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Investigation of Machining Parameters in Abrasive Flow Machining of Hybrid Composite Materials using Taguchi Method

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Abstract

Objective: To investigate the effect of parameters XRD for finished workpiece with 20%, 40% and 60% using Taguchi method analysis. **Methods/Statistical Analysis:** The Utility theory and Taguchi methodology has been applied for the improvement of the assorted characteristics of the AFM. 3 potential response parameters i.e., material removal, the development of surface end and scatter of surface roughness square measure taken into thought for sleeve sort finished work of set on. The Utility values of those response parameters square measure analyzed and optimized by mistreatment Taguchi methodology. **Findings:** The individual responses and their correlation are eliminated by mistreatment the purposed methodology. Concentration of abrasive particles and extrusion pressure square measure the necessary parameter for the surface finishing of the work. **Application/Improvements:** AFM are often used for the complicated shapes of work throughout the experiments, parameters love extrusion pressures, abrasive particles and variety of cycles were varied to explore their effects on scatter of surface roughness and Material Removal Rate (MRR).

Keywords: Abrasive Flow Machining, Taguchi Method, Utility Concept etc

1. Introduction

The need of extremely and precise surface finishing of the materials we tend to use completely different quite processes Abrasive flow machining (AFM) is such one quite processes. Abrasive flow machining (AFM) could be an advance and non-conventional machining method. It's used for sharpening, deburring and removal of unwanted material from the surface of the work. AFM are often used for complicated shapes thanks to its flexibility. There square measure 3 major parts for the method to taken i.e. the machine, the work fixture and also the media. The media is semi solid material that is compose of viscous rubber or liquid and abrasive grains.

There square measure 3 quite AFM method that square measure unidirectional method two-way method and orbital method. within the unidirectional method we tend to use single cylinder to hold out the method and media is down by gravitation. In 2 means method we tend to use 2 cylinders during this the media is pushed from one facet and extruded from another facet by the strokes of cylinder during this means cycle is completed. The flow of media on the surface take away the chips and sleek the surface of work. The chips square measure removed by the action of abrasive grains gift within the media. Increasing of chips within the media conjointly will increase the density of the media that reduces the flexibleness of the viscous media. To get surface finishing at small level we tend to use the abrasive grains in small size. The hardness of abrasive grains should we tend to over the hardness of the work permanently surface finishing. With the rise of variety of cycles the fabric removal rate is diminished and also the temperature of the media is enlarged. currently the diesel contraption nozzles, microchannels and

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spring collets square measure finished by the abrasive flow finishing that improve their performance. Materials like soft Al to 0onerous nickel alloys are often machined by this method. during this paper we tend to introduce Taguchi experimental quality style thought on MATLAB and set on take a look at values to point the numerous AFM parameters touching the finishing performance. Choosing the numerous parameters mathematical models are developed and valid.

2. Literature Survey

The material removal (MR) and also the surface roughness is tormented by the media outflow and also the single passages produce the higher results than multi-dimensional passage and also the surface roughness is will increase with length and reduces with cross section[1]. It conjointly complete that because the length of the work will increase the fabric removal rate of the work will increase however the worth of surface roughness decreases.

The hybrid stuff is created with the reinforcement of agro waste and industrial waste improved the performance of work and cut back the value and replacement of fifty of artificial material than the unreinforced material. The reinforcement primarily through with stir casting[2].

The conventional and non-conventional machining have their own benefits and downsides over the historically method. The cutting of composite materials with the historically method is time taking however once the composite materials square measure operated with non-conventional machining the results were found precise and correct and consume less time than ancient machining[3]. So, she completes that each stuff has their own property or characteristics in order that they square measure picked in line with the wants of machining method requirement[4].

The stir casting is with success used for factory-made metal matrix composite with the required properties and also the reinforcement of ceramics in Al increase the mechanical property of the fabric. The addition of polymer inorganic compound and atomic number[5] inorganic compound increase the lastingness, yield strength and also the hardness of the fabric however the plasticity of the fabric is diminished and also the addition of the atomic number[6] increase the lastingness and modulus of the fabric however it decreases the hardness of material[6]. The reinforcement of organic material like coconut ash rice husk ash conjointly enlarged the mechanical property of the fabric. The reinforcement hybrid ceramic enlarged the mechanical property however little literature study of regarding the hybrid ceramics is present[7].

The parts created from complicated shapes square measure onerous to finished specially internally. AFM offer US surface finishing from internally the maximum amount as for complicated shapes conjointly. The viscous material is pushed through the element and extruded from the opposite facet. With the extrusion pressure it reaches the points wherever tool cannot be operated except for the surface finishing the extrusion pressure is very important parameter[8]. If the extrusion pressure is high it leaves the scratches on the surface of the element. This study conjointly unconcealed that because the length of the work is enlarged the surface finishing of the work is additionally enlarged however decreases with cross section of the workpiece[9]. If the viscous material is passage through one dimensional it provides additional surface finishing than the multi-dimensional passage[10].

The different procedures for cutting the chemical compound framework composites like cotton fiber polyester composites. During this study they compared the processes like carbon dioxide optical device, water jet cutting and diamond saw cutting with their method parameters[11]. Seeable of experimentation completed they likely that optical device cutting is best finished water jet and jewelry saw cutting in light-weight of fiber haul get into jewel saw and fiber furling and birth control in multiple directions that is ascertained in water jet cutting. Concerning water jet cutting they commented that fibers is also tormented by water moisture[12].

The solid molecule disintegration of chemical compound grid composites like vinyl ester/glass utilizing Taguchi approach. He selected parameters like impingement speed, have an effect on edge, grating molecule size and standoff take away. S/N quantitative relation analysis is distributed to search out most vital factor[11]. He completes that erosion rates square measure lower at lower values of S/N quantitative relation. Jet impingement purpose demonstrates additional disintegration rate with high estimation of S/N proportion. The grating molecule estimate doesn't assume large half in disintegration rates.

3. Proposed Method

In this project foreshorten the study parameters like Abrasive concentration, variety of parameters and MRR and variation in experimentation of the surface finishing

method within the AFM is optimized by mistreatment the Taguchi methodology. To search out the optimum worth of parameters the ultimate results square measure verified by mistreatment the Taguchi Method[12]. Through experimentation it's been found that the optimum results obtained once variety of XRD cycles is experimented for finished set on, within the results of Taguchi style shows that not all the factors are often controlled that cause variability. The effects of controlled factors with different percentage of Sic in the XRD finished workpiece is shown in Figures 1-3.

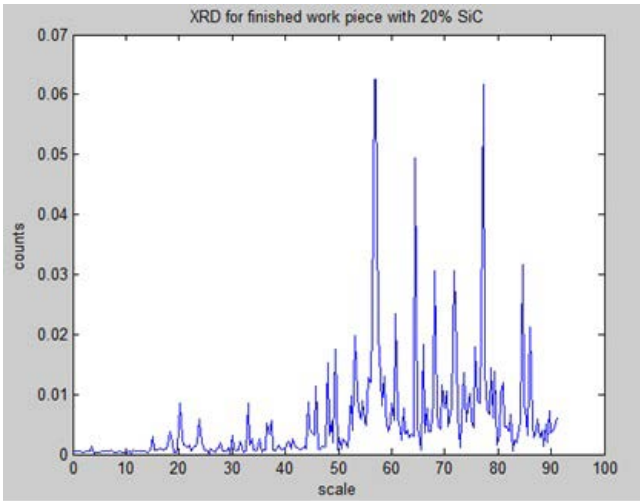

Figure 1. XRD for finished work piece with 20% Sic.

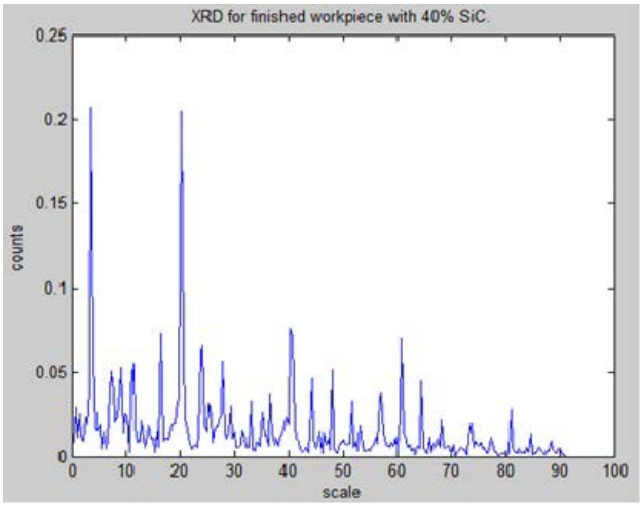

Figure 2. XRD for finished work piece with 40% Sic.

There square measure a number of non-controllable issues gift within the Taguchi style these non-controllable factors referred to as noise factor. The result of noise factors is often reduced by establish the governable factors through Taguchi style.

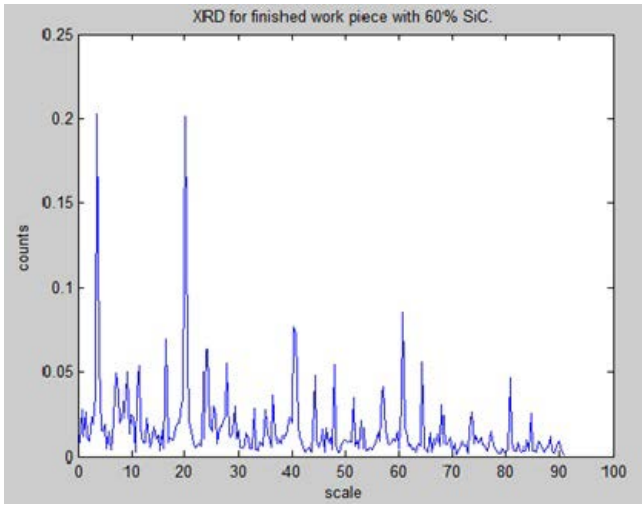

Figure 3. XRD for finished work piece with 60% Sic.

To find out the result of fixing parameters i.e. abrasive concentration, no of scale, no of cycle the work metal removal rate and surface roughness[13]. By use of Taguchi as associate degree improvement methodology we tend to calculate the work MRR and Surface Roughness and see the foremost necessary parameter that effects the work shown in Figures 4-5.

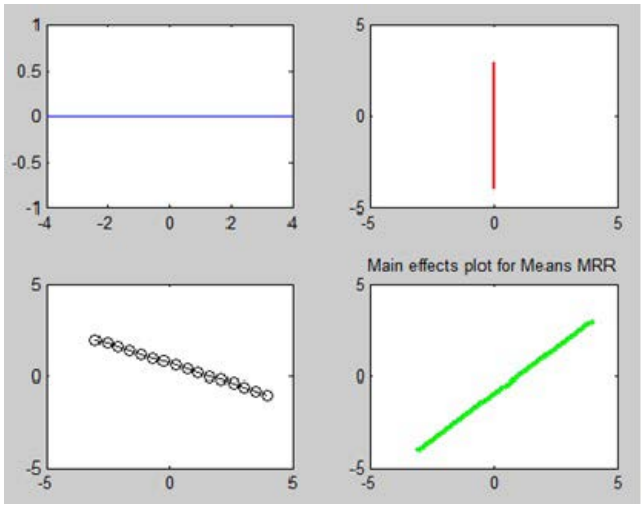

Figure 4. Main effects plot for Means MRR.

When the standard characteristics square measure calculable on the idea of sure variety generally that may be conflicting in nature. Therefore, a combined approach is created for overall performance to live it that should take into the relative contribution of all the characteristics[14]. For determinant the best setting of method, supported Taguchi method and utility thought is developed that live all the multi characteristics method or product.

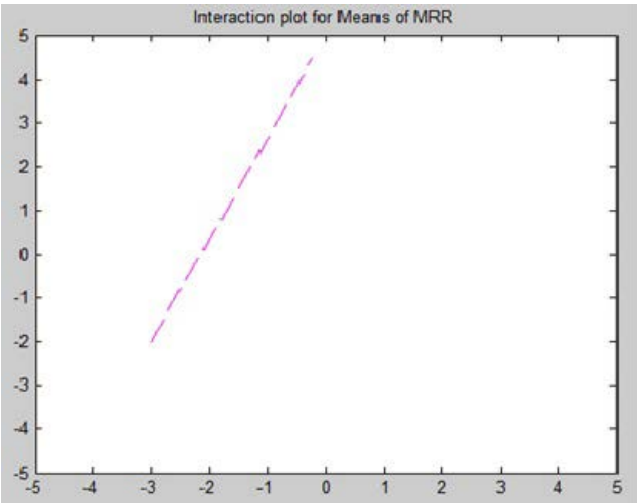

Figure 5. Interaction plot for Means MRR.

4. Determination of Utility Value

To determine its utility value for each quality characteristic a preference scale is constructed. The best value of the quality characteristics can be measured by assigning the two arbitrary or preference number and 0 and 9. On the logarithmic scale the preference number () can be expressed as follow:

$$P_i = A \times \log\left(\frac{X_i}{X_i^{'}}\right) \quad (1)$$

Where,

X_i = value of any quality characteristic or attribute

$X_i^{'}$ = acceptable value of quality characteristic or attribute

A = constant

If $X_i = X^*$ on this condition the value of A can be found (where X* is the optimal or best value), then $P_i = 9$

Therefore,

$$A = \frac{9}{\log\frac{X^*}{X_i}} \quad (2)$$

The overall utility can be calculated as:

$$U = \sum_{i=1}^{n} W_i P_i \quad (3)$$

Subject to the condition:

$$\sum_{i=1}^{n} W_i = 1 \quad (4)$$

Taguchi suggested that, if Utility function is higher than it is better to find out the results. Therefore, the quality characteristics considered for its evaluation will automatically be optimized, if the Utility function is maximized. The optimization can be maximum or minimum as the case is considered.

5. The Multi-Characteristic Optimization Algorithm

The accompanying stepwise methodology for completing multi reaction streamlining with Utility idea and Taguchi method was utilized.

Stage 1: The ideal estimations of the chose execution qualities had been discovered separately by utilizing Taguchi's parameter configuration approach.

Stage 2: Using the ideal qualities and the base levels, inclination scales for every execution trademark had been developed. (Utilizing Equation (1))

Step 3: Weights W_i, i = 1, 2, n, Stage 2: Using the ideal qualities and the base levels, inclination scales for every execution trademark had been developed. (Utilizing Equation (1))

Stage 4: Using Equation (3), the utility qualities for each trial against every preliminary state of the examination had been found.

Stage 5: The got utility qualities in stage 4 were utilized as a reaction of the preliminary states of the chose test design.

Stage 6: The outcomes were broke down utilizing strategy proposed by Taguchi.

Stage 7: The ideal settings of the procedure parameters for ideal utility (mean and least deviation around the mean) had been found.

Stage 8: After considering the ideal critical parameters as decided in stage 7, the individual trademark esteems were anticipated.

Stage 9: Number of affirmation tests had been led at the ideal setting and results were contrasted and the anticipated ideal qualities.

6. Result and Discussion

A simplified model based on the Taguchi method and utility concept was used to analyze the multi-response optimization of XRD for finished work piece Sic AFM. In this present study, the characteristics parameters of

(AFM) abrasive flow machining are taken with three values of variables. For optimization of this operation "Taguchi l9 orthogonal array" was used. Then the out response i.e. depth of indentation is recorded in given figure below. For the optimization MATLAB was used. As concentration of silicone carbide is increased in the workpiece the value of MRR is decreasing it is may be due to random distribution of particles of silicone carbide in the workpiece.

7. Conclusion

Abrasive flow machining is a non-conventional machining which is used to do internal surface finishing. This process is particularly used where the tool cannot reach directly in the internal surface of the workpiece.so with help of media or viscous fluid is used to reach in that area. The viscous fluid produces more abrasion where it is restricted. The surface finish and material removal rate have been directly related to productivity of the workpiece. Here the extrusion pressure is also an important parameter for the surface finish. This optimization problem has been solved by Taguchi method by eliminating individual response by means of the proposed method. Various work-pieces of XRD have been used for the experiments. During the experiments, parameters such as abrasive type, extrusion pressures and number of cycles were varied to explore their effects on MRR and scatter of surface roughness.

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