ICMSSM 2021

2021 7th International Conference on Mechanical Structures and Smart Materials

JUNE 14-15, 2021   CHANGSHA, CHINA

Determination of Optimum WEDM Parameters for Maximum Material Removal Rate when Arc Cutting SKD11 Tool Steel

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Introduction

This paper deals with a study on the effect of input factors on optimal WEDM process parameters when cutting circular arcs SKD11 steel. To do that, seven input parameters were considered. The impact of the input factors on the MRR were discovered. Also, a proposed model to determine the optimum WEDM parameters was given.

Experimental procedure

Table 1. Input parameters and their levels

Parameter	Code	Unit	Level 1	Level 2	Level 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 radious	R	mm	3	6	9
Cutting speed	SPD	mm/min	2	4	-

Table. 2. Experimental plan and the MRR

No.	VM	Ton	Toff	SV	WF	SPD	R	MRR (mm^3/min)	S/N
1	3	6	8	24	8	2	3	1.560	3.8625
2	6	6	12	29	10	2	6	3.176	10.0376
3	9	6	16	34	12	2	9	8.180	18.2551
4	6	9	8	24	10	2	9	8.460	18.4835
5	9	9	12	29	12	2	3	10.793	20.6628
...	...	...	...	...	...	...	...	...	....
16	9	12	8	34	10	4	3	12.437	21.8943
17	3	12	12	24	12	4	6	14.142	23.0653
18	6	12	16	29	8	4	9	12.722	22.0281

Results and discussion

Larger is better

Level	SPD	Ton	Toff	SV	WF	VM	R
1	16.50	11.31	15.91	16.17	15.87	15.13	15.86
2	17.70	18.70	17.33	17.13	17.23	16.75	17.72
3		21.28	18.05	17.98	18.19	19.42	17.70
Delta	1.20	9.98	2.14	1.81	2.33	4.29	1.86
Rank	7	1	4	6	3	2	5

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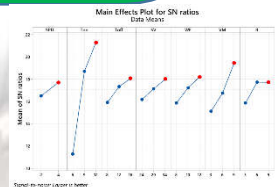
Fig. 3. Effect of input parameters on S/N ratio

Source	DF	Seq SS	Adj SS	Adj MS	F	P	C (%)
SPD	1	6.496	6.496	6.496	0.85	0.410	1.38
Ton	2	321.754	321.754	160.877	20.97	0.008	68.55
Toff	2	14.219	14.219	7.109	0.93	0.467	3.03
SV	2	9.822	9.822	4.911	0.64	0.574	2.09
WF	2	16.405	16.405	8.203	1.07	0.425	3.49
VM	2	56.310	56.310	28.155	3.67	0.124	12.00
R	2	13.706	13.706	6.853	0.89	0.478	2.92
Residual Error	4	30.692	30.692	7.673			6.54
Total	17	469.404					

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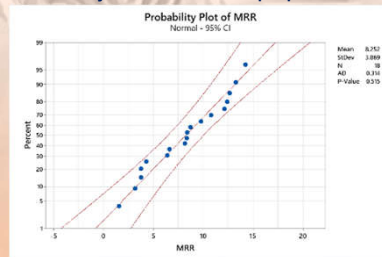

Fig. 5. Probability plot of MRR

Conclusions

The present work introduces the calculation of optimum WEDM parameters when arc cutting SKD11 steel. In this work, seven input process parameters including the cutting voltage, the pulse on time, the pulse off time, the serve voltage, the wire feed, the cutting speed, the arc radious were investigated. The impacts of the input factors on the MRR were explored. It was noted that T_{on} has the greatest influence on MRR (68.55%) and after that is VM (12.00%). The other input factors have a lower influence on MRR: WF (3.49%), T_{off} (3.03%), R (2.92%), SV (2.09%) and SPD (1.38%). In addtion, the following optimum input factors was suggested: VM=12; T_{on} = 12; T_{off} =8; SV=24; WF=12; and SPD=4. It is also found that the proposed model is proper to use in practice.