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The effect of cutting speed on the roughness level of low carbon steel cutting results using the trulaser 3030 machine

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Abstract

This research aims to determine the effect of variations in cutting speed on the roughness value of low carbon steel cutting results using CNC Laser Cutting TruLaser3030. This research uses experimental methods and descriptive statistical data analysis techniques and diagrams to present data on the measurement results of research specimens using cutting speeds of 2520 mm/minute, 2205 mm/minute, and 1890 mm/minute. Roughness testing was carried out using Surface Roughness Mitutoyo SJ-210. The results of the research produced data showing that the higher the cutting speed, the roughness value increases and the lower the cutting speed, the roughness value will decrease. And if the cutting speed is too high then the material cannot be cut. The lowest roughness value, namely 8.46µm, was at a cutting speed variation of 1980 mm/minute. The highest roughness value, namely 23.63µm, occurs at a cutting speed variation of 2520 mm/minute.

1. INTRODUCTION

Laser cutting is a method of cutting materials using tools available in the industrial world to maximize material cutting results (Isyrouddin & Sumbodo, 2020). In a laser machine there are various settings and parameters that must be adjusted to the material to be worked on so that in the processing process the energy required is sufficient for what is to be done and does not waste excessive energy so that the production process will be more effective and efficient (Hidayat et al., 2021).

Metal laser cutting has advantages over plasma cutting, namely more precise machining and lower energy consumption when cutting sheet metal and automation capabilities. However, most industrial laser cutters cannot cut thick metal like plasma cutters.

The main disadvantage of laser cutting is that the energy consumption required is quite high. Industrial laser cutting efficiency can vary from 5 to 15%. Laser power consumption of course varies depending on output power and operating parameters.

Improper determination of cutting parameters during the laser cutting process is the most significant problem causing factor. A mismatch of these parameters results in reduced cut surface quality, which is difficult to restore. This decrease in quality is usually caused by the problem of the appearance of waste (cutting residue) and variations in the width of surface kerf gaps (Rizal et al, 2022). Looking at this theory, it can be ascertained that setting the parameters on the laser machine for the workpiece will affect the cutting results and reduce the quality of the cutting results, therefore it is necessary to set the cutting parameters to achieve maximum cutting results.

Badoniya (2018) explained that machining parameters such as laser power, cutting speed, amount of gas pressure, nozzle diameter, location of the focus point, and choice of material type greatly influence the quality of the cutting edge of the material and operational costs. This needs to be taken into account considering that in the industrial world, production effectiveness is the main concern so that the next process is as planned.

Cutting gas and cutting speed have a significant influence on cutting results and geometric accuracy. The material tested was 304 stainless steel with a thickness of 3 mm using a TruLaser 3060 machine using nitrogen gas with a cutting speed variation of 4.5 m/min producing a surface roughness value of 12.26 μm (Ningrum, 2021).

Cutting carried out with a laser machine using varying speeds results in increased roughness values, even the material is not cut perfectly during one processing process as the laser speed increases. So these parameters need to be limited and regulated so that they do not cause double work and time loss (Satyawardhana, 2022).

Based on the literature review that has been explained above, it can help in drawing the conclusion that the factor of increasing the value or level of roughness of the cutting results is due to not or less precisely setting the cutting speed parameters for the thickness of the workpiece material to be worked on, namely the cutting speed is too low or too high.

2. METHODS

The research method used was an experimental method using test specimens, namely low carbon steel type ST-37 with variations in cutting speed and material thickness of 4mm. The location of this research is at CV Laksana Karoseri which is located at Jl. Ungaran-Bawen KM25, Bergas District, Semarang Regency, Central Java. This research was conducted to determine the effect of variations in cutting speed on surface roughness in ST 37 steel cutting results using the TruLaser 3030 CNC Laser cutting.

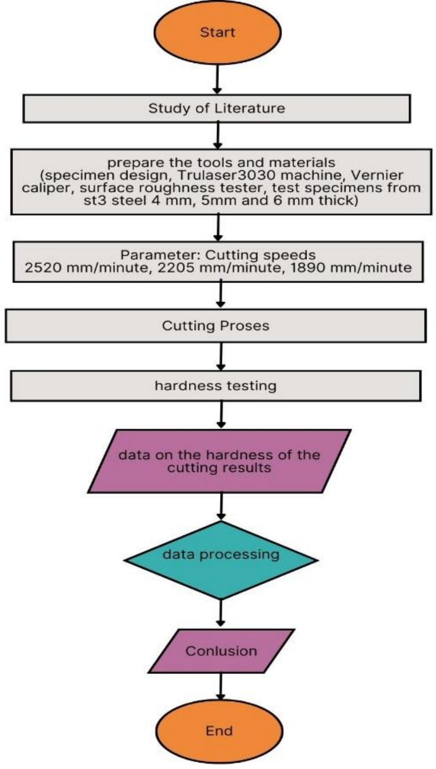

Figure 1. Research Flow Diagram

Before cutting materials using CNC Laser Cutting, first prepare the tools and materials and determine the parameters to be used.

The material used in this research was ST 37 steel plate with a thickness of 4 mm. The specifications of ST 37 steel plate are as follows:

1. ST 37 steel is a low carbon steel
2. Carbon content as much as 0.17%
3. Tensile strength 37kg/mm^2

The design of the specimen to be made using Autocad software is as follows.

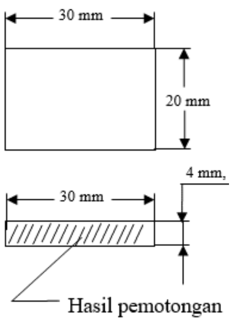

Figure 2. Design of testing material

After the design is created, it is transferred to the machine's computer using a flash disk and set the cutting speed parameters according to the type of material to be cut.

The tools used in this research include the TruLaser 3030 CNC Laser Cutting Machine, Autocad Software, Vernier Caliper, Surface Roughness Tester, and Personal Computer.

The variations in cutting speed used are 2520 mm/min, 2205 mm/min, and 1890 mm/min. Next, the cutting speed is converted into % (percent), namely 80%, 70% and 60%, while the thickness of the ST 37 steel plate used is 4 mm.

After the material cutting process is complete, the next process is to mark the specimen and carry out tests to determine the roughness value of the cutting results and the effect of cutting speed on surface roughness. The dimensions of the specimens tested in this study are shown in the following figure.

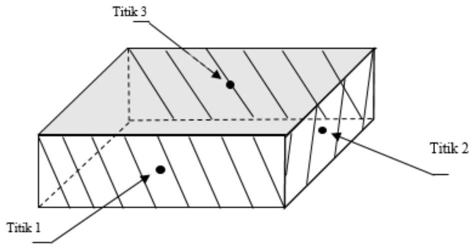

Figure 3. Surface roughness measurement points

Roughness testing was carried out using the Mitutoyo SJ-210 Surface Roughness Tester at predetermined points on the specimen. From the three test points, the data was then recorded and analyzed from the lowest level of roughness to the highest level of roughness.

3. RESULTS AND DISCUSSION

The results of cutting ST 37 steel using the TruLaser3030 machine with variations in cutting speed are presented in the following image.

Figure 4. Cutting speed 80%

Figure 5. Cutting speed 70%

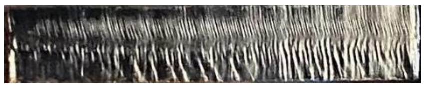

Figure 6. Cutting speed 60%

Figure 4 is a specimen cut with a thickness of 4 mm using a speed variation of 80% using a TruLaser 3030 CNC Laser Cutting machine producing a roughness value of 23.63 μm.

Figure 5 shows a specimen cut with a thickness of 4 mm using a speed variation of 70% using a CNC Laser Cutting TruLaser 3030 machine producing a roughness value of 12.93 μm.

Figure 6 shows a specimen cut with a thickness of 4 mm using a speed variation of 60% using a TruLaser 3030 CNC Laser Cutting machine producing a roughness value of 8.46 µm.

The following is data from measuring the hardness values of research specimens using the TruLaser 3030 CNC Laser Cutting machine.

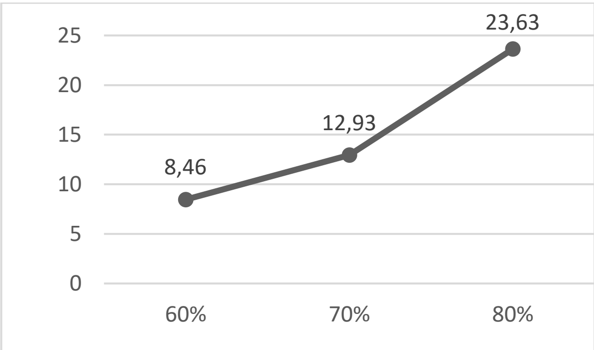

Figure 7. Roughness value

The lines in the figure show that the roughness value of the specimen increases with increasing cutting speed.

Cutting results with varying cutting speeds have different roughness values. The roughness value of 8.46µm is the lowest value, namely when using a cutting speed of 60%. Meanwhile, the highest value was obtained from cutting results with a speed of 80%, namely 23.63µm.

This shows that changes in cutting speed have an effect on increasing the roughness value of cutting low carbon steel materials using a laser cutting machine. This can happen because the time for the laser light to melt the material is not perfect, then it has to move or move from one point to another.

From each test point shown in Figure 7, it shows that the thickness of the material and the cutting speed are greater, the roughness value of the cutting results also increases, this is because the thicker the material and the higher the cutting speed, the more time it takes for the laser beam to cut or melt. the material is not perfect enough. With a lack of ideal time for cutting material, the cutting kerf will also become rougher or the value of the cutting result will also increase. In simple terms, it can be said that the laser beam which has not yet completely cut the material has been shifted during the cutting process to another point, and so on, causing a less efficient cutting process.

4. CONCLUSIONS

The conclusions that can be drawn from this research are as follows. The most efficient parameter in the process of cutting ST 37 steel material on the TruLaser 3030 machine is that in this case the lowest roughness value is found at a cutting speed variation of 60% with a roughness value of 8.46µm. This value is included in the N9 roughness level category which ranges between 4.8-9.6µm.

Meanwhile, the highest roughness is at a cutting speed variation of 80% with a roughness value of 23.63 µm and falls into the N11 roughness level, which ranges from 18-37 µm. The results of this research conclude that with variations in cutting speed, there is an influence on the results obtained. Namely, the higher the cutting speed used, the higher the roughness value of the cutting results, this will have a significant effect on the roughness value of the ST 37 steel material cut on the Trulaser 3030 machine because the data shows that the roughness value is getting bigger.

Suggestions that can be given to this research are that further research is needed regarding the roughness value of cutting results with the TruLaser 3030 laser cutting machine with variations in material types and also variations in other parameters because there are still many parameters that can be used. There needs to be calibration of the laser machine and also testing equipment to ensure the data taken is valid.

5. DECLARATION/STATEMENT

5.1 Acknowledgments

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5.2 Author Contributions

Husni Amron contributed to observations, consulting research topics with field supervisors. Ahmad Roziqin contributed to collecting research data, analyzing and concluding the data obtained.

5.3 Conflicts of Interest

The authors declare that they have no conflict of interest.

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