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Experimental study of mild steel cutting process by using the plasma arc method

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ABSTRACT

Purpose: In this study, plasma arc cutting (PAC) is an industrial process widely used for cutting various away types of metals in several operating conditions.

Design/methodology/approach: It is carried out a systematic or an authoritative inquiry to discover and examine the fact, the plasma cutting process is to establish the accuracy and the quality of the cut in this current paper assessed a good away to better the cutting process.

Findings: It found that the effect of parameters on the cutting quality than on the results performed to accomplish by statistical analysis.

Research limitations/implications: The objective of the present work paper is to achieve cutting parameters, thus the quality of the cutting process depends upon the plasma gas pressure, scanning speed, cutting power, and cutting height.

Practical implications: The product of the plasma cutting process experimentally has been the quality of the cutting equipment that was installed to monitor kerf width quality by exam the edge roughness, kerf width, and the size of the heat-affected zone (HAZ).

Originality/value: The results reveal that were technically possessed of including all the relevant characteristics, then a quality control for the cutting and describe the consequence of the process parameters.

Keywords: Cutting power, Edge roughness, Mild steel, Plasma arc cutting, Scanning speed

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MANUFACTURING AND PROCESSING

1. Introduction

Adopted in the early 1950s Plasma cutting machine at processing for two thermal non-traditional machining processes Flame cutting uses in cutting stainless steel and other nonferrous metals. Throughout a period, the process limitations regarding lower cutting speed, poor machining quality, and unreliable equipment were clear [1-6]. Perform a series of mechanical operations on plasma arc cutting (PAC) in order to improve a non-conventional manufacturing process that was capable of processing a variety of electrically conducting materials. Conventional processes have been approximately thirty years ago, the plasma process has been developed for the cutting of hard metals formed through traditional processes. It uses the high-energy current of separation, gas ionization, known as plasma, heat source [2]. Plasma is nothing but a state of a substance that is got by providing an enormous amount of energy to the gas or when the plasma gas is affected by a high electric field. In a plasma arc cutting plasma, gas is used as a heat source. At present, a variety of non-conventional thermal processes are used to cut a variety of materials that have high strength and high melting point and which cannot be satisfactorily cut through the traditional methods of cutting. These methods include non-conventional Oxy-fuel cutting, laser cutting, abrasive jet water cutting, and plasma arc cutting. These have different advantages such as the narrow cut, better cut profile, flat edges less work piece deformation, high feed rates, etc. In a plasma arc cutting plasma, gas is used as a heat source. When a specific heat is equipped to the iron it melts and gets converted into the liquid, add more heat is supplied liquid becomes vapor or gas, furthermore, the heat is equipped to the gas in order to obtain on the ionization that converts a plasma to a high electrical conductive gas. At that time, it was viable for the limited materials such as aluminium and high alloy steel, but today it is used to cut a variety of materials such as titanium alloys, aluminium, copper, manganese, magnesium, stainless steel, steel, and cast iron including alloys and non-alloy and low alloy steels due to its narrow heat-affected zone and high cutting speed. simultaneously, the electric current is threaded through the gas with the assistance of a tungsten electrode due to which a high-intensity plasma arc is generated so that the plasma gas extends the high speed through the orifice. Their plasma arcs are then transferred to the surface cut and convert some gas into plasma. The plasma arc has forced sufficient energy to melt or evaporate The surface is cut and moved very quickly to flux the molten metal far from the cutting. In the plasma arc nozzle, there is an area between the outer boundary of the pole and the inner boundary of the nozzle where the plasma gas gets heated and ionizing resulting in plasma expansion in size and pressure will greatly thus plasma gas comes out of the orifice with very high temperature and velocity. In the generation and sustainability of plasma, the energy is transferred to the electrons by the electric field and the active electrons create ionization by colliding the electron atom. Electrons in the plasma arise from: secondary emission processes of ions or electron-cut surfaces (secondary electrons), collisions of ionizing gases, and electrons from an electron thermal emission source (hot cathode) [3]. Plasma cutting is a process that metal from a cutting narrow aperture is fused and thrown out with a highly concentrated electric arc glowing between a non-consumable electrode and the object being was determined to cut it [4]. The plasma electric arc is a highly ionized high electric energy gas, which moves from a plasma nozzle which narrows it down towards the cutting slot with a speed close to the speed of sound. The plasma beam temperature relies on the current vehemence, arc contraction degree, the type of the plasma gas, and ambit from 10,000 to 30,000k. in the plasma, the pieces use reverse only the direct current polar current provided by the inverter or inverter current generators. It can cut all conduct electrical building material. Plasma is also used in high-speed hand, mechanical and automatic cutting of steel and non-ferrous metals. Thanks to the high temperature of the plasma arc, cutting starts immediately without preheating. Simultaneous movement of several axes using CNC technology yields smooth tool paths that are accurate and repeatable [5]. Anyways, they accurately depended on the cutting on material thickness and the thermal cutting procedure even more on the used the biggest deviations appear by flame cutting, which is usually used for cutting thicker materials with lower speed. But then, the lowest deviations appear by laser cutting, which is usually used for cutting thinner materials with increased cutting speed [6,7]. Use of this source in order to ascertain also shown that laser beam machines offer more accuracy and precision, but plasma cutting machines used to introduce, compare with what has already been mentioned have a significant advantage over laser machines in terms of the acquisition cost, they´re processed of maintaining and productivity [8-10]. They investigated the effect of plasma-arc cut process parameters on the dimensional accuracy of St37 steel work pieces. A multi-parameter optimization was found out by using the factorial design in empirical procedures [11]. Researchers used multi-criteria decision making (MCDM) based optimization methods in order to get the best parametric combination of cutting parameters [12]. Author studied the possibility of the nozzle and beam Lasers for cutting processes and the improvement of the best of their beam speed. Different material thick and cutting speed is used with capacity power (2 kw, 4 kw, 6 kw). Suitable type of beam nozzle, orifice kind, and Pierce period is reference value of beam irradiation period, not guaranteeing work period [13]. Camera photos and SME images were taken symmetrically for a one–to-one comparison to detect the effect of plasma on the morphological structure [14]. The sintering methods use in order to effect the cutting performances of the diamond cutting tools [15]. The rate of corrosion in cast irons specimen depended upon the cutting speed [16]. In present paper, there are three parameters that have been selected which are used to identify cutting speed, the power of the lifting motor, and plasma gas pressure. Take measures to check the quality the effect of one parameter on the cut quality requires a change of one parameter while keeping the second parameter at the pre-selected value. Notwithstanding, the regarded and identified laser and plasma arc cutting machines to offer good results depending on the type of material cut and of the results needed. Perform a series of mechanical operations on plasma CNC machine cutting in order to be changed. Our primary aims to achieve of study the effect of the cutting process parameters like plasma gas pressure, cutting speed, power, and on the kerf width in mild steel, in order to obtain on the optimum condition from plasma gas pressure and cutting speed.

2. Materials and methods

2.1. Experiment function of the machine

The main use and function of this machine cutting are composed of an electrical, mechanical shown as Figure 1. The CNC plasma cutting machine by plasma head nozzle cutting. Messer cutting systems, consisted of power of the lifting motor 25.1 W / 60 Watt, the thickness of cutting 18 mm, cutting speed 1000-6000 mm/min, punch mark option gas type (compressed air), punch frequency about 3000 time/min, pressure of the oxygen 1.2 MPa, the purity of the oxygen 99.6% experiments. The CNC gateway system, like cutting machines, is an extremely accurate, and reliable source. The machine quality has been two heads of one head for flame cutting of sheet metal within the duplicate side longitudinal axis, drive with AC motors, and then plasma sheet metal cutting. In order through achieving the stated aim of the research, plasma cutting experiments are carried out using material characteristics, parameter details are shown in Tables 1, 2 and 3, in order to achieve the cut quality. Empirical investigations were performed "Elecon Engineering Company Limited" India /Anand in Gujarat. The CNC Plasma Cutting Machine by plasma device Messer cutting systems is used in the experiments.

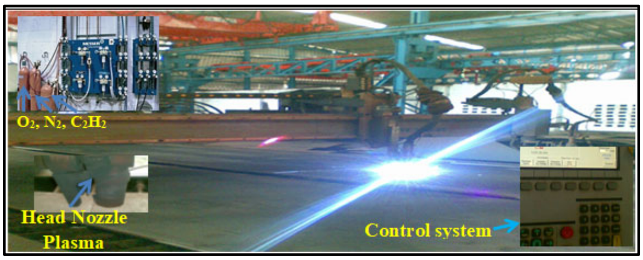


Fig. 1. CNC Plasma Cutting Machine, India/Anand at Gujarat "Elecon Engineering Company Limited"[14]

Table 1.
Material is mild steel specification of system gas requirements and characteristics

Material	Fe 4 10W B IS: 2062
Thickness	18 mm
Size	293 x 1080 LG.
User size	185 x275
Off cut	0.0 x 0.0m
Stock	63 kg
Used	63 kg
Balance	0 kg
Utile	12.8%
Kerf width	3.000 mm
Speed cutting	500-1000 mm per minute

Table 2.
Mild Steel, O_2 Plasma / O_2 Shield, 30 A Cutting

Flow Rates – Ipm / scfh		
	O_2	Air
Pre-flow	0 / 0	46 / 97
Cut-flow	22 / 46	0 / 0

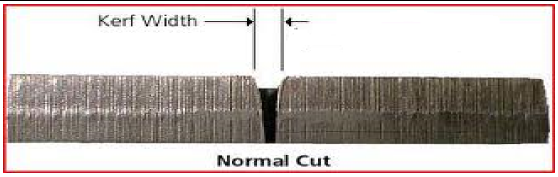
There are three parameters that have been selected for the present study. These are used to identify cutting speed, the power of the lifting motor, and plasma gas pressure. The properties vary within this range as described above. Take measures to check the quality the effect of one parameter on the cut quality requires a change of one parameter while keeping the second parameter at the pre-selected value. The chemical composition of the examined material is in Table 3. The controlled substance parameters have been the kerf width. A visual perception inspection of each cut was carried through to ensure that no pitting is present in the cut area. Figure 2 shows the cut sample of the measurements taken.

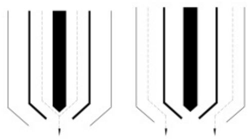
Fig. 2. The cut samples (6) after plasma cutting mild steel with varying the cutting speed and the plasma gas pressure, "Elecon Engineering Company Limited"[13]

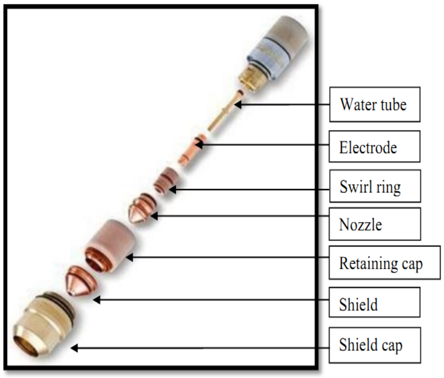
Table 3.
Mild Steel, O_2 Plasma / O_2 Shield, 30 A Cutting data regular coordinates for each parameters operation

Select Gases		Set Pre flow		Set Cut flow	Amperage	Material Thickness	Torch-to-Work Distance	Cutting Speed	Arc Voltage
Plasma (1)	Shield (2)	Plasma (3)	Shield (4)	Shield (6)	Amps	mm	mm	mm/min	Volts
O_2	O_2	10	10	10	30-260	18	2.5	500-1000	105

Table 4.
Specification of system gas requirements







	Mild steel	
Gas types	plasma	shield
Cutting 30 to 45	O_2	O_2
Cutting 80A	O_2	Air
Cutting 130A	O_2	Air
Cutting 200A	O_2	Air
Cutting 260A	O_2	Air

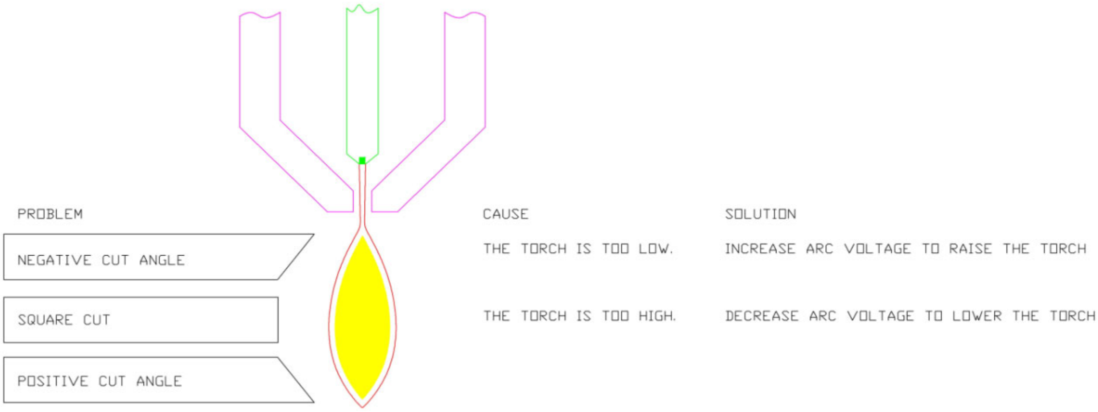


Fig. 3. Type of flames during cutting

2.2. Mild steel

Mild steels are ranged around from near-zero up to 0.25% in low carbon content. The arrangement of the important factor dominant the content of mild steel (carbon) is the most important factor governing the mechanical properties of light steel – a low carbon content analysis system produces greater flexibility during the time when it produces higher carbon content and stronger content. It is also known that mild steel (Fe 4 10W B IS: 2062) contains manganese by 0.4-0.7% for the stabilization of sulfur, 0.1-0.5% of silicon to remove oxidation, and various other elements. The substantial common classification of light steel is a low carbon (less than 0.08%, with no more than 0.4% manganese) used to variations formed to packaging as shown Table 3. The standoff distance and the current intensity during the carrying out of experiments kept constant such as shown in Table 4 and Figure 3. Problems such as negative cut angle, square cut, and positive cut angle are caused by the torch being too low or too high. Therefore, solutions are to increase arc voltage to raise the torch and decrease arc voltage to lower the torch.

The top from high kerf width in the surface was measured using optical microscopy, two-coordinate microscope, Figure 4. The kerf data were obtained using an enlarged force of 1.2 x with clear penetrative of less than of cut 6 mm thickness. Three kerfs the measurements were collected for each sample, then the average kerf was calculated and used as a reaction to the process.

Fig. 4. Optical microscopy to inspection onto kerf width (mag. 1.2x)

2.3. Design of experiments

The appearance of design in the world of experiments (DOE) is a group of arranged in systematic scientific procedures the effect of process parameters uses to empirically understand variability and influence that contributes a result of the performance of the process and assist determine optimal values. The essential significance takes advantage of theirs of these a scientific procedure that they can provide results with the mathematical computations, assesses skills in interaction with whole numbers from process parameter variables, then a comparison between the results, adds to this each the conceivable empirical integrations. In spite of all reasons, the design of the experiment to widely used in the optimization of a quantity, the number of manufacturing processes ranging from laser cutting, welding, turning, milling and roll forming [3-5]. However, done appointment (DOE) for the successful program, the process variables for parameter levels have to be defined. That is the desired objective through screening experiments. The comprehensive review of the existing literature revealed that the main process parameters were cutting speed (CS), current cutting (CC), cutting height (CH), and plasma gas pressure (PPG). To prepare the DOE, a number of screening experiments were conducted. Search Table 1: the set of different process parameters of the same type can be for achieving through cuts is presented.

3. Results and discussion

The change that is a result of cutting speed on the kerf width at different plasma gas pressures are shown in Figures 5, 6, 7, and 8, respectively, and Tables 5, 6, and 7 respectively.

Table 5.
Extreme operating window for respective process parameters

	Gas pressure, psi	Power, watt	Speed, mm/min	Level
- Alpha	2	1250	500	Minimum
+ Alpha	6	2500	1000	Maximum

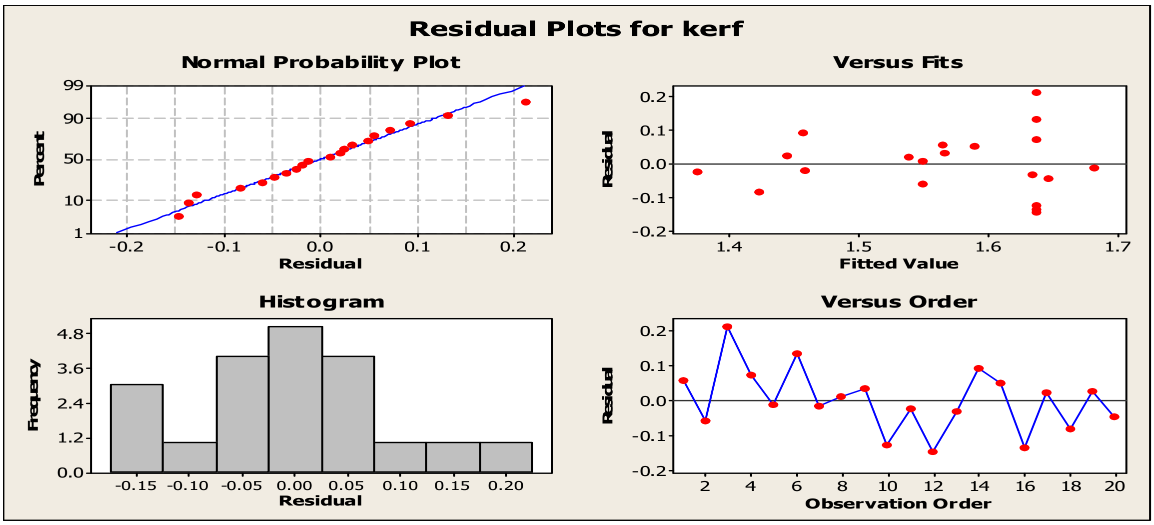


Fig. 5. Residual plots for kerf

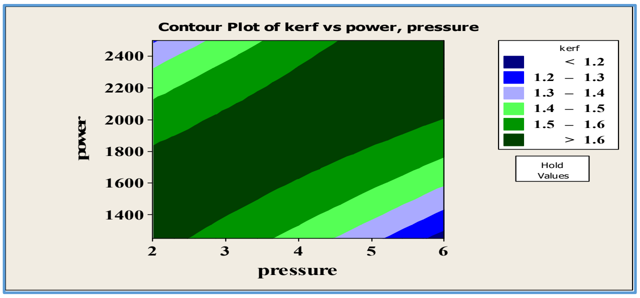


Fig. 6. Contour Plot of Kerf vs Power, Pressure

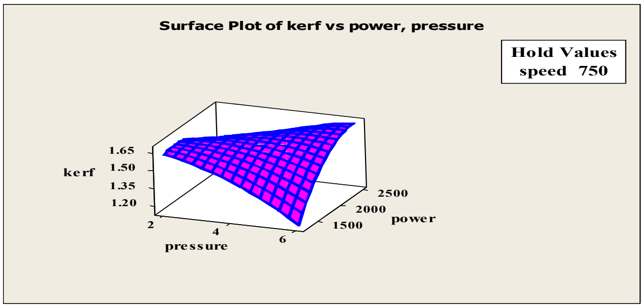


Fig. 7. Surface Plot of Kerf vs Power, Pressure

Table 6.
Experimental run and results of kerf width

Run	StdOrder	RunOrder	PtType	Blocks	Pressure	Power	Speed	kerf
1	4	1	1	1	5.18921	2246.63	601.35	1.62
2	10	2	-1	1	6.00000	1875.00	750.00	1.49
3	20	3	0	1	4.00000	1875.00	750.00	1.85
4	17	4	0	1	4.00000	1875.00	750.00	1.71
5	8	5	1	1	5.18921	2246.63	898.65	1.67
6	15	6	0	1	4.00000	1875.00	750.00	1.77
7	11	7	-1	1	4.00000	1250.00	750.00	1.44
8	12	8	-1	1	4.00000	2500.00	750.00	1.56
9	7	9	1	1	2.81079	2246.63	898.65	1.60
10	18	10	0	1	4.00000	1875.00	750.00	1.51
11	2	11	1	1	5.18921	1503.37	601.35	1.35
12	16	12	0	1	4.00000	1875.00	750.00	1.49
13	14	13	-1	1	4.00000	1875.00	1000.00	1.60
14	6	14	1	1	5.18921	1503.37	898.65	1.55
15	9	15	-1	1	2.00000	1875.00	750.00	1.64
16	19	16	0	1	4.00000	1875.00	750.00	1.50
17	1	17	1	1	2.81079	1503.37	601.35	1.56
18	3	18	1	1	2.81079	2246.63	601.35	1.34
19	13	19	-1	1	4.00000	1875.00	500.00	1.47
20	5	20	1	1	2.81079	1503.37	898.65	1.60

Table 7.
Estimated for kerf Regression Factors

Term	Coef	SE Coef	T	P
Constant	1.63803	0.05099	32.125	0.000
pressure	-0.01188	0.03383	-0.351	0.733
power	0.02723	0.03383	0.805	0.440
speed	0.05628	0.03383	1.664	0.127
pressure*pressure	-0.02397	0.03293	-0.728	0.483
power*power	-0.04695	0.03293	-1.426	0.184
speed*speed	-0.03457	0.03293	-1.050	0.318
pressure*power	0.07625	0.04420	1.725	0.115
pressure*speed	-0.00625	0.04420	-0.141	0.890
power*speed	0.00875	0.04420	0.198	0.847

Note: S = 0.125019 Press = 0.445246 R-Sq = 49.23% R-Sq (pred) = 0.00% R-Sq (adj) = 3.55%

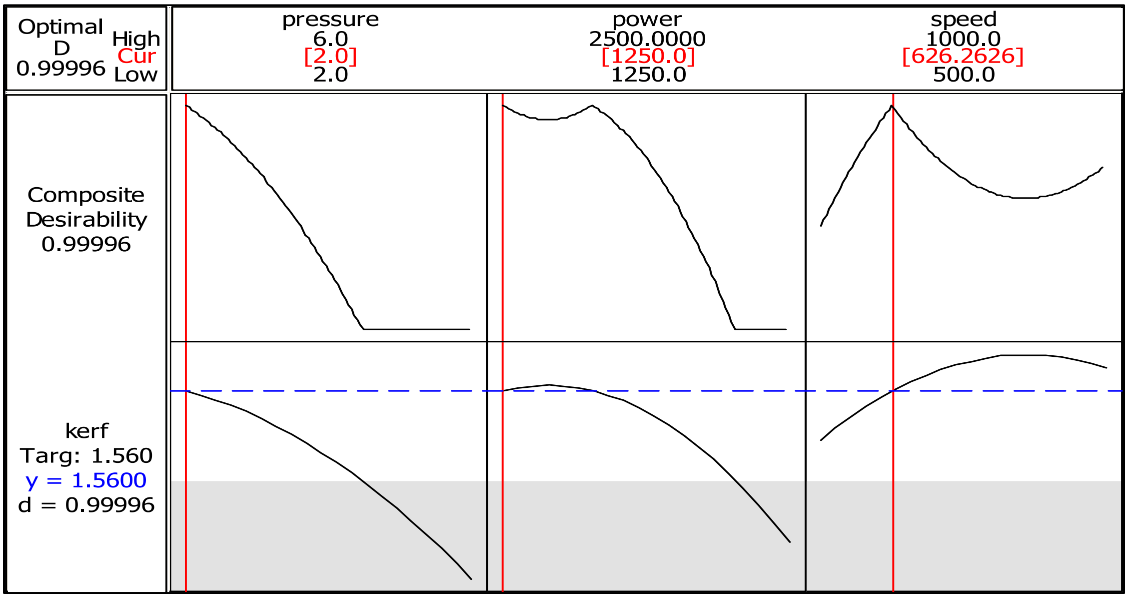


Fig. 8. Optimization plot

The change that is a result of cutting speed on the kerf width at different plasma gas pressures of 500 to 1000 psi shown in Figures 5, 6, 7, and 8, respectively. It can be concluded that the kerf width increases by increasing cutting speed. Therefore, refer to the diagrams in Figures 6-8.

3.1. Discussion and explain patterns of the results

Since the linear model, so that not enough to be a higher-order model is needed to adequately respond to a surface. Therefore, the top model proposal fits the full quadratic patron. For the full quadratic model, the (p) value for inappropriateness is 0.922 indicating that this model fits the data appropriately. Note: null hypothesis in a hypothesis test. P-values range from 0 to 1. The appropriate multidimensional equation has been identified to represent the graphic model of the data analysis fee using a design expert program. The appropriate polynomial equations have been determined can be the relationships between input and responded output parameters appear for (cutting kerf) through the implementation of the serial squares model and the absence of an appropriate test shown in Tables 7, 8, 9 and 10, respectively. Both analyses suggested that the relationship between input parameters and the display of the resulting Kerf width plots can be modelled using quadratic equations.

3.2. Response surface regression

Kerf versus pressure, power, speed. The analysis was performed using encrypted modules.

3.3. Analysis of variance (ANOVA)

The main outcome is arranged to analyse the variance study in Table 7 and Table 8. It lists sources of variance, centre squares, total squares, and degrees of freedom. The data analysis of the variance table includes F and P values. They are used to determine whether predictions or factors are highly correlated with the response. ANOVA is used in analysis and regression. P-Value uses to determine whether the factor is sufficiently great; usually compared to the value of alpha 0.05. If the value of p is less than 0.05 since the factor is significant. The value of p is 0.000 indicates that the factor of pressure is significant. For a two-way ANOVA, you will have two factors and an interaction term. ANOVA analysis of the Response Surface Quadratic Model for cutting kerf width. Table 8 shows an ANOVA analysis of the quadratic model. The "typical F value" in 1.18 means that the model is not large for noise. There is a 36.6% chance that the "F-value model" of this large can occur due to noise. This means that the form does not represent the data within the required 95% confidence interval. In order to improve the model, the square-range pressure is added to press the model and ANOVA analysis of the reduced square model is shown in Table 8. In the ANOVA analysis. The value of the F-1.04 form indicates that the form is large and the "Pro> F" value indicates that there is only a 41.6% chance that this "F-value model" is large and can be caused by noise. In addition, the ANOVA analysis of the reduced interaction model is shown in Table 9.

Table 8.
Analysis of variance for kerf width

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Regression	9	0.151582	0.151582	0.016842	1.08	0.451
Linear	3	0.055311	0.055311	0.018437	1.18	0.366
pressure	1	0.001928	0.001928	0.001928	0.12	0.733
power	1	0.010123	0.010123	0.010123	0.65	0.440
speed	1	0.043260	0.043260	0.043260	2.77	0.127
Square	3	0.048834	0.048834	0.016278	1.04	0.416
pressure*pressure	1	0.004046	0.008279	0.008279	0.53	0.483
power*power	1	0.027561	0.031765	0.031765	2.03	0.184
speed*speed	1	0.017227	0.017227	0.017227	1.10	0.318
Interaction	3	0.047437	0.047437	0.015812	1.01	0.428
pressure*power	1	0.046512	0.046512	0.046512	2.98	0.115
pressure*speed	1	0.000313	0.000313	0.000313	0.02	0.890
power*speed	1	0.000612	0.000612	0.000612	0.04	0.847
Residual Error	10	0.156298	0.156298	0.015630		
Lack-of-Fit	5	0.031414	0.031414	0.006283	0.25	0.922
Pure Error	5	0.124883	0.124883	0.024977		
Total	19	0.307880				

Table 9.
Parameter response optimization

Goal	Lower	Target	Upper	Weight	Import
kerf Target	1.34	1.56	1.77	1	1

Table 10.
Starting point, global solution and predicted responses

Starting point	Global solution	Predicted responses
Pressure = 2.000	Pressure = 2	Kerf = 1.56001
Power = 1250	Power = 1250	Desirability = 0.999958
Speed = 500	Speed = 626.263	Composite desirability = 0.999958

In ANOVA analysis the value F (1.01) means the model is large and the "PROP> F" value indicated that there is only a 42.8% chance that the "F-value model" this large can be caused by noise. This model accurately supports the lack of proper analysis and lack of a valid F value" 0.25 means not significant. There is a 92.2% chance that is to say "lack of F-value" because of this occurs because of the noise.

All terms in the model coefficients result given in Table 7. The orthogonal design is used for analysis; each effect is estimated independently. Therefore, the coefficients of linear terms are the same when they are identical only to the linear model. The length of the error, S = 0.125019 because of the smaller reduction variance represented by the error. Figure 5 shows that the residual plots for the Kerf width are obtained when pressure levels are low and energy levels are high. In the remaining four graphs, the area appears and the potential value of the plot is fixed.

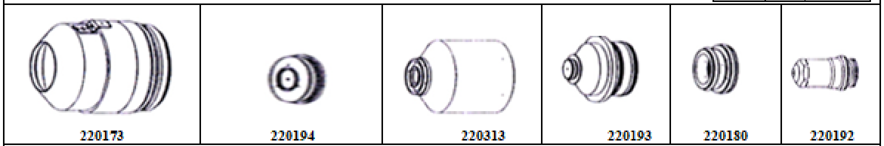
3.4. Discussion of interpreting the results

The subsistence plots shown in Figure 6 show mean the highest return is obtained when pressure low levels and energy level are high. It is apparent from this figure that region indicates in the upper left corner of the drawing. Figure 7 also shows in Figure 8 that the highest yield is obtained when pressure levels are low and energy levels are high. In addition, you can see the shape of the response surface and get a general idea of the yield in different pressure and power settings. Keep in mind that these plots are based on a typical equation. You should be sure that your model is sufficient for evidence to interpret the plots.

Table 9 shows parameter response optimization while Table 10 shows starting point, global solution and predicted responses. Both the kerf width and the variance for the individual the desirable make the kerf width is 0.99996,

Mild steel
O2 Plasma /O2 Shield
30 A Cutting
Note: Air must be connected to use this process. It is used as the preflow gas

Flow Rates – lpm/scfh	O_2	Air
Preflow	0/0	46/97
Cutflow	22/46	0/0



Metric

Select Gases		Set Preflow		Set Cutflow		Material Thickness	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma (1)	Shield (2)	Plasma (3)	Shield (4)	Plasma (5)	Shield (6)	mm	Volts	mm	mm/m	mm	Factor %	Seconds
O_2	O_2	80	15	92	15	0.5	114	1.3	5355	2.3	180	0.1
						0.8	115		4225			0.2
						1	116		3615			0.3
						1.2	117		2865			
						1.5	119		2210			
			35		5	2	120	1.5	1490	2.7		
						2.5	122		1325			0.4
			75			3°	123		1160			0.5
						4°	125		905			0.7
						6°	128		665			1.0

Fig. 9. Sum the specification of plasma cutting machine and material mild steel, HPR260 Manual Gas Instruction Manual "Elecon Engineering Company Limited" India /Anand in Gujarat

Table 11.
HPR260 Manual Gas Instruction Manual "Elecon Engineering Company Limited" India /Anand in Gujarat

	Thickness, mm								
Process	1.5	3	6	10	12	20	25	32	38
				MS					
260A O_2-Air				2.54	2.79	3.43	3.81	4.32	4.45
200A O_2-Air				2.18	2.26	2.95			
130A O_2-Air			1.803	2.032	2.08	2.642	3.429		
80A O_2-Air		1.372	1.727	1.905					
30A O_2- O_2	1.346	1.448							
				SS					
260A N_2-Air					2.54	3.08	3.30		
260A H_{35}-N_2					3.81	4.06	4.32		
200A N_2-N_2				2.16	2.29	2.92			
200A H_{35}-N_2				3.68	3.81	3.94			
130A H_{35}- N_2				2.718	2.769	2.896			
130A N_2-N_2			1.829	1.879	2.413				
80A F_5-N_2			1.194						
45A F_5-N_2	0.584	0.381	0.533						
45A N_2-N_2	0.483	0.229	0.152						
				AL					
260A N_2-Air					3.05	3.05	3.30		
260A H_{35}-N_2					2.79	3.30	3.56		
200A N_2-N_2				2.03	2.58	3.01			
200A H_{35}-N_2				2.67	2.92	3.30			
130A H_{35}-N_2				2.718	2.769	2.896			
130A Air-Air			2.083	2.083	2.184				
45A Air-Air	1.067	1.092	1.245						

for that reason, by the means combined with the acceptance of variables is 0.99996. This desirability obtain information; you can set agent levels in the values shown under global solution. This means that the pressure will be set at 2.000, the power at 1250, the speed at 626.2626.

4. Conclusions

In this paper, experiments are carried out for cutting speed, power, and gas pressure with a response as the kerf width. There are 20 experimental readings are taken. Response surface methodology (RSM) is selected for the optimum parameter levels. We compared the input parameters and the response by using the design of expert software (DOE). Both the kerf width and the variance for the individual the desirable make the kerf width is 0.99996, for that reason, by the means combined with the acceptance of variables is 0.99996. Therefore, the combined or compound acceptance of these three variables is 0.99996. To obtain this desirability, you can set agent levels in the values shown under Global Solution. That is, the pressure would be set at 2.000, power at 1250, and speed at 626.2626. Sum the specification of the plasma cutting machine and material mild steel depended on Table 10 and Figure 9. As shown in Table 11, the illustration kerf width reparations in the chart below are for reference. The difference between installations and material composition may cause specific user results.

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