Optimized Surface roughness for WEDM using Genetic Algithm

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Abstract: Surface Roughness (Ra) throughout the procedure has been taken into consideration as productivity estimate with the aim to minimize it. With an goal of minimizing floor roughness is been taken as maximum vital output parameter. This can be glad by way of choosing an superior process environment (most beneficial parameter setting). Objective feature is obtained with the aid of Neural Network tool of MATLAB. Then goal characteristic is optimized using Genetic Algorithm optimization tool of MATLAB. The model is shown to be effective Surface Roughness advanced the usage of optimized machining parameters.

Keywords: EDM, WEDM, Surface Roughness, Work piece.

1. Introduction:

It is a non-conventional electro-thermal machining technique, in which electrical strength is used to generate electric spark and material elimination happens due to thermal strength produced via the spark. EDM is specially used to system excessive power temperature resistant alloys and materials hard-to-device. EDM can be used to machine abnormal geometries in small batches or maybe on process-store foundation. Work cloth is to be electrically conductive to be machined through EDM.

EDM machining techniques had been determined a ways back in the 1770s via an English Scientist. However, this approach become no longer fully taken benefit until 1943 whilst Russian scientists found out how its erosive consequences will be controlled and used for machining functions. It became advanced commercially in the mid-1980s, cord EDM made lot of trade that helped shape the metallic operating enterprise we see these days.

Now the now concept of producing makes use of non-conventional power sources like light, sound, chemical, mechanical, electric and ions. With the technological and business boom, devolvement of more difficult machining materials, which find extensive utility in nuclear engineering ,aerospace and different industries thanks to their excessive electricity to weight ratio, warmness resistance and hardness characteristics has been witnessed New tendencies inside the area of material technology have led to new engineering metal substances, excessive tech ceramics and composite substances having correct mechanical residences and thermal characteristics in addition to sufficient electric conductivity a good way to comfortably be machined by using spark erosion. Non-traditional machining has progressed out of the need to device these alien materials. The machining procedures are non-traditional in the sense that they do no longer employ traditional tools for metallic removal and however they at once use other types of electricity. The issues of excessive complexity in size, form and better demand for product accuracy and floor end may be solved via non-traditional methods.

EDM has been replacing grinding, milling, drilling and different conventional machining Operations and is now a nicely-set up machining choice in lots of manufacturing industries everywhere inside the international. And is able to machining difficult fabric components or geometrically complicated, that are specific and tough-to-device inclusive of warmness dealt with great alloys, ceramics, composites, carbides device steels, heat resistant steels and many others. Being broadly used in mould and die making industries, nuclear industries, aeronautics and aerospace. Electric Discharge Machining has also made its presence felt within the new fields such as medical, sports activities and surgical, optical, instruments, which include automotive R&D regions.

2. Related Work:

Atul kumar and Dr D.K. Singh [8] have look at version of reducing overall performance with pulse on time, pulse off time, open voltage, feed rate override, twine feed, servo voltage, twine tension and flushing strain have been test investigated in cord electric powered discharge machining methods. Brass cord with zero.25 mm diameter and SKD sixty one alloys steel with 10 mm thickness were used as tool and work substances. The output taken into consideration has been MRR and surface roughness. Experimentation has been competed by using the usage of Taguchi's L18 (21×37) orthogonal array below specific conditions of parameters. Finally it concluded that the MRR will increase with the increase in pulse on time and reduce with increase in pulse off time and open voltage. The impact of feed price overdrive, wire feed, servo voltage, twine tension and flushing pressure on MRR is not very giant. For the surface roughness it lower with growth of pulse off time open voltage and cord feed and increases with growth in feed price override and servo voltage. The effect of other parameter is not giant.

Pujari Srinivasa Rao, Koona Ramji, Beela Satyanarayana [9] studied Wire-cut electric powered discharge machining of Aluminum-24345. Experimentation has been achieved via using Taguchi's L18 (21x37) orthogonal array below one-of-a-kind conditions of parameters. The reaction of floor roughness is taken into consideration for enhancing the machining efficiency. Optimal combos of parameters had been received through this approach. The confirmation experiment indicates, the great development in floor end (1.03μm) changed into received with this method. The examine suggests that with the minimum wide variety of experiments the stated hassle can be solved whilst compared to full factorial design. All the experiments were performed on Ultra Cut 843/ ULTRA CUT f2 CNC Wire-cut EDM device. The size of the paintings piece considered for experimentation on the twine-reduce EDM is 25 mm x 20 mm x 10 mm. Increasing the discharge power commonly increases floor irregularities due to much extra melting and re-solidification of substances. Hence, it's far located that SR tends to lower substantially with lower in IP and TON. The parameters twine tension and spark hole voltage are discovered as big parameters in obtaining higher floor finish.

Kuriachen Basil, Dr. Josephkunju Paul, Dr. Jeoju M.Issac [10] investigates the impact of voltage, dielectric strain, pulse on-time and pulse off-time on spark hole of Ti6AL4V alloy. It has been located that pulse on time and pulse off time have the more effect at the spark hole. The minimum spark gap changed into obtained as 0.040407mm. The WEDM experiments have been conducted in Electronic Ultracut S1 machine using zero.25 mm brass twine because the tool electrode. Pulse on time, pulse off time, voltage and dielectric pressure are the 4 WEDM parameters that have been selected for investigations. In this experimental observe stage complete factorial test is followed due to the fact this offers all feasible mixtures of machine parameters. It may be noticed from that corresponding to minimal cost of pulse off time the spark gap decreases with growth in dielectric strain, whereas the spark hole increases with growth in dielectric strain corresponding to maximum fee of pulse off time.

Saurav Datta, Siba Sankar Mahapatra [11] experimented with six manner parameters are discharge present day, pulse duration, pulse frequency, wire velocity, wire anxiety and dielectric flow rate; to be numerous in three distinct ranges. A block of D2 tool metallic with 2 hundred mm × 25 mm ×10 mm length. Data associated with the method responses are material elimination fee (MRR), roughness fee of the worked surface and kerf has been measured for each of the experimental runs. These statistics had been applied to fit a quadratic mathematical model (Response Surface Model) for each of the responses, which can be represented as a characteristic of the six method parameter. Predicted facts given by way of the models as per Taguchi's L18 (3*6) Orthogonal Array (OA) layout have been used looking for an highest quality parametric combination to attain preferred yield of the procedure, most MRR, appropriate floor finish and dimensional accuracy of the product. Grey relational analysis has been adopted to transform this multi-goal criterion into an equivalent single goal function. It has been determined that that the spark gap will increase with increase in pulse on time, whereas spark hole decreases with boom in pulse off time. The pulse on time, pulse off time, the interplay of dielectric stress and pulse off time, and interaction of pulse on time and pulse off time are full-size parameters which affect the spark gap of WEDM.

Nihat, Can, Gul [12] investigated at the impact and optimization of machining parameters on kerf and material elimination charge (MRR) in WEDM operations. Experimental studies have been conducted the usage of special pulse length, open circuit voltage, wire speed, and dielectric flushing stress. Importance levels of parameters had been analysed using analysis of variance (ANOVA). The premiere machining parameter mixture was obtained with the aid of using the analysis of sign-to-nois (S/N) ratio. The variation of kerf and MRR with machining parameters is mathematically modelled by the usage of regression analysis approach. Objective of minimum kerf together with most MRR become done. The experimental research have been carried out on a Sodick A320D/EX21 WEDM gadget device. CuZn37 Master Brass wire with 0.25mm diameter was used inside the experiments. As paintings piece material, AISI 4140 metal with 200mm × 40mm × 10mm size became used. The consequences display that open circuit voltage changed into three instances greater vital than pulse duration for controlling kerf, whilst for MRR, open circuit voltage changed into about six times greater critical than pulse length.

3. Methodology:

This experimental work performed at Hindustan Aeronautical Limited, Lucknow . The experiment work is carried out in wire cut electro discharge machine (CHARMILLES TECHNOLOGIES ROBOFIL 300) of MMC Of Al 7075 reinforced with 10 Wt% of boron carbide (B_4C) material by varying machining parameters. The wire cut electric discharge machine is consist of a machine tool, a power supply unit and dielectric supply unit. A schematic diagram of the wire cut EDM is shown in Fig 1.

Fig 1: Wire Cut EDM.

Table 1: Specification of CNC Wire EDM

WORK TABLE	
Design	Fixed Column, Moving Table
Table Size	440 x 650 x 300 mm
MAXIMUM WORKPIECE DIMENSION	
Max. Workpiece Height	20mm
Max. Workpiece Weight	7.5 kg

Main Table Transverse (X,Y)	30 x 40 mm
Aux. Table Transverse (U,V)	8 x 8 mm
Wire Electrode Diameter	0.25 mm (std.) 0.15 mm, 0.20 mm (opt.)
PULSE GENERATOR	
Pulse Generator	ROBOFILL 300
CNC Controller	EMT 100W-5
Input Power Supply	3 phase, AC, 415 V , 50 Hz
Connected Load	10 kVA
Avg. Power Consumption	6 to 7 kVA
DIELECTRIC SYSTEM	
Dielectric Unit	DL 25 P
Dielectric Fluid	Deionised water
Tank Capacity	250 Litters

3.1 Surface Roughness

Surface roughness values of finished work pieces were measured by Mitutoyo Surface Roughness Tester SJ – 201 by a proper procedure. The Mitutoyo Surface Roughness Tester SJ – 201 is an instrument that works by gently dragging a mechanical stylus across a Surface. Surface Roughness Tester acquires data by moving the sample beneath the diamond tipped stylus. Vertical movements of the stylus are sensed by an LVDT, digitalized, and stored in the instruments memory. Its output is a digital display of measured Surface roughness value Ra and other features. Surface Roughness Standard ISO was used for measurement. The temperature of environment was 32 ± 1◦C. In this present study we have taken Ra for measuring Surface Roughness.

Table 2: Specification of Mitutoyo surface roughness tester SJ-201

Detector	
Detection Method	Different inductance method
Measurement Range	350µm (-200 µm to + 150 µm) 1370 µin (-7880 µin to + 5900 µin)
Stylus Material	Diamond
Tip Radius	5 µm (200 µin) 2 µm (80 µin)
Measuring Force	4 MN (0.4 gf) 0.75 MN (0,075 gf) (0.75 MN measuring force type)
Radius of skid curvature	40mm (1.57 in)

Drive Unit	
Detector Drive Range	21mm (0.82 in)
Traversing speed Measurement Return	0.25 mm/s, 0.5 mm/s (0.10 in/s, 0.02 in/s) 0.8 mm/s (0.30 in/s)
Detector retraction function	Stylus UP
Bottom configure ration	V – way
Ra	Ra (0.01 µm to 100 µm)

Fig 2: Surface Roughness Tester SJ-201

4. Result and Discussion:

This chapter covers the results of work that is based on the development and analysis for model development of surface roughness (SR) estimator for EDM machine using artificial neural network model for SR estimator and genetic algorithm dependent search of optimized input parameters for getting minimum surface roughness.

We have taken a database consist of four input voltage, current T_{on} and T_{off} and one output as surface roughness. The table 3 shows the input output data.

Table 3: Experimental Data

Voltage	Current	TON	TOFF	Surface Roughness (µm)
40	6	4	9	6.146
60	6	8	9	10.542
50	10	4	7	7.376
50	10	6	7	10.619
50	6	6	7	8.571
60	14	4	5	9.708
40	14	8	9	18.446
40	6	8	9	10.097
50	10	6	9	10.246
40	6	4	5	6.752
60	10	6	7	14.652
60	6	8	9	23.846

50	10	6	7	6.571
50	10	8	7	11.517
40	14	4	9	9.727
50	10	6	7	10.219
50	10	6	7	10.726
60	6	4	9	16.144
60	14	8	5	6.288
60	6	4	5	9.061
40	14	8	5	4.326
60	14	4	9	15.821
50	14	6	7	12.706
50	10	6	7	10.425
60	6	8	5	12.801
50	10	6	7	10.325
40	14	4	5	7.824
40	6	8	5	10.453
50	10	6	5	14.041
40	10	6	7	11.695

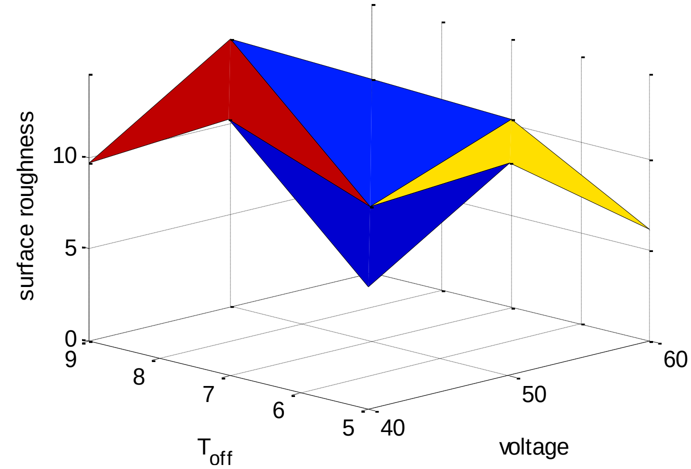

Fig 5: Surface plot for surface roughness as a function of EDM T_{OFF} and voltage.

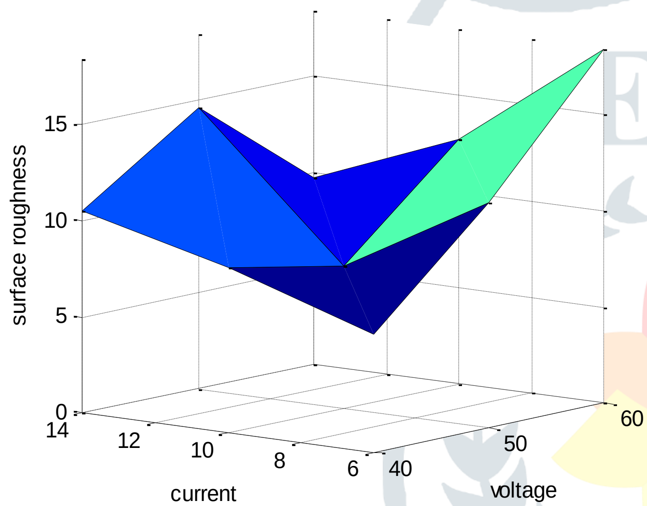

Fig 3 : Surface plot for surface roughness as a function of EDM current and voltage.

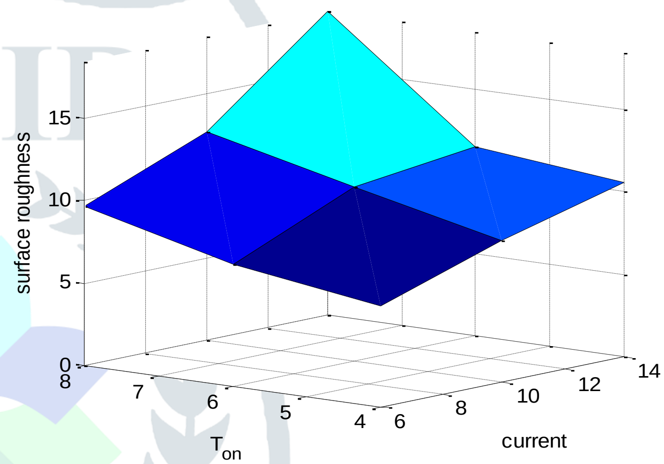

Fig 6: Surface plot for surface roughness as a function of EDM current and T_{ON}.

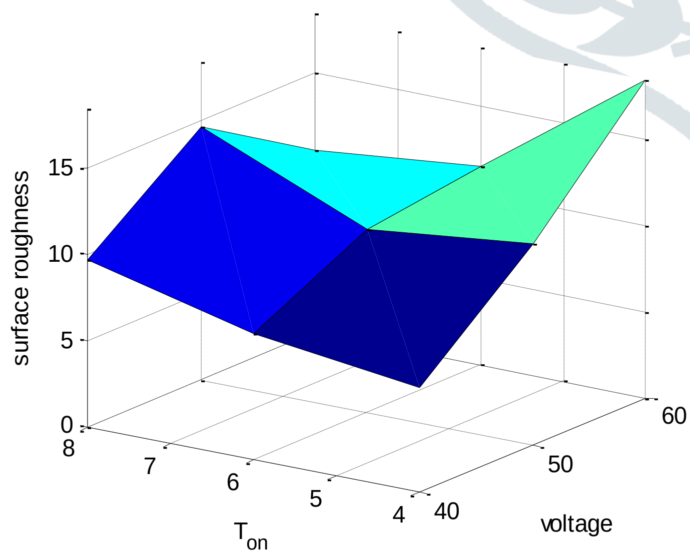

Fig 4: Surface plot for surface roughness as a function of EDM T_{ON} and voltage.

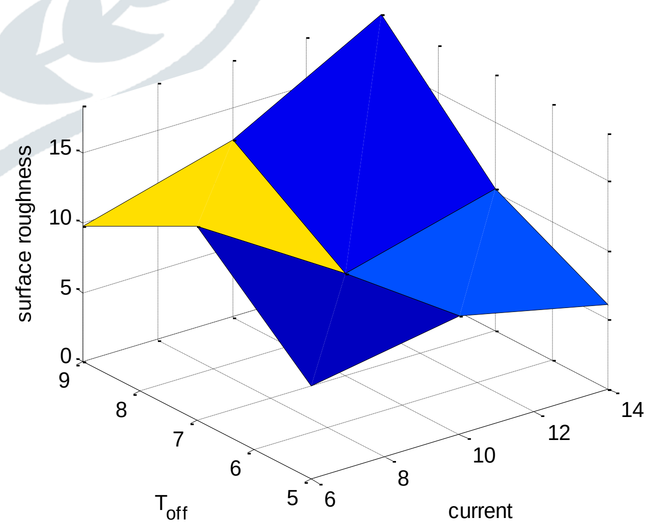

Fig 7: Surface plot for surface roughness as a function of EDM current and T_{OFF}.

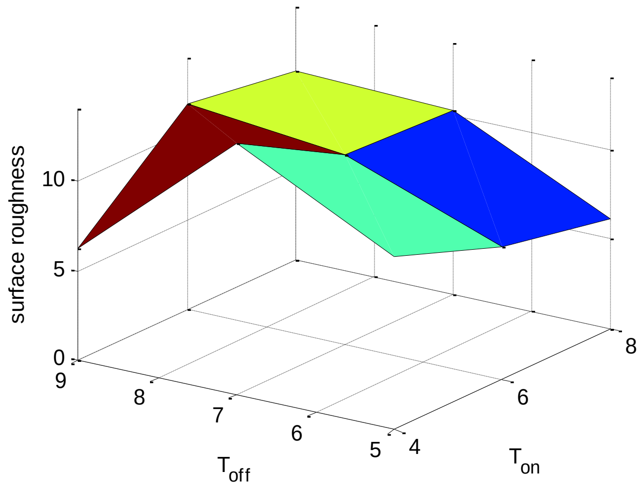

Fig 8: Surface plot for surface roughness as a function of EDM T_{OFF} and T_{ON}.

5. Conclusion:

This work used enter parameters inclusive of voltage, cutting-edge, TON and TOFF values processed into three stages -1 to +1 to discover the foremost enter parameter conditions for minimized surface roughness for EDM gadget. The next conclusions can be derived from the experiments and observe that had been done on the Aluminium alloy 7075, with zinc because the number one alloying element. Artificial Neural Network is applied as estimation method for efficaciously use in high-quality manipulate by way of estimating surface roughness for the duration of wherein the experimental design is blended with the pleasant loss. A genetic algorithm based totally optimization code is evolved that makes use of the ANN estimator outcomes and top-quality looking has been carried out for input parameters at which we can get minimum floor roughness. After getting the optimal settings of voltage, current, T_{ON} and T_{OFF} values as 40 , 14, 8, 5 the value of surface roughness was found to 3.2454 µm.

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