A Brief Review on Effect of Various Parameters on Material Removal Rate and Surface Roughness of Different Tool Conditions in Electro Discharge Machining by Taughi Method

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Abstract-- EDM is an unconventional electro thermal machining process used for manufacturing geometrically complex or hard material parts that are extremely difficult-to-machine by conventional machining process. The process involves a controlled erosion of electrically conductive materials by the initiation of rapid and repetitive spark discharges between the tool and work piece separated by a small gap of about 0.01mm to 0.50mm. This gap is either flooded or immersed in a dielectric fluid. The controlled pulsing of direct current between the tool and the work piece produces the spark discharge. This paper reviews the vast array of research work carried out within past decades for the development of EDM. This study is mainly focused on surface quality and metal removal rate which are the most important parameters from the point of view of selecting the relevant process parameters as well as different heat treatment process. This process will be established for the Better tool life and Better Surface finish.

Keywords: - Electric Discharge Machining (EDM), Process Parameters, Optimization, Material Removal Rate, Surface Roughness, Cryogenic Treatment, Taguchi Technique.

I. INTRODUCTION

Electro Discharge Machining (EDM) is an electro thermal non-traditional machining Process, where electrical energy is used to generate electrical spark and material removal mainly occurs due to thermal energy of the spark. The new concept of manufacturing uses non-conventional energy sources like sound, light, mechanical, chemical, electrical, electrons and ions. With the industrial and technological growth, development of harder and difficult to machine materials, which find wide application in aerospace, nuclear engineering and other industries owing to their high strength to weight ratio, hardness and heat resistance qualities has been witnessed. New developments in the field of material science have led to new engineering metallic materials, composite materials and high tech ceramics having good mechanical properties and thermal characteristics as well as sufficient electrical conductivity so that they can readily be machined by spark erosion. Non-traditional machining has grown out of the need to machine these exotic materials. The machining processes are non-traditional in the sense that they do not employ traditional tools for metal removal and instead they directly use other forms of energy. The problems of high complexity in shape, size and higher demand for product accuracy and surface finish can be solved through nontraditional methods.

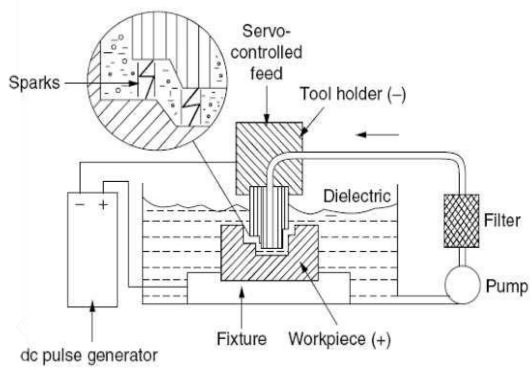

Fig-1 Schematic Diagram of EDM

Currently, non-traditional processes possess virtually unlimited capabilities except for volumetric material removal rates, for which great advances have been made in the past few years to increase the material removal rates. As removal rate increases, the cost effectiveness of operations also increases, stimulating ever greater uses of non- traditional process. The Electrical Discharge Machining process is employed widely for making tools, dies and other precision parts. EDM has been replacing drilling, milling, grinding and other traditional machining operations and is now a well-established machining option in many manufacturing industries throughout the world. And is capable of machining geometrically complex or hard material components, that are precise and difficult-to machine such as heat-treated tool steels, composites, super alloys, ceramics, carbides, heat resistant steels etc. being widely used in die and mold making industries, aerospace, aeronautics and nuclear industries. Electric Discharge Machining has also made its presence felt in the new fields such as sports, medical and surgical, instruments, optical, including automotive R&D areas.

II. WORKING

Electrical spark machining is a Thermo-electric non- traditional machining processes. Local melting of the material and content of the work piece is removed through evaporation. Electric sparks caused by sparks between two electrode surfaces are generated between the two electrodes via an electrode dielectric a short distance from each other and are held at a large potential gap is set up across them. Localized high temperature areas are formed Work piece material in the local area melts and evaporates. Waste molten and vaporized material between the electrode and work piece a spacing of debris particles carried by the dielectric flow. To resist an excessive this heating, electricity is supplied as short pulse. Spark is where the gap between tool and the work piece surface is the smallest.

A spark material, the difference increases to a different point on the surface of the material shifts the position of the spark is removed later. In this way many sparks work piece- equipment at various locations on the entire surface of the gap are the same. Sparks caused by the removal of material, after some time interval of an equal distance across the gap across the tool material and the work piece is formed. Device is held steady; the machining will stop at this level. But if the device in the direction of the work piece is continuously fed more material is removed and the process is repeated. It has achieved the required depth of cut until the tool is fed. Finally, the device size replica of a cavity is formed on the same work. The work piece and work tool as the electrode in electrical circuits. Pulsed power from a separate power supply unit is supplied to the electrodes. Work piece feed speed appropriate to the device generally shown in Figure 1 between tool and work piece during machining to maintain a constant gap distance is provide.

III. PRINCIPLE

EDM has a controlled removal of metal through the electric spark erosion is used to extract the metal. In the process, the cutting tool to cut an electrical spark (Erode) finished work piece part production to the desired size as is used. The process of removing metal electrode to the work piece through a pulsing (on / off) of the high frequency current is performed by applying electrical charge. This removes the metal work piece at a controlled rate (impaired) is very small.

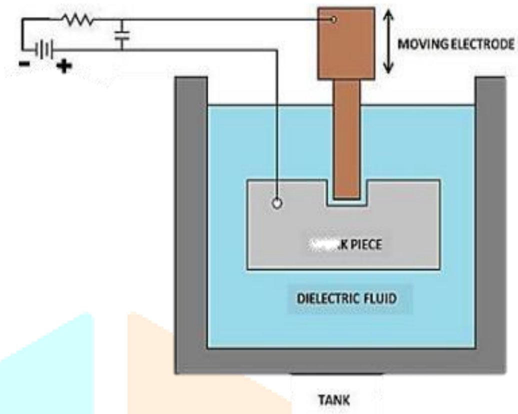

Fig-2Working Principal of EDM

IV. WORKING METHODOLOGY OF EDM

The tool is made up of cathode and work piece is of anode. When the voltage across the gap becomes sufficiently high it discharges through the gap in the form of the spark in interval of from 10 of micro seconds. And positive ions and electrons are accelerated, producing a discharge channel that becomes conductive. It is just at this point when the spark jumps causing collisions between ions and electrons and creating a channel of plasma. A sudden drop of the electric resistance of the previous channel allows that current density reaches very high values producing an increase of ionization and the creation of a powerful magnetic field. The moment spark occurs sufficiently pressure developed between work and tool as a result of which a very high temperature is reached and at such high pressure and temperature that some metal is melted and eroded. Such localized extreme rise in temperature leads to material removal. Material removal occurs due to instant vaporization of the material as well as due to melting. The molten metal is not removed completely but only partially. As the potential difference is withdrawn, the plasma channel is no longer sustained. As the plasma channel collapse, it generates pressure or shock waves, which evacuates the molten material forming a crater of removed material around the site of the spark.

V. IMPORTANT PARAMETER IN EDM

- ✓ **On-time or pulse time:** It is the duration of time (µs) for which the current is allowed to flow per cycle. Material removal is directly proportional to the amount of energy applied during this on-time.
- ✓ **Off-time Or Pause time:** It is the duration of time between the sparks. This time allows the molten material to solidify and to be wash out of the arc gap.
- ✓ **Arc Gap:** It is the distance between the electrode and the work piece during the process of EDM. It may be called as the spark gap.
- ✓ **Duty Cycle:** It is the percentage of on-time relative to total cycle time. This parameter is calculated by dividing the on-time by the total cycle time (on-time plus off-time). The result is multiplied by 100 for the percentage of efficiency or the so-called duty cycle.
- ✓ **Intensity:** It points out the different levels of power that can be supplied by the generator of the EDM

machine.

- ✓ **Voltage (V):** It is a potential that can be measure by volt it is also effect to the material removal rate and allowed to per cycle. Voltage is given by in this experiment is 50 V.
- ✓ **Effect of pulse on time:** To observe the effect of pulse-on time on MRR and SR value of peak current is varied while keeping the other parameter like pulse-off time, servo voltage, wire feed rate fixed. The MRR increases with increase in pulse duration at all value of peak current. The MRR is a function of pulse duration but at low value of peak current, the MRR is low due to the insufficient heating of the material and also after pulse duration, the MRR increases less because of insufficient clearing of debris from the gap due to insufficient pulse interval. Surface roughness increases with increase in pulse duration at different value of peak current but it is observed that surface roughness at low value of pulse duration and high value of peak current is less than the at high value of pulse duration and low value of peak current. This is due to because at low pulse duration materials remove mainly by gasifying and forms craters with ejecting morphology due to high value of peak current and heat flux in the ionized channel, which causes the temperature of the work-piece to be raised or to be easily exceed the boiling point. On the other hand, long pulse duration removes material mainly by melting and forms craters with melting morphology due to low value of peak current and heat flux in the ionized channel, which prevents the temperature of the work-piece from reaching a high value Which is in agreement with the work carried by others.

VI. LITERATURE REVIEW

S.H.Lee , X.P LI (1999) studied *the effect of machining characteristics in EDM machining of tungsten carbide* it stated that machining parameter are electrode materials, electrode polarity, open circuit voltage, peak current, pulse duration. The machining characteristics are MRR, relative wear ratio, surface roughness. Electrode material graphite has highest MRR followed by copper tungsten then copper electrode as cathode and workpiece as anode in EDM of tungsten carbide better Machining performance can be obtained.MRR generally decrease with the increase of open circuit voltage whereas the wear ratio and Surface roughness increase with increase of open circuit voltage. MRR increase with the increase of peak current in range of low current setting. The MRR decrease when pulse interval is increased. Both wear ratio and Surface roughness have minimum value when varying pulse interval.

H.K kansal , Sehijpal Singh , P. Kumar (2004) studied *parametric optimization of powder mixed EDM by response surface methodology*. It stated that by adding silicon powder into dielectric fluid of EDM and it enhanced rate of material removal and Surface finish has been achieved silicone powder suspended in the dielectric fluid of EDM affect both Material removal rate and Surface roughness.

Quan Yan Ming, Liu You studied *powder suspended dielectric fluid for Electrical Discharge Machining* stated that several kinds of additives that can elevate the productivity of EDM. when added to kerosene additives to kerosene can decrease the loss of alloy element, increase the micro hardness some conductive powder and lipophilic surface agent can lower surface roughness.

J.L. Lin, K.S Wang, B.H Yan, Y.S Tarng (1998) studied *optimization of EDM process based on taguchi method with fuzzy logic* it stated that performance characteristics such as EWR and MRR can be improved through applying fuzzy logic unit. It is useful in improving multiple performance characteristics in the EDM operation

Kun Ling Wu, Being Hwa Yan, Fuang Yuan Huan, Shin Chang chen studied *improvement of surface finish on SKD steel using EDM with Aluminum and surfactant added dielectric* stated that by adding aluminum powder in dielectric the surface roughness of workpiece in EDM improved. dielectric mixed with both aluminum powder and surfactant can improved surface roughness up to 60% than machined under pure dielectric.

Sushil Kumar Choudhary (2014) studied advanced research development of electric discharge machining that vibration rotary and vibro- rotary mechanism makes the equipment simple and increase the material removal rate provide better surface finish. Water as dielectric is provide to better health and safe equipment while kerosene will decompose and release harmful vapor. Powder mix in electrolyte provide mirror like surface finish, increase in material removal rate and no stress are produce on work piece

C. Krishna raj (2015) studied analysis of machining and surface finishing of various materials in edm that copper offered high MRR and brass produce low surface finish and graphite produce high surface roughness. Tungsten carbide workpiece and graphite electrode material gives low MRR, highest relative wear and best Surface Roughness.

Year	Author	Contribution	Work material	Tool materi	Parameters	Methodology	Response
2016	Mohit Kumar	Machining on c-45 steel	C-45	copper	Current, Ton, Gap voltage	Taguchi	MRR, SR
2015	Modi,Jignesh Patel,	Optimization of process parameter of EDM: review	air hardening tool steel	----------	Current, pulse on, pulse off,	RSM. Taguchi	MRR. TWR, SR
2014	Sk pradhan	Parameters optimization of EDM	-----------	Copper	Current, pulse Current, Ton, duty cycle	Taguchi	MRR. TWR, SR
2013	Harprret singh	Effect of pulse on / off time	AISI D3 steel	Brass, copper	Pulse on , pulse off	Taguchi	MRR. TWR
2012	Harpreet singh, Amandeep singh	The impact on operating parameters on EDM	AISI D3 steel	cryogenic, non-cryogenic copper electrode	Pulse on , pulse off	Taguchi	MRR. TWR
2011	Mahesh popat	Investigation of Process Parameters for EDM	EN 31	Brass	Current, Pulse on time, pulse off time	Taguchi	SR, TWR, MRR
2010	S. Prabhu	AFM surface investigation	Inconel 825	Copper	voltage, pulse duration, pulse current	RSM	SR
2010	Sanjeev Kumar	Effect on EDM with powder mixed dielectric	OHNS die steel	Copper	Sparking gap, voltage,	Taguchi	SR
2009	MA Lajis	Implementation Taguchi on EDM	Tungsten Carbide	Graphite	Current, voltage , pulse duration	Taguchi	EWR, MRR, SR
2009	K. Ponappa	Effect of process parameters on EDM	Nano alumina composite	Brass hollow tubular electrod	Ton, Toff, Voltage, speed	Taguchi	SR
2007	Ak. Khanra, B.R bhattchria	Performance of ZrB2-Cu composite on EDM	Mild steel	Cu, ZrB@-Cu	Duty Cycle, Ton, current, voltage.	Taguchi	MRR, EWR

2006	D Duowen	Cutting parameters in EDM	Brass	EN-8	Power supply, polarity,	Taguchi	MRR. TWR
2005	Kun Ling wu, Bling Hwa Yan	Improvement on SKD steel	SKD-11	Copper	polarity, peak-current, pulse duration	RSM	SR, MRR

VII. CONCLUSION

Literature review finding on Electro Discharge Machining of various materials. Most of the work is reported to study the parameters like Peak current, Pulse on time, pulse off time and voltage to find out Surface roughness, Material removal rate (MRR) and Tool wear ratio (TWR) using different types of tools and with the help of design of experiments and statistical optimization techniques.

Parameters like discharge current, gape voltage, pulse on time, pulse off time, power intensity, amplitude, overcut, dielectric fluid are affect in electro discharge machining process directly or indirectly.

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