



Modeling and Evaluation of EDM Process Parameters using Taguchi Method and Fuzzy Logic Technique

O. Rajender, K. Krishna, T.Krishnaiah

Abstract: *In present day years, the mechanical results no longer call for high exactness and incredible, anyway furthermore should be created in negligible time to help inside the fairly forceful commercial center. Subsequently it's far required to accomplish the exact yield by method for following the framework and parameters according to the necessity. The information parameters play imperative position in making sense of the surface harshness, instrument put on rate and also material end cost. Among the various machining procedures of EDM is one of the most extreme pleasant substitutes for the business because of its pleasant astounding of no touch between the apparatus and work piece. In the predominant watch the unmistakable writing assess of various contemporary machining procedures is brought. The prevalent center is at the displaying normal for assorted parameters of the EDM methodologies and therefore just such research works are secured in this work wherein the use of favors demonstrating procedures come to be finished. This assess look at has been ordered in accordance with special framework as EDM and different total and ventured forward assessment. The assess depictions on relating immense scale was presently not endeavored early by means of thinking about numerous methodology at once, and in this manner, this assess work may likewise wind up the prepared data at one region and it might be very utilizing full for the ensuing specialists to decide their course of studies.*

Keywords: *Electric discharge machining, process parameters, taguchi method, fuzzy logic technique, TWR, MRR and SR.*

I. INTRODUCTION

The Electrical release machining is contemplated as one of the essential non-customary machining systems utilized for assembling geometrically perplexing or hard texture added substances that are amazingly difficult to instrument by utilizing conventional machining strategies. New attributes inside the field of texture innovation have cause new designing metal substances, composite materials, and pottery, having amazing mechanical homes and warm qualities notwithstanding enough electrical conductivity so it will

serenely be machined with the guide of flash disintegration. Electrical release machine (EDM) innovation is progressively being actualized in gadget, bite the dust and form making enterprises, for machining of warmth treated instrument steels and propelled substances (awesome combinations, earthenware production, and metallic grid composites) requiring unreasonable accuracy, confused shapes and extreme ground give up.

II. LITERATURE REVIEW

Some picked research papers have been reviewed identified with Electrical Discharge Machining. The assessments did in these papers are basically worried over the EDM process parameters, for example, current, voltage, beat on schedule, duty cycle, and so on and how these effect the machining attributes like MRR, TWR and SR, and so forth.

[1] B. H. Yan, J. L. Lin and K. S. Wang, the finished a have a take a look at the Optimization of the electrical discharge machining method primarily based totally on the Taguchi method with fuzzy real judgment. A multi-response standard performance index is used to treatment the EDM system with more than one typical performance tendencies. The machining parameters pulse on time, pulse off time, voltage, modern-day and obligation factor are the optimized with troubles of the more than one usual performance dispositions Material elimination rate, Tool placed on price and Surface.

2] Venkata Ramaiah, PRajyalakshmi.G, the take a look at the Optimization of Process Parameters of Wire Electrical Discharge Machining Using Fuzzy suitable judgment included with Taguchi Method. This paper discusses the software of the Taguchi technique with fuzzy incredible judgment to optimize the machining parameters for Wire electric powered discharge machining of Income 825 with a couple of traits. Multi-reaction everyday basic performance indexes (MRPI) have come to be used for optimization. The machining process parameters viz., pulse on time, pulse off time, nook servo voltage, flushing pressure, cord feed, cord anxiety, spark hollow voltage, servo feed were optimized with interest of a couple of normal everyday widespread famous general performance traits. The results from confirmation runs indicated that the decided best aggregate of machining parameters superior the overall ordinary not unusual general widespread average performance of the machining approach.

[3] T. Rajmohan, R. Prabhu, G. Subba Rao, K. Palanikumar. The research on optimization of machining process parameters in EDM.

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Throughout this check, its miles determined that specific aggregate of EDM method parameters square measure needed to acquire better MRR for 304 stainless steel. Signal to noise importance relation (S/N) and assessment of variance (ANOVA) is hired to research the result of the parameters on MRR and similarly to understand the foremost suitable reducing parameters. [4] B.S. Reddy et al. finished a have a have a take a look at the impact EDM parameters over MRR, TWR, SR and hardness. Mixed factorial format of experiments and a couple of regression evaluation strategies had been hired to build up the well-known consequences. The parameters in the reducing order of importance for; MRR: servo, obligation cycle, contemporary-day-day and voltage; TWR: modern-day-day, servo and responsibility cycle; SR: modern-day; HRB: investigated the impact of the peak contemporary and pulse period on the general massive everyday common ordinary performance tendencies of the EDM. The conclusions the contemporary-day by day and pulse on time considerably affected the MRR, TWR and SR, the MRR will growth almost linearly with the developing modern-day-day, the SR will increase linearly with contemporary-day for precise pulse on time, TWR superior with growing pinnacle modern-day-day at the same time as reduced on the equal time due to the reality the coronary heart beat on time modified into advance. [5] B. Bhattacharyya et al. Located that pinnacle modern-day and pulse on time extensively encouraged specific standards of surface integrity which includes ground crack density, ground roughness and white layer thickness. [6] S. Dhar got proper right here to the following conclusions: with growth in pinnacle current MRR, TWR and ROC extended drastically in a nonlinear style; MRR and ROC prolonged with the boom in pulse on time and hollow voltage end up located to have some effect at the 3 responses. [7] A. Jyoti Swarup and Raj Ballav. Modeling and evaluation of way parameters of Die sinking EDM 31 Tool Steel. In this examine three process parameters, viz., discharge modern; voltage and pulse on time at three distinct ranges are taken. Experiments have been completed on an Oscar Max die-sinking electric powered discharge device with artwork piece fabric as EN 31 device metallic and electrode of natural copper. A regression version is advanced for each output reaction viz. MRR and EWR. The contribution of every gadget parameter for influencing output reaction modified into analyzed thru ANOVA tables. [8] S. H. Tomadi. The complete factorial format of experiments changed into used for reading the parameters. In case of SR, the important factors have been voltage and pulse off time while contemporary-day-day and pulse on time were no longer splendid. For MRR the most influential end up pulse on time located through manner of voltage, modern-day and pulse off time. Finally, in case of TWR the critical trouble to become pulse off time observed through pinnacle contemporary. [9] Kiyak and Cakir. Found that SR of tough paintings piece and electrode were inspired with the beneficial aid of modern-day-day and pulse on time, better values of those parameters prolonged the floor roughness. Lower modern-day and pulse time and better pulse off time produced a higher ground give up. [10] Lin. Has furnished using grey relational evaluation primarily based absolutely definitely absolutely mostly on an orthogonal array and the furry-primarily based sincerely in truth in reality Taguchi technique for the optimization of the electric discharge machining technique with a couple of manner responses. Both

the grey relational evaluation method without the use of the S/N ratio and fuzzy not unusual experience assessment are applied in an orthogonal array desk in sporting out experiments. Experimental consequences have examined that each approach can optimize the machining parameters (pulse on time, obligation problem, and discharge modern) with troubles of the more than one responses (electrode positioned on ratio, material removal price, and ground roughness) successfully and may considerably enhance way responses. It seems that the gray relational assessment is more sincere than the bushy-based absolutely simply certainly Taguchi technique for optimizing the EDM technique. [11] E. Anand Pandey and Shankar Singh complete appraisals on Flow explore characteristics in forms of Electrical Release Machining. He composed that Present generation ventures are going through upsetting conditions from those unrivaled materials viz. amazingly explicit compounds, earthenware production, and composites, which might be hard and hard to gadget, requiring exorbitant exactness, floor brilliant on the off chance that you have to expand machining charge. To meet those stressing conditions, non-conventional machining methodology are being enlisted to increase higher steel end charge, better floor surrender and moreover dimensional precision, with tons stacks considerably less gadget situated on. Electric Release Machining (EDM), a non-customary methodology, has a gigantic bundle in vehicle, insurance, aviation and miniaturized scale structures businesses performs is awesome trademark inside the improvement of least value stock with more prominent dependable unprecedented certification. They had condensed the paper as EDM has come about out as most charge ground-breaking and accuracy machining way in very contemporary years. The capacity of machining troublesome and hard to gadget segments has made EDM as one of the greatest crucial machining systems. The commitment Variations of EDM has presented extraordinary improvements inside the ground stop of machined prevalent building materials. Powder blended EDM and Ultrasonic helped EDM has now not amazing lessens instrument set on but rather may even development material evacuation cost. Demonstrating and improvement of various electric controlled and nonelectric parameters in EDM unrivaled in exactness machining of troublesome works of art substances The think about of the examinations inclinations in EDM on revolving EDM, dry EDM machining, EDM with powder added substances, Ultrasonic helped EDM, WEDM and Smaller scale EDM exhibitions is advertised. In each test remember, the improvement of the procedures for the absolute most recent 50 years is said. [12] Yih-fong Tzeng and Fu Chen, Multi-objective improvement of unnecessary speed electric controlled release machining approach utilizing a Taguchi fluffy fundamentally based absolutely method Materials and Structure 28 (2007) 1159–1168, time direct. The paper depicts the utilization of the shaggy presence of mind examination combined with Taguchi methods to streamline the exactness and precision of the high-pace electric release machining (EDM) approach. A fluffy ordinary feel contraption is utilized to investigate connections some of the machining exactness and precision for making sense of the proficiency of each parameter plan of the

Taguchi dynamic examinations. From the ragged surmising strategy, the zenith of the street route circumstances for the high-speed EDM technique might be easily chosen. Moreover, the assessment of change (ANOVA) is likewise utilized to find thing B (beat time), C (commitment cycle), and D (stature charge of release present day) on the grounds that the most extreme fundamental parameters, which record for around 81 % of the fluctuation. The variables E (powder intrigue) and H (powder period) are resolved to have entirely flimsier impacts at the device plan of the unbalanced rhythm EDM. Moreover, an affirmation trial of the most top notch procedure proposes that the focused different run of the mill by and large execution attributes are eminently better than obtain more prominent relevant stages. Here Contrasting with the underlying preliminary, the MPCIs of the most proper parameter organization are reached out with the asset of fifty 4.21%. The dimensional exactness and precision are ventured forward by means of 25. 8% and zero.8%, individually. [13] Michael F.W. feasting paper in 2001 as bearing for the look and Assessment of Preliminaries. A check is a way for gathering remedial information as an approach to answer a theory, or to offer surface for conveying new speculations, and differentiations from an examination in perspective on the truth the specialist has direct over the fixes that may be finished. The most broadly perceived being in every way that really matters randomized, and randomized square plans A couple of assessments fuse a singular impartial (treatment) variable, at the comparable time as express factorial structures all the while arrangement or progressively critical self-ruling components, which combines medicine fix and cell line. Factorial structures as regularly as conceivable give progressively important experiences at insignificant extra expense. Preliminaries should be carefully endure at the highest point of the need rundown to avoid inclination, be incredible in any case flawless, suit an authentic quantifiable evaluation and, in two or three cases, have a huge style of real nature. In every practical sense all examinations need a type of genuine appraisal while in travel to evaluate normal assortment most by far of the preliminary subjects. Parametric frameworks the utilization of the t-test or assessment of contrast is regularly extra effective than non-parametric methodologies, gave the essential assumptions of the residuals and same changes are significant. [14] J.L. Lin and C.L. Lin used gray-fuzzy actual judgment for the optimization of the producing device in 2003. In this paper, the usage of the grey-fuzzy not unusual enjoy primarily based honestly mostly on orthogonal array for optimizing the electric discharge machining method with multi-reaction has been said. The machining parameters (pulse on time, responsibility trouble and discharge present day) with troubles of multiple responses (electrode placed on ratio, cloth removal fee and ground roughness) are effective. The gray-fuzzy common experience method can help to optimize the electric discharge machining way with multiple technique response. The paper has provided using the gray-fuzzy logics based mostly on orthogonal array for the optimization of the electrical discharge machining method with the couple of device responses. Grey relational coefficient analyzes the relational degree of the couple of responses (electrode positioned on ratio, cloth elimination charge and floor roughness). Fuzzy outstanding judgment is used to carry out a fuzzy reasoning of the multiple commonplace famous performance trends. As a give up give up save you cease end result, those strategies can

considerably decorate the method responses collectively with the electrode located on ratio, cloth removal rate and floor roughness within the electric powered discharge machining method. [15] Prof. Dr. - Ing. A. Behrens and Dipl.- Ing. M.P. Witzak had favoring a paper underneath the see. New twist area period for particularly green electro-discharge machining. Control of Electro-discharge machining is prepared toward a solid framework, with most removal cost altogether with radical huge surfaces. Electro discharge machining is known for its ridiculous estimation and non-straight nature and is consequently hard to control. Furthermore there does now not exist a whole logical adjustment for the considerable sorts related to the departure technique. There metal it is silly to hope to encounter an old style character framework to find a switch limit allowing a controller bunch for solid technique manage. Therefore, EDM manage requires a few modules did in gear sensors and pc structures in blend with guessed age tables. These time tables which is probably made with the profitable resource of the use of the usage of the creator incorporate customers acknowledge and supply a first rate scope of straightforward machining parameters. Current EDM verdure embodies asserted adaptable control upgrade? Which ends up in online difference in a social occasion of working parameters? This paper will favoring a way that has a spot with conventional system equality control and consolidates a present day-day twist disclosure period. The resulting contraption lets in the individual to strain the EDM technique under all conditions near its physical bind. Most transfer blame for regard to a described floor remarkable. [16] C. K. Biswas. In this evaluation, the movement of more than one reactions of Electric release machining (EDM) the utilization of Padded ordinary recognize united with Taguchi strategy is tried. The expressive arts piece surface come to be AISI P20 instrument metallic and a round and void copper terminal injury up utilized with weight drive flushing. Beat present day-day (Ip), beat length (Ton), creative indications time (Tw), supply time (Tup) and Spread Anode Opening (IEG) on the Material Expulsion Rate and Surface Roughness in EDM are attempt. L27 symmetrical gathering end up being utilized to organize the test and the impact of the sections on the reactions had been thought about. Exploratory affirmations have been bankrupt down the utilization of assessment of advancement (ANOVA). As the reactions are clashing in nature, an unmarried mix of elements can't be managed as mind boggling machining traditional ordinary generally speaking execution for all reactions. Fluffy not weird experience is utilized to change a couple of reactions genuine into an unmarried segment record called Multi Execution Trademark Archive (MPCI). At long last, MPCIs were improved using liberal Taguchi plan. This paper has given the utilization of fluffy central feel for progress of the EDM approach with a couple of direct normal execution inclinations. The fundamental favored normal execution property which joins MRR and SR can be progressed through this methodology. [17] Has exhibited the utilization of dim social investigation dependent on a symmetrical cluster and the fluffy based Taguchi strategy for the improvement of the electrical release machining process with various procedure reactions.

Both the dark social investigation technique without utilizing the S/N proportion and fluffy rationale examination are utilized in a symmetrical exhibit table in doing tests. Trial results have demonstrated that the two methodologies can advance the machining parameters (beat on schedule, obligation factor, and release current) with contemplations of the different reactions adequately and can significantly improve process reactions. It appears that the dim social investigation is clearer than the fluffy based Taguchi technique for advancing the EDM procedure with various procedure reactions.

III. TAGUCHI DESIGN METHOD

Taguchi procedures have been used extensively in structure assessment to redesign execution characteristics by strategies for setting of structure parameters. Taguchimethod is a mix of logical and truthful techniques used in an observational examination. It uses less preliminaries required to think about different degrees of all data parameters, and filtering through couple of effects as a result of genuine assortment. Taguchi technique can similarly choose the preliminary condition having negligible irregularity as the perfect condition. The variability of a property is a result of "commotion factor," which is a factor hard to control. Regardless of what may be normal, the factor easy to control is called "control factor." Taguchi generous arrangement technique is a strong mechanical assembly for the structure of astonishing systems. Taguchi solid structure procedure presents an organized philosophy that is fundamental and convincing for redesigning plans for quality, execution and cost. The objective of Taguchi approach is to choose the perfect setting of method parameters or control factors, thusly making the strategy unfeeling toward the wellsprings of assortments in light of wild or uproar factors. In this system, central strategy parameters or control factors which effect methodology results are taken as information parameters and the assessment is executed by expressly arranged symmetrical group. The assurance of appropriate symmetrical group relies upon complete degree of chance (DOF) which is figured as, $DOF = (\text{Number of level-1 for each factor} + (\text{number of level-1}) * (\text{number of level-1}) \text{ for each interaction})$. The changeability of the quality trademark can be conveyed by sign to noise (S/N) extent. The terms "sign" and "upheaval" address the alluring and shocking characteristics for the qualities exclusively. Taguchi system uses the S/N ratio to measure the trademark getting sidetracked from the perfect worth. The preliminary condition having the best S/N extent is considered as the perfect condition, as the variability of trademark is backward degree to the S/N ratio. The (S/N) extent addresses the quality Characteristic for the watched data in the Taguchi's structure of preliminaries (DOE) and numerically it might be enrolled from condition referred to underneath.

$$\eta = -10 \log (MSD)$$

Where MSD is the mean square deviation and normally known as quality misfortune work. Contingent upon the trial objective, the quality misfortune capacity can be of three kinds: bring down the-better (LB), higher-the better (HB), and ostensible the-best (NB) type. These quality misfortune capacities are figured as pursues:

$$MSD = (1/n) \sum 2$$

Where y_i is the watched data of significant worth trademark at the i th starter and n is the amount of emphases of a comparable fundamental. The S/N extent addresses the perfect part/undesired part and which is intended to enlarge the S/N extent continually whatever may be worth characteristics. From the S/N extent, the suitable parameters affecting the system results were thought about and the perfect courses of action of method parameters can be settled. Despite the S/N extent, a true examination of distinction (ANOVA) can be used to demonstrate the impact of methodology parameters on execution measure. Thusly, the perfect degrees of technique parameters can be assessed.

IV. TAGUCHI FUZZY-BASED APPROACH

Taguchi fuzzy based methodology is the fuzzy rationale examination combined with Taguchi method for advancement if there should be an occurrence of various execution attributes. In Taguchi technique, for single procedure reaction, the ideal degree of the procedure parameters is the level having most noteworthy S/N proportion. In any case, streamlining of numerous reactions isn't as direct as that of the improvement of single procedure reaction. A higher S/N proportion for one procedure reaction may relate to a lower S/N proportion for another procedure reaction. Therefore, a general assessment of S/N proportions is required for the enhancement of multi process reaction. To tackle this issue, fuzzy rationale investigation is brought into Taguchi method for advancement of multi process reaction. Fuzzy rationale is utilized to build up the fuzzy thinking of different execution attributes. The misfortune Function comparing to each procedure reaction is fuzzified and after that a single fuzzy thinking evaluation is acquired by fuzzy derivation and defuzzification. A fuzzy rationale unit contains a fuzzifier, an enrollment work, a fluffy standard base, a deduction motor and a defuzzifier. Initially, the fuzzifier utilizes participation capacities to fuzzify the sign to clamor (S/N) proportions gotten by Taguchi technique. Next; The induction motor plays out the fuzzy thinking on fuzzy standards to create a fuzzy worth. At last, the defuzzifier changes over the fuzzy incentive into a multi-reaction execution list. A fuzzy rationale framework is along these lines used to examine connections between reactions for deciding the productivity of every parameter plan of the Taguchi dynamic investigations. From the fuzzy surmising procedure referenced over, the ideal procedure conditions can be effectively decided.

V. CONCLUSION

The EDM is the most multipurpose and maximum traditional, unconventional machining technique green of manufacturing maximum compound shape and it is impartial of the mechanical homes of the work piece fabric if it is conductive. With non-forestall development within the MRR, the practical of the Electrical discharge device method in shape of packages can be drastically prolonged. By direct Electrical discharge device system commonly relies on variable strategies extensively talking due to the nonrandom of the sparking incidence concerning both electric powered and non-electric technique parameters.

The compound dating a number of the awesome modeling Process and parameters is therefore essential factors of deliver to the general machining overall performance. But, numerous method of decorate the machining discharge frequently measured in MRR, TWR and SR were generating with and confound research appeal to been paid to the metallurgical homes of Electrical discharge machine. The modeling property of the massive used cutting-edge machining method which encompass Electrical discharge machining techniques. The Electrical discharge tool has introduced many improvements in the machining method nowadays. The capability of machining hard factors and difficult cloth has made Electrical discharge tool as one of the most well-known machining tactics. A vital statement on numerous research works is furnished and the following observations are crafted from this study artwork. In this assessment paper series of Electrical discharge gadget studies courses in optimization approach which used within the production area to reach for the amazing manufacturing conditions which can be an essential want for industries in the direction of production of superb products at decrease rate. For each method brought and hired in EDM technique, the goals are the identical: to decorate the ability of machining performances, to get a higher output merchandise, to extend method to tool new substances and to have higher operating conditions. Through the contemporary modeling technique used within the Electrical discharge machining tactics maximize the MRR, reduced the TWR and decorate the SR & Surface extraordinary.

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