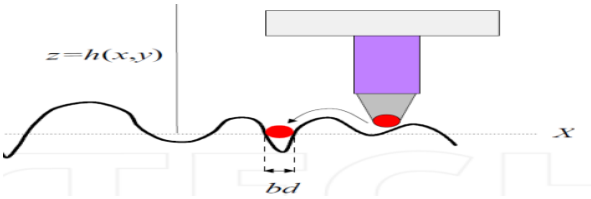
2.1. Materials and Procedures

The experiment can be carried out the work piece of mild steel work piece. Mild Steel is the most commonly used material in the industry. It is easy to manufacture and cost of the material is also less .There are many uses of mild steel like machinery parts and many cookware products and steel frames. The experiment is done by using the jet machining process for the cutting of the work piece and the surface roughness is measured. [2]

2.1.1. Measurement of Surface Roughness

Surface roughness is one of the most important parameters in the industry. The surface quality is the prior requirement of all the industries.

The measurement of the surface roughness can be done by using Roughness Tester. The roughness tester works by measuring the surface by the motion of the stylus pen on the surface of the work piece. The movement of the stylus on the surface of the work piece creates the profile of the surface of the work piece; the calculation of the profile gives the value of the roughness of the work piece. If the value comes as specified in the experiment the readings of the experiment are noted however if the readings of roughness does not lie as per the specification the experiment is rejected and the experiment is conducted again. The experiment is carried out till we have a set of 10 readings for which the values of roughness are as per specification.[4]



[redacted]

Moreover if we require making better analysis of the surface of the work piece, the results obtained in the experimentation can be used to work on the MATLAB Analysis to develop a surface representation of the work piece obtained. [4]

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2.1.2. Bubble Sort

The bubble sort algorithm is used for the sorting of the various and random values into one set that can be used for the comparison purpose. The algorithm is also called as the sinking sort. [5, 6]

2.1.3. Metal Removal Rate

The metal removal rate is the rate at which the metal is removed from the work piece. The metal removal rate is also a measure of the machining quickness as the formulae depends upon the time taken by the machine to complete the machining of the work piece. [7]

$$\text{Formulae for MRR} = \frac{\text{Volume of metal removed}}{\mathbf{T}}$$

2.1.4. Grey Relational Analysis

The Grey Relation analysis is used to compare the parameters based on the quantified analysis and ranking system. The ranking system is based on the weightage based compromising solution to the parameters. The weightage of the parameters is depending upon the importance of individual parameters towards the result.

The Grey Relation analysis is used when there are multiple parameters acting simultaneously towards one result. In our case the common parameters are machining time and surface roughness. [7, 8, 9]

Grey Relation analysis is done by using following steps to compare the parameters:-.

Step 1- Data Pre Processing

This step uses the formulae based upon the requirement of the individual.

If the requirement is for the parameters to be the larger. If the value is large the better the parameter is.[6, 7, 8]

$$Aij = \frac{B_{ij} - Min_i B_{ij}}{Max_i B_{ij} - Min_i B_{ij}}$$

If the requirement is for the parameters to be the smaller. If the value is smaller the better the parameter is**.**

$$Aij = \frac{Max_i B_{ij} - B_{ij}}{Max_i B_{ij} - Min_i B_{ij}}$$

Where Aij =Data preprocessing Value
Bij = value of the cell
Mini Bij= smallest value in the column
MaxBij = Largest value in the column

Step 2- Reference Sequence Generation

This step generates a common sequence for all the parameters; this step converts all the common parametric values to comparable values. [7, 8, 9]

Step 3- Grey Relation Coefficient calculation

The measurement of the values of Aij and Aj is the process of Grey relation coefficient calculation

The formulae used for the calculation is

$$Bij = \frac{(\Delta Min + (\zeta + \Delta Max))}{(\Delta ij + (\zeta + \Delta Max)}$$

Where Bij= grey relation coefficient,
$\Delta Min = min_{ij} \left| Aj - Aij \right|$
$\Delta Max = max_{ij} \left| Aj - Aij \right|$
$\Delta ij = \left| Xj - Xij \right|$
i=1, 2, 3 ……. m
j= 1, 2, 3…….. n

Step 4- Grey Relational Grade calculation

The Grey Relational Grade is calculated based on the total of the product of the weightage of each parameter with the grey relation coefficient. The weightage to each parameter depends on the individual choice. In our case the parameters are MRR and roughness. The highly finished material will require more weightage given to the roughness parameters. On the other hand if our requirement is fast working then more weightage will be given to MRR. The general values of the weightage are 0.5 and 0.75. [7, 8, 9]

$$Bi = \sum_{j=1}^{n} W_j \cdot B_{ij}$$

Where i = 1, 2, 3 ……..m

j = 1, 2, 3 ……..n

Yi = Grey relational grade b/w Xi and Xn

Wj=Weightage of Performance Measure.

3. RESULT AND DISCUSSION

The results will be based on the ranking obtained by the Grey relation Analysis. The Non-conventional machining process which secures the rank one in the analysis will be considered best for the cutting of mild steel.

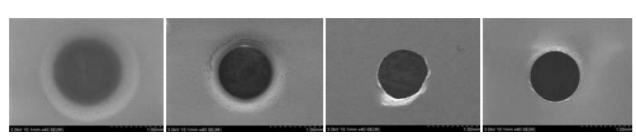

Figure 2: SEM images of top and bottom diameter of the machined holes [3]

However for different condition the rank obtained for the Non-conventional machining process might be different depending onthe grey relational coefficient and the weightage given to each parameter in different conditions.

If the weightage given to the parameters are varied a different set of results can be obtained from the same set of experiments. So from the same we can obtain the conclusion for mild steel cutting in both finished (more weightage given to the surface roughness) and semi-finished (more weightage is given to the metal removal rate).

4.Future Scope

The experiment can be carried out on various different metals and even on different working conditions depending upon the requirement of the industry and the experiment.

Moreover on requirement the measured parameters can also be changed depending on the researcher and his requirement. Some other important parameters that might be considered are the flexibility of the machining process or the cost of the machining process.

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