THE EFFECT OF CUTTING SPEED ON CUTTING QUALITY WITH LASER CUTTING MACHINE

Arya Yusuf
Yogyakarta State University, Indonesia
E-mail: aryayusuf.2021@student.uny.ac.id

Abstract

This research investigates the influence of cutting parameters on a laser cutting machine when used on acrylic material. The primary objective of this study is to analyze how cutting speed, electric current, and the type of material affect the quality of the cutting results. An experimental method was employed by varying the cutting speed and adjusting the electric current during the process, followed by measuring the width and precision of the cuts produced. The findings indicate that as cutting speed increases, the width of the cut decreases, resulting in a finer cut. Additionally, higher electric currents can enhance the precision of the cut, ensuring more accurate results. Furthermore, materials with lower melting points were found to be easier to cut with less effort. These results emphasize that the correct combination of cutting parameters is crucial in achieving optimal cutting performance and improving productivity. This study concludes that careful calibration of cutting speed, current, and material selection is essential for obtaining high-quality laser cutting outcomes and enhancing manufacturing efficiency.

Keywords: *Cutting Speed, Experiment, Laser Cutting*

1. INTRODUCTION

The technology used by humans is constantly changing with the development of the times. This technological change is becoming increasingly sophisticated and complex (Akhmad, 2009). In the framework of vocational education competencies, educational institutions are expected to have laboratory facilities and equipment that can support practical work (Saputro & Darwis, 2020). One of these is the use of laser cutting in non-conventional machining practices. Laser technology is rapidly developing and is used in manufacturing fields such as printing. In line with that, according to Halim et al. (2022), laser cutting has high power and flexibility in its application, allowing it to be used on both thin sheet materials and somewhat thicker materials.

Laser cutting is one of many applications of thermal energy based on a non-contact machining process that can be applied to almost all types of materials (Badoniya, 2018). The cutting process using laser cutting is performed on sheet metal materials that are widely used in the manufacturing industry. The working method of laser cutting involves directing a high-powered laser to cut the material with the assistance of a computer guiding it (Martowibowo & Andriansyah, 2007). The form of laser cutting is light that cannot be seen or can be seen with the naked eye. Typically, the beam has a diameter of about 0.003-0.006 inches when used (Saputro & Darwis, 2020).

In the manufacturing industry, the selection of cutting parameters is an important aspect carried out to achieve the appropriate laser cutting width dimensions. Kerf is the quality of the cut edge, and operational costs are greatly influenced by machining parameters such as laser power, cutting speed, gas pressure, nozzle diameter, focal point location, and material type selection (Saputro & Sumbodo, 2019). Choosing the right

parameters will help achieve material cutting results that meet quality standards on laser cutting machines. Dragline is a form of cutting result that appears as lines according to the markings made due to the cutting rate in laser cutting. The dimensions that correspond to the design represent the precision achievement of a machining process, ensuring that the sizes produced meet the demands set by the customer. The quality standards that need to be achieved are well-cut material without producing chips, having good draglines, and the dimensions produced matching the design from Corel Draw software. The appearance of chips on the workpiece after the machining process is caused by the accumulation of material melt (slag) that is not properly disposed of, resulting in sharp edges on one side of the workpiece referred to as dross (Budianto, 2021). The learning objectives of this laser cutting practicum are for students to be able to understand the basic principles of laser cutting machine work, including the types of lasers and materials that are suitable for use and machine parameters that can affect the cutting results.

2. LITERATURE REVIEW

2.1. The Effect of Laser Cutting Machine Cutting Parameters

Laser cutting has become a highly popular technology in various industrial applications for producing precise and high-quality cuts. Factors that influence the use of laser cutting include cutting parameters such as cutting speed, current, laser power, and so on. According to Oh et al. (2019), the correct cutting speed is crucial to achieving a balance between production speed and the quality of the cuts on laser cutting machines. A high cutting speed will produce fast movement that can reduce the width of the cut (kerf) but has the potential to result in uneven edges of the material.

2.2. Types of Materials Commonly Used in Laser Cutting Machine

The selected material greatly influences the use of laser cutting in the final result. According to Chryssolouris (2006), the characteristics of the material, such as thickness, melting point, and thermal conductivity, affect the laser processing of that material. Materials like plywood or acrylic are easier to cut compared to hard metals like steel. Hard materials require a high current setting to produce a good cut.

2.3. Safety and Energy Efficiency in Laser Cutting Machine

Safety and energy efficiency are benchmarks in the laser cutting machine cutting trials. Liu et al. (2019) state that the use of laser cutting machines is more efficient in energy consumption, especially by optimizing parameters and using the latest laser technology. In addition, safety is also addressed through an automatic monitoring and control system for laser radiation to reduce risks for operators in enhancing occupational safety and health (OSH) operations.

3. RESEARCH METHODS

3.1. Variable of Research

This research method uses an experimental method. The experimental method is used to observe the effects obtained from a specific treatment under controlled conditions (Sugiyono, 2009). According to Yusuf et al. (2024), the experiment begins with designing the research procedure and preparing the tools for testing. The variable we use is the independent variable. The independent variable is the variable obtained by the researcher to see its effect on the dependent variable. In the context of laser cutting, the size of the workpiece and the current are independent variables that can be observed for their effects on the dependent variables, such as cutting speed and the quality of the cutting results achieved.

3.2. Location of Research

The laser cutting research was conducted at the Non-Conventional Machining Laboratory in the Department of Mechanical Engineering Education, Yogyakarta State University. This laboratory consists of several laser cutting machines, measuring tools, and materials that have been provided. The measuring tools used are a metal ruler and caliper. The steps taken in this electroplating process experiment are carried out in three stages: sample preparation, cutting with the machine, and measurement.

3.3. Sample of Research

The sample preparation stage begins with taking the workpiece. The workpiece to be used for the cutting trial is acrylic with dimensions of 20 mm in length, 20 mm in width, and 3 mm in thickness, with a quantity of 1 piece. The software used for processing the trial is Corel Draw version X7. The experiment was conducted using a current of 60 amperes on the laser cutting machine settings. The experiment was performed three times with cutting speeds of 3, 7, and 11 mm/second.

4. RESULTS AND DISCUSSION

4.1. Design Stage

The design process uses CorelDRAW software which will be processed on a laser cutting machine. First, start by opening the software and then create a new document on the page. Create simple shapes like squares or circles as shown in Figure 1. Adjust the size using the "annotate" feature. Ensure the size matches the desired cutting shape. The final step is to save the file in "cdr" format and conduct a test on a small material before production on the main material.

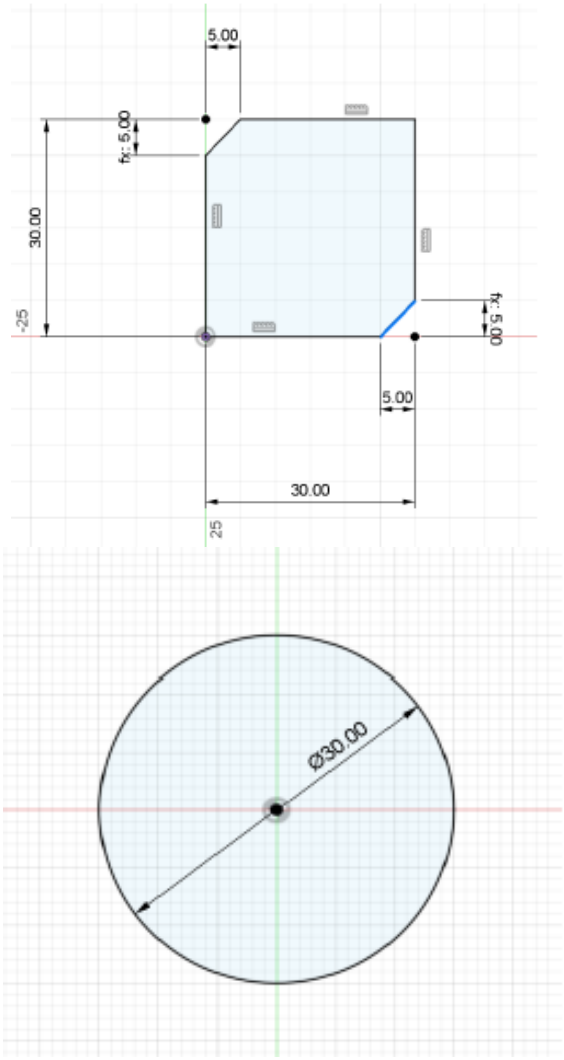

Figure 1. Design of square and circle shapes

4.2. Machining Stage

This stage begins by placing the material to be processed on the machine table. The second step continues by setting the laser parameters such as cutting speed and electrical current according to the type and thickness of the material as shown in Table 1. Then the third step is to calibrate the laser focus to ensure the material is optimally exposed to the laser. After setting the parameters, the cutting process continues with monitoring to avoid issues. The final stage involves cleaning and inspecting the machine to ensure it remains in good working condition for future use.

Table 1. Laser cutting machine parameters

Experiment	Cutting Speed (CS)	Current (C)
1	3	60
2	7	60
3	11	60

4.3. Data Presentation Stage

This data presentation includes observations on the accuracy of the dimensions of square and circular objects. In this stage, it can be found that understanding how each variable affects the result is important. The sizes of the objects and the cutting marks obtained are found to match the reference in Figure 2. The following is the size data obtained for both objects in Table 2. The size difference between the square and circular objects, as well as the hardness values obtained, are also found as shown in Table 3.

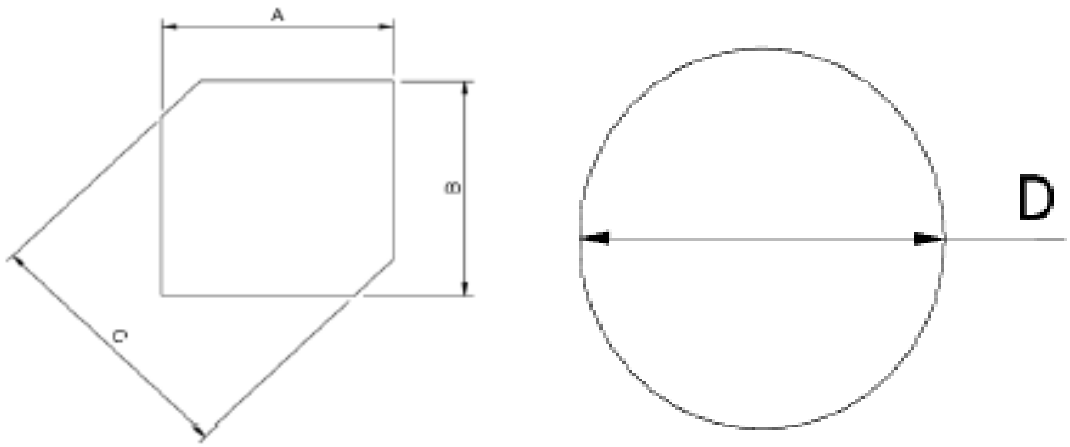

Figure 2. Size reference of the square and circle

Table 2. Measurement results on square and circular objects

Experiment	Square (mm)						Circular (mm)	
	A1	B1	C1	A2	B2	C2	D1	D2
1	30,1	30,2	35,6	30,9	30,9	36,1	30	30,6
2	30,3	30,3	35,8	30,8	30,7	36,2	30,1	30,6
3	30,3	30,4	35,7	30,6	30,7	36	30,2	30,6

Table 3. Difference in reference sizes between square and circle

Experiment	Square			Circular	
	A2-A1	B2-B1	C2-C1	D2-D1	Value of Roughness
1	0,8	0,7	0,5	0,6	Extreme
2	0,5	0,4	0,4	0,5	Normal
3	0,3	0,3	0,3	0,4	Slight

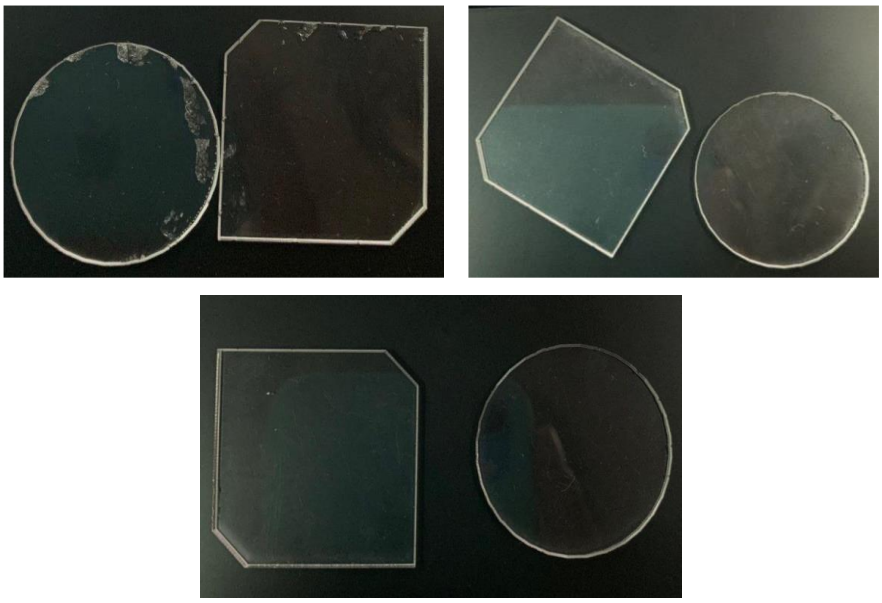

Figure 3. View of objects 1, 2, and 3 squares and circles

5. CONCLUSION

The practical results show that cutting speed can affect the cutting results. The faster the cutting speed rule, the smaller the roughness of the cutting result. There is also an effect of current on the precision of the cutting results, like cutting speed, that with a higher current, the cutting results become more precise. The type of material also affects the ease of cutting, where acrylic material has characteristics with a high melting point.

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