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Effect of WEDM Parameters on Surface Roughness when cutting SKD11 Steel

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Introduction

This paper introduces a study on determination of optimal process parameters when Wire Electrical Discharge Machining (WEDM) when processing circular arcs SKD11 steel. In this study, several input parameters counting the pulse on time, the pulse off time, the cutting voltage, the serve voltage, the wire feed, the cutting speed, and the arc radius were considered. The effects of these parameters on the workpiece surface roughness were learned. In addition, optimal process parameters for getting the minimum surface finish were found.

Experimental procedure

Table 1. Input parameters and their levels

Parameter	Code	Unit	Level		
			1	2	3
Cutting voltage	VM	V	6	9	12
Pulse on time	Ton	μs	6	9	12
Pulse off time	Toff	μs	8	12	16
Servo voltage	SV	V	24	29	34
Wire feed	WF	mm/min	8	10	12
Arc radius	R	mm	3	6	9
Cutting speed	SPD	mm/min	2	4	-

Table 2. Experimental plan and the MRR

No	V M	T on	T of f	SV	WF	SPD	R	Ra (μm)			Mean	S/N
								Trial 1	Trial 2	Trial 3		
1	3	6	8	24	8	2	3	1.719	1.720	1.700	1.7130	-4.6753
2	6	6	12	29	10	2	6	1.680	1.793	1.767	1.7466	-4.8472
3	9	6	16	34	12	2	9	1.414	1.321	1.238	1.3243	-2.4523
4	6	9	8	24	10	2	9	1.707	1.736	1.730	1.7243	-4.7324
5	9	9	12	29	12	2	3	1.643	1.620	1.656	1.6397	-4.2955
...
16	9	12	8	34	10	4	3	1.737	1.751	1.767	1.7515	-4.8683
17	3	12	12	24	12	4	6	2.016	2.184	2.193	2.1310	-6.5781
18	6	12	16	29	8	4	9	1.852	1.907	1.895	1.8846	-5.5051

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Results and discussion

Response Table for Signal to Noise Ratios

Level	SPD	Ton	Toff	SV	WF	VM	R
1	-4.689	-3.938	-4.526	-4.951	-4.784	-5.140	-4.984
2	-4.727	-4.577	-4.981	-4.932	-4.885	-4.847	-4.764
3		-5.608	-4.617	-4.240	-4.454	-4.136	-4.376
Delta	0.038	1.670	0.455	0.711	0.431	1.003	0.608
Rank	7	1	5	3	6	2	4

Table 3. Order of influence of input parameters on S/N

Source	DF	Seq SS	Adj SS	Adj MS	F	P	C (%)
SPD	1	0.0064	0.00642	0.00642	0.06	0.811	0.04
Ton	2	8.5180	8.51802	4.25901	43.10	0.002	51.54
Toff	2	0.6974	0.69737	0.34868	3.53	0.131	4.22
SV	2	1.9698	1.96981	0.98491	9.97	0.028	11.92
WF	2	0.6093	0.60929	0.30465	3.08	0.155	3.69
VM	2	3.1961	3.19606	1.59803	16.17	0.012	19.34
R	2	1.1362	1.13615	0.56808	5.75	0.067	6.87
Residual Error	4	0.3953	0.39531	0.09883			2.39
Total	17	16.5284					

Table 4. Analysis of Variance of input parameters on S/N

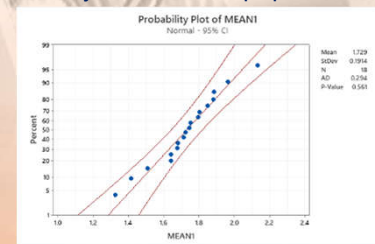


Fig. 5. Probability plot of MRR

Conclusions

This work deals with a study on the influence of WEDM process parameters when processing circular arcs SKD11 tool steel. In this work, seven input parameters containing the cutting voltage, the pulse on time, the pulse off time, the serve voltage, the wire feed, the cutting speed, and arc radius were explored. The effects of these parameters on the surface finish were studied. It was found that Ton has the greatest effect on Ra (51.54%); followed by VM (19.34%), SV (11.92%), R (6.87%), T_{off} (4.22%), WF (3.69%) and SPD has a negligible effect on Ra. Besides, a set of optimum input parameters was proposed: VM=9; T_{on}=6; T_{off}=8; SV=34; WF=12; R=9, and SPD=2. Also, it is noted that the proposed optimum model is suitable to apply.