International Journal of Engineering Research in Current Trends (IJERCT)
ISSN: 2582-5488, Volume-2 Issue-3, Jun 2020

Experimental Investigation of Process Parameters on the Performance of WEDM Process Using Nicrofer 3718

Anu Thomas
Mechanical Engineering Department, SIRT-Excellence, Bhopal, India, email:eranuthomas@gmail.com

Dr. Dharmendra Tyagi
Mechanical Engineering Department, SIRT-Excellence,Bhopal, India email: dharmendratyagi87@gmail.com

***Abstract*—The machine tool industry has steadily increased its manufacturing capabilities over the last decade but still machine tools have not been used at their full potential. This limitation is the result of failure to run machine tools at their optimal operating conditions. The problem of operating parameters reaching optimal levels has attracted the attention of researchers and practicing engineers for a very long time. The aim of the present work is to investigate the effects of various process parameters on the quality of cuts in wire electrical discharge making (WEDM) and parametric optimization of process parameters in WEDM for work materials. The quality of the cut is observed through evaluating the surface roughness and material removal rate. The objective of optimization is to achieve the best cut quality together with high material removal rate. The machining parameters chosen for this work are peak current, pulse on time, and pulse off time. In this research, Taguchi technique (L27) was selected for optimization of processes.**

This study discusses the impact of process parameters such as pulse on time, pulse off time and Current on the performance parameters such as material removal rate and surface roughness. Nicrofer 3718 is using as work piece and molybdenum wire has been used in WEDM Process. The experimental layout is based on the Taguchi L27 orthogonal array.

Analysis of the results obtained for the material removal rate indicated that time and electric current have the most influence on the material removal rate and surface roughness. As the current and pulse increase over time, the material removal rate also increases. Pulse of time has no significant effect on material removal rate and surface roughness. After analyzing the effects of each relevant factor on the surface roughness, suitable values of all parameters are chosen and a good surface roughness Ra is equal to 0.885µm.

***Keywords*—MRR, Nicrofer, molybdenum, pulse on time, current, pulse off time,Ra (Surface Roughness),Taguchi WEDM (Wire Electric Discharge Machining).**

I. INTRODUCTION

A. Principal of WEDM

In this process the metal is rapidly removed from the work piece due to erosion by recurring spark discharge. Taking place between equipment and work pieces. Display Mechanical set up and electrical set up and electrical circuits for electrical discharge machining. A thin gap of 0.025 mm is placed between the tool and the work piece by a servo system. Both the tool and the work piece are immersed in a dielectric fluid. Kerosene / EDM oil / deionized water is a very common type of liquid dielectric - Gaseous dielectric is also used. In some cases as shown in Fig. 1.Moving towards the development of the mechanical industry, the demand for alloy materials with high hardness, toughness and impact resistance is increasing. Nevertheless, such materials are difficult to be mechanized by conventional machining methods.

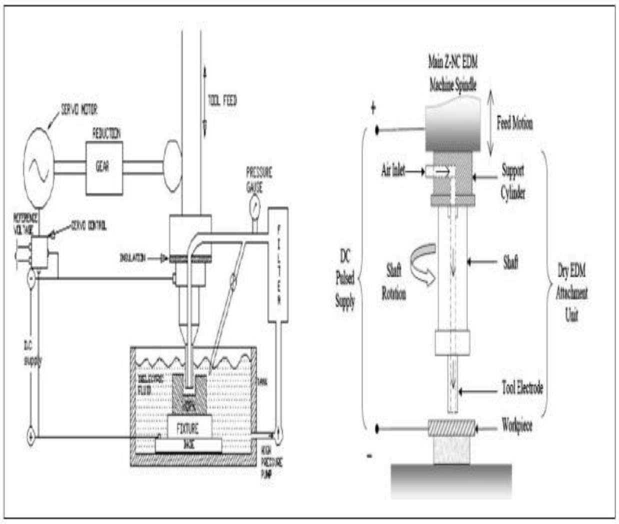

Fig. 1. Setup for Wire Cut Electrical Discharge Machining

Therefore, non-conventional machining methods that include electrochemical machining, ultrasonic machining, electrical discharging machines (EDM), etc., are applicable to such a difficult machine for machine materials. With a thin wire as the electrode the WEDM process converts the electrical energy into thermal energy for the cutting material. With this process, alloy steel, can be made to items of conductive ceramics and aerospace materials, despite their hardness and toughness.

In addition, WEDM is capable of creating fine, precise, corrosion and resistant surfaces. WEDM is considered as a unique adoption of the traditional EDM process, which uses an electrode to initiate the sparking process.

B. Importance of Wedm Process in Present Day Manufacturing

And the extensive capabilities that allow to cover almost all areas of production, automotive and aerospace industries and machining conductive materials. This is because WEDM provides the best alternative or sometimes the only alternative for machining conductive, exotic, high strength and temperature resistive materials, conductive engineering ceramics with the scope of generating intricate shapes and profiles.

WEDM currently has the ability to truly achieve the dimensional lattice, and the surface of perfection and beauty products generation has a role or cutting metal industry. Furthermore, the cost of the wire contributes only 10% of operating costs are WEDM process. The problem is sunk into the EDM

WEDM intention is to avoid wares moved by the relative motion does not replace clinical conductive television and guide.

C. Advantages of Wedm Process

- Wire cut EDM machine is capable of machining materials with high hardness, high strength, high fragility and high tenacity, which is not easy to be machined or not by conventional method, even some semi-conductive materials can also be machined Can be processed by wire cut EDM machine.
- A tiny size of electrode wire, the wire cut EDM can machine small abnormal shape holes, small gap or job with complicated shape.
- During machining, the electrode wire does not touch the work, there is no physical cutting force, it is good for processing work piece with rigidity.
- Since the cutting path is very short, the material removal ratio is very low, so the material use ratio is very high

D. Application of Wedm Process

- WEDM can be used in the production of dead cavities for the production of automotive body components.
- The ability to cut the taper makes WEDM particularly useful in die cutting.
- WEDM is useful in the plastics and rubber mould making industries for casting die, forging die and production of any complex shape. It is useful for manufacturing electrodes for EDM.

E. Description of the Problem

The present work "Effect of process parameters on performance measurement of wire electrical discharge machining" has been done keeping in mind the following problems:

- It has long been believed that cutting conditions such as timed pulse, pulse off time, servo voltage, peak current and other machining parameters should be selected for good surface finish.
- Part The higher cost of numerically controlled machine tools than their traditional counterparts has forced us to operate these machines as efficiently as possible to get the necessary paybacks.
- Predicted a pre-determined optimal solution using the best possible setting of the machining parameters suggested by any technique cannot be practically obtained. Therefore, all predictive parameters must be verified experimentally using a combination of machining parameters.

F. Objectives of the Current Study

After a thorough study of the existing literature, several graphs have been observed in the machining of WEDM.

Most researchers have investigated the effects of a limited number of process variables on the processes responses of WEDM processes.

A review of the literature suggests that researchers have done most of the work on the development, monitoring, and control of WEDM, but very limited work has been reported on the optimization of parameters for processes.

From now on, current methods for developing mathematical models of machining reactions and performing a comprehensive analysis of input process parameters. The reaction surface methodology (RSM) used for this purpose with optimization techniques has been effective. It is very necessary to establish the optimal parametric combination with the intention of obtaining a better machined surface. The results of the investigation confirm the feasibility of the approach and the extent of machining conditions will be useful for manufacturing communities.

The aim of the present work is an attempt to find the feasibility of machining (NICROFER 3718) equipment using molybdenum wire electrodes and internal flushing. The machining parameters are spark gap, pulse on time, and pulse off for time using the Taguchi design approach that analyzes reactions MRR, and SR.

- Study of working limits and levels of WEDM process parameters using a factor on a time approach
- Viz. is Experimental determination of the effects of various process parameters such as pulse on time, pulse of time, and peak current, performance measures such as on surface roughness in the WEDM process
- The process parameters of the WEDM process are changed according to the main parameters according to the surface roughness

II. LITERATURE REVIEW

Before starting an investigation in the field of WEDM, it is mandatory to familiarize yourself with the existing literature in the appropriate field. Over the years, many researchers have revealed various facts associated with the complex process of WEDM including a large number of process variables. WEDM has become one of the most demanding options for precision machining and complex shape processing in modern tool room industries. Because it offers many advantages, WEDM remains a competitive, advanced machining option in manufacturing industries. Many authors have come up with their research findings and recommendations about the development of the WEDM process, as well as their ultimate goal of process optimization to improve machining efficiency, accuracy, and productivity. A significant amount of experimental investigation has demonstrated the effect of WEDM process parameters on the output reactions for a wide range of work materials, composites and alloys. The literature sheds light on process optimization in relation to the various output responses of the WEDM process.

A. Identified Gaps in the Literature

After a comprehensive study of the existing literature, a number of gaps have been observed in machining of WEDM.

- Most of the researchers have investigated influence of a limited number of process parameters on the performance measures of WEDMparts.
- Literature review reveals that the researchers have carried out most of the work on WEDM developments, monitoring and control but very limited work has been reported on optimization of process variables.
- The effect of machining parameters on Die steel has not been fully explored using WEDM with brass wire as electrode.
- Surface Roughness of WEDM parts is another thrust area which has been given less attention in past studies.

III. EXPERIMENTAL SETUP

A. Input Parameters

Electrical Parameters

- Machining peak current Pulse/ Time domain
- Pulse On period
- Pulse Off period

B. Output Parameters

Performance Measure

- Surface Quality:

Surface roughness

- Process Inaccuracies:

Material removal rate

C. Technical Specifications

Table Size	:-	860X580mm
Maximum work-piece height	:-	300mm
Maximum work-piece weight	:-	1000 kg
Main Table Traverse (X, Y)	:-	600, 400 mm
Positioning Accuracy	:-	0.005 mm
Positioning Repeatability	:-	± 0.002 mm
Aux. table traverse (u, v)	:-	80, 80 mm
Maximum taper angle	:-	$\pm 30^0$ / 50 mm
Maximum JOG speed	:-	900 mm / min
Resolution	:-	0.0005 mm
Maximum wire spool capacity:	-	6 Kg.
Wire electrode diameter	:-	Dia. 0.25 mm (Standard)0.1, 0.15, 0.20, 0.30 mm (optional)

A. Dielectric Fluid

Most WEDMs use water as a dielectric fluid. Electrolysis occurs with all machines that use water as a dielectric fluid. This phenomenon causes metal changes in the surfaces, which can reduce the life of the dies and punches made by wire EDM.

The electrolysis effect is directly proportional to the conductivity of water (i.e., its ion content). Ions may be invisible, but they make their presence felt by increasing the electrical conductivity of the solution. Therefore the water must be deionized to ensure that it contains as few ions as possible (Devrat, 1993).

Fig.2. Machine Detail of Fanuc Robocutalpha-1iB CNC Wire Cut Machine

IV. EXPERIMENTAL PROCEDURE

A. Experimental Design and Planning

In this research, the main machining performance measured is the machined surface roughness (Ra) and material removal rate. A fine surface was expected by adjusting the machining parameters in the finishing phase. Keeping in mind the actual machining situation, the factors that control the factors including spark on time, pulse off time and peak current are chosen to conduct the experiments.Similarly the wire is also fitted in the holder passing through various rollers to maintain the desired roll, after that the doors of this setup are closed, the dielectric fluid (D. M. Water) is poured into a tank 40 mm above the sample and then sparked at a pre-determined setting.The sample surface roughness is measured with the Taylor –Hobson machine after each experiment. These results are organized in tabular form and then graphs are plotted based on the results.

Fig.3. Specimens of WEDM Machined

B. While Performing Various Experiments, the Following Precautionary Measures Were Taken

- To reduce error due to experimental set up, each experiment was repeated three times in each of the trial conditions.
- The order and replication of experiment was randomized to avoid bias, if any, in the results.
- Each set of experiments was performed at room temperature in a narrow temperature range (28±2ºC).
- Before taking measurements of surface roughness, the work piece was cleaned with acetone.

C. MEASUREMENT

In this work the surface roughness was measured by a profilometer. The surface test is a shop-floor type surface-roughness measuring instrument, which detects the surface of various machined parts and calculates the surface roughness based on roughness parameters, and displays the results in μm. . The work piece is attached to the detector unit which detects minute irregularities of the work surface. The vertical stylus displacement is processed and digitally displayed on screen during the trace

V. EXPERIMENTAL RESULTS AND DISCUSSION

A. Effect of Pulse on Time on Performance Measures

The Pulse on Time (TON) is varied from 100unit to 200 unit in steps of 6 units. The values of the other parameters are kept constant and their values are given as Toff = 16-24-32 unit; IP = 5-10-15 Amp. The experimentally observed data for the response characteristics for different values of pulse on time is given. The value of surface roughness though increases with decrease in pulse on time and as well as the peak current while Material removal rate is increases with the increase in pulse on time and current.

TABLE.1 Experiment (L27 Parameters and Surface Roughness Results)

EXP. NO.	I_A	T_{ON}	T_{OFF}	MRR (m^3/min.)	SR (µm)
1	5	100	16	0.546	2.345
2	5	150	16	0.673	2.154
3	5	200	16	0.846	2.075
4	5	100	24	0.473	2.357
5	5	150	24	0.574	2.075
6	5	200	24	0.784	1.981
7	5	100	32	0.452	2.375
8	5	150	32	0.534	2.247
9	5	200	32	0.741	2.142
10	10	100	16	0.756	1.924
11	10	150	16	0.654	1.875
12	10	200	16	0.984	1.625
13	10	100	24	0.462	1.756
14	10	150	24	0.541	1.856
15	10	200	24	0.771	1.792
16	10	100	32	0.412	1758
17	10	150	32	0.521	1.652
18	10	200	32	0.718	1.551
19	15	100	16	1.853	1.478
20	15	150	16	1.981	1.462
21	15	200	16	2.624	0.885
22	15	100	24	1.250	1.178
23	15	150	24	1.125	1.025
24	15	200	24	1.026	1.087
25	15	100	32	1.171	0.987
26	15	150	32	1.030	0.953
27	15	200	32	0.985	0.941

VI. CONCLUSIONS

The main objective of this study was to find optimal values Process parameters for maximum values of materialCurrent, pulse on time, removal rate using pulse offTime as process parameters. From this study, the following conclusions have been drawn:

- After analyzing the effect of each relevant factor on the surface roughness and MRR, the appropriate values of all the parameters are chosen and a good surface of the roughness Ra is equal to.0.885.
- The material removal rate increases with the increase in current and pulse over time. As we increase the current, the discharge energy also increases and over a period of time the number of discharges increases, resulting in higher material removal rates.
- As the voltage and pulse off time increase, the material removal rate decreases. The material removal rate is maximum at the third level of current [15 Amp], the pulse at time [200 μ s] and the level of the pulse before time is 16 μ s.
- Pulse off time has no significant effect on the material removal rate.
- The correction is limited, as the refining process becomes more difficult due to the occurrence of a short circuit, which is caused by wire deflection and vibration when the energy is gradually reduced.
- It was observed that excellent machined surface quality can be achieved by setting machining parameters in short pulse current and short pulse time. This combination will unfortunately produce a low material removal rate and lead to high machining time.
- When a high material removal rate is required, high pulsed current and pulse time must be selected. However, this selection will produce a poor surface finish due to the deep and wide boxes on the machined surface.

REFERENCES

[1] Goklar Mustafa Ilhan, Ozanozgu EF Mithi - In the process of cutting surface roughness in the Journal of Genetic Investigations, Soccer, International Machine Tools and Manufacturing Journal, Volume 40, Volume 40, Issue 40, Issue 13, Pages 1331-1848, October 2000

[2] M.T. Antar, S.L. Soo, D. C. Espinwall M. R. Jones - Aluminous The Workpiece Fibers, and Waymore Alloys Wiring with Integrity Using Armenia Engineering, Volume 19, Pages 3-8, 2011

[3] Fuzu Han Jiang Jun and Dingwen Yu Cut, Infusion of machining surface roughness to cut Weymour ended, The International Journal of Advanced Technology Platform, 2007, Volume 34, Number 5-6, pages 538-546.

[4] The wire electrical discharge macking (Vesmore) process set the Mahapatra using holy water and salt. Optimize it s00170-006-0672-6

[5] M. J. a. Hyder Said Tehran - Physical Force Rate (MRR) User Interest Tapard Turn Electrical Discharge (cwed) Process Materials Available Technology Sed 199, Issue 1ñ3 April 1, 2008, page 369ñ378

[6] Tosun and Caine Arthur Kogan - Wear Testing on Wire Waymore Materials Veil Available Technology SED 134, Issue 3, 20 March 2003, p.273 M278

[7] Materials Technology Sad Journal Volume 152, Issue 3, 30 October 2004, Page 316ñ2 Wire electrical discharge machining, according to Arthur Tosun, can only Kogun Teguchi Tosun and Gul.

[8] Aminullah Mohammed, Neglect Aliraja Tehrani, Ehsan Imanian and Davoodi Karimi - Analysis of current rate of removal of wire electrical discharge of material available material CAD 205 SD, Issue 1 A3, 26 August 2008, page 283ñ289

[9] P. Nilesh Patil Ganpatrao c. Brahmankar (May 2010). "Determination of material removal, wire rate.

This Paper is presented in conference
Conference Title : Advances in Mechanical, Industrial and Material Engineering (AMIM-2020)
Organised By : Mechanical Department, Sagar Institute of Research and Technology-Excellence, Bhopal, MP
Date : 28-May-2020