

Analysis of Process Parameters in Plasma Arc Cutting

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ABSTRACT: Plasma arc cutting (PAC) is a widely used industrial process for the cutting of different types of metals in several operating conditions. PAC of stainless steel thin plates through a Hypertherm1650 plasma source, operating in the range 40-80 A. PAC of stainless steel thick plates (thickness in the range 3-16 mm) are characterized by low current levels (40-80 A) and the use of O₂ both as plasma gas and secondary gas. The aim of the work is the analysis of PAC of stainless steel thick plates, both in terms of cut quality and performances of the consumables, to achieve cut quality standards and productivity levels usually obtainable through plasma cutting processes. Three process parameters are considered viz. cutting current, cutting height, cutting speed are considered and L₉O_A are conducted. Process responses viz. machining time, surface roughness, kerf taper of the machined surface are measured for every experimental runs. The experiment was designed and carried out on the basis of standard L₉ Taguchi's orthogonal array in which the three cutting parameters were arranged at three levels. From the analysis of mean values of variance, the significant PAC parameters were identified. For minimize the machining time, kerf taper, surface roughness and hardness is analysis based on s/n ratio Taguchi design. Our goal of the experiment of s/n ratio is small. Finally analysis the process parameters of PAC.

I. INTRODUCTION

The recent advancements in manufacturing technology have enabled Manufacturers to make parts and products faster, with better quality, and more Complexity. Laser, water jet, and plasma techniques represent some of these newly Established technologies in part manufacturing. The process of plasma cutting was introduced in 1950. Since then, the Manufacturing industries are using this process extensively because of its wide Applications. In spite of its development, the field was given little attention by the Researchers. The different processes included in the plasma cutting process are plasma material Interaction, process control, thermal plasma generation, liquid metal removal, Etc.

I.1 PROCESS VARIABLES

I.1.1 Gases

Plasma gas – flows through the orifice and becomes ionized

Shielding gas – flows through the outer nozzle and shields the molten weld from the atmosphere

Back-purge and trailing gas – required for certain materials and applications.

These gases can all be same, or of differing composition.

I.1.2. Input parameters

1. Cutting Current.
2. Cutting speed.
3. Cutting height

Output Parameters

1. Machining Time
2. Kerf Taper
3. Surface Roughness
4. Hardness

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II. EXPERIMENT

The Taguchi method has been used, in which the experiments are performed as per standard Orthogonal Arrays (OA) while the optimum level of input process parameters (control factors) are decided on the basis of a statistical analysis of the experimental results. Based on the review of the literature, the selected parameters to be investigated were three, namely the cutting speed, cutting current, and the cutting height the assist gas. This led to the use of an L9 orthogonal array. The experimental regions of these parameters were determined after the first experiments had been conducted that would identify the initial process parameters settings for which through cuts could be obtained. The Levels of each parameter are listed below.

Parameters					
Cutting speed(mm/min)		Cutting current(A)		Cutting height(mm)	
Min	Max	min	max	min	max
1500	4500	40	80	1	10

According to L9, three parameters with three levels are considered. The parameters to be examined and the levels of each parameter are sorted out. The L9 orthogonal array used is presented below.

Ex.no	Cutting speed	Cutting current	Cutting height
1	1	1	3
2	2	1	2
3	3	1	1
4	1	2	2
5	2	2	1
6	3	2	3
7	1	3	1
8	2	3	3
9	3	3	2

Table 1.Taguchi L9 Orthogonal array DOE

III. MACHINING OPERATIONS

A PAC cutting system was used for the performance of the experiments. The cuts were performed on 6 mm thickness stainless steel plate, with the use of oxygen gas. The specimens were made up of a linear cut of 10 mm in length for measuring kerf taper. The machine used for this machining was Hypertherm I650 plasma source.

A stainless steel plate of 6mm is cut into 420x350x6mm length work piece by power hacksaw and the corners are filled for better finish. Then the work piece is cleaned and dried.

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Testing Machines

In this project the responses which are to be found were Mean surface hardness, Kerf Width (CMM). Different machines are used to find the values for each parameter.

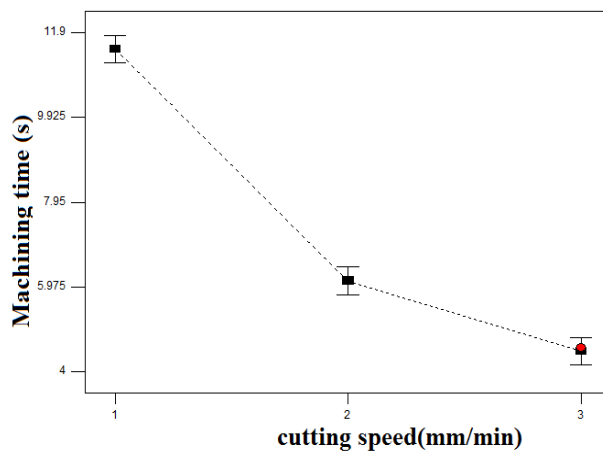
Response	Equipments
Surface roughness(μm)	SURFACE ROUGHNESS TESTER
Hardness (HRB)	ROCKWELL
Kerf taper (CMM)	TOOL MAKERS MICROSCOPE

Table 2. Response and their measuring tool

Response values

The below response was analyzed with the help of above instruments

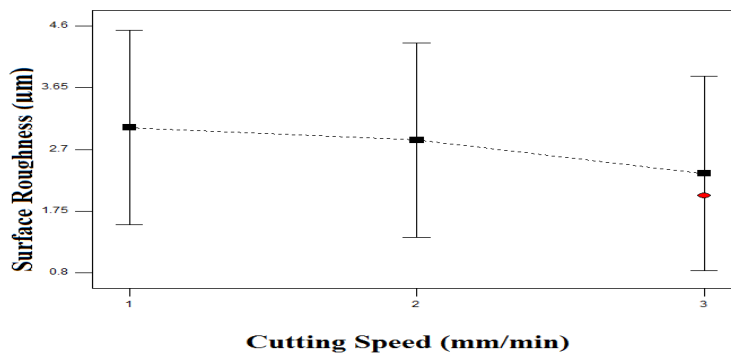
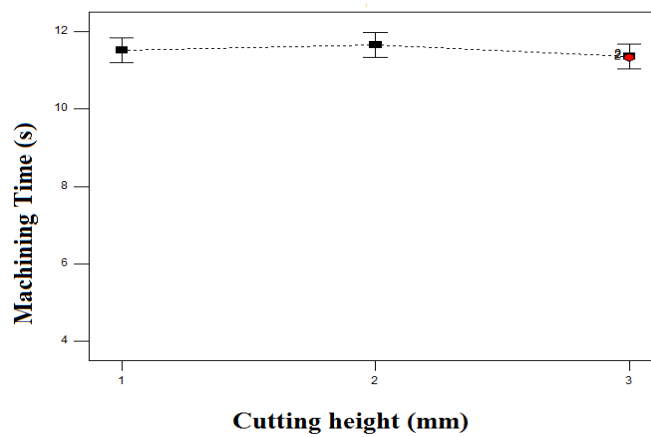
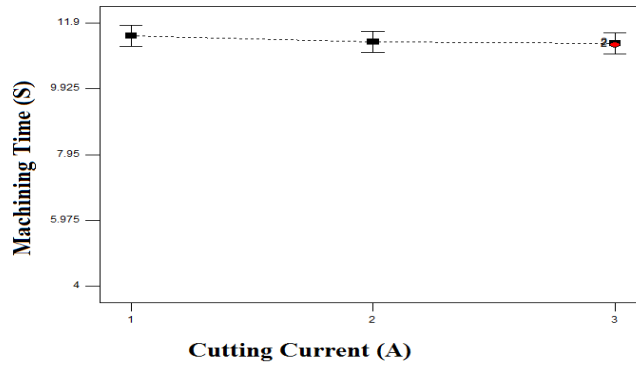
Ex.no	Machining time(S)	Kerf taper(%)	Surface roughness(μm)	Hardness(RHN)
1	11.33	82.3	4.19	187
2	6.21	87.6	3.09	88.6
3	4.56	92.8	1.9	140.3
4	11.5	98.1	0.89	82.3
5	5.8	6.3	1.13	184
6	4.1	26.7	1.21	162.6
7	11.2	53.9	1.09	95.3
8	5.8	81.6	1.37	118.3
9	4.3	53.3	0.85	96.16



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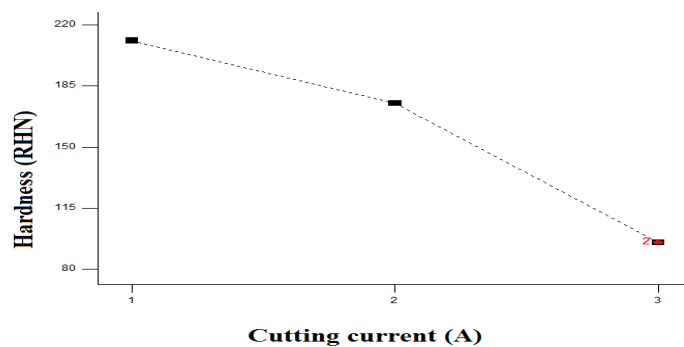
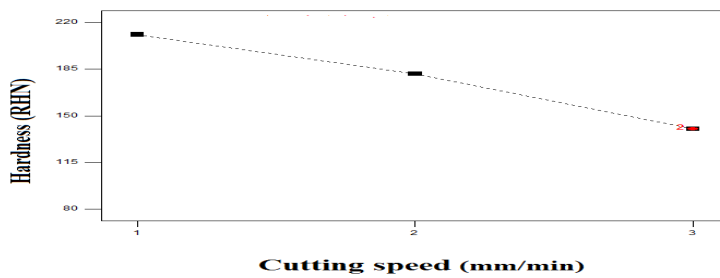
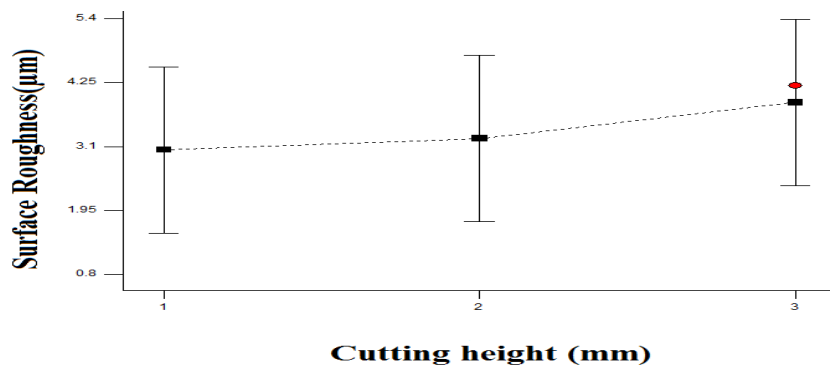
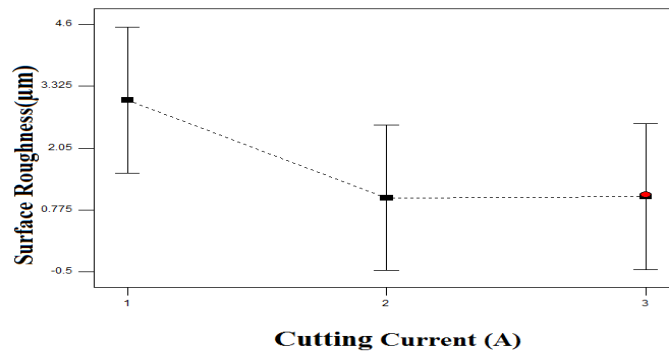
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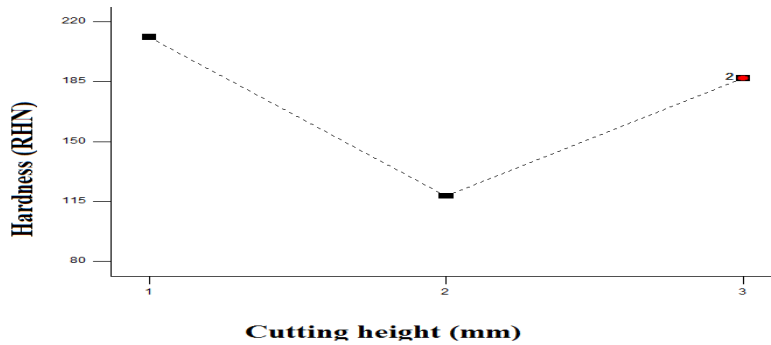
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S/N RATIO OF OUTPUT RESPONSES

Ex.no	s/n Ratio			
	Machining time	Kerftaper	Surface roughness	Hardness
1	-21.0846	-67765.824	-12.4546393	-45.4368
2	-15.8688	-76737.6	-9.79916959	-38.9526
3	-13.1793	-86266.944	-5.97706153	-42.943
4	-21.2516	-96353.856	-1.012199867	-38.3112
5	-15.4023	-405.769	-1.06156887	-45.2964
6	-12.2557	-7171.684	-1.65570741	-44.2261
7	-21.0231	-29127.609	-0.74852996	-39.5819
8	-15.2835	-66650.896	-2.73441134	-41.4619
9	-12.7498	-28665.316	-1.411621486	-39.6599

MINIMIZATION OF OUTPUT RESPONSES

EX.O	Responses	Minimization
4	Machining time	-21.2516
4	Kerf taper	-96353.856
1	Surface roughness	-12.4546393
1	Hardness	-45.4368

IV. CONCLUSION

In this project experiments are carried out for cutting speed, cutting current, cutting height with responses as the machining time, kerftaper, surface roughness and hardness. There are nine experimental readings are taken. Taguchi orthogonal array is selected for the optimum parameter levels. Taguchi level 9 orthogonal array is selected. We compared the input parameters and the responses by using the Design of Expert Software. Each input parameters are affects the each responses. Minimization the process responces are carried by the s/n ratio. Our goal of the experiment of s/n ratio is smaller is better. Finally analysis of best combination of process parameter.

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