Simultaneous Optimization of Multiple Performance Characteristics for Pure Titanium using multi-response signal-to-noise (MRSN) ratio in WEDM process

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Abstract- This paper describes the development of multi response optimization technique using multi-response signal-to-noise (MRSN) ratio to predict and select the best machining parameters of wire electro-discharge machining (WEDM) process. The experimental studies in WEDM process were conducted under varying condition of process parameters such as pulse on time(Ton),pulse off time(Toff),peak current(IP),wire feed(WF),wire tension(WT) and spark gap voltage(SV) using pure Titanium as workpiece material.Experiments were performed using Taguchi's L27 orthogonal array. The optimized level of machining parameters was predicted for simultaneous optimization of material removal rate, surface roughness and wire consumption. The significant parameters affecting each machining characteristics were identified based on ANOVA analysis. Finally experimental confirmation was performed to identify the effectiveness of the above proposed method. A good improvement was obtained.

Index Terms—WEDM, Taguchi Method, MRSN ratio, ANOVA, Pure titanium, multi-response optimization, Pulse on time

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1 INTRODUCTION

WEDM (Wire electro-discharge machining) has been found to be an extremely potential thermal based non-traditional machining process in which the spark is generated between workpiece and conductive wire (usually copper, brass, aluminum brass, tungsten, molybdenum, zinc coated wire, etc.) flushed with de-ionized water (Fig. 1). The material removal takes place due to rapid and repetitive spark discharges between work piece and tool electrode connected in an electrical circuit. The gap suitably ranges between 0.025-0.075 mm across the wire and workpiece. A liquid dielectric medium (de-ionized water) is continuously passed in the gap through nozzle between the wire and work piece. A collection spool, which is located at the bottom is utilized to collect the used wire. WEDM process is generally used in tool and dies industry where accuracy and surface finish is having great importance. WEDM has the capability to impart production accuracy in the range of ±0.0001 inches. WEDM is used for machining of hard to machine materials, like hardened steel, high strength temperature resistant alloys(titanium, nickel, molybdenum and tungsten carbide), fiber-reinforced composites and ceramics in aerospace, nuclear, missile, turbine, automobile and tool and die making industries. This process enables machining of any type of feature such as deep, blind, inclined and micro holes and complicated profiles. Titanium and its alloys are used extensively in aerospace because of its high specific strength (strength to weight ratio) maintained at higher temperature. These are having exceptional corrosion resistance and exclusively used in aerospace, defense, biomedical, offshore applications. Pure titanium finds some applications in potential areas such as petroleum refining, chemical processing, surgical implantation, pulp and paper, pollution control, nuclear waste storage, food processing, gas turbines, marine application etc. [1]. Conventional machining of titanium and its alloys is difficult due to the following reasons; titanium is very chemically reactive and has a tendency to weld to the cutting tool during machining, the poor Young's modulus attributes to excessive chatter and deflection. Poor thermal conductivity leads to severe heat concentration at the cutting edge and higher mechanical stresses are concentrated due to small chip-tool contact area on the rake face of the tool [1,2]. As a result, tool encounters notching, flank wear, crater wear, chipping and catastrophic failure due to combination of high temperature, high cutting stresses

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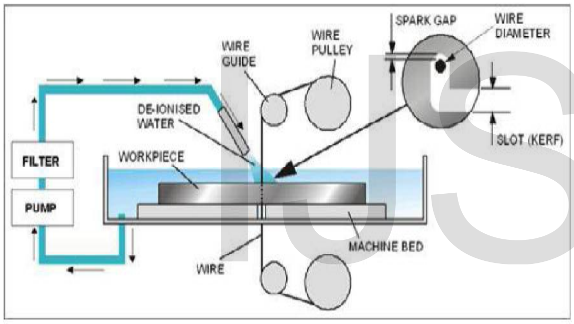
and strong chemical reactivity during machining. In the recent past, many approaches have been tried for improvement of machinability of titanium. Few of them are; use of coated carbide tools, development of effective cutting fluids, cryogenic treatment of work material and use of innovative systems for discharge of cutting fluids [1,2]. Wire electric discharge machining is a potential candidate for machining of titanium and its application in this regard needs proper investigation. The poor thermal conductivity of titanium (16.3W/m-K) as compared to medium carbon steel(43 W/m-K)is expected to develope higher amount of heat in machining zone and result in higher cutting speed of workpiece during wire electrical discharge machining. Moreover, many of the problems encountered in machining of titanium have been linked to the physical interaction of the tool and work materials. As WEDM is a non-contact process, almost all of these problems may be addressed. Also, the process capabilities are not restricted by the mechanical or physical properties of the work material, which could be an added advantage [3].



Schematic diagram of WEDM process

1.1 Literature Review

Liao et al. [4] investigated that with increased value of pulse on time, material removal rate (MRR), surface roughness (SR) and gap width increase during machining of SKD11 alloy steel in WEDM process. Tosun and Cogun [5] reported experimentally that wire wear ratio (WWR) increases with increased value of pulse duration and open circuit voltage. WWR decreases with increased value of wire speed and dielectric fluid pressure while machining AISI 4140 steel. Hascalyk and Caydas [6] reported investigation of machining characteristics of AISI D5 tool steel in WEDM process. The input process parameters such as open circuit voltage, pulse duration, wire speed and dielectric fluid pressure were varied to explore their effects on surface roughness and metallurgical structure. Tosun et al. [7] reported experimentally that open circuit voltage and pulse duration are more influential parameters than wire speed and dielectric flushing pressure for their effects on both material removal rate and surface roughness during machining of AISI 4140 using WEDM. Mahapatra and Patnaik [8] investigated that discharge current, pulse duration, dielectric flow rate and interaction of discharge current with pulse duration and dielectric flow rate are highly significant for both material removal rate and surface roughness while machining D2 tool steel with WEDM. Ramakrishnan and Karunamoorthy [9] showed that if pulse on time is increased and delay time is decreased then material removal rate and surface roughness increases for machining of Inconel 718 alloy in WEDM process.Jangra et al. [10] exhibited optimization of multi performance characteristics such as cutting speed, surface roughness and dimensional lag using Taguchi method and grey relational analysis in WEDM process. Garg et al. [11] investigated the wire electric discharge machining of titanium alloy 6-2-4-2, to study their effect on dimensional deviation. Lahane et al. [12] optimized multi respionse characteristics such as material removal rate and wire wear rate using principal component analysis method. Chalisgaonkar & Kumar [13] optimized WEDM process parameters for performance characteristics i.e. cutting speed and surface roughness using utility concept, while machining pure titanium. Singh and Sharma [14]obtained optimal parametric setting for material removal rate and surface finish during WEDM of P20 tool steel. Lodhi and Agarwal [15] optimized process parameters for surface roughness in WEDM process for AISI D3 steel. Rao and Krishna [16] developed the empirical model between input parameters (SiC particulate size, volume percentages, pulse-on time, pulse-off time, and wire tension) and response parameters(surface roughness, metal removal rate, and wire wear ratio) using response surface methodology. Khan et al. [17] reported the effect of WEDM process parameters on surface roughness and micro-hardness using grey relation analysis for machining of high strength low alloy steel (ASTM A572-grade 50). Chalisgaonkar & Kumar [3] perormed multi response optimization of material removal rate, surface roughness and wire consumption using grey fuzzy logic approach for titanium in WEDM process. This investigation is focused at collective optimization of multiple performance characteristics using MRSN ratio concept, namely material removal rate, surface roughness and wire consumption. Taguchi's method of experimental design has been employed for investigation of two factor interactions among selected factors and an attempt has been made to obtain robust process design for multiple performance characteristics, which could be very useful for the machinists in the industry.

2. EXPERIMENTATION

2.1 Method, material and measurement

In this research work commercially pure titanium was taken as a work material in the form of rectangular block of thickness 24.25mm (Fig. 2b). The chemical composition of material is given in the Table 1.The experiments were performed on sprintcut ELPULS-40A DLX) wire-EDM manufactured by Electronica Machine Tool Limited, India (Fig. 2a). Zinc coated brass wirehaving 0.25 mm was used in these experiments.Six process parameters namelypulse on time(TON), pulse off time(TOFF), peak current(IP), wire feed(WF), wire tension(WT), spark gap voltage(SV) and three one-way interactions viz. TON×TOFF, TON×IP and TOFF×IPwere selected as input variables during machining of pure titanium with WEDM. The selection of above interactions is based on the review of past literature. The experiments were carried out with fixed value of wire offset (0.148mm), dielectric fluid pressure (WP=1 machine unit), pulse peak voltage (VP=2 machine unit) and distilled water as dielectric fluid with a conductivity of 20S. All six variables were assigned three levels. The values for these levels were fixed on the basis of a pilot experimentation, which was conducted using 'One factor at a time' (OFAT) approach, to recognize the trends of influence for the machining variables. Table 2 depicts the levels of the selected process variables.The orthogonal array forms the basis for the experimental analysis in the Taguchi method. The selection of orthogonal array is concerned with the total degree of freedom of process parameters. Total degree of freedom (DOF) associated with six parameters and three one way interactions is equal to 24 (4×3+6×2). The degree of freedom for the orthogonal array should be greater than or at least equal to that of the process parameters. Thereby, a L27 orthogonal array having degrees of freedom equal to 26 has been considered in present case. The experimental layout along with the mean values of the responses is shown in Table 3. Input parameters and their interactions were allocated using modified linear graph. Analysis of variance (ANOVA) was performed using Minitab16 Software.

Fig.2. (a) Experimental Set up and (b) titanium workpiece machined with WEDM

Table 1 Chemical composition of commercially pure titanium

N	C	Fe	O	Ti
0.001	0.06	0.10	0.002	99.82

Table 2Process parameters with their levels

Process Parameters(unit)	Parameter Designation	Level 1	Level 2	Level 3
Pulse on time(μs)	A	0.5	0.7	0.9
Pulse off time(μs)	B	7	9.5	14
Peak Current(Amp.)	C	80	140	200
Wire feed(m/min)	D	6	8	10
Wire Tension(gm)	E	850	1200	1600
Spark gap Voltage(Volts)	F	30	50	70

Based on the experimental layout depicted in Table 3, the experiments were performed in random order and each specific experiment was repeated three times to have an estimate of the experimental error. Three machining characteristics namely material removal rate (MRR), surface roughness(SR) and wire consumption (WC) were measured.

Cutting speed was measured by CNC WEDM monitor and subsequently, the MRR was calculated by using the formula:

MRR (mm3/min) = Cutting speed (mm/min) × kerf (mm) × thickness of plate (mm) [6]
(1)

Kerf width was measured by subtracting the size of punch from the measured dimension of cavity produced after each experimental run.

Kerf width = $\frac{\text{Size of cavity} - \text{Size of punch}}{2}$

The size of cavity was measured using Tool maker's microscope (Carl-Zeiss, model-MultitekB-21 CEC) up to accuracy level of 0.001 mm, while punch size was measured using Mitutoyo digital vernier caliper having least count of 0.001mm.

A roughness tester (Mitutoyo make) was used for the measurement of average surface roughness (Ra) of the workpiece.The cut off length (λc) and the sampling number were chosen as 0.8 mm and 5 respectively. Three independent readings were taken on each surface of machined surface and the average of these was taken. Eroded wire after completion of each experiment was collected from collection spool and weighted by weighing machine (SHIMADZU electronic balance) with 0.01 gm accuracy to compute the wire consumption.

Table 3 L27Orthogonal array and the experimental results

Run	A	B	A×B	A×B	C	A×C	A×C	B×C	D	E	B×C	F	MRR (mm^3/min)	WC (gm)	SR (μm)
	1	2	3	4	5	6	7	8	9	10	11	12			
1	1	1	1	1	1	1	1	1	1	1	1	1	15.923	37.61	2.084
2	1	1	1	1	2	2	2	2	2	2	2	2	15.265	43.84	2.141
3	1	1	1	1	3	3	3	3	3	3	3	3	9.723	82.227	2.063
4	1	2	2	2	1	1	1	2	2	2	3	3	5.278	115.55	2.014
5	1	2	2	2	2	2	2	3	3	3	1	1	14.935	48.113	2.136
6	1	2	2	2	3	3	3	1	1	1	2	2	11.311	46.81	2.016
7	1	3	3	3	1	1	1	3	3	3	2	2	5.573	118.02	2.021
8	1	3	3	3	2	2	2	1	1	1	3	3	4.549	116.49	1.961
9	1	3	3	3	3	3	3	2	2	2	1	1	11.647	58.16	2.05
10	2	1	2	3	1	2	3	1	2	3	1	2	18.326	33.66	2.333
11	2	1	2	3	2	3	1	2	3	1	2	3	14.284	53.47	2.247
12	2	1	2	3	3	1	2	3	1	2	3	1	19.285	28.877	2.382
13	2	2	3	1	1	2	3	2	3	1	3	1	18.620	44.213	2.456
14	2	2	3	1	2	3	1	3	1	2	1	2	17.889	29.533	2.283
15	2	2	3	1	3	1	2	1	2	3	2	3	13.347	48.017	2.263
16	2	3	1	2	1	2	3	3	1	2	2	3	6.682	80.05	2.265
17	2	3	1	2	2	3	1	1	2	3	3	1	20.140	32.543	2.416
18	2	3	1	2	3	1	2	2	3	1	1	2	16.254	56.637	2.411
19	3	1	3	2	1	3	2	1	3	2	1	3	16.789	47.98	2.261
20	3	1	3	2	2	1	3	2	1	3	2	1	23.789	25.367	2.882
21	3	1	3	2	3	2	1	3	2	1	3	2	34.033	24.13	2.774
22	3	2	1	3	1	3	2	2	1	3	3	2	19.617	24.753	2.483
23	3	2	1	3	2	1	3	3	2	1	1	3	17.221	40.87	2.483
24	3	2	1	3	3	2	1	1	3	2	2	1	27.191	35.35	2.538
25	3	3	2	1	1	3	2	3	2	1	2	1	20.763	35.05	2.44
26	3	3	2	1	2	1	3	1	3	2	3	2	20.384	41.627	2.365
27	3	3	2	1	3	2	1	2	1	3	1	3	13.815	37.163	2.434

3.RESULT AND DISCUSSION

3.1 Multi-machining characteristics optimization using MRSN

3.11 Determination of quality loss for each response parameter

The material removal rate (MRR) is "larger the better" and wire consumption (WC), surface roughness(SR) are the "lower the better type" characteristics. The quality loss or mean square deviation function is used to calculate the deviation between the experimental value and the desired value. Quality loss has been calculated using equations (2) and (3) considering raw data of MRR, SR and WC and tabulated in Table 4.

Where Yi represents the response of each experiment.

3.12 Determination of normalized quality loss for each response parameter

The normalized quality loss is determined by using following formula:

$$Yij=\frac{Lij}{Lim} \qquad (4)$$

Where Yij represents the normalized quality loss,Lij is quality loss for the ith quality characteristics at the jth run and Lim is maximum quality loss for for ith quality characteristics among all experimental runs.The normalized quality loss values for each characteristic are shown in Table 4.

3.13 Determination of total normalizes qualityloss

The total normalized quality loss is determined by following equation:

$$Yj=\sum_{i=1}^{k} ZiYij \qquad (5)$$

Where Yj represents the total normalized quality loss,Yij is normalized quality loss for an ith quality characteristic in jth experimental run.Zi is the

Considering MRR as "larger the better" type characteristic

$$\text{Quality loss} = \left[\frac{1}{n}\sum_{i=1}^{n}\frac{1}{y_i^2}\right] \qquad (2)$$

Considering SR and WC as "lower the better type" type characteristics

$$\text{Quality loss} = \left[\frac{1}{n}\sum_{i=1}^{n} y_i^2\right] \qquad (3)$$

weighing factor for the ith quality characteristic and k is the number of quality characteristics.
Equal weightage for MRR(0.4) and SR(0.4) has been given while a weightage of has been assigned for WC(0.2). Results of total normalized quality loss have been tabulated in Table 4.

3.14 Determination of Multiple Response Signal to Noise (MRSN) ratio and optimal setting

The MRSN ratio is calculated by following formula:
MRSN ratio=-10Log10(Yj)(6)
Multiple S/N ratio has been calculated and summarized in Table 4.
Since orthogonal design has been considered in this study, so it is possible to separate out the effect of each machining parameter for different levels. The optimal combination of process parameters under multi-response study was determined by plotting mean effect plot using Minitab16 software. The optimal combination was found to be TON-0.7 µm, TOFF-7 µm, IP-200 A, WF- 9 m/min, WT- 1200 gm, and SV- 30 V (Fig. 3).The overall results for multi response S/N ratio are tabulated in following Table 4.

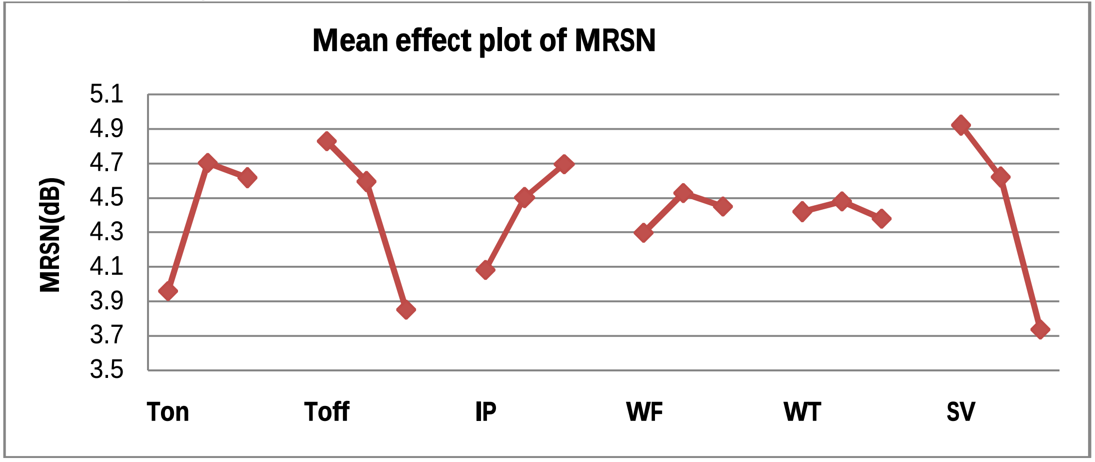


Fig.3. Mean effect plot of multiple S/N ratio.

Table 4 Computational results of multi-response signal to noise ratio

Qualty loss	Normalized quality loss	Total Normalized	Multiple S/N Ratio

				Quality Loss				
Exp. No.	MRR[a]	WC[b]	SR[c]	MRR	WC	SR	TNQL[d]	MRSN(dB)[e]
1	0.003965	1442.703	4.35700	0.081	0.020514	0.52403	0.2626	5.806587
2	0.004317	1954.3552	4.58800	0.088	0.027789	0.55180	0.2839	5.46837
3	0.010767	6782.6757	4.27000	0.221	0.096444	0.51348	0.3901	4.08837
4	0.036057	13435.819	4.05800	0.739	0.191047	0.48804	0.6818	1.663369
5	0.004529	2344.4735	4.56400	0.093	0.033337	0.54888	0.2900	5.375863
6	0.008005	2249.1375	4.06600	0.164	0.031981	0.48900	0.2932	5.328414
7	0.032525	14065.488	4.08500	0.666	0.2	0.49131	0.6631	1.784086
8	0.048807	13667.339	3.85100	1.000	0.194339	0.46308	0.7796	1.081126
9	0.007542	3433.3171	4.20900	0.155	0.048819	0.50617	0.3131	5.043121
10	0.003004	1158.5287	5.45300	0.062	0.016473	0.65574	0.3034	5.179884
11	0.004956	2898.6865	5.05000	0.102	0.041217	0.60740	0.3248	4.883905
12	0.002722	857.2635	5.68000	0.056	0.01219	0.68310	0.3077	5.118116
13	0.002889	1982.4911	6.07400	0.059	0.028189	0.73047	0.3441	4.633627
14	0.003148	900.175	5.21500	0.064	0.0128	0.62722	0.2895	5.383739
15	0.005803	2331.2304	5.12900	0.119	0.033148	0.61683	0.3274	4.848597
16	0.022475	6430.3563	5.13600	0.461	0.091435	0.61766	0.5227	2.817275
17	0.002470	1081.2687	5.84300	0.051	0.015375	0.70269	0.3167	4.993503
18	0.003884	3237.7201	5.81800	0.080	0.046038	0.69965	0.3577	4.464374
19	0.003559	2340.2821	5.11700	0.073	0.033277	0.61542	0.3086	5.105781
20	0.001768	671.22487	8.31500	0.036	0.009544	1.00003	0.4240	3.725837
21	0.000868	610.63697	7.76100	0.018	0.008683	0.93338	0.3892	4.098816
22	0.002601	637.479	6.16900	0.053	0.009064	0.74191	0.3271	4.852547
23	0.003374	1698.043	6.17800	0.069	0.024145	0.74304	0.3490	4.571536
24	0.001368	1277.371	6.44500	0.028	0.018163	0.77509	0.3394	4.692705
25	0.002329	1252.023	5.95800	0.048	0.017803	0.71659	0.3235	4.900905
26	0.002407	1757.4198	5.60800	0.049	0.024989	0.67446	0.3145	5.02368
27	0.005344	1415.9488	5.92600	0.110	0.020134	0.71272	0.3490	4.571409

a: material removal rate, b:wire consumption, c: surface roughness, d: total normalized qualityloss,
e: multi-response signal to noise ratio.

3.2 ANOVA

The relative significance of input parameters for their effects on machining characteristics such as MRR, SR and WC was determined accurately by applying ANOVA test to the experimental results obtained. F-test reveals the information of decision at predefined confidence level whether the parameters selected under study are statistically significant. Larger F value indicates a strong significance level of input parameter for its effect on output parameter. ANOVA was performed for raw data of MRR, SR and WC.TON (percent contribution-46.86%), SV (percent contribution-26.61%) and TOFF (percent contribution-10.77%) factors have a strong influence on MRR (see Table 5). All the factors investigated are statistically significant for MRR. All the three interactions have been found to be significant for SR. TON (percent contribution-62.76%), SV (percent contribution-6.94%) and interaction TOFF × IP (percent contribution-3.6%) have a strong influence on SR. All the factors investigated are statistically significant for SR, except wire feed rate (see Table 6).TON (percent contribution-36.09%), SV (percent contribution-21.96%) and TOFF (percent contribution-11.23%) factors have a strong influence on WC (see Table 7). All the factors investigated are statistically significant for WC, except wire tension.

Table 5 ANOVA summary for material removal rate (Rough cut)

Factor	DOF[a]	Seq SS[b]	Adj MS[c]	F-Ratio	p-value	Percentage contribution (%)
T_{ON}	2	1646.81	823.405	511.38	0.000*	**46.86**
T_{OFF}	2	378.51	189.255	117.54	0.000*	**10.77**
IP	2	149.52	74.76	46.43	0.000*	4.25
WF	2	89.49	44.745	27.79	0.000*	2.54
WT	2	38.47	19.235	11.95	0.000*	1.09
SV	2	935.12	467.56	290.38	0.000*	**26.61**
T_{ON} × T_{OFF}	4	40.79	10.1975	6.33	0.000*	1.16
T_{ON} ×IP	4	97.47	24.3675	15.13	0.000*	2.77
T_{OFF} ×IP	4	47.53	11.8825	7.38	0.000*	1.35
Error	56	90.17	1.61			2.56
Total	80	3513.88				

a: Degree of freedom; b: sequential sums of squares; c:adjusted mean of square, *significant at 95% level

Table 6 ANOVA summary for surface roughness (Rough cut)

Factor	DOF[a]	Seq SS[b]	Adj MS[c]	F-Ratio	p-value	Percentage contribution (%)
T_{ON}	2	2.95648	1.47824	131.31	0.000*	**62.76**
T_{OFF}	2	0.10974	0.05487	4.87	0.011*	2.31
IP	2	0.07146	0.03573	3.17	0.049*	1.50
WF	2	0.03041	0.01520	1.35	0.267	0.63
WT	2	0.09816	0.04908	4.36	0.017*	2.08
SV	2	0.32741	0.16370	14.54	0.000*	**6.94**
T_{ON} × T_{OFF}	4	0.16560	0.04140	3.68	0.010*	3.50
T_{ON} ×IP	4	0.15055	0.03764	3.34	0.016*	3.18
T_{OFF} ×IP	4	0.17048	0.04262	3.79	0.009*	3.60
Error	56	0.63044	0.1126			13.37
Total	80	4.71074				

a: Degree of freedom; b: sequential sums of squares; c:adjusted mean of square, *significant at 95% level

Table 7 ANOVA summary for wire consumption (Rough cut)

Factor	DOF[a]	Seq SS[b]	Adj MS[c]	F-Ratio	p-value	Percentage contribution (%)
T_{ON}	2	22465.8	11232.9	114.22	0.000*	**36.09**
T_{OFF}	2	6988.7	3494.35	35.53	0.000*	**11.23**
IP	2	2836.8	1418.4	14.42	0.000*	4.56
WF	2	2156.1	1078.05	10.96	0.000*	3.46
WT	2	184.1	92.05	0.94	0.398	0.30
SV	2	13672	6836	69.51	0.000*	**21.96**
T_{ON} × T_{OFF}	4	3396.3	849.075	8.63	0.000*	5.46
T_{ON} ×IP	4	1965.9	491.475	5	0.002*	3.16
T_{OFF} ×IP	4	3083.4	770.85	7.84	0.000*	4.95
Error	56	5507.2	98.34286			8.85
Total	80	62256.3				

a: Degree of freedom; b: sequential sums of squares; c:adjusted mean of square, *significant at 95% level

4. CONFIRMATION EXPERIMENTS

The final step is to predict and verify the improvement of the performance characteristics with the selected optimal setting of the input parameters. The predicted optimum values of the MRS/N ratio (ηopt) using the optimal level of process parameters can be calculatedas:

$$\eta opt = \eta m + \sum_{i=1}^{n} (\eta i - \eta m) \qquad (7)$$

where ηm represents is the average value of multiple S/N ratios in all experimental runs, ηi are multiple S/N ratios corresponding to optimum factor levels and n is the number of factors.

Verified results of the confirmatory experiments at the selected optimum conditions are shown in Table 8. The predicted machining performance was compared with the actual machining performance and a good agreement was obtained between these performances. The improvement of the MRSN from the initial setting to optimal process setting is 3.806%. Based on the experimental confirmation, the material removal increased 21.30%. The surface roughness was decreased by 2.35% and the WC decreased by 23.12%. Hence, the machining performance is improved significantly after using the optimal process setting.

Table 8 Confirmatory results

	Initial setting	Optimum values	
		Predicted	Experimental
Level	$T_{on1}T_{off1}IP_1WF_1WT_1SV_1$	T_{on2} T_{off1} IP_3 WF_2WT_2 SV_1	T_{on2} T_{off1} IP_3 WF_2WT_2 SV_1
MRR (mm^3/min.)	15.923		19.315
SR (μm)	2.084		2.035
WC(gm.)	37.610		28.912
MRSN(dB)	5.806	6.027	6.117

4. CONCLUSION

In this paper Taguchi's DOE with multi response optimization technique (MRSN ratio) has been investigated to optimize the WEDM process with the multi performance characteristics. The optimal process parametric setting for simultaneous optimization of MRR, SR and WC was found as Ton(0.7μs),Toff(7μs),IP(200A),WF(8m / min),WT(1200 gm) and SV(30V). Pulse on time (Ton) and spark gap voltage (SV) have been found to be most influential parameters for material removal rate, surface roughness and wire consumption as verified through statistical testing. The confirmation results reveals that experimental results are close to predicted optimal value and fall within estimated confidence interval.

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