Literature review on optimization of Powder Mix Electrical Discharge Machining

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Abstract: The last decade has witnessed an increasing interest in the novel applications of electrical discharge machining (EDM) process. Due to the continuous efforts by the researchers many innovations have been made to improve the performance of EDM process. Among various EDM variants, powder EDM is one of the successful technique, which shows the considerable improvement in the performance of EDM by increasing the MRR and surface finish as both of these responses are mainly considered by the industries. Despite the better processing results, powder mixed EDM process is used in industry at slow pace. Therefore, with a vast future scope of powder EDM in areas of machining and surface modification of difficult-to-machine materials, authors in this paper explored all the parameters and terms related with powder mixed EDM process.

I. INTRODUCTION OF PMEDM:

EDM is classified under thermo-electric method in which material removal takes place through the process of controlled spark generation. It is commonly used to machine hard and electrically conductive materials for making of mould, die, and automotive, aerospace and surgical components. Powder Mixed EDM (PME DM) has one of the newly developed superior techniques by adding suitable powder like aluminum, chromium, graphite, copper, silicon or silicon carbide etc. into the dielectric fluid of EDM. The powder particles in the spark gap get energized and accelerated in a zigzag fashion and help to boost the spark gap between tools along with the workpiece. The interlocking between the different powder particles takes place in the direction of current flow. This cluster chain development helps in bridging the discharge gap between electrodes thus decreasing the insulating strength of the dielectric fluid and increases the spark gap distance between the tool electrode and workpiece. The diagram of principle of PMEDM is shown in Fig 1.

Due to bridging effect, the insulating strength of the dielectric fluid decreases and easy short circuit takes place, which causes early explosion in the gap. As a result, a ‘series discharge’ starts under the electrode area causing faster erosion from the workpiece surface thereby improving material removal rate (MRR). The added powder modifies the plasma channel between tool and workpiece. The plasma channel becomes enlarged and widened. The sparking among the powder particles is uniformly distributed, hence electric density of the spark decreases.

II. LITERATURE SURVEY:

The author Sriram Kaldhone has carried out a study on the influence of the parameters such peak current, Duty factor, pulse on time , work piece material, powder type , powder concentration and flushing pressure. Taguchi methodology has been adopted to plan and analyze the experimental results. Experiments have been performed on newly designed experimental setup. In this study seven factors with three levels are investigated using Orthogonal Array (OA) L27.Material removal rate (MRR) in this experiment was calculated by using mathematical method. [2]

In the present study of an H.K.Hansal an axisymmetric two-dimensional model for powder mixed electric discharge machining (PME DM) has been developed using the finite element method (FEM). The model utilizes the several important aspects such as temperature sensitive material properties, shape and size of heat source (Gaussian heat distribution), percentage distribution of heat among tool, workpiece and dielectric fluid.
fluid, pulse on/off time, material ejection efficiency and phase change (enthalpy) etc. to predict the thermal behavior and material removal mechanism in PMEDM process.[3]

In this paper aluminum metal matrix composite was fabricated and machined in EDM by mixing aluminum powder in kerosene dielectric by author Gangadharudu talla. The effect of process parameters (powder concentration, peak current, pulsed on time, and duty cycle) on two responses namely, material removal rate (MRR) and surface roughness (SR) were measured. A multi response optimization was performed using grey relation analysis (GRA) to find the optimum combination of the process parameters for maximum MRR and SR[4].

In this paper, satpal sing carried out an experimental study of the machining performance of PMEDM on EN 24 alloy steel in terms of Material Removal Rate has been carried out. A fine powder of tungsten has been suspended in the EDM oil dielectric as an additive. Four input parameters i.e. concentration of tungsten powder; peak current; pulse on time and duty cycle were selected as process variables to investigate PMEDM performance. Experiments have been designed using Taguchi method. [5]

The objective of Mahendra Rathi experimentation is to Study on Effect of Powder Mixed dielectric in EDM of Inconel 718. The effect of various powder mixed in dielectric is studied input parameters like Duty cycles, current, pulse on time and powder media in that Silicon carbide, Aluminum oxide, Graphite powder used. Machining characteristics measured in terms of Material removal rate, tool wear rate.[6]

Nitin K. Khedkar has carried out the experimental study to evaluate the improvement in machined surface properties of OHNS die steel machined by electrical discharge machining using tungsten powder mixed in the dielectric medium. Gap current, pulse on time and pulse off time were taken as process parameters and micro-hardness of the machined surface was taken as the response parameter.[7]

Shivam Goyal carried out a research work on the effect of machining parameters on Surface Roughness and Material Removal Rate (MRR) in a machining operation on Powder Mixed EDM Machine is investigated and the results are optimized by using the Taguchi method. The experimental studies are conducted by keeping various parameters like Current, Voltage, and Pulse on time, Duty factor constant and by varying two parameters i.e. Grain size of Aluminum powder & Concentration of Aluminum powder.[8]

J.M.Muniu investigated the potential of diatomite powder suspension in distilled water for electrical discharge machining and compared its performance with that of aluminum and copper which are established in industry. Mild steel work pieces were machined using graphite.[9]

F.Q. Hu, F.Y. Cao carried out a study for a kind of moderate volume fraction (40%) of SiC particle reinforced Al matrix composites (SiCp/Al) to research how the surface properties are affected in conventional EDM (EDM) and powder-mixed EDM (PMEDM). By means of environment scanning electron microscope (ESEM) and HIT friction and wear tester, surface micro-topography, elements and wear resistance were analyzed.[10]

V.S.Ganachari in his study it has been experimentally demonstrated that the presence of suspended particle in dielectric fluid significantly increases the surface finish and machining efficiency of EDM process. Concentration of powder (Aluminum + Silicon carbide) in the dielectric fluid, pulse on time, duty cycle, gap voltage and peak current are taken as independent variables on which the machining performance was analyzed in terms of surface roughness (SR).[11]

Ashvarya Agrawal in his research investigates the machining performance of copper-iron-carbide MMC using PMEDM. A hybrid approach of artificial neural network and genetic algorithm has been used to develop the intelligent model for TWR and subsequent optimization with the experimental data obtained by central composite rotatable design.[12]

The objective of Devdatt R. Vhatkar study was to realize the potential of silicon powder as additive in enhancing machining capabilities of PMEDM on EN31. Taguchi methodology has been adopted to plan and analyze the experimental results. Peak current, Pulse on time, Pulse off time, gap voltage, and concentration of fine silicon powder added into the dielectric fluid were chosen as input process variables to study performance in terms of material removal rate & surface roughness.[13]

Behzad Jabbaripoura, in his study the powder mixed electrical discharge machining (PMEDM) of γ-TiAl by means of different powders such as aluminum, chrome, silicon carbide, graphite and iron is performed to investigate the output characteristics of surface roughness and topography, material removal rate (MRR), electrochemical corrosion resistance of machined samples and also the machined surfaces are investigated by means of EDS and XRD analyses.[14]

N. B. Gurule in this study it investigates the potential of PMEDM for enhancing material removal rate (MRR) of Die steel with rotary tool. Taguchi methodology has been adopted to plan and analyze the experimental results. Experiments have been performed on newly designed experimental setup. In this study seven factors with three levels are investigated using Orthogonal Array (OA) L27[15]

Mohd. Junaid Mir study explains the state of the art technology of high-performance machining of advanced materials i.e. Powder mixed EDM. In this study, parametric optimization of Surface Roughness (SR) study on the powder mixed electrical discharge machining (PMEDM) of H11 steel has been carried out.
Response surface methodology (RSM) has been used for developing, improving and optimizing the experiments[16].

The author Kuldeep Ojha studied parametric optimization for material removal rate (MRR) and tool wear rate (TWR) study on the powder mixed electrical discharge machining (PMEDM) of EN-8 steel has been carried out. Response surface methodology (RSM) has been used to plan and analyze the experiments. Average current, duty cycle, angle of electrode and concentration of chromium powder added into dielectric fluid of EDM were chosen as process parameters to study the PMEDM performance in terms of MRR and TWR. Experiments have been performed on newly designed experimental setup developed in laboratory. [17]

Nimo Singh in this experimental study, the effects of various process parameters; powder concentration, peak current, pulse off time, tool electrode diameter and flushing pressure of powder mixed EDM (PMEDM) have been investigated to reveal their impact on material removal rate (MRR) of EN-8 steel by mixing Zinc (Zn) powder to kerosene dielectric. The optimal set of process parameters has also been predicted to maximize MRR. It is found that powder concentration and peak current are the significant parameters for MRR.[18]

Farhad Kolahan in his paper addresses modeling and optimization of process parameters in powder mixed electrical discharge machining (PMEDM). The process output characteristics include metal removal rate (MRR) and electrode wear rate (EWR). Grain size of Aluminum powder (S), concentration of the powder (C), discharge current (I) pulse on time (T) are chosen as control variables to study the process performance. The experimental results are used to develop the regression models based on second order polynomial equations for the different process characteristics. Then, a genetic algorithm (GA) has been employed to determine optimal process parameters for any desired output values of machining characteristics. In the present work, a set of second order curvilinear regression models is developed to represent relationship between input process parameters and output machining characteristics. The adequacy of the proposed models has been investigated using ANOVA technique. The results of ANOVA indicate that the proposed models have very good conformity to the real process. Then an optimization method, based on Genetic Algorithm, have been employed to determine the proper process parameters values for any given set of desired machining characteristics.[19]

Paramjit Singh, in this study author analyze the effect of electrical parameters on the performance of PMEDM process. Peak current, gap voltage, pulses on time and duty cycle are taken as machining parameters. Material removal rate, tool wear rate, wear ratio and surface roughness are taken as response parameters to measure process performance.[20]

### III. CONCLUSION:

The conclusion of this literature survey is to do study the effect of various powders and tool rotations upon MRR, RWR and SR for the purpose experimentation on tungsten carbide along with the copper electrode. Kerosene has to be used as a dielectric. Aluminum, Silicon and Graphite powder should be added in to dielectric and that has to study. Also to do a study of the technology of powder mixed EDM for finishing tungsten carbide composite. Develop a mathematical model for response variables.

### REFERENCES


