MULTI-OBJECTIVE PARAMETRIC ADVANCEMENT ON MACHINING WITH WIRE ELECTRIC RELEASE MACHINING

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Abstract:
The choice of ideal machining conditions, during wire electric release machining process, is of extraordinary worry in assembling businesses nowadays. The expanding quality requests, at higher profitability levels, require the wire electric release machining procedure to be executed all the more productively. In particular, the material evacuation rate should be expanded while controlling the surface quality. Regardless of broad research on wire electric release machining process, deciding the alluring working conditions in mechanical setting despite everything depends on the expertise of the administrators and experimentation strategies. In the present work, an endeavor has been made to enhance the machining conditions for most extreme material evacuation rate and greatest surface completion dependent on multi-objective hereditary calculation. Examinations, in view of Taguchi's parameter configuration, were done to consider the impact of different parameters, viz. beat top current, beat on time,pulse-off time, wire feed, wire strain and flushing pressure, on the material evacuation rate and surface completion. It has been seen that a blend of variables for improvement of every exhibition measure is unique. Thus, numerical models were created between machining parameters and reactions like metal evacuation rate and surface wrap up by utilizing nonlinear relapse examination. These numerical models were then advanced by utilizing multi-target improvement procedure dependent on Non-overwhelmed Sorting Genetic Algorithm-II to acquire a Pareto-ideal arrangement set.

Keywords: ***WEDM . Taguchi technique . Multi-objectivegenetic algorithm***
DOI Number: 10.48047/nq.2017.15.1.1018 **NeuroQuantology 2017; 15(1): 124-128**

I. INTRODUCTION

Machining processes play a significant role in manufacturingindustry where cost and quality are the main driving forces.Among various manufacturing processes existing today, wireelectrical discharge machining (WEDM) is one of the widelyused processes [1] because of its capability of machiningintricate shapes and profiles irrespective of hardness of thematerial. This process finds widespread applications inmould-making tool and die industries, aerospace, automobileand electronics industries.The principle of WEDM is shown in Fig. 1. In thisprocess, a small-diameter wire is used as the electrode tocut a narrow width of cut in the workpiece. The workpiece isfed continuously and steadfastly past the wire in order toachieve the desired cutting path. Numerical control is usedfor precise control of the motions during cutting. As it cuts,the wire is continuously advanced between a supply reel anda take-up reel to present a fresh electrode of constant diameter to the work. This helps maintain a constant width of cutduring cutting. The dielectric fluid is continuously injectedto flush away minute amounts of the removed material.One of the most investigated areas of machining isprocess modeling and optimization as these result in bothreduced production cost and improved product quality.However, experimental optimization of any machiningprocess is costly and time consuming due to the complex, coupled and non-linear nature of the input–outputvariables of machining processes [2]. This means that,

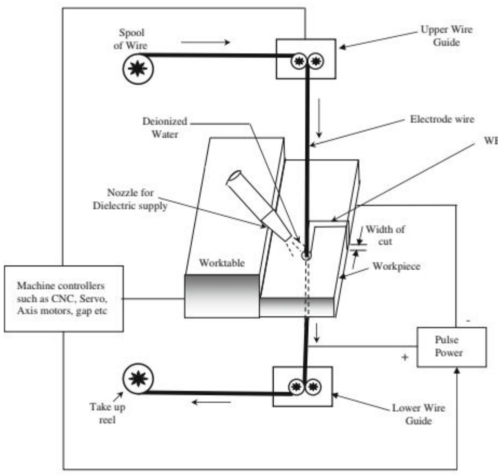


Fig. 1 Schematic diagram of WEDM

due to the highly complicated interactions between process parameters, current analytical models and analysescannot provide accurate process prediction for betterquality control and higher throughput. Therefore, an efficient method is needed to determine the optimal machining parameters.In case of WEDM, the most significant performanceindicators are metal removal rate and surface finish. Metalremoval rate (MRR) is an indicator for productivity whilesurface roughness (Ra) is a measure of work quality.WEDM, being a complex stochastic process, is very difficult to determine optimal machining parameters for bestmachining performance. Moreover, the performance measures, viz. MRR and Ra, are conflicting in nature as it isdesirable to have higher MRR with a lower value of surfaceroughness (or high surface finish).

II. LITERATURE REVIEW

WEDM is a necessary operation in several manufacturingprocesses in some industries, which gives importance to variety, precision and accuracy. Several researchers have attempted to improve the performance characteristics, namely, thesurface roughness, cutting speed, dimensional accuracy andmaterial removal rate, etc., but the full potential utilization ofthis process is not completely solved because of its complexand stochastic nature and higher number of variables involvedin this operation. In order to improve the process performance,experiments were conducted with different steel materials forinvestigating the effects of cutting parameters on surfaceroughness in the WEDM process and practical results can beused in industry in order to select the best suitable parametercombination to get the required surface roughness values forthe products [3]. A semi-empirical model of surface finish ofPulsePower Machine controllerssuch as CNC, Servo,Axis motors, gap etc

workpiece in EDM has been established by employing dimensional analysis based on pertinent process parameters such aspeak current, pulse duration, electric polarity and properties ofthe work material and then verified by using standard Taguchimethod [4]. After that, a new approach came for the optimization of EDM process with various machining parameters tooptimize the multiple performance characteristics, viz. material removal rate, surface roughness and electrode wear ratio,and results were found good [5]. Further, the use of the greyrelational analysis (GRA) based on an orthogonal array andfuzzy-based Taguchi method was to be done for optimizingthe multi-response, viz. electrode wear ratio, material removalrate and surface roughness, on EDM process and found thatthe grey relational analysis is more straightforward than thefuzzy-based Taguchi method for optimizing the EDM processwith multiple process responses [6].

The relative optimization performances of thesemethods are unknown, and therefore there are chances thatthe past researchers on WEDM processes have achieved suboptimal or near-optimal solutions. So, the aim of the presentwork is to obtain the optimum machining conditions forWEDM of high-speed steel (M2, SKH9) for maximum material removal rate and maximum surface finish based on multi-objective genetic algorithm. Experiments, based on Taguchi'sparameter design, were carried out to study the effect of variousparameters, viz. pulse peak current, pulse-on time, pulse-offtime, wire feed, wire tension and flushing pressure, on materialremoval rate and surface finish. From the experimental data,multiple regression models for the MRR and surface finish areobtained in the present work. A non-dominated sorted geneticalgorithm has been used to obtain an optimal combination ofparameters and a non-dominated set obtained is reported in this paper.

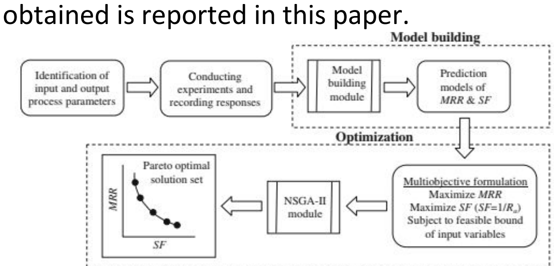
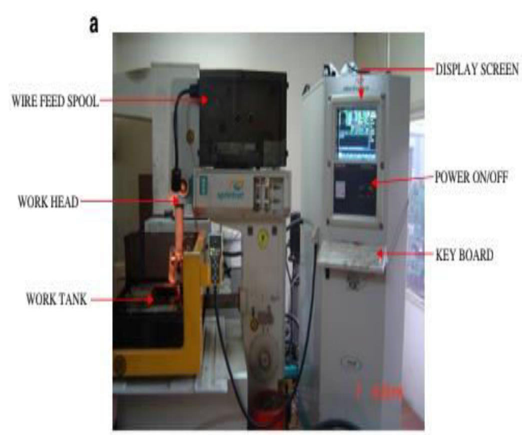


Fig 2 Multi-objective optimization methodology

III. EXPERIMENTATION

Wire EDM is a very complicated process consisting ofcomplex interactions between a large numbers of variablessuch as machine tools, workpiece materials and operatingparameters. However, to facilitate experimental data collection, only six dominant factors were considered in the planning of experimentation. A sprint-cut high-precision fouraxis CNC wire EDM was used to machine the high-speedsteel (M2, SKH9) pieces of size 230×25×10 mm, havingcut in length with 12-mm depth along the longer length. Thecomposition of high-speed steel (M2, SKH9) workpiecematerial used for experimentation in this work is as givenin Table 1. The parameters, selected for experimentation,

were as shown in Table 2, along with their limits, units andnotations. The photographic view of the machine and machining zone has been shown in Fig. 3a, b, respectively. Theother details of experimentation have been shown in Table 3.A 0.25-mm-diameter stratified wire (zinc-coated copperwire) with vertical configuration was used and discardedonce used. High metal removal rate in WEDM without wirebreakage can be attained by the use of a zinc-coated copperwire because the evaporation of zinc causes cooling at theinterface of the workpiece and wire and a coating of zincoxide on the surface of the wire helps prevent short circuits[30]. The two most important performance measures inWEDM are metal removal rate and workpiece surfaceroughness. The material removal rate (g/min) was calculatedby weight difference of the specimen before and after ma-chining using high-precision balance. The surface roughness was measured with Talysurf-6 at three differentlocations (at 0.8 µm cutoff value) on the workpiece aftermachining and the average value has been taken in thepresent study. 126



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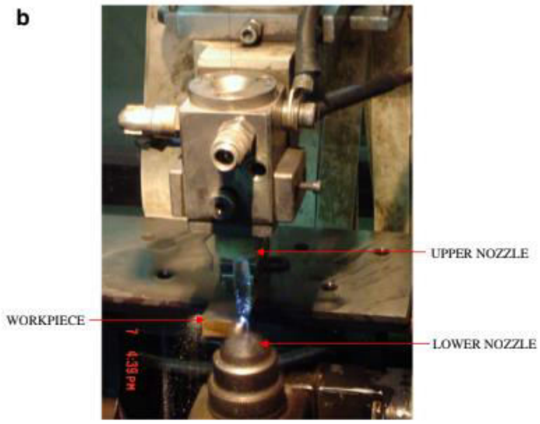

Fig. 3 a Photographic view ofthe machine. b Photograph ofmachining zone

indicates better machining performance, such as surface roughness, is addressed as the-smaller-the-better type of problem.

The S/N ratio, i.e. η, can be calculated as shown below:(a) Forthe-larger-the-better type of problems:

$$S/N\,\text{ratio} = \eta = -10\log\left(\frac{1}{n}\sum_{i=1}^{n}\frac{1}{y_{\text{MRR}}^{2}}\right)$$

(2) For the-smaller-the-better type of problems:

$$S/N\,\text{ratio} = \eta = -10\log\left(\frac{1}{n}\sum_{i=1}^{n}y_{SR}^{2}\right)$$

whereyMRR and ySR denote the response for metal removal rate and surface roughness, respectively, and n denotes the number of trials in each experiment.

CONCLUSION

The present study reveals that factors like pulse peak current, pulse duration, pulse-off period, wire feed, wire tension and flushing pressure are the primary influencing factors which have affect not only on the productivity but also on the surfacequality of machined components. Optimal machining conditions are obtained for maximization of both the material removal rate and the surface finish based on the modelsdeveloped using the non-linear regression method. The resultsof optimization indicate that the material removal rate and surface finish is influenced more by pulse peak current, pulse duration, pulse-off period and wire feed than by flushing pressure and wire tension. Results also indicate that the surface quality decreases as the MRR increases and they vary almostlinearly. Out of 50 optimal solutions, the best parametric combination that yield the highest possible MRR, while maintaining the specified surface finish requirement, i.e. 3.69 μm,would be as follows: pulse peak current030 A, pulseduration037 μs, pulse-off time050 μs, wire feed07 m/min, wire tension01260 g, flushing pressure02.1 kg/cm2

REFERENCES

1. Ho KH, Newman ST, RahimifardS, Allen RD (2004) State of art in wire electrical discharge machining. Int J Mach Tools Manuf44:1247–1259

2. Warren Liao T, Chen LJ (1998) Manufacturing process modelingand optimization based on multi-layer perceptron network. Trans ASME, J ManufScEngg 120:109–119

3. IlhanGokler M, MithatOzanozgu A (2000) Experimental investigation of effects of cutting parameters on surface roughness in theWEDM process. Int J Mach Tools Manuf 40:831–1848

4. Pei-Jen W, Kuo-Ming T (2001) Semi-empirical model on work removal and tool wear in electrical discharge machining. J Mater Process Technol 114:1–17

5. Lin JL, Lin CL (2002) The use of the orthogonal array with greyrelational analysis to optimize the electrical discharge machining process with multiple performance characteristics. Int J Mach Tools Manuf 42:237–244

6. Lin CL, Lin JL, Ko TC (2002) Optimization of the EDM processbased on the orthogonal array with fuzzy logic and grey relational analysis method. Int J AdvManuf Tech 19:271–277

7. Narender Singh P, Raghunandan K, Pai BC (2004) Optimization by grey relational analysis of EDM parameters on machining Al–10% SiCP composites. J Mater Process Technol 155–156:1658–1661

8. Ko-Ta C, Fu-Ping C (2006) Optimization of the WEDM process ofparticle-reinforced material with multiple performance characteristics using

grey relational analysis. J Mater Process Technol180:96–101
9. Yih-fong T, Fu-chen C (2007) Multi-objective objective optimization of high-speed electrical discharge machining process using aTaguchi fuzzy-based approach. Mater Des 28:1159–1168
10. Yih-fong T (2008) Development of a flexible high-speed EDMtechnology with geometrical transform optimization. J Mater Process Technol 203:355–364