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ELECTRICAL DISCHARGE MACHINING: STATE OF THE ART AND FUTURE PROSPECTS

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Abstract- In this paper there is a review on various aspects of electric discharge machining and various materials which are machine on EDM and WEDM. Titanium, titanium alloys, aluminium and aluminium alloys are widely used in aerospace, automotive industries, and also used in medical implant material in wide variety application. These all are mainly machined by EDM. WEDM is an important non-traditional machining process, mainly used for machining a variety of difficult to machine material including D3 (Die Steel), hard composite materials which are difficult to machine with traditional machining process. This review paper gives understanding of previous research works in various areas of WEDM and EDM. and also give understanding on various parameters used in electric discharge machining like pulse on – time, pulse – off time, pulse width, time between two pulse, feed rate, mechanical tension, negative (-) and positive (+) polarity and shows which parameter gives more effect on material removal rate and which parameter gives more effect on surface roughness and from this paper reader clearly understand the response variable which are mainly used in EDM, like as (MRR, SR, TWR) and kerf width.
Keyword: Material Removal Rate, Surface Roughness, Tool Wear Rate, Electrical Discharge Machining & Wire Electrical Discharge Machining.

1. INTRODUCTION

The history of EDM Machining Techniques goes as far back as the 1770s when it was discovered by an English Scientist. However, Electrical Discharge Machining was not fully taken advantage of until 1943 when Russian scientists learned how the erosive effects of the technique could be controlled and used for machining purposes.

When it was originally observed by Joseph Priestly in 1770, EDM Machining was very imprecise and riddled with failures. Commercially developed in the mid-1970s, wire EDM began to be a viable technique that helped shape the metal working industry we see today. In the mid-1980s the EDM techniques were transferred to a machine tool. This migration made EDM more widely available and appealing over traditional machining processes. 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. 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.

1.1 Working principle of EDM process:

In electrical discharge machining process the metal is removed from the work piece due to erosion by rapidly recurring spark discharge taking place between the workpiece and tool. Show the mechanical set up and electrical set up and electrical circuit for EDM. A thin gap active of 0.025 mm is maintained between the tool and workpiece by a servo system shown in the Figure 1.1. The both of tool and work piece are submerged in a dielectric fluid. Kerosene and de-ionized water is popular type of liquid dielectric although gaseous dielectrics are also utilized in some cases.

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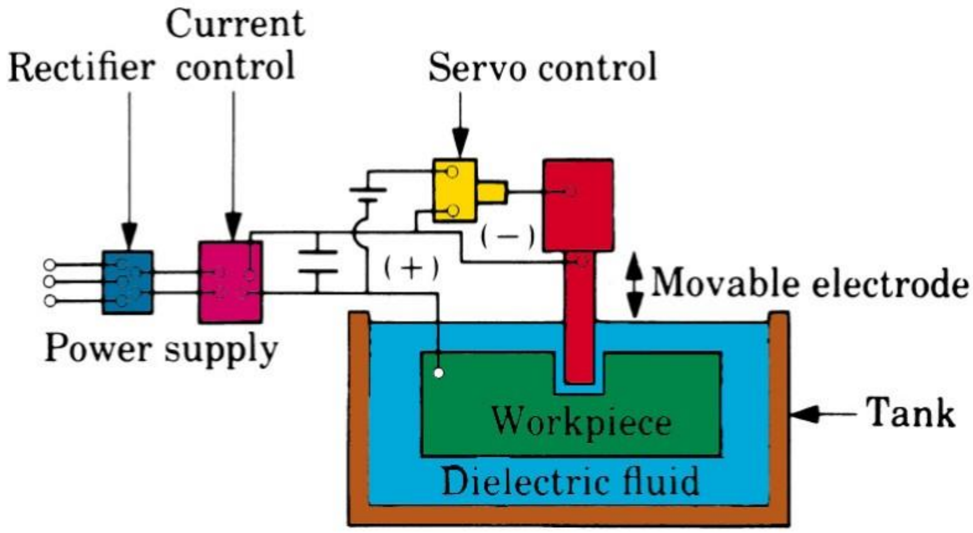

Figure 1.1: Schematic diagram of EDM

The Figure 1.1 shows the electric setup of the EDM. The tool is brew cathode and work piece is anode. When the voltage across the gap becomes decently high, it discharges through gap in the form of the spark in time interval from 10 of micro seconds. Positive ions and electrons are accelerated, creating a discharge channel that becomes conductive. It is just at this point when the spark jumps causes collisions between ions, electrons and creating a channel of plasma. A sudden drop of electric resistance of the previous channel allows that the current density reaches very high values producing a step-up of ionization and the creation of a regnant magnetic field. The moment spark occurs decent pressure develops between work piece and tool as a result of which a very high temperature is reached and at such high pressure and temperature some of the metal is melted and eroded.

1.2 Wire Electrical Discharge Machining process:

Now a days, wire electrical discharge machining (WEDM) is one of the widely used non traditional machining process for machining and shaping hard, fragile and difficult-cutting in the tool and die industry process, in which thin wire as an electrode converts electrical energy into thermal energy for disappearing materials. In the wire EDM erosion, mechanism has been described as melting or evaporation of the surface material by the heat produced in the plasma channel. A spark is produced between the wire electrode and work piece through de-ionized water and erodes away the work piece to create complex of two and three dimensional shapes. Wire EDM is considered as a particular selection of the conventional electrical discharge machining process which comprises a main work table, a CNC controller, wire drive mechanism, working fluid tank and attachments. The work piece is placed on the fixture table and fixed securely with the help of clamps and bolts. The table moves along X and Y axes and the DC servo motors drive it. Various kinds of wire electrodes made of copper, brass or molybdenum having diameter 0.05-0.30 mm, are being used as cutting tools. The wire is wound on a wire drum which can rotate at 1500 rpm. A schematic diagram of a WEDM process is shown in Figure 1.2, where the wire and the work piece are immersed in a dielectric fluid.

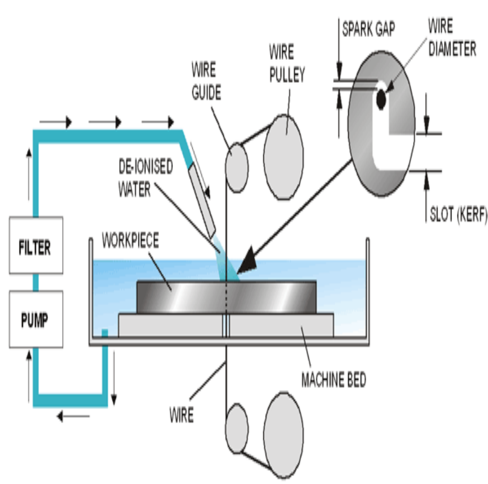

Figure 1.2 Schematic diagram of WEDM system [36]

The machining of wire EDM works by creating an electrical discharge between the wire or electrode, and the work piece. When the spark jumps over the gap then material is removed from both the work piece and the electrode. To stop consonant of the sparking process from shorting out then a non-conductive fluid or dielectric is utilized which act as a coolant and removes waste eroded particle or debris coming out from the gap. Wire-cutting EDM is widely utilized when low residual stresses are to be obtained, because it does not require high cutting forces for removal of material. If the energy/power per pulse is relatively low, then little change in the mechanical properties of a material is expected because of these low residual stresses, though material that hasn't been stress-relieved can distort in the machining process and because of the inbuilt properties of the process, wire EDM can easily machine the complex parts and precision components out of hard conductive materials.

2. LITERATURE SURVEY

Alias et al. [1] analyzed the WEDM: influence of machine feed rate in the machining titanium Ti-6AL-4V using the brass wire and constant current (4A). The material was selected titanium Ti-6AL-4V and used the wire EDM machining. The process that was used by author characterized by the process parameters such as machine feed rate, wire speed, voltage, and wire tension. It was a non-traditional machining process which used the endlessly circulating wire as electrode and cuts the work piece along a programmed path. Before and after machining, all the specimens will be cleaned in an alcohol bath using mini ultrasonic cleaner modal MUC-100 and then dried up using beuhler metaserv specimens dryer in blower mode. It was found that machining parameter for performance of WEDM kerfs width, material removal rate and surface roughness.

Chattopadhyaya et al. [2] analyzed the machining characteristics of the EN-8 steel with the Cu as a tool electrode during rotary electrical discharge machining process. The mathematical models for forecasting of the output parameters have been highly developed, utilizing linear regression analysis. Three input parameters of the model that is to order peak current, pulse on time and the rotational speed of tool electrode were selected as variables for evaluating the output parameters such as the MRR, electrode wear ratio and SR. The results were analysed by using Taguchi Method and the analysis of variance.

Candane et al. [3] investigated the effect of cryogenic treatment on microstructure and wear characteristics of AISI M35 HSS. The specimens were prepared from AISI M35 high speed steel bar of 15 mm square cross section with a nominal composition of C - 0.889%, Mn - 0.273%, Si - 0.364%, S - 0.006%, P - 0.024%, Cr - 4.175%, Ni - 0.171%, Mo - 4.656%, V - 1.788%, W - 6.087%, CO - 4.551%. All the specimens were subjected to conventional heat treatment in a barium chloride salt bath furnace in the following sequence. As a first step specimens were pre-heated in a forced air circulation furnace maintained at a temperature of 500˚C to remove the moisture content for a period of 30 minutes. Shallow cryogenic treatment was carried at -85˚C with a soaking time of 8 hours. Deep cryogenic treatment was carried at -195˚C with a soaking time of 24 hours. There was a marginal improvement in hardness from 64 HRC to 64.5 HRC for shallow cryogenic treated specimens and it improved further after deep cryogenic treatment to 65.5 HRC. It was concluded that also the micro hardness measured in Vickers scale shows an increase in hardness value from 920 to 934 in case of shallow cryogenic treatment and it was 980 in case of deep cryogenic treatment.

Cicek et al. [4] analyzed the application of Taguchi method for surface roughness and roundness error is drilling of the AISI 316 stainless steel. It was selected the work piece AISI 316 austenitic stainless steel and dimensions of work piece were 100 mm x 170 mm x 15 mm. The three holes were drilled to comparison the surface roughness (Ra) and roundness error (Re) measurement in the all machining condition and the drilling tests were performed using John Ford VMC 850. The surface roughness of the machined holes was calculated utilizing a Mitutoyo Surftest SJ-301 portable surface roughness tester and average roughness values (Ra) was evaluated. The roundness error measurements were performing using a Mitutoyo CRT - AC 544. It used the Taguchi method to improving the industrial product quality. It was found that cutting speed had a significant effects on the surface roughness and that the cutting speed, feed rate had significant effects on the roundness error.

Datt and singh [5] investigations the optimization of WEDM parameters using Taguchi and ANOVA method. The material was used EN-31 and using WEDM machining. The process parameters are like as wire feed, flushing pressure and gap voltage. Author was used the response variables like MRR and SR. It was found that most favourable parameters for compromise between SR and MRR are Wire Speed (7), Flushing Pressure (24), and Gap Voltage (60) which presents a values 4.025Ra and 5.640 mm3/ min respectively.

Dhar and Purohit [6] evaluated the effect of current, pulse-on time, and air gap voltage on MRR, TWR, ROC of EDM with Al–4Cu–6Si alloy–10 wt% SiC composites. An EDM machine and a cylindrical brass electrode of 30 mm diameter were used. And three factors, three levels full factorial design was using and analyzing the results. A second order, non-linear mathematical model has been developed for establishing the relationship among machining parameters. The significant of the models were checked using technique ANOVA and finding the MRR, TWR and ROC increase significant in a non-linear fashion with increase in current.

Gill et al. [7] investigated the effect of deep cryogenic treatment on the surface roughness off OHNS die steel after wire electrical discharge machining. The material was selected for OHNS die steel (oil hardened non-shrinking) and used the wire electrical discharge machining. Deep cryogenic treatment of work piece was done using 9-18-14 cycle. The machining time for each cut was 12 minutes and after cutting the work piece machine checked the surface roughness. It was found that cryogenic treatment of the work piece significantly improved the surface finish of machined surface.

Gubencu and Pop-Calimanu [8] investigated the study of the factors influence on the objective functions of wire EDM of AA2124/SiC/25p. The composite material was selected AA2124/SiC/25p and using a wire electro discharge machining. The systemic analysis was the basis of detailed experimental research, having a final aim, the process parameters by wire EDM of AA2124/SiC/25p. The input parameters like such as a pulse-on time, pulse-of time, peak current, table feed rate, offset correction, wire tension and wire speed. The influence of thickness of the material laminate and the wire material on the material removal rate of the EDM AA2124/SiC/25p composite material, a bi-factorial ANOVA was considered to be an appropriate assessment method. The experiment was carried out on 3 values for the material thickness. These samples were machined by wire EDM cutting, using the same straight pattern, each of 200 mm length. The authors was used the two types of brass wire, uncoated brass wire and coated brass wire. The objective function chosen was the material removal rate. The results of the bi-factorial analysis were to determine which factors have a statistically significant effect on material removal rate [mm^3/min] using Fisher tests. It was concluded that the thickness laminate doesn't have a significant influence on the material removal rate of wire EDM of AA2124/SiC/25P at the 95.0% confidence level.

Huang and Liao [9] investigated the optimization of machining parameters of wire-EDM based on grey relational and statistical analysis. The work piece material was selected SK D11 alloy steel and using the wire EDM machine. The electrode brass wire was used 0.25 mm diameter of wire. The author used six machining parameters such as pulse-on time, pulse-off time, table feed rate, wire tension, wire velocity and each parameter was designed to have three levels. The machining result after wire EDM process were evaluated in term of the following measured machining performance metal removal rate; gap width; surface roughness. The relation between machining parameters and machining performance can be observed by using the grey relational analysis. It was found that significant machining parameters for machining performance of metal removal rate, gap width and surface roughness.

Kapoor et al. [10] analyzed the effects of cryogenic treated wire electrode on the surface of an EN-31 steel machine by the WEDM. The work piece material was selected EN 31 steel plate of thickness 11 mm and used the Robofil 290 CNC wire cut EDM machine. The process that was used by authors characterized by the process parameters such as wire electrode, pulse width and wire tension. The surface roughness values were measured with the Surf Tester (SJ201). It was concluded that kind of wire, pulse width and wire tension significance affected the surface roughness in wire electrical discharge machine.

Khullar and Sharma [11] investigations the surface quality analysis of EN 31 processed by Wire EDM using taguchi method. The material was selected EN-31 and using the CNC-Wire EDM. The process parameters was used like as pulse on time (T_{on}), pulse off time (T_{off}), and servo voltage (SV) and response variables like as surface roughness (SR). It was found that percentage contribution of input factors is given by pulse on time: 26.59%, pulse off time: 69.28%, Servo voltage: 4.03% and residual error: 0.08%.

Jangra et al. [12] investigated one by one optimization of material removal rate, surface roughness for the wire EDM of WC-Co composite utilizing grey relational analysis on with the Taguchi method. The influence of the peak current, taper angle, pulse-off time, pulse-on time, wire tension and the dielectric flow rate are analyzed for material removal rate, surface roughness during complicated machining of a carbide block. In order to optimize material removal rate and surface roughness one by one, grey relational analysis was employed along with the Taguchi method. The WC-Co composite was designed, grey relational analysis was employed on with Taguchi method and percentage error between experimental values and the predicted results are less than 4% for some machining characteristics.

Kumar and Sivasubramanian [13] investigated the machining parameters optimization of WEDM process using Taguchi method. The material was selected for EN 31 alloy steel and used ST CNC-E3 (MCJ) wire cut electrical discharge machine. The experiments were conducted on EN 31 alloy steel material having the composition varies (1.00% C, 0.50% Mn, 1.40% Cr and 0.20% Si) as a work sample. The work piece was in the shape of rectangle plate and work piece had been machined utilizing molybdenum wire was utilized as a tool having 0.20 mm diameter and the de-ionized water as a dielectric fluid. All the samples had been machined for a length of the 4 mm. The machining time were measured using a stop watch and after machining to calculate the material removal rate and surface roughness values were measured using Mitutoyo SJ201 portable device surface tester. It was determined that the significant machining parameters for the performance measures like material removal rate and surface roughness one by one in the WEDM process. It was found that Taguchi method plays a significant role for material removal rate and surface roughness.

Liao and Yu [14] investigated the study of the specific discharge energy in WEDM and its application. The work piece materials was selected were aluminum alloy, titanium alloy, stainless steel, a cold work tool steel, a hot work tool steel and used the flushing 5-axis CNC wire electrical discharge machine. The author was characterized by the process parameters such as discharge on time, discharge off time, wire speed, flushing pressure and servo voltage. It was found that the material having close value of specific discharge energy demonstrate very similar machining characteristics such as machining speed, discharge frequency, groove width and surface finish of the machine surface under the same machining condition. It was derived the machining parameters and the machining characteristic such as material removal rate and the efficiency of material removed.

Lahaneet, Rodge and Sharma [15] investigations the practical number of reaches to determine the optimal process place setting that can optimize multiple performance measures of the wire EDM operation. In this paper, the weighted principle component method was used to modify many responses of the wire EDM process and the results show that the weighted principal component method offers up importantly finer overall quality as compared to other reaches.

Mahapatra and Patnaik [16] described the optimization of wire electrical discharge machining process parameters by using Taguchi methods. In this paper author modified metal removal rate, surface finishing and the cutting width for a rough cut. The Taguchi's L_{27} was utilized to optimize single response characteristic. Finally, genetic algorithm, a common revolutionary approach, was employed to modify the wire electric discharge machining process with many types of objectives. The study demonstrates that wire EDM process parameters can be adjusted to attain the finer metal removal rate, surface finish and cutting width simultaneously. The confirmation experiments were carried out that shows the error associated with MRR, SR and kerf was less than 5 %.

Nagaraja, Chandrasekaran and Shenbhgaraj [17] presents an investigation on the optimization of machining parameters in Wire EDM of bronze-alumina MMC. Main objective is to find the optimum cutting parameters to achieve a low value of Surface roughness and high value of material removal rate (MRR). The process parameters are like as pulse on time (Ton), pulse off time (Toff) and wire feed rate. The settings of cutting parameters were determined by using Taguchi experimental design method. An L9 orthogonal array was chosen. Signal to Noise ratio (S/N) and analysis of variance (ANOVA) was used to analyze the effect of the parameters on surface roughness and to identify the optimum cutting parameters. The contribution of each cutting parameters towards the surface roughness and MRR is also identified. The study shows that the Taguchi method is suitable to solve the stated problem with minimum number of trails as compared with a full factorial design.

Okada et al. [18] investigated the effect of surface quality of brass coating wire on wire EDM characteristics. The author used a trial made thin of 50 µm in diameter. The experiments were carried out using a commercial wire electrical discharge machines with linear motor drive (Sodick AP200L and AQ550L). The wire was newly developed for this research, in which brass was coated on high tensile strength steel wire. The metal mould steel SK D11 in Japanese Industrial Standard specifications was used as a work piece, whose thickness was 10 mm. The coated brass wire with copper content of 60-70% was effective and the thickness of coated brass is needed to be more than 1.45 µm for high removal rate. It was concluded that the case of conventional tungsten wire, when the wire tension was too high, the removal rate decreases because of unstable wire vibration.

Patel et al. [19] investigated the parametric analysis and mathematical modelling of material removal rate and surface roughness for H-11 material on wire cut EDM by DOE approach. The material was selected H-11 die tool steel and used the wire-cut EDM machining. The process that was used by authors characterized machining process parameters such as pulse duration, specific energy, discharge frequency and discharge current intensity. The input parameters can be used material removal rate, surface roughness and kerf width. The molybdenum coated brass wire was used 0.25mm diameter. The surface roughness of specimen measured with the help of roughness tester Mitutoyo SJ-201 portable device. It was found that parametric analysis the process parameters affect different response in different ways and improved the surface roughness, kerf width, material removal rate.

Payal et al. [20] investigated the tool materials for metal removal rate in electrical discharge machining. The work piece material was selected AISI H11 tool steel. Three different tool electrodes of cylindrically shaped namely copper (Cu), graphite (Gr) and aluminium (Al) were used. The input process parameters were current and gap voltage and response variable was material removal rate. It was concluded that graphite offers the higher MRR followed by aluminium and copper.

Popli and Sharma [21] investigated the surface roughness for wire EDM of MONEL 400 alloy. The process parameters were: pulse on time, pulse off time, peak current and servo voltage and the output response was surface roughness. It was found Pulse off time (p-value 0.0002) is the most significant factor for surface roughness. Additionally, peak current (C) and spark gap set voltage (D) are also significant for their effect on surface roughness.

Purcar and Simion [22] investigated the studies about the roughness of the surface machined by EDM. Two components part, craters produced through with material parting and welding practices had modified in the analysis. The flushing gap was rectified through rotation of the electrode. It was testified that the tool rotation has much influence on productivity and the precision of machining. The plots settled on the experimental results of actual EDM operation related to a machine and combinations of work and tool material and observational relationship in the form of regression equations had been utilized for selecting machining parameter.

Tosun et al. [23] analyzed the effects and improvement of machining parameters on the notch and material removal rate in wire electrical discharge machining (WEDM) operations. The studies were managed under variable pulse duration, open circuit voltage, wire speed and discharge flushing pressure. The settings of machining parameters were observed by utilizing the Taguchi design methods.

Rao et al. [24] investigated the effect of the wire EDM conditions on the surface roughness: A parametric optimization by utilizing the Taguchi method. The material selected was aluminium BIS 24345 alloy and used the CNC wire- cut EDM machine. The authors used eight machining parameters such as pulse off time, pulse on time, peak current, dielectric fluid, wire feed rate, wire tension, spark gap voltage and servo feed. The measurement of surface roughness has been done using a stylus- type profilometer of Talysurf 10. Analysis of variances and S/N ratios determined the importance of parameters and the optimum parametric combination respectively for the response of surface roughness. It was found that using Taguchi method to surface roughness tends to decrease significantly with decrease in peak current and pulse on time and the improvement in surface finish using Taguchi method.

Saini and Garg [25] investigated the effect of cryogenically treated wire on surface roughness in Wire EDM process. The work piece material used was AISI D3 die steel. The tool material was zinc coated diffused brass wire. Two wires were used:

one was cryogenically treated and second was without any cryogenic treatment. The input process parameters were: pulse width (µs), time between two pulses (µs), wire feed rate (m/min) and wire mechanical tension (daN). It was found that the cryogenically treated wire produces better surface finish as compared to non-cryogenically treated wire for same material.

Saini and Garg [26] investigated the enhancement of material removal rate in Wire EDM process with cryogenically treated wire. The work piece material used was AISI D3 die steel. The tool material was zinc coated diffused brass wire having diameter 0.25 mm. Two wires were used one wire was cryogenically treated and the other was simple and without any cryogenic treatment. Four process parameters viz. pulse width (µs), time between two pulses (µs), wire feed rate (m/min), wire mechanical tension (daN) were studied. It was found that the cryogenically treated wire produces more material removal rate as compared to non-cryogenically treated wire for same material.

Singh and Singh [27] investigated effects of cryogenic treatment on high-speed steel tools. The material selected was high speed steel tool and used higher power rigid lathe machine. It used machining parameters such as machine tool, cutting tool, tool geometry, work material, work piece specifications, cutting speed, feed rate and depth of cut and the surface roughness of work specimens was measured by surface roughness tester, model SURF TEST4; nose radius of both the UT and CT HSS tools was measured using universal measuring microscopic least count 0.0001 mm. The speed of the work piece was measured with digital tachometer, model DT-2234. It was found that cryogenic treatment of work piece significantly improves the surface roughness.

Singh et al. [28] experiment analyze of wire EDM variables on surface roughness (SR) of the AISI D3 die steel by utilizing the two cryogenically treated dissimilar wires. The work piece material was used AISI D3 die steel and using the Charmilles Model 290 wire EDM machine. Two kinds of wire electrodes were utilized which brass wire and zinc coated diffused wire. The various machining parameters were utilized like pulse width, time between two pulses, wire tension and wire feed rate. It was observed that the cryogenically treated zinc coated diffused brass wire gives fine surface finish as considered to the cryogenically-treated plain brass wire.

Singh and Singh [29] investigated wear behaviour of the AISI D3 die steel utilizing the cryogenic treated Cu and Brass electrode in the electric discharge machining. The input process parameters in these days are utilizing four different types of electrodes that is Cu, cryogenic treated Cu, brass and cryogenic treated Brass, the weight of the work pieces and electrodes was accomplished before machining and after machining on the weighing machine having least count of 1 mg. The kerosene oil was utilized as dielectric fluid experiments. The electrodes had 16 mm diameter and 55 mm lengths were fitted out of rods of Cu and brass for performing the experiments. After preparing the needful size the face of each electrode was polished so as to obtain fine surface finish utilizing dissimilar emery papers ranges between 220-2000 grit sizes. After that electrodes of Cu and Brass were cryogenically treated to improve properties. The work piece size of 25 mm × 18 mm × 6 mm was ready-made by utilizing the wire EDM. The prepared specimen was heat treated to improvise their hardness. After heat treatment the hardness of work piece material was 58 HRC. The Cu electrode was good electrode for high MRR. But cryogenic treated Cu electrode had low tool wear as analyzed to Cu electrode.

Singh et al. [30] investigated the effects of two dissimilar cryogenic treated wires in the wire electrical discharge machining (WEDM) of the AISI D3 die steel. The work piece material was selected AISI D3 die steel and used the Charmilles Model 290 WEDM machine. The two types of wire electrodes were the namely Brass wire and Zn coated diffused wire. The various machining parameters which were taken over for observational study are: pulse width, time between two pulses, wire feed rate and wire mechanical tension. There was not significant effect of wire tension and wire feed rate on MRR. It was observed that the cryogenically treated zinc coated diffused brass wire generates 22.55% more than material removal rate as compared to the plain brass wire.

Sharma and Khanna [31] utilized the Taguchi method to modify the process parameters of cryogenic treated D-3 machined by the wire EDM. In this study the material was stored in cold environment to step up wear resistance and relieving residential stress. More process parameters as the pulse width, time between two pulses, maximum feed rate and servo- reference mean voltage. It was found that the pulse width, time between two pulses has significant effect on surface roughness values.

Siddique and Tiwari [32] investigated the indentation hardness on Aluminium-Silicon carbide with p-bond composite. The particle size of 74 microns of silicon carbide corresponding to 200 mesh was taken. It was found from the results that with the increase in silicon carbide, the hardness value of the metal matrix composite increased drastically and hardness increased by two times with weight fraction of 9% silicon carbide when compared to that of the pure form of aluminium.

Yang and Chen [33] analyzed the Taguchi parameters design in the order to identify optimum surface roughness performance on an aluminium material with cutting machining parameters of the depth of cut, cutting speed, feed rate and tool diameter. It was found that tool diameter is not a significant cutting factor touching the surface roughness.

Singh and Khullar [34] investigations EDM processing of MS IS: 2062 by using Taguchi approach. The material was selected MS IS: 2062 and used EDM machine. The powder material was used copper (300 mesh number) and copper used the electrode material. The process parameters were like as machine voltage V (volt), peak current P (ampere), pulse duration T_A (µs), interval time T_B (µs). The response variables are MRR and SR. It was concluded that both MRR and SR shows better results by using copper powder and copper electrode.

Muthuramalingam and Mohan [35] investigations the importance of tool electrode materials (copper, brass, tungsten carbide) on the machining performance of AISI 2020 stainless steel in EDM process. The work piece material was selected AISI 2020 stainless steel and using electric discharge machine. The author was used the various process parameters. It was concluded that copper electrode produces higher MRR and tungsten carbide electrode showed better surface finish.

3. SUMMARY

From the above present literature, it has been observed that in most of the studies, the effect of the independent variables has been studied for the surface roughness and material removal rate for EDM and WEDM machine. The effects of input parameters were evaluated utilizing ANOVA for S/N ratios. In addition, main effects plots for S/N ratios have been drawn and analyzed. It is also found that there is less works carried out in electric discharge machining process composites. However, some investigations into the machining aspects of EDM on typical MMCs with only a single particulate reinforcement have been carried out and reported. The main findings are listed below:

i. Literature review shows that the researchers have carried out most of the work on SR and MRR achieved by using EDM and Wire EDM.
ii. The effect of process parameters on low carbon alloy steel has not been investigated using EDM and Wire EDM.
iii. Multi-response optimization of EDM and Wire EDM process had paid a less attention in past research.
iv. The literature available on the machining of some composites like machining of aluminium boron carbide composites is very less.

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