NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT]
ISSN: 2394-3696
VOLUME 2, ISSUE 4APR.-2015

REVIEW OF ANNOVA TECHNOLOGY FOR CNC MACHINING

Mr. Rohan R. Kurri

Postgraduate Scholar/Solapur University, Maharashtra, India

ABSTRACT

This paper discuss of literature review of EDM and ANNOVA Technology used in on CNC. Today CNC technology has major contribution in industries. CNC machines are main platform in the contribution of good quality products in industries. Basically CNC machines are automated operating machines which are based on code letters, numbers and special characters. The numerical data required for manufacturing a part provided by machine is called CNC (Computer Numerical Controlled). To remain successful in today's competitive market, the manufacturers should rely on their Engineers and production professionals for quick and effective manufacturing setup and also to achieve Quality products. The machining process on a CNC Milling is programmed by speed, feed rate, and cutting depth, which are frequently determined based on the job shop experiences However, the machine performance and the product characteristics are not guaranteed to be acceptable.

KEYWORDS: CNC, SR, MRR, Taguchi, optimization

INTRODUCTION

With the advancement and developments in new technologies, low weight- high strength, high hardness and temperature resistant materials have been developed for special applications such as aerospace, automobile, medical etc. In the machining of hard and metal matrix composite materials, traditional manufacturing processes are being increasingly replaced by more non-traditional machining processes such as Electrical Discharge Machining (EDM). Since the introduction of the WEDM process, it has evolved from a simple means of making tools and dies to the best alternative of producing micro-scale parts with the highest degree of dimensional accuracy and surface finish.

Selection of correct machining conditions is the most important aspect to be taken into consideration while machining a component. WEDM is a complex machining process controlled by a large number of process parameters such as the pulse duration, discharge frequency and discharge current intensity, wire electrode speed, dielectric flow rate etc. Any slight variations in the process parameters can affect the machining performance. Therefore, detailed information of the WEDM parameters and their influence on output machining characteristics should be available before shaping any material into useful application.

This literature reviews the research work with an attempt to understand and interpret the previous work on different aspects related to EDM/WEDM. The literature is subsequently reviewed under different categories as shown in Figure 1.

Investigation and modelling of wedm parameters:

There are number of process parameters associated with WEDM process such as peak current, pulse-on time, pulse-off time, wire electrode material, wire speed, wire tension, flushing pressure, work material properties etc which can be modelled with the outcome responses such as material removal rate, surface roughness, dimensional accuracy, recast layer etc. Several researchers have attempted to improve the performance characteristics but the full potential utilization of this process is not completely solved because of its complex and stochastic nature and more number of variables involved in WEDM operation (Spedding and Wang, 1997).

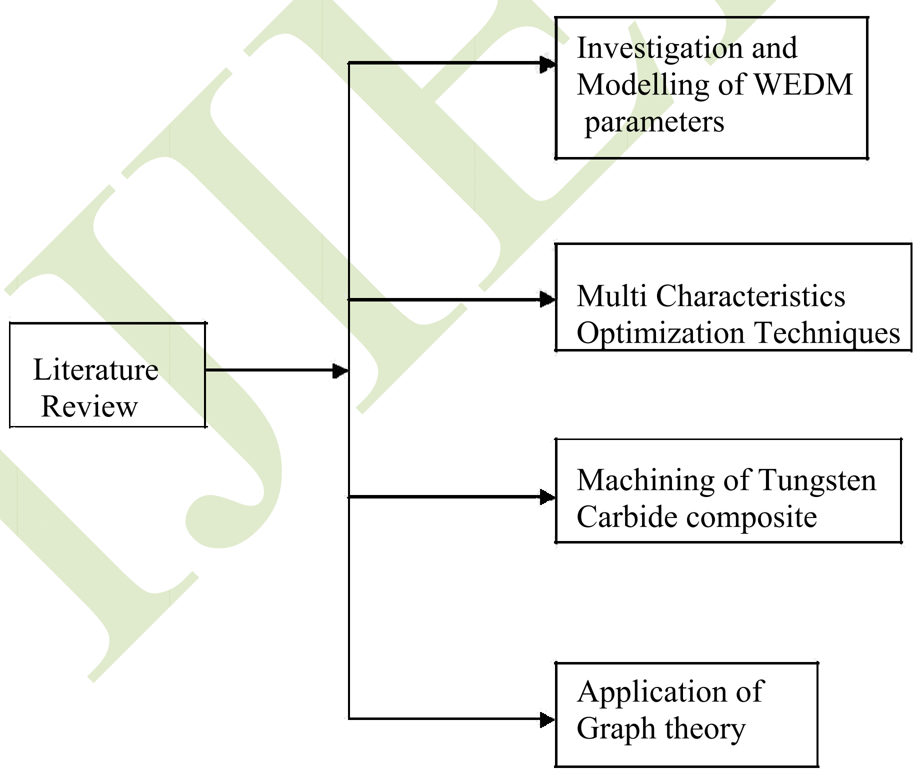

Figure 1 Classification of Literature survey

Tarng et al. (1995) developed a model using neural network and simulated annealing algorithm in order to predict and optimize the surface roughness and cutting speed of WEDM process in machining of SUS-304 stainless steel materials.

Liao et al. (1997) investigated WEDM parameters in machining of SKD11 alloy steel using Taguchi quality design method and analysis of variance (ANOVA). Using regression analysis mathematical models relating to the machining performance namely MRR, SR and gap width with various machining parameters were developed.

Prohaszka et al. (1997) reported the requirements of wire electrode materials for improving WEDM performance. Three kind of wire material namely Mg, Sn and Zn were selected to perform the experiments. It was concluded that the materials used for the fabrication of wire electrodes must be characterized by a small work function and high melting and evaporation temperatures.

Spedding and Wang (1997) attempted to model the cutting speed, surface roughness and surface waviness in wire EDM process through response-surface methodology and artificial neural networks (ANNs). The pulse-width, pulse duration, wire tension and injection set point were selected as input parameters.

Huang et al. (1999) investigated experimentally the effect of various machining parameters on gap width, surface roughness and depth of white layer on the machined workpiece (SKD11alloy steel). They adopted the feasible-direction non-linear programming method for determination of the optimal parameter settings.

Lin et al. (2001) proposed a control strategy based on fuzzy logic to improve the machining accuracy. Multi-variables fuzzy logic controller was designed to determine the reduced percentage of sparking force. The objective of the total control was to improve the machining accuracy at corner parts, keeping the cutting feed rate at fair values. Experimental results show that, machining errors of corner parts, especially in rough-cutting, could be reduced to less than 50% of those in normal machining, while the machining process time increased not more than 10% of the normal value.

Liao et al. (2002) used a feed-forward neural network with back propagation algorithm to estimate the work piece height. The developed model could successfully estimate the work piece height. Based on the on-line estimated work piece height, a rule-based strategy for adaptive parameters setting was proposed to maintain stable machining and to improve the machining efficiency.

Puri and Bhattacharyya (2003) carried out an experimental investigation based on Taguchi method involving thirteen control factors in WEDM process comprising a rough cut followed by a trim cut. The main influencing factors were determined for given machining criteria such as average cutting speed, surface finish characteristics and geometrical inaccuracy caused due to wire lag.

Ho and Newman (2003) presented the review of vast research work carried out from the inception to the development of die-sinking EDM within the past decade. It reports the EDM research relating to improving performance measures, optimizing the process variables, monitoring and control of sparking process, simplifying the electrode design and manufacturing. A range of EDM applications were highlighted together with the development of hybrid machining processes.

Tosun et al. (2003) studied the effect of cutting parameters on size of erosion craters (diameter and depth) on wire electrode in WEDM. Brass wire of 0.25 mm diameter and AISI 4140 steel of 0.28 mm thickness were used as tool and work piece materials in the experiments. It was found that, increasing pulse duration, open circuit voltage and wire speed increases the crater size, whereas increasing the dielectric flushing pressure decreases the crater size. The variation of wire crater size with machining parameters was modelled mathematically by using a power function.

Saha et al. (2004) developed a finite element model and optimization procedures for analyzing the process of wire electro-discharge machining. The results of modeling and optimization showed that non uniform heating is the most important variable affecting the temperature and thermal strains.

Miller et al. (2004) reported the effect of spark on-time duration and spark on-time ratio on MRR and surface integrity of four types of advanced material; porous metal foams, metal bond diamond grinding wheels, sintered Nd-Fe-B magnets and carbon–carbon bipolar plates. Regression analysis was applied to model the WEDM process. Scanning electron microscopy (SEM) analysis was done to investigate the effect of important WEDM parameters on surface characteristics.

Huang et al. (2004) reported the microstructure analysis for martensitic stainless steel quenched and then tempered at 600°C. Specimens were finished with either 4 or 5 cutting passes. Negatively polarized wire electrode (NPWE) was applied in the first four cutting passes, except the last cutting pass, in which the positively polarized wire electrode (PPWE) was used. Craters and martensitic grains were registered in SEM micrograph for finished surface, machined after the 4th cutting pass. From the results of transmission electron microscopes TEM-examination, a heat-affected zone (HAZ) of 1.5μm thick was detected in the surface layer finished with NPWE.

Liao and Yu (2004) presented a new concept of specific discharge energy (SDE), a material property in WEDM. The relative relationship of SDE between different materials remained fixed as long as the materials were machined under the same machining conditions. Under steady machining process, the smaller discharge gap resulted in higher discharge efficiency. Shorter the normal discharge on time, higher was the discharge efficiency. Using the characteristics of SDE, determination of parameter settings for different materials could be greatly simplified.

Ho et al. (2004) reviewed the vast array of research work carried out from the spin-off from EDM process to the development of WEDM. They reported the WEDM research involving the optimization of process parameters surveying the influence of various factors affecting the machining performance and productivity. They highlighted the adaptive monitoring and control of the process investigating the feasibility of different control strategies for obtaining the optimal machining conditions.

Tosun et al. (2004) modelled the variation of response variables with the machining parameters in WEDM using regression analysis method. Simulated annealing method was then applied to determine the machining parameters that can simultaneously optimize kerf and MRR.

Sarkar et al. (2005) performed experimental investigation on single pass cutting of wire electrical discharge machining of γ-TiAl alloy. The process was successfully modelled using additive model. The process was optimized using constrained optimization and pareto optimization algorithm. Based on constrained optimization algorithm the WEDM process was optimized under single constraint as well as multi-constraint condition. By using pareto optimization algorithm, the 20 pareto optimal solutions were searched out from the set of all 243 outputs.

Hewidy et al. (2005) correlated the inter-relationship among various input parameters namely peak current, duty factor, wire tension and water pressure with output measures namely material removal rate, wear ratio and surface roughness in wire electrical discharge machining of Inconel 601.

Kuriakose and Shunmugam (2005) used a multiple regression model to represent relationship between input and output variables to optimize WEDM process. Multi-objective optimization method based on a non-dominated sorting genetic algorithm (NSGA) was used further. The sorting procedure employs a fitness assignment scheme which prefers non dominated solutions and uses a sharing strategy which reserves diversity among the solutions.

Sarkar et al. (2005) formulated mathematical models to predict the cutting speed, surface roughness and dimensional deviation as the function of different control parameters in WEDM of γ-titanium aluminide alloy. They determined the optimal process parameters by applying constrained optimization technique in which one performance characteristic was optimized considering others as constraints.

Manna and Bhattacharyya (2006) established mathematical models relating to the machining performance criteria like material removal rate (MRR), surface roughness (SR) and spark gap and gap current using the Gauss elimination method for effective machining of Al/SiC-MMC.

Hargrove and Ding (2007) applied finite element method (FEM) to determine work piece temperature for different machining parameters. They investigated the effect of WEDM parameters namely discharge voltage and pulse on-time on damaged layer thickness on machined work surface of low carbon steel (AISI 4340). The thickness of the temperature affected layers for different cutting parameters was computed based on a critical temperature value. By minimizing the thickness of temperature affected layers and satisfying a certain cutting speed, a set of the cutting process parameters were determined for work material.

Mahapatra and Patnaik (2007) developed relationships between various process parameters and responses like MRR, SR and kerf by means of non-linear regression analysis and then genetic algorithm was employed to optimize the WEDM process with multiple objectives.

Kanlayasiri and Boonmung (2007) investigated influences of WEDM machining variables namely pulse-on time, pulse-off time, peak current and wire tension on surface roughness of newly developed DC53 die steel. The variables affecting the surface roughness were identified using ANOVA technique. Results showed that pulse-on time and pulse-peak current are significant variables to the surface roughness of wire-EDMed DC53 die steel. The maximum predicted error of the model was less than 7% and the average percentage error of prediction was less than 3%.

Chiang et al. (2008) presented a methodology for modelling and analysis of the rapidly solidified layer of spheroidal graphite (SG) cast iron in the EDM process using the response surface methodology (RSM). The input parameters considered were the quantity, diameter and the area fraction of spheroidal graphite particle. The performance measures were resolidified layer thickness and ridge density.

Sarkar et al. (2008) developed a second order mathematical model using response surface methodology (RSM) in terms of machining parameters and performance measures in trim cutting of wire electrical discharge machining of γ-TiAl alloy. The experimental plan was based on the face centered central composite design (CCD). The residual analysis and experimental results indicate that the proposed models could adequately describe the performance indicators within the limits of investigated factors.

Choi et al. (2008) studied the effect of machining methods and heat treatments on the service life of a press die made of die steel STD11. On-line experiments for the service life of a press die for a chain product showed that the quality of the die made by high temperature heat treatment after machining with wire-EDM could be as good as those made by milling and then grinding.

Sanchez et al. (2008) presented an approach to predict the angular error in wire EDM taper cutting. A systematic analysis of the influence of process parameters on angular error was carried out using design of experiments (DoE) techniques.

Ramakrishnan and Karunamoorthy (2008) developed artificial neural network (ANN) models and multi response optimization technique to predict and select the best cutting parameters for wire electro-discharge machining (WEDM) process. Inconel 718 was selected as work material to conduct experiments and brass wire of 0.25mm diameter was used as tool electrode. Experiments were planned as per Taguchi‟s L-9 orthogonal array. Experiments were performed under different cutting conditions of pulse on time, delay time, wire feed rate and ignition current. It was found that the pulse on time, delay time and ignition current has more influence than wire feed rate on performance characteristics considered in the study. An MRR was improved with increase in pulse on time and ignition current. But the surface quality of the work specimen was affected adversely with increased value of pulse on time and ignition current.

Çydas et al. (2009) developed an adaptive neuro-fuzzy inference system model for the prediction of white layer thickness and average surface roughness as a function of process parameters. Pulse-duration, open circuit voltage, dielectric fluid pressure and wire feed rate were taken as model‟s input parameters.

Wang et al. (2009) explored the feasibility of removing the recast layer after EDM process, using etching and mechanical grinding for Ni-based superalloy material. In first stage of experiments, a thick recast layer was acquired by using EDM with high discharge energy. The second stage optimizes the recast layer removal technique. L9 orthogonal array set up the etching and mechanical grinding parameters and observes the recast layer removal quantity. Finally, surface characteristics of Ni-based superalloy have been investigated.

Prasad and Krishna (2009) presented a model for material removal rate and surface roughness in terms of input variables using response surface methodology. Non-dominated sorting algorithm was then applied to obtain the preto-optimal solutions for optimization purpose.

Patowari et al. (2010) attempted to model the surface modification phenomenon by EDM with artificial neural networks. Two output measures namely material transfer rate and average recast layer thickness were correlated with different process parameters.

CONCLUSION/IDENTIFIED GAPS IN THE LITERATURE

After a comprehensive study of the existing literature, a number of gaps have been observed in machining of tungsten carbide with WEDM.Most of the available literature on machining of tungsten carbide (WC-Co) composite deals with sinking EDM. Machining of tungsten carbide yet to be tried on WEDM (Garg et al., 2010). Researchers have investigated the influence of a limited number of process parameters on the performance measure of WC-Co composite on EDM/WEDM. Only two machining characteristics namely material removal rate and surface roughness has been investigated, on EDM/WEDM of WC-Co composite, so far. No investigation found related to intricate machining of WC-Co composite on WEDM which focus on multi machining characteristics in applications like die manufacturing. Researchers have focused on recast layer as a major flaw on surfaces machined on WEDM. But in die cutting with WEDM some unmachined area always exist after rough cutting operation which has not been investigated yet. In order to solve the machining problems, several process parameters and their interdependencies need to be considered. Graph theory is a simple and effective tool to solve these problems which has been utilised in many engineering applications. No literature has been found regarding the application of graph theory on WEDM.

REFERENCES

The references are already discussed in the literature Review.