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A Review Study On Optimisation Of Process Of Wedm And Its Development

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Abstract: *Wire-cut Electrical Discharge machining is a non-conventional machining method used to cut hard to machine material, which are difficult to process by conventional processes. The applications of WEDM are in automobiles, aero-space, medical instruments, tool and die industries. Productivity and quality are two important aspects have become great concerns in today's competitive global market. Every production/manufacturing unit mainly focuses on these areas in relation to the process as well as product developed. Since wire-cut EDM has experienced explosive growth in application users demand and need maximum productivity and through-put, increased accuracy, and predictable performance. WEDM is now growing as an important process in various fields. This process is based on the a continuously moving conductive wire acts as an electrode and material is eroded from the work piece by series of discrete sparks between the work piece and wire electrode separated by a thin film of dielectric fluid. The dielectric is continuously fed to the spark zone to flush away the eroded material and it acts as a coolant. This Review Research paper is based on the development and processes of WEDM.*

***Index Terms*:** *Wire-cut Electrical Discharge Machine, Process, Development, Non-conventional machining process.*

I. Introduction

Wire electrical discharge machining involves complex physical process including heating and cooling. The electrical discharge energy, affected by the spark plasma intensity and the discharging time, will determine the crater size, which in turn will influence the machining efficiency and surface quality. Hence, the operating parameters should be chosen properly so that a better performance can be obtained. However, the selection of appropriate machining parameters for WEDM is difficult and the operation has more roles to play[1]. The process doesn't deal with the metal chip and only water is used as an electrode. Wire-EDM as a precision cutting technology is possible to fabricate from a small range of product to a large size of component. All types of good conductivity metal such as mild steel and copper are possible to be cut using wire-EDM. However, machine setting varies for each type of metals. So, certain parameters need to be clearly defined for each of materials. The setting is easy tuned for a straight line and become more difficult for the curve or part which is involving an angle. Rough cutting operation in wire EDM is treated as challenging one because improvement of more than one performance measures viz.[2]. Very high temperature ranging 8000 C° - 10000 C° creates during machining, so that minute amount of material removal may takes place by not only melting but directly vaporizations, which are then ejected and flushed away by influence of dielectric fluid. Manufacturing processes (WEDM) has been chosen depending on the material characteristics and the type of responses required to evaluating. Many attempts has been made to modelled the EDM processes for improving responses smooth surface with high MRR, but still it is challenging, which restrict the expended application of the technology[3].

Working Principle of WEDM

A model of WEDM is shown in fig.1. The electric discharge is caused to occur erratically in a pulse-like manner between an electrode wire and a work piece through a processing liquid so as to fuse-cutting the work piece in a desired configuration. A pulse voltage is applied between the wire electrode and workpiece in the processing fluid to melt the surface of the workpiece by the thermal energy of an arc discharge, while at the same time removing machining dust through a vaporizing explosion and recirculation of the processing fluid.

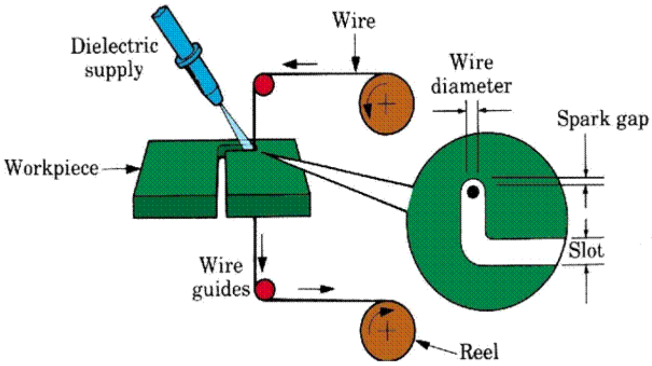

Fig. 1. Schematic of Wire EDM[1]

The residue resulting from the melting of a small volume of the surface of both the workpiece and the EDM wire electrode is contained in gaseous envelope .The plasma eventually collapses under the pressure of the dielectric fluid. The liquid and the vapour phases created by the melting are quenched by the dielectric fluid to form solid debris. This process is repeated at nanosecond interval along the length of the wire in cutting zone. The most important performance measures in WEDM are metal removal rate, surface finish, and cutting width. They depend on machining parameters like discharge current, pulse duration, pulse frequency, wire speed, wire tension and dielectric flow rate.

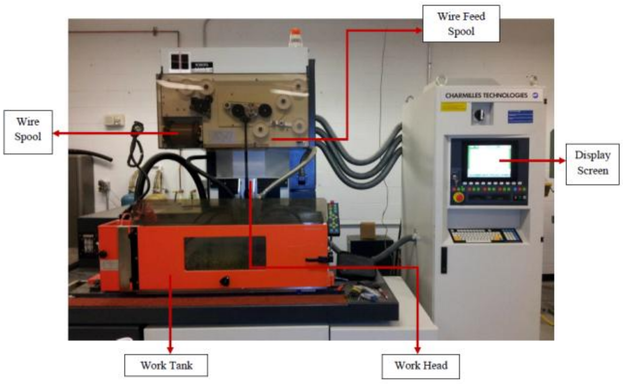

Fig. 2. WEDM Machine[2]

The internal corner radius to be produced in WEDM operations is also limited by the kerf. The gap between the wire and work piece usually ranges from 0.025 to 0.075 mm and is constantly maintained by a computer controlled positioning system. Here we can see the WEDM Process containing process parameters and responses.

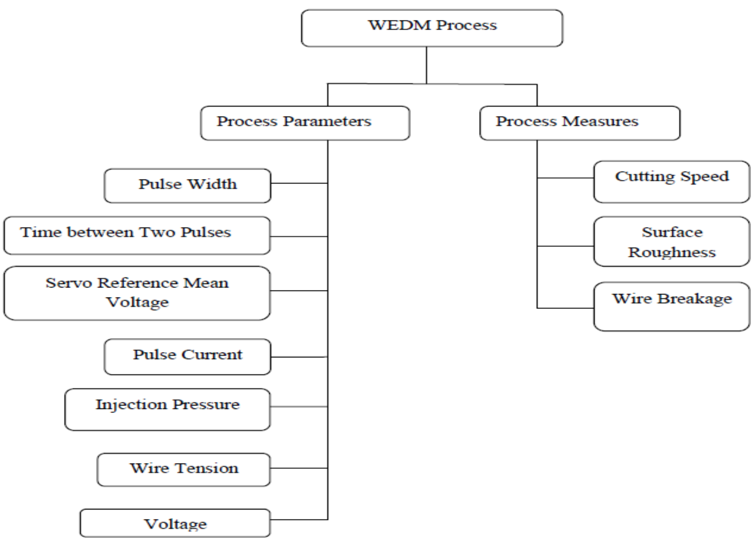

Fig.3 . WEDM Process

Importants Parameters In Wedm
1 Pulse Width The pulse width is referred as A and all the process is done during pulse duration (on time). During this time the voltage is applied across the electrodes, the current is generated and the work is accomplished.
2. Time between Two Pulses
Time between two pulses is referred as B. In time between two pulses, the pulse rests and re-ionization of the dielectric take place since the machining take places during one pulse width
3. Servo Reference Mean Voltage The servo reference mean voltage is represented by Aj. The width of the gap between wire electrode and work piece is determined by servo voltage. The gape size increases with a high voltage setting that increases flushing and machining.
4. Striking Pulse Current
The pulse current is represented by IAL. Pulse current is also another crucial primary input of WEDM process.
5. Injection Pressure
Injection pressure is for selection of flushing input pressure of the dielectric. Dielectric fluid rushes into the work piece to cool the area and remove eroded material. Input pressure of de-ionized water has a direct relation with the work piece thickness.
6. Wire Tension
Wire tension determines the amount of stretch in wire between upper and lower wire guides. Higher wire tension is required for cutting work piece with more thickness. Low wire tension is used for cutting thin work pieces. Inaccuracy in job and wire breakage may happen because of improper setting of tension.
7. POLARITY
Polarity can be either positive or negative. The current will pass through the gap and create high temperature that will cause the material to evaporate at both the electrode spots.
The plasma channel is made of ion and electron flows. Electrons have mass smaller than anions and as the electrons processes it shows quicker reaction, the anode material is worn out predominantly.

II. Literature Survey

A literature survey was made on the various optimization techniques that have been used for these WEDM process parameters. All have used different material for their work. So some of them are as:

Alpesh M. Patel et a[1] (2013), Optimization of operating parameters is an important step in machining, particularly for operating unconventional machining procedure like Wirecut Electro Discharge Machining. Since wire-cut EDM has experienced explosive growth in application users demand and need maximum productivity and through-put, increased accuracy, and predictable performance. Also machines and job requirements vary greatly, which can make selection of the correct operation parameters a daunting task. As a result, experimentation is necessary if optimum results are to be achieved. Although this reference is not intended to be all-encompassing, it should be a useful guide for selection of parameters. A suitable selection of machining parameters for the process relies heavily on the operator's technologies and experience and they do not provide the optimal machining conditions. In every manufacturing process, material removal rate needs to be maximized while controlling quality by controlling electrode wear rate. In this work, an attempt has been made to optimize the machining parameters for minimum electrode wear rate and maximum material removal rate in WEDM process. Experiments were performed under different cutting conditions of Wire feed (WF), wire tension (WT), discharge current of the machine and discharge voltage (V). Experiments were executed as per Taguchi's L-9 orthogonal array. The output responses were optimized using signal-to-noise (S/N) ratio in addition to Desirability function approach to convert a multi objective optimization problem to a single objective optimization problem.

Dr. K. Varatharajan et al 2014, Wire-cut Electrical Discharge Machining (WEDM) is extensively used in machining of conductive materials producing intricate shapes with high accuracy. This study exhibits that WEDM process parameters can be altered to achieve betterment of Material removal rate (MRR), Surface Roughness (SR) and Electrode Wear**.** The objective of our project is to investigate and optimize the potential process parameters influencing the MRR, SR and Electrode Wear while machining of Titanium alloys using WEDM process. This work involves study of the relation between the various input process parameters like Pulse-on time(Ton), Pulseoff time(Toff), Pulse Peak Current(IP), Wire material and Work piece material and process variables. Based on the chosen input parameters and performance measures L-16 orthogonal array is selected to optimize the best suited values for machining for Titanium alloys by WEDM.

U.K.Vates et al 2014, Aimed to investigate the experimental process and surface roughness optimization of cold working, high carbon high chromium hardened die (D2) steel during Wire Electrical Discharge Machining processes. Response Surface Methodology (RSM) and an Artificial Neural Network (ANN) approaches have been applied to investigate the effect of six independent input parameter namely gap voltage (V_g), flush rate (F_r), Pulse on time (T_{on}), pulse off time (T_{off}), wire feed (W_f) and wire tension (W_t) over CLA value of surface roughness (R_a) and material removal rate (MRR). A fractional factorial Design of Experiment of two level were employed to conducted the experiment on D2 die steel with chromium coated copper alloy wire electrode . The responses, CLA values of SR and MRR were observed by combined approach of training, validation and testing programme in MATLAB 2010a and mathematical modelling using RSM on experimental data respectively. Significance coefficients were observed by performing analysis of variance (ANOVA) at 95% confidence level. Prediction against second order RSM mathematical modelling technique is the best performing to MRR and ANN Modelling has most significant for surface roughness by conducting only very less experimentation.

Sanjay Kumar Majhi et al [4] (2013), This paper presents a hybrid optimization approach for the determination of the optimal process parameters which maximize the material removal rate and minimize surface roughness & the tool wear rate. The input parameters of electrical discharge machining considered for this analysis are current, pulse duration and pulse off time. The influences of these parameters have been optimised by multi response analysis. The designed experimental results are used in the gray relational & the weight of the quality characteristics are determined by the entropy measurement method. The effects of the parameters on the responses were evaluated by response surface methodology, which is based on the optimization results.

Anjali V. Kulkarni et al [5] (2007), Synchronised study of the process revealed that the discharge temperature rise is due to the bombardment of the electrons generated during the the discharge process. At times, the temperature rise at the discharge-affected zone is of the order of the boiling temperature of workpiece material. Machining, and hence, the material removal takes place. Geometry of the discharge-striking zone, and hence, the machining can be performed in the micron region using this process. The dimensions can be further reduced by reducing the geometry of the cathode tip, and by careful design of the process and its parameters. Close-loop control of the process can be achieved. Experiments are performed with graphite anode, 2 mm thick copper wire as cathode, and copper workpiece in 2.5 cm x 2.5 cm dimensions with 0.6 mm thickness. The working voltage is 155 V. Hydrochloric acid with 5 per cent concentration is used as electrolyte. Workpiece and cathode separation is of the order of 600 m.

A Thillaivanan, P.Asokan et al [6] (2010), Optimization of operating parameters for EDM process based on the Taguchi Method and Artificial Neutral Network. In this paper the complexity of electrical discharge machining process which is very difficult to determine optimal cutting parameters for improving cutting performance has been reported. Optimization of operating parameters is an important step in machining, particularly for operating unconventional machining procedure like EDM. An approach to determine parameters setting is proposed. Based on the Taguchi parameter design method and the analysis of variance, the significant factors affecting the machining performance such as total machining time, oversize and taper for a hole machined by EDM process, are determined.

Ashok Kumar et al [7] (2007), Experimental Investigation of Machine parameters for EDM using U shaped electrode using Taguchi experiment. Where diameter of U-shaped electrode, current and pulse on time are taken as process input parameters and material removal rate, tool wear rate overcut on surface of work piece are taken as output parameters. Taguchi method of eighteen experiments were performed on electronica make smart CNC electric discharge machine and relationships were developed between input and output parameters. The study indicates that MRR increased with the discharge current (Ip). As the pulse duration extended, the MRR decreases monotonically. In the case of Tool wear rate the most important factor is discharge current then pulse on time and after that diameter of tool. In the case of over cut the most important factor of discharge current then diameter of the tool and no effect on pulse on time.

Ajeet Bergaley, Narendra Sharma et al [8] (2013), Optimization of Electrical and Non Electrical factors in EDM for machining Die steel using copper electrode by adopting Taguchi Technique. This paper presents a work on the performance parameter optimization for material removal rate (MRR) and electrode wear rate (EWR). There are electrical and non-electrical factors which influences MRR and EWR such as voltage, current, pulse on time, pulse off time, dielectric fluid material, flushing pressure, tool rotation etc. in this paper both the electrical factors and non-electrical factors has been focused which governs MRR, EWR and there optimization. This was based on design on experiments and optimization of EDM process parameters. The technique used is Taguchi technique which is a statistical decision making tools help in minimizing the number of experiments and the error associated with it.

Nikhil Kumar, Lalit Kumar et al [9] (2012), Comparative study for MRR on Die-sinking EDM using electrode of copper & graphite. In their research Die-sinker EDM using copper and graphite electrode experiment has been done for optimizing Performance parameters and reducing cost of manufacturing, finally it is found that a silver electrode give better performance in certain characteristics but the cost become high for machining so keeping in mind cost and other some characteristics a graphite electrode is more suitable than copper electrode in case of both MRR and TWR.

III. Conclusion

From the literature review, it may therefore be concluded that there could have been more research on this WEDM machine parameters and their response parameters. Response parameters could be Material Removal Rate (MRR), Surface Roughness and Tool wear Rate. Various Researchers have done their work with different materials and different tool materials. So here are some points which consider their work.

1. The hardness and strength of the work material are no longer the dominating factors that affect the tool wear and hinder the machining process.
2. Some novel material like metal matrix composite can also be another thrust area for research.
3. The increasing pulse duration and open circuit voltage increase the wire wear ratio whereas the increasing wire speed decreases it.
4. The surface roughness can be improved by decreasing both pulse duration and discharge current.

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