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An Overview of Electro Discharge Machining:-A Review

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Abstract- *EDM is nothing but the Electrical Discharge Machining is one of the most commonly used Non-Conventional Machining Method.EDM Process is one of the most commonly used Non-conventional Precise material Removal Process.EDM is a process for shaping hard Metals and Forming Deep Complex Shaped holes by arc erosion in all kinds of electro conductive material. Erosion plus Discharge Occurs in a Small gap between the work piece and the Electrode. This removes the unwanted material from the parent material through melting and vaporizing in presence of Dielectric fluid. The mechanical characteristics of work piece and electrode are not a concerned because the Electric energy is converted into thermal energy causing melting of the material. Hard materials and more complex shapes which can be easily processed by EDM process. The Material removal rate is low but it provides the Highly Surface Fin shined Materials with improved mechanical properties due to thermal effect.*
In recent years, EDM researcher have explored a number of ways to EDM process parameters such as Electrical Parameters, Non-Electrical Parameter, Tool Electrode based parameter and types of Flushing method used During Experimentation.

This new research shares the some objectives of achieving more MRR, Less TWR and Smooth Surface Finish. This Paper Review the Research work completed from the initiation to the development of Die-Sinking EDM inside The Past Decade and furthermore quickly the different influencing parameter to EDM for good MRR, Less TWR and Less SR.

Key Words- Electro discharge machining (EDM), Process Parameter, MRR, and TWR, SR

1. INTRODUCTION

Electrical Discharge Machining, commonly known as EDM is a non-conventional machining method used to remove material by a number of repetitive electrical discharges of small duration and high current density between the work piece and the tool. EDM is a critical and financially savvy strategy for machining to great degree extreme and fragile electrically conductive materials. In EDM, since there is no immediate contact between the work piece and the electrode, thus there are no mechanical powers existing between them. Any sort of conductive material can be machined utilizing EDM independent of the hardness or durability of the material.

2. Review of Literature

Electrical Discharge Machining (EDM) is a non-traditional machining process that has become a well-established machining option in manufacturing industries throughout the world. It has supplanted penetrating, processing, granulating and other customary machining operations in various angles. Miniaturized scale EDM, a current development, is observed to be a practical process for creation of smaller scale devices, miniaturized scale segments and miniaturized scale highlights with great dimensional exactness and repeatability.

Influences of Discharge Energy

The elements impacting the machining execution to a great extent rely on upon the discharge vitality connected for machining. The different issues, for example, surface unpleasantness, warm influenced zone, miniaturized scale hardness and break developments and machining nature of the workpiece are dictated by the measure of vitality discharged in each spark ***(Masuzawa 2000).***

Jahan et al. (2009a) concentrated the execution of kick the bucket sinking small scale EDM of tungsten carbide utilizing distinctive electrodes. They watched that the lower discharge vitality indicates better surface wrap up. Bring down information vitality demonstrates to show decrease in surface harshness and burr width.

Somashekar et al. (2010) investigated the influence of discharge energy and predicted that the increase in discharge energy leads to increase in MRR. ***Wong et al. (2003***) developed a single spark generator to study the erosion characteristics from the micro-crater size. The result shows that the volume and size of the micro-craters are found to be more consistent at lower energy discharges and the specific energy required to remove the material is found to be significantly less at lower energies (< 50 m) when compared with that at higher energies.

Gostimirovic et al. (2012) examined the influence of discharge energy during the micro-EDM process of manganese-vanadium tool steel using copper electrode. The outcomes uncovered that MRR and HAZ increment because of increment in discharge vitality.

Chung et al. (2007) explored different avenues regarding small scale electrical discharge processing utilizing tungsten carbide (WC) as device electrode and stainless steel plate as work piece, with deionized water as a dielectric liquid. They utilized deionised water with high resistivity to limit the machining crevice and researched machining attributes, for example, apparatus wear, machining hole and machining rate.

3. Principles of EDM

In this process the material is removed from the work piece due to erosion caused by rapidly recurring electrical spark discharge between the work piece and the tool electrode. There is a small gap between the tool and the work piece. The work piece and apparatus both are submerged in dielectric liquid, usually utilized are EDM oil, deionized water, and lamp oil.

Components of Electro discharge Machine:-

a. **Work piece**- All conductive materials can be Machined.

b. **Tool Electrode-**The EDM tool Electrode determines the shape of the cavity to be produced.

c. **Dielectric fluid**-It is used to work as a medium between electrode and work piece. In EDM tank, Electrode and Work piece is submerged into the dielectric liquid for the reason.

d. **Servo System**- It is utilized to control the encourage of the electrode and work piece to correctly coordinate MRR.

e. **Power Supply**- The Power Supply is required as direct current (DC) to create the spark discharge at machining hole. So a transformer is used to change over alternative current from the essential utility supply into pulse direct current (DC).

f. **The DC pulse Generator-** It is responsible for supplying pulse at ascertain voltage and current for a specific amount of time.

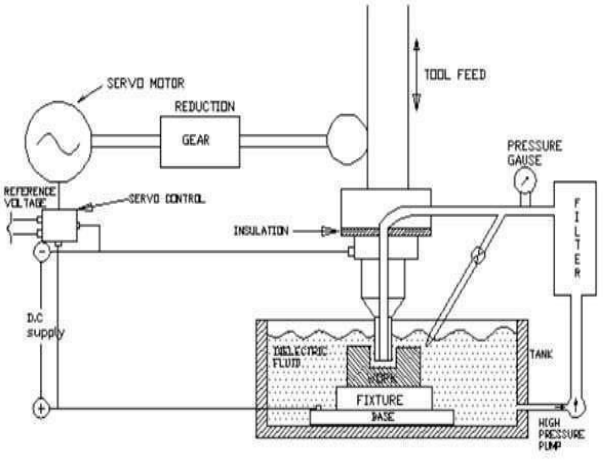

Fig -1: Experimental Setup of EDM Machine

4. Recents Trends in EDM Machine:-

1. Ultrasonic vibration assisted EDM Machine

2. Dry EDM

3. Powder Mixed EDM

4. Water Based EDM

5. Micro EDM

4.1 Ultrasonic vibration Assisted EDM Machine:

Acquaintance of ultrasonic vibration with the cathode is one of the techniques used to grow the utilization of EDM and to enhance the machining execution on hard to machine materials. The investigation of the impacts on ultrasonic vibration of the cathode on EDM has been embraced since mid 1980s. The higher proficiency picked up by the work of ultrasonic vibration is fundamentally ascribed to the change in dielectric dissemination which encourages the flotsam and jetsam expulsion and the formation of a vast weight change between the terminal and the work piece, as an upgrade of liquid metal discharge from the surface of the work piece.

4.2 Dry EDM:-

In dry EDM, device cathode is shaped to be thin walled pipe. High-weight gas or air is provided through the pipe. The part of the gas is to expel the flotsam and jetsam from the hole and to cool the entomb cathode hole. Fig. 2 demonstrates the guideline of dry EDM. The method was created to diminish the contamination brought about by the utilization of fluid dielectric which prompts to generation of vapor amid machining and the cost to deal with the waste.

4.3 Powder Mixed EDM:-

Powder added substances Fine grating powder is blended into the dielectric liquid. The half breed material expulsion process is called powder blended EDM (PMEDM) where it works relentlessly at low heartbeat vitality [45] and it essentially influences the execution of EDM process. Electrically conductive powder diminishes the protecting quality of the dielectric liquid and increment the start hole between the apparatus and the work piece. EDM handle turns out to be more steady and enhances machining effectiveness, MRR and SQ. Be that as it may, most reviews were led to assess the surface complete since the procedure can give reflect surface complete which is a testing issue in EDM. The attributes of the powder, for example, the size, sort and fixation impact the dielectric execution.

4.4 Water Based EDM:-

EDM in Water as dielectric is an other option to hydrocarbon oil. The approach is taken to advance a superior wellbeing and safe condition while working with EDM. This is by virtue of hydrocarbon oil, for instance, light fuel will rot and discharge ruinous vapor (CO and CH4). Research throughout the latest 25 years has incorporated the use of unadulterated water and water with included substances.

4.5 Micro EDM:-

Miniaturized scale Electrical Discharge machining is very comparative with the principals of Electrical Discharge Machining. As per Z. Katz and C.J Tibbles from the article "Investigation of small scale EDM prepare" states that Electro release machining (EDM) is a warm procedure that utilizations electrical releases to disintegrate electrically conductive materials. EDM has a high ability of machining the precise depressions of bites the dust and forms (H. Zarepur, A. Fadaei Tehrani, D. Karimi, S. Amini, 2007). EDM is a compelling system in the creation of miniaturized scale parts that are littler than 100µm. EDM is a contactless procedure that applies each little compel on both the work piece and device anode. EDM is a procedure that gives an option technique to create microstructures. It is likewise expresses that the smaller scale EDM is like the essential of large scale EDM where the procedure instrument depends on an electro-warm process that depends on a release through a dielectric so as to supply warmth to the surface of the work piece. The introduce causes the warming of the dielectric, the work piece, and the anode. The dielectric shapes a channel of somewhat ionized gas. The discharge power is scattered in the plasma direct with total in the region of 2% and 10%. The channel goes about as a warmth

source on the surface of the work piece. By then the work piece is secretly warmed past its melting point and emptied after the material shot out solidifies inside the cooler dielectric medium. The basic capability among little scale and broad scale EDM is the plasma channel amplify (Diameter). In full scale EDM the plasma size is more noteworthy by a few sales of size than the plasma channel clear. The cross of the plasma can be changed by the beat length in light of the way that the channel clears augmentations as the time increments. In the event that the beat term time enables the channel to extend until it is more prominent than the cathode estimation, the rate of its development will change.

5.Types of EDM

Basically there are two types of EDM: Die-sinking EDM and Wire-cut EDM.

a. Die-sinking EDM-

Die-sinking EDM, also known as Volume EDM or cavity type EDM consists of an electrode and a work piece which is submerged in an insulating fluid such as oil or other dielectric fluids.

b. Wire-cut EDM-Wire-cut EDM, also known as Spark EDM is mostly used when low residual stresses are required, as it does not needs high cutting forces for removal of material.

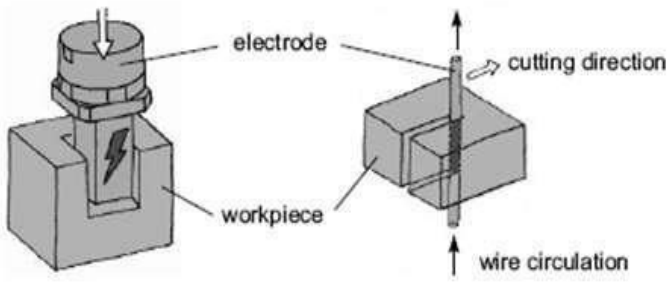

Fig.-2: Die sinking & wire cut EDM Process

6. Important parameters of EDM

There are different Electrical parameters which will play a very vital role in erosion of material presented below.

6.1 Electrical Process Parameters:-

a. Spark On-time (pulse time or Ton):

The span of time (μs) the current is permitted to stream per cycle. Material expulsion is directly relative to the measure of vitality connected amid this on-time. This vitality is truly controlled by the pinnacle current and the length of the on-time.

b.Spark Off-time (pause time or Toff):

The term of time (μs) between the sparks (that is to state, on-time). This time enables the liquid material to harden and to be wash out of the circular segment hole. This parameter is to affect the speed and the stability of the cut. Thus, if the off-time is too short, it will cause sparks to be unstable.

c. Arc gap (or gap):

The Arc gap is distance between the electrode and workpiece during the process of EDM. It may be called asspark gap. Spark gap can be maintained by servo system.

d. Discharge current (current Ip):

Current is measured in amp Allowed to per cycle. Discharge current is directly proportional to the Material removal rate.

e.Duty cycle (τ):

It is a percentage of the on-time relative to the total cycle time. This parameter is calculated by dividing the on-time by the total cycle time (on-time plus off time).

f.Voltage (V):

It is a potential that can be measure by volt it is also effect to the material removal rate and allowed per cycle.

g.Polarity:

It specifies to the potential of the work-piece with respect to tool, depending on the application, the polarity can be either way . Carbide, Titanium and copper are generally cut with negative polarity.

6.2 Non- Electrical Process Parameters:-

There are distinctive Non-Electrical parameters which will assume an extremely crucial part in disintegration of material introduced underneath.

a. Electrode Material:- EDM electrodes comprise of profoundly conductive and/or curve disintegration safe materials, for example, graphite or copper. EDM is an acronym for electrical discharge machining, a process that uses a controlled electrical spark to dissolve metal. EDM electrodes join fragments created utilizing metal, copper and copper mixes, graphite, molybdenum, silver, and tungsten.

Electrical discharge machining (EDM) makes it conceivable to work with metal for which conventional machining methods are insufficient. It just works (aside from by particular outline) with materials that are electrically conductive. Utilizing repeating electric discharge, it is conceivable to cut little, odd-molded points and itemized forms or pits in solidified steel and in addition fascinating metals, for example, titanium and carbide.

b. Electrode Shape: - The most bewildering MRR was found for round electrodes taken after by triangular square, triangular and valuable stone shaped electrodes. In any case, the most hoisted EWR and WR were found for the valuable stone formed electrodes. The base surface cruelty was found for the round electrodes taken after by square, and valuable stone shaped electrodes. Regardless, the effect of the condition of the electrodes on surface repulsiveness was seen to be unimportant. So the electrode shape is basic for good MRR, Less TWR and Higher Surface Roughness.

c. Electrode Size: - The most astounding MRR was found for round electrodes taken after by square, triangular and jewel formed electrodes. Be that as it may, the most elevated EWR and WR were found for the precious stone molded electrodes. The base surface unpleasantness was found for the round electrodes taken after by square, triangular and precious stone molded electrodes. In any case, the impact of the state of the electrodes on surface unpleasantness was observed to be unimportant.

d. Flushing Type: - — Flushing is an essential capacity in any electrical discharge machining (EDM) operation. It not just serves to expel the disintegrated trash from the spark-hole area additionally has different capacities which exceedingly impact the result of this machining process.

7. Performance Parameters- These parameters measure the various process performances of EDM results.

1. Material removal Rate:-MRR is the rate at which the material is removed the work piece. Electric sparks are produced between the tool and the work piece during the machining process. Each spark produces a tiny crater and thus erosion of material is caused.

The MRR is defined as the ratio of the difference in weight of the workpiece before and after machining to the density of the material and the machining time.

$$MRR = (Wi-Wf)/T^* \rho$$

Where Wi= initial weight before machining

Wf= final weight after machining

T = machining time = 15 min

ρ is the density

2. Tool Wear Rate:- TWR is expressed as the ratio of the difference of weight of the tool before and after machining to the machining time. That can be explain this equations