© 2014 IJEDR | Volume 2, Issue 4 | ISSN: 2321-9939

Comparative Study for the effect of Powder mixed dielectric on Performance of Wire EDM

A Literature Review

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Abstract **- Wire cut EDM process is an extended form of Electrical Discharge Machining. Input parameters of Wire EDM such as Pulse ON time, Pulse Off time, Peak current, wire tension, wire speed etc. have major effect on the performance of the process. Wire cut EDM process is evaluated on the basis of surface finish, MRR, machining time and wire erosion. Main emphasis in this review is to identify the process parameters, performance measures, effect of parameters on performance and optimization. Use of powder mixed dielectric is the main focus of the review. Nowadays, application of DOE, optimization techniques are playing vital role to establish the relation between input and output. They provide best combinations of parameters for desired quality. Experimental studies have been conducted under varying pulse ON time, pulse OFF time and peak current. Effect of mixing powder in dielectric on quality characteristics (Surface finish, kerf width and machining time) and have been studied.**

Keywords **- Wire cut EDM, Powder mixed dielectric, Kerf width**

I. INTRODUCTION

Wire EDM process was introduced in late 1960's and it had revolutionized the tool and die, metal working, mold industries. It is probably the most exciting and diversified machine tool developed for this industry. It can machine anything that is electrically conductive regardless of the hardness, from relatively common materials such as tool steel, aluminum, copper, and graphite, to exotic space-age alloys including hast alloy, wasp alloy, Inconel, titanium, carbide, polycrystalline diamond compacts and conductive ceramics. It is single step process. Wire electrical-discharge machining is an adaptation of the basic EDM process.

In wire EDM process metal removal process is carried out by spark erosion mechanism. When high frequency of alternating or direct current is discharged from wire to work piece with a very small spark gap through dielectric fluid, many sparks can be observed at one time. The heat of each electrical spark, estimated at around 15,000° to 21,000° Fahrenheit, erodes away a tiny bit of material that is vaporized and separated from the parent material. The resulting particles (chips) are flushed away from the gap with a stream of clean, de-ionized water from the top and bottom flushing nozzles [1].

There are some parameters which control the quality of the product made by wire EDM. And they are as given below diagram.

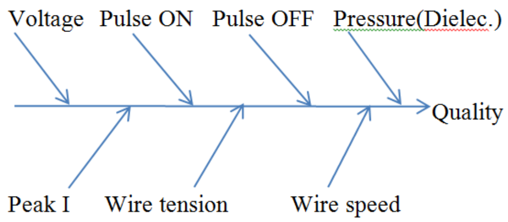

Fig 1 Cause and effect (fishbone) diagram of wire EDM process parameters

A. *Effect of pulse on time (T_{on})* - It controls the length of time that electricity is applied to the wire (per spark). Increase the on time, the machine will cut faster but the surface finish gets more porous and accuracy may decrease because increased cutting speed. If the on time is too great, the wire will be prone to breakage.
B. *Effect of pulse off time (T_{off})* - It controls length of time that the electricity applied to wire is turned off between each spark. Off time is very important since during off time particles are flushed out of the gap. Increasing off time mean slower cutting, increased stability and less wire breakage. The off time also governs the stability of the process. An insufficient off time can lead to erratic cycling and retraction of the advancing servo, slowing down the operation cycle.
C. *Effect of peak current (I_{max})* - IP controls the amount of amperage (current) that is applied to the wire. It adds power to wire as with on time, the higher the IP, the faster the machining will take place, but accuracy and finish will suffer.
D. *Effect of voltage* - Voltage is a function of work piece thickness. The thicker the work piece, the greater the voltage can be without fear of wire breakage. This is because a thick part allows the power in the wire to be dispersed over a greater area.
E. *Effect of wire speed* - It is the rate at which the wire passes through the work piece and is controlled by the speed of the pinch rollers. Faster wire speed for roughing and a slower wire speed for finishing. When roughing, the wire will usually be under a

great deal of power and stress it results in pitting on the wire and reduction of the wire diameter. By increasing the wire speed, wire breakage can reduce.

F. *Effect of wire tension* - "Stretching Pressure" applied from the tension roller to the wire ejection rollers. This is a gram-equivalent load with which the continuously fed wire is kept under tension so that it remains straight between the wire guides. Wire vibration is controlled by the wire tension. During roughing, wire will be under a great deal of stress due to the high power. This excessive stress having too much tension on the wire, causing wire breaks. Generally, slightly lower wire tension during roughing and a higher tension for finishing.

G. *Effect of Dielectric pressure* - Flushing removes small particles created by the process. Particles must be removed from the work area; otherwise double burning of these particles eliminates insulation properties of the dielectric resulting in unstable cutting.

II. LITERATURE SURVEY

Wire electrical discharge machining (WEDM)

The emphasis is on the generation of mathematical modeling having quadratic nature (respond surface model). Multi-objective optimization with considering discharge current, pulse duration, pulse frequency, wire speed, wire tension and dielectric flow rate as the process parameters are done. Taguchi method with L27 orthogonal array has been selected for experiment and to convert multi objective criterion to equivalent single objective function grey relational analysis has been adopted. Mathematical model and effects of the highlighted parameters on the performance measures are established with the use of statistical software MINITAB 13 [2]. Optimization of process parameters (peak current, duty factor, wire tension and dielectric pressure) with number of nontraditional optimization techniques (genetic algorithm, particle swarm optimization, sheep flock algorithm, ant colony optimization, artificial bee colony and biogeography-based optimization) is done for wear ratio, surface finish and MRR as performance measures. Among all biogeography based technique provides best results [3]. Prediction and modeling of the surface finish in wire EDM titanium alloy (Ti-6Al-4v) with the use of two levels full factorial method. And experimental values are compared with predicted values. Pulse on time, pulse off time, voltage and dielectric flushing pressure. The WEDM experiments are conducted in Electronica ultra-cut s1 machine using 0.25 mm brass wire as the tool electrode. Comparison between experimental values and predicted values has been carried out and error margin is found to be 7% [4]. Parametric optimization of composite material (Al+3%Sic) with the use of Taguchi method (L13 orthogonal array) is done and compared with ANNOVA method. Surface finish and MRR decreases when work piece is machined with air as a dielectric fluid [5]. Graphical representation for effect of input parameters on MRR and surface roughness has been carried out and studied using respond surface methodology. Work piece and tool material are SS304 and brass wire. CCD (central composite rotatable factorial design) is adopted as DOE [6]. Mathematical model has been developed using design expert system software and optimization is carried out using MATLAB (GA algorithm). Desired responses are maximum MRR and minimum surface roughness [7]. Mathematical modeling has been done with the use of respond surface modeling with quadratic nature. Pulse on time, pulse of time, wire speed and wire feed are the parameters. Performance measures are MRR and Surface roughness [8]. Wire failure occurred in wire cut EDM is a result of severity in wire wear rate, which is function of discharge current and discharge time. For the same MRR, wire wear rate is observed to be lower with zinc coated brass but with bare wire high erosion rate is observed [9]. WEDM (wire electro discharge grinding) is a one of the hybrid machining process for micro machining the fine electrodes or pins with a large aspect ratio [10].

Use of Powder mixed dielectric in EDM

Electrical conductive powder used in dielectric reduces the insulating strength of dielectric fluid and increases the spark gap between tool & workpiece. It improves MRR and surface finish. Aluminum, chromium, graphite, silicon, copper and silicon carbide are the powders can be used. Powder creates bridging effect [11]. Use of Silicon powder in Wire electro discharge machining has positive influence on the operating time and surface finish and best results are achieved when powder grain size is below 15 µm with AIHI H13 steel [12]. Thin electrode and rotating disk are used to keep powder concentration in gap between workpiece and electrode. TiC layer is grown on carbon steel when titanium powder is used in dielectric [13]. Aluminum powder leads the thinnest rim zone and highest MRR and silicon powder produces grey zone beneath the actual 'white zone'. Powder addition produces the thinner rim zone [14]. With smaller electrode area surface finish is good with simple EDM but with the use of powder mixed dielectric, sensitivity to surface quality is lower. There is linear relationship between electrode area and surface quality [15]. Pick current is emerged as a most significant parameter and tungsten carbide formation in workpiece indicate the reaction of tungsten powder with carbon present in it. Surface alloying with tungsten and carbon has a significant effect on properties of workpiece material [16]. Introduction of the MoS_2 micro powder in dielectric fluid using ultrasonic vibration significantly improves the MRR and surface quality by providing a flat surface free of black carbon spots [17]. Features of powder mixed dielectric EDM are shorter machining time, more uniform dispersion of electrical discharges and stable machining [18]. setting of peak current at a high level (16 A), pulse-on time at a medium level (100 µs), pulse-off time at a low level (15 µs), powder concentration at a high level (4 g/l), and gain at a low level (0.83 mm/s) produced optimum MR from AISI D2 surfaces when machined by silicon powder mixed EDM [19]. Pulse on time, duty cycle, peak current and concentration of the silicon powder added into the dielectric fluid of EDM are the variables to study the process performance in terms of material removal rate and surface roughness [20].

III. REVIEW FINDINGS

Lots of work has been done on the wire EDM process by researchers with traditional optimization techniques (Taguchi method) as well as nontraditional optimization techniques (genetic algorithm, particle swarm optimization, sheep flock algorithm, ant colony optimization, artificial bee colony and biogeography-based optimization). Parameter optimization covers major portion of research. Use of powder mixed dielectric in electrical discharge machining directs the new way of thinking for the improvements. But main gap found is:

- Comparative study for use of powder mixed dielectric and simple dielectric in Wire EDM process.
- Checking the effect of concentrations of powder in dielectric on performance measures (surface finish, machining time and kerf width) in Wire EDM.
- Use of powder mixed dielectric through nozzle directly.
- Use of various mesh sized powder in wire EDM and checking the effect.
- Designing stirring system for powder mixing in dielectric.
- Comparative study for the different types of powders mixed with dielectric in wire EDM process.

IV. CONCLUSION

From the literature it is found that remarkable work has been done in the field of optimization of the wire EDM process. But very limited work has been done by researchers for the usage of conductive powders with dielectric in wire EDM through nozzle directly. Comparative study can be the done for checking the effect of powder (Graphite) mixing in dielectric (distilled water) on the performance measures (machining time, kerf width and surface finish) with varying input parameter values (Pulse on time, pulse off time and peak current) of workpiece (SS304).

REFERENCES

[1] Donald B. Moulton, “Wire EDM, The Fundamental.

[2] Saurav Datta1, Siba Sankar Mahapatra, 2010, “Modeling, simulation and parametric optimization of wire EDM process using response surface methodology coupled with grey-Taguchi technique.”, International Journal of Engineering, Science and Technology, Vol. 2, No. 5, pp. 162-183.

[3] Rajarshi Mukherjee, Shankar Chakraborty, Suman Samanta, 2012, “Selection of Wire electrical Discharge Machining processs parameters using nontraditional optimization algorithm”, Applied Soft Computing, Vol. 12, Issue 8, pp. 2506-2516.

[4] Basil Kuriachen, Dr. Josephkunju Paul, Dr.Jose Mathew, 2012, “Modeling of Wire Electrical Discharge Machining Parameters Using Titanium Alloy (Ti-6AL-4V)”, International Journal of Emerging Technology and Advanced Engineering, Vol. 2, Issue 4, pp 377-381.

[5] Sateesh Kumar Reddy K,Ramesh S, 2012, “Parametric Optimization of Wire Electrical Discharge Machining of Composite Material”, International Journal of Advanced Research in Computer Engineering & Technology Vol. 1, Issue 3.

[6] M.Geetha, Bezawada Sreenivasulu, G. Harinath Gowd, 2013, “Modeling & Analysis of performance characteristics of Wire EDM of SS304”, International Journal of Innovative Technology and Exploring Engineering, Vol. 3.

[7] Rajneesh Kumar Singh, D.K. Singh, 2013, “Control parameters optimization of wire – EDM by using Genetic Algorithm”, VSRD International Journal of Mechanical, Civil, Automobile and Production Engineering, Vol. III, Issue IX, pp. 327-332.

[8] K. Kumar, R. Ravikumar, 2013, “Modeling and Optimization of Wire EDM Process”, International Journal of Modern Engineering Research, Vol. 3, Issue. 3, pp. 1645-1648.

[9] B.J.Ranganath, K.G.Sudhakar, A.S.Srikantappa, 2013, “Wire Failure Analysis in Wire-EDM Process”, International Conference on Mechanical Engineering.

[10] K.H Ho, S.T Newman, S. Rahimfard, R.D Allen, 2004, “State of art in Wire electrical discharge machining (WEDM)”, International Journal of Machine Tools and Manufacture”, Vol. 44, Issue. 12-13, pp. 1247-1259.

[11] H.K. Kansal, Sehijpal Singh, Pradeep Kumar, 2007, “Technology and Research developments in powder mixed dielectric discharge machining (PMEDM)”, Journal of Material Processing Technology, Vol. 184, Issue 1-3, pp. 32-41.

[12] P Peças, E Henriques, 2003, “Influence of silicon powder-mixed dielectric on conventional electrical discharge machining”, International Journal of Machine Tools and Manufacture, Vol. 43, Issue. 14, pp. 1465-1471.

[13] Kakushi Furutania et al, 2001, “Accretion of titanium carbide by electrical discharge machining with powder suspended in working fluid”, Precision Engineering, Vol. 25, Issue. 2, pp. 138-144.

[14] F.Klocke, D. lung et al, 2004, “The effect of powder suspended dielectrics on thermal influenced Zone by electro discharge machining with small discharge energies”, Journal of Material Processing Technology, Vol. 149, Issue 1-3, pp. 191-197.

[15] P. Pecas, E. Henriques, 2008, “Electrical discharge machining using simple and powder dielectric- The effect of electrode area in Surface and Topography”, Journal of material processing Technology, Vol. 200, Issue 1-3, pp. 250-258.

[16] Sanjeev Kumar, Uma Batra, 2012, “Surface modification of Die steel materials by EDM method Using tungsten powder mixed dielectric”, Jounal of Manufacturing process, Vol. 44, Issue 12-13, pp. 1247-1259.

[17] Gunawansetia Prihandana et al, 2009, “Effect of micro powder suspension and ultrasonic vibration of dielectric fluid in Micro EDM process- Taguchi Approach”, International journal of Machine tools and manufacture, Vol. 49, Issue 12-13, pp. 1035-1041.

[18] Y.S. Weng, L.C. Lim, Iqbal Rahuman, W.M Tee, 1998, “Near-mirror finish phenomenon in EDM using powder mixed dielectric”, Journal of Material processing Technology, Vol. 79, Issue 1-3, pp. 30-40.

[19] H.K. Kansal, Sehijpal Singh, Pradeep Kumar, 2007, “Effect of Silicon Powder Mixed EDM on Machining Rate of AISI D2 Die Steel”, Journal of Manufacturing Processes, Vol. 9, Issue 1, pp. 13-22.

[20] H.K. Kansal, Sehijpal Singh, Pradeep Kumar, 2005, “Parametric optimization of powder mixed electrical discharge machining by response surface methodology”, Journal of Materials Processing Technology, Vol. 169, Issue 3, pp. 427-436.