The Effect of Air Pressure on Plasma Cutting Process

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Abstract. The study was conducted with pressure variations, with variations of 20 psi, 30 psi, 40 psi, 50 psi, 60 psi, 70 psi, 80 psi, and 90 psi (maximum working pressure/compressor standard). For other variables set fixed, machine ampere 25 ampere, cutting speed 545.45 meters per minute, iron plate thickness 3 mm, torch distance to material 0.5 mm. This study aims to obtain the best pressure in the process of cutting iron plates with plasma cutting, which can be used as a reference in the use of plasma cutting. The right pressure value in plasma cutting affects operational costs and compressor selection. The study used the observation and repetition method, the test was repeated 3 times. The test result indicator was carried out visually, the flatness of the cut surface. The right pressure is the result of plasma cutting with the flattest cut surface. The cutting pressure for 3 mm thick metal plates is 50 psi, flow rate of 75 LPM.

Keywords: Air Flow, Air Pressure, Metal Plate, Plasma Cutting

1 Introduction

In general, the metal production process, especially iron, includes several processes including planning, measuring, marking, cutting, bending, forming, joining, finishing. The cutting process can be done manually and using tools. One of the metal plate cutting tools is plasma cutting, this tool uses the plasma method or heat generated from the phenomenon of electrical energy, the heat generated is combined with wind pressure so that it can cut the plate. The gas flows out of the nozzle, and the gas expands rapidly carrying molten metal resulting in the cutting process. The plasma temperature reaches 33,000°C, 10 times the temperature produced by the reaction of oxygen and acetylene (Akhmad, 2009).

The lower the distance between the torch and the material, the smaller the kerf width and surface roughness values produced will be (Saputro & Sumbodo, 2019). The lower the cutting speed, the higher the hardness value and the higher the surface roughness value or vice versa (Rahmawati et al., 2019). Travel speed of 500 mm/min, ampere of 75, and torch-material distance of 3 mm, get neat cutting results and at least change the hardness properties of the material (Agnitias & Rusiyanto, 2019). Several studies have stated that torch height, ampere and cutting speed can affect material properties. Plasma cutting was carried out with a travel speed of 500 mm/min, ampere 75, and a torch-material distance of 3 mm on ST 42 material with a thickness of 8 mm' where the

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study obtained quite good cutting results (Wibawa & Suherman, 2021). The most appropriate cutting speed to produce the best cut using a Redbo brand cut40 plasma cutting machine is 643 mm/min, in cutting plate 8 (Wibawa, 2022). Based on the references, the author intends to conduct tests with the same tool but with variations in cutting pressure.

2 Methodology

In this study uses experimental methods by direct testing, where the initial data is obtained from previous research, information from journals, trial, and error, then data collection by testing, and the results are compared with research from other journals. The technical data of the plasma cutting machine can be seen in Table 1, air compressor in Table 2, and air flow meter in Table 3. The main instruments (Agrawal et al., 2019) applied in this study are ampere, torch distance to material, fixed cutting speed, and pressure and changes in air flow rate that adjust to working pressure (Rizkiawan & Sumbodo, 2020; Salonitis & Vatousianos, 2012; Saputro & Sumbodo, 2019). The working pressure variation is 20 psi, 30 psi, 40 psi, 50 psi, 60 psi, 70 psi, 80 psi, 90 psi. The torch distance to the material is 0.5 mm, the cutting speed is 545.45 mm / minute, the material plate thickness is 3 mm, machine ampere setting is 25 ampere.

Table 1. In-depth details on the specifications of plasma cutting machine

Model	Cut 40	
	Unit	Value
Input voltage	V	220
Rated input capacity	A	5.3
No-Load voltage	V	270
Load voltage	V	96
Power factor	-	0.93
Output current	A	15 - 40
Duty cycle	%	60
Suggested Pressure	Mpa	0.3 - 0.5
Max Cutting Thickness	mm	0.1 - 12
Protection Class	-	IP21S
Weight	Kg	8
Dimensions	mm	440 × 160 × 310

Table 2. In-depth details on the specifications of airflow water

Model	Air Flow Meter	
	Unit	Value
Input line	Inch	1/2
Rated input flow capacity	LPM	20 - 200
Weight	Kg	0.4
Dimensions	mm	150 × 50 × 50

Table 3. In-depth details on the specifications of the air compressor

Model	Air compressor oil less	
	Unit	Value
Input voltage	V	220
Frequency	HZ	50
Tank Capacity	Liter	100
Capacity	L/MIN	508
Power	W	1390 × 2
Speed	RPM	2850
Insulation Class / Grade	-	B
Working Pressure	Bar / psi	8 / 116
Weight	Kg	65

Data collection begins with preparing tools and materials, the material in the form of 3 mm thick iron plate st 42 is placed on the prepared work table. The torch rail mechanism is prepared and set above the plate to be cut, installing the torch on the rail, the rail speed is set at 545.45 mm/minute. The torch height is set at 0.5 mm from the material, as in Figure 1. Set the pressure on the plasma cutting machine as in Figure 2.

Figure 1. Torch height setup between the based plate and torch plasma cutting machine

Figure 2. Pressure setup in plasma cutting machine

Figure 3. Air compressor and flow meter setup

3 Result and Discussion

3.1 Result

From the tests that have been carried out, pressure data was obtained on the cutting process, such as in Table 4 and the graph of the effect of working pressure on air flow rate in Figure 4 below.

Table 4. In-depth details view a result of research

Pressure	Cut off	References
20 psi	No	Cannot penetrate material
30 psi	yes	Uneven cutting results
40 psi	yes	Good
50 psi	yes	Good
60 psi	yes	Good
70 psi	yes	Good
80 psi	yes	Uneven cutting results
90 psi	yes	Uneven cutting results

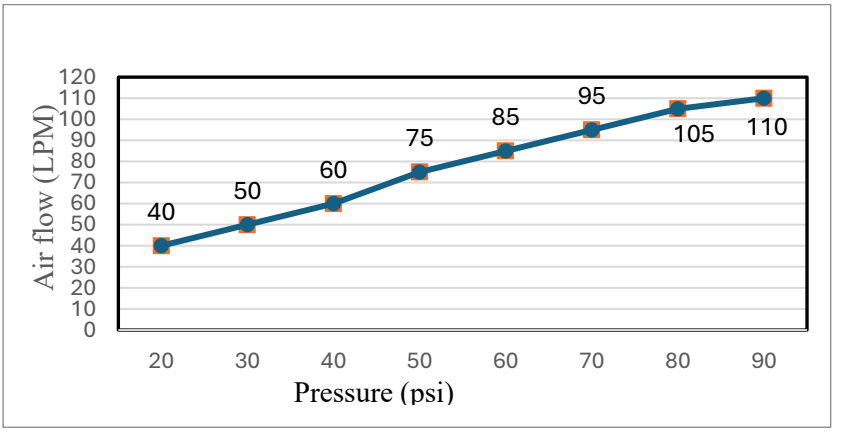

Figure 4. Air pressure variation against air flow rate

Figure 4 shows the relationship between air pressure and the amount of air flow in the cutting process using a plasma cutting machine, from the graph it can be seen that significantly the pressure increases then the amount of air flow increases. To cut a 3 mm thick st 42 iron plate with a cutting speed of 545.45 mm / minute, an air pressure of 50 psi requires an air flow of 75 liters per minute.

The cutting result assessment is done visually, from several pressure variation results show different results. For 20 psi pressure, the material cannot be cut due to the lack of air pressure to break/cut the molten metal as seen in the Figure 5. For 30 psi air pressure, the material can be cut but the cut surface is uneven the cause of the unevenness is because the air pressure is not too high considering there are differences in several metal particles. Pressures of 40 psi, 50 psi, 60 psi and 70 psi can cut metal well. For working pressures of 80 psi and 90 psi can cut metal as seen in the Figure 6, but the cut surface results are already uneven, this is because the working pressure is too high so that it can easily cut the material. For pressures of 80 psi and 90 psi can be overcome by changing the cutting speed or reducing the machine ampere to get good results. From all the tests and looking at the flatness of the surface produced, the best pressure for cutting 3 mm thick st 42 iron plate with a cutting speed of 545.45 mm/minute is a pressure of 50 psi as seen in the Figure 7.

Figure 5. Cutting result with air pressure 20 psi

Figure 6. Cutting result with air pressure 90 psi

Figure 7. Cutting result with air pressure 50 psi

3.2 Discussion

From the data obtained to cut a 3 mm thick ST 42 iron plate, in addition to having a plasma cutting machine, torch rail (recommended so that the cutting results are straight and the results are good, because if manual it needs stability both forward movement and the distance between the torch and the material must be stable), also requires an air compressor that has a minimum output flow rate of 75 liters per minute and a minimum pressure of 50 psi. if less then the cutting process is not good even the plate will not be cut but having a compressor with specifications that exceed it is highly recommended.

4 Conclusion

The pressure and airflow rate greatly affect the cutting process using plasma cutting, to cut a 3 mm thick iron metal plate with a cutting speed of 545.45 mm/minute requires a pressure of 50 psi and an airflow of 75 LPM to produce good cutting results. The air compressor as a minimum pressure generator must produce an air output of 75 liters per minute and a pressure of 50 psi, it is highly recommended if using higher specifications.

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