

EXPERIMENTAL INVESTIGATION AND ANALYSIS OF ROUGHNESS AND KERF CHARACTERISTICS FOR STRAIGHT AND CURVED CUT DURING CO₂ LASER CUTTING OF MILD STEEL USING RESPONSE SURFACE METHODOLOGY (RSM)

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ABSTRACT

The objective of this paper is to investigate the effect of laser cutting parameters on roughness and kerf characteristics for straight and curved cut during CO₂ laser cutting of mild steel. Box behenken design considering three parameters laser power, cutting speed and assist gas pressure at three levels. Based on ANOVA, it was observed that cutting speed is the most influential parameter than laser power and gas pressure.

1. Introduction

Laser cutting is a technology that uses a laser to cut materials, and is widely used for industrial transforming finished product & applications, but is also starting to be used by small businesses and small industries. It will directly used as a high power laser emphasized with the help of computer, at the materials to be cut by laser. The material then burns, melts or is blown away by a jet of gas impact, leaving an edge with a high-quality good surface finish. Laser cuttings are mainly concerned with industrial application such as cutting, drilling & boring of any solid state article stimulated lasers are characterized by capacitive in coupling of the electrical energy needed for gas discharge. CO₂ lasers were used to cut many materials including Mild steel, Aluminium, Stainless steel etc.,

2. Literature Review

A. Lamikiz.et.al., discussed on CO laser cutting 2mm for high strength steels and studied the most influencing parameters. S.Vatousianos et.al., investigated the quality of the cut by measuring the kerf, taper angle and roughness. Riveiro et.al., found that processing in CW mode substantially increases the cutting speed as compared to pulsed model.

3. Methodology

Based on the review of the literature, the selected parameters to be investigated were laser power, cutting speed and the pressure of the assist gas. This led to the use of box-behenken 17 experiments. The Levels of each parameter are listed below

Table1 Experiment parameters

| | Level 1 | Level 2 | Level 3 |
|-----------------------|---------|---------|---------|
| Laser power (kW) | 0.8 | 0.9 | 1 |
| Cutting speed (m/min) | 4.3 | 4.4 | 4.5 |
| Gas pressure (Bar) | 0.05 | 0.15 | 0.25 |

4. Results And Discussion

The below response was analysed with the help of above instruments and following the graphs and mathematical equations are obtained.

4.1.Roughness

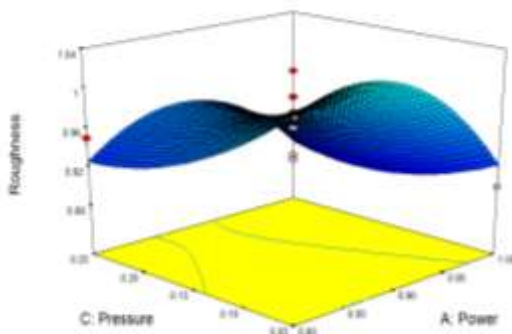


Figure 1 Pressure Vs Power

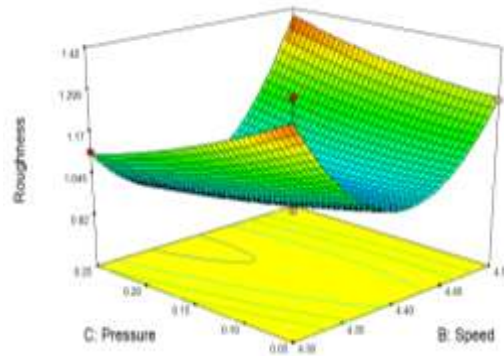


Figure 2 Speed vs Pressure

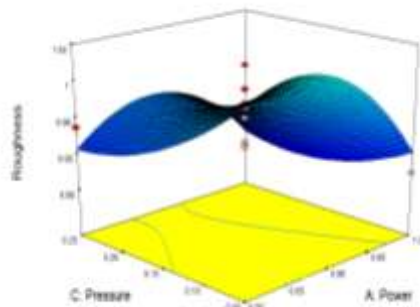


Figure 3 Power vs Pressure

From ANOVA, model “F-value”4.2 of implies that the model is significant. There is only 0.001% chance that a model “F-value” this large could occur due to noise. Values of “Prob < F” less than 0.01 indicate that model terms are significant this case B, B² are significant model terms. Greater than 0.015 indicate the model terms are not significant. If there are many in significant model terms F-value excluding those required to Lack of fit not significant

4.2.Kerf ratio straight - Profile

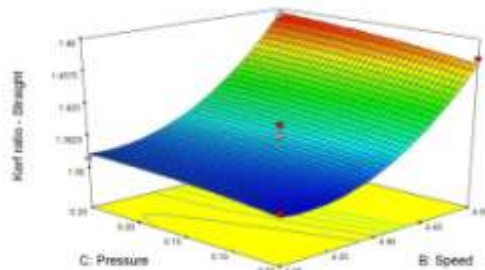


Figure 4 Speed Vs Pressure

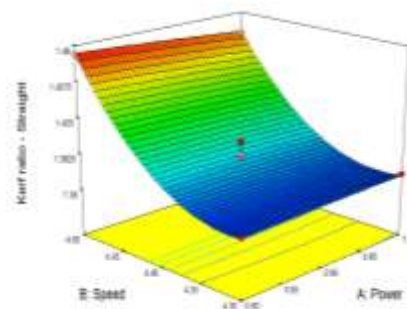


Figure 5 Speed vs Power

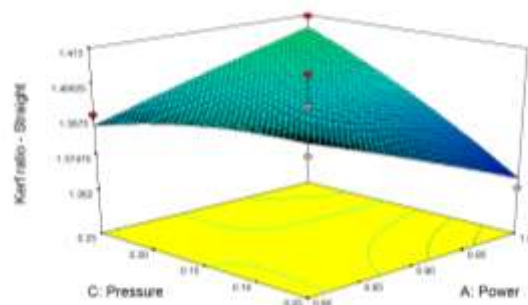


Figure6 Power vs Pressure

From ANOVA, model “F-value”4.2 of implies that the model is significant. There is only 0.001% chance that a model “F-value” this large could occur due to noise. Values of “Prob < F” less than 0.01 indicate that model terms are significant this case B, B² are significant model terms. Greater than 0.015 indicate the model terms are not significant. If there are many in significant model terms F-value excluding those required to Lack of fit not significant

4.3 Kerf ratio - curved profile

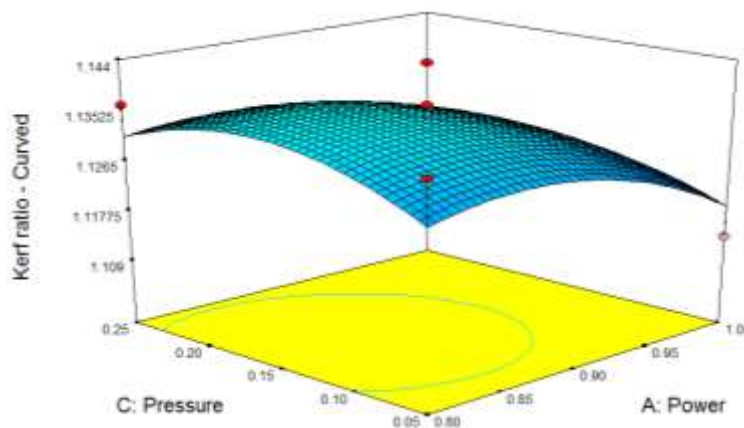


Figure 9 power vs Speed

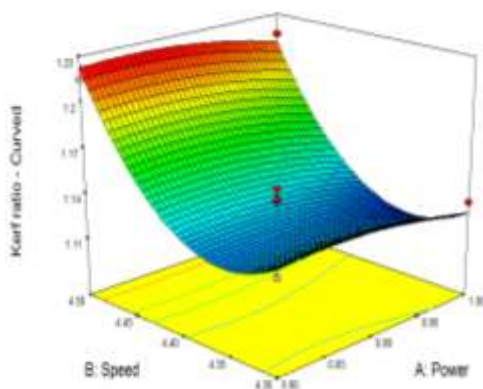


Figure 7 power vs Speed

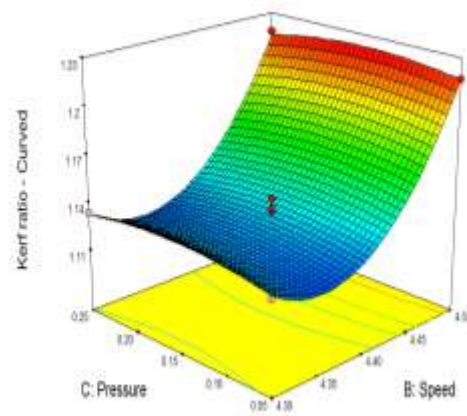


Figure 8 Speed vs Pressure

From ANOVA, model “F-value” of implies that the model is significant. There is only a 0.013% chance that a model “F-value” this large could occur due to

noise. Values of “Prob > F” less than 0.01 indicate that model terms are significant B²; in this excluding those required to Lack of fit not significant.

4.4.Kerf width straight - Profile

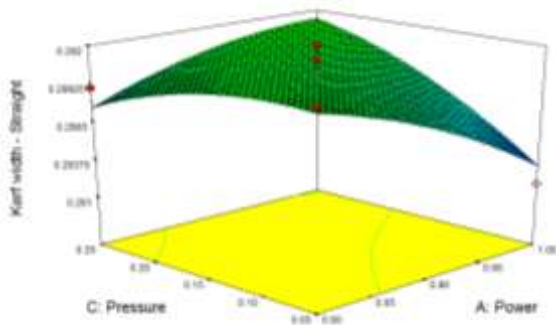


Figure 10 Power vs Pressure

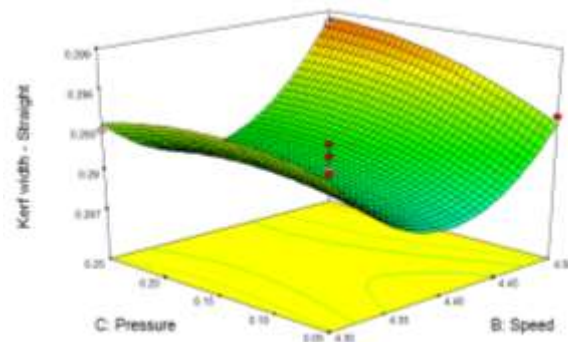


Figure 11 Speed vs Pressure

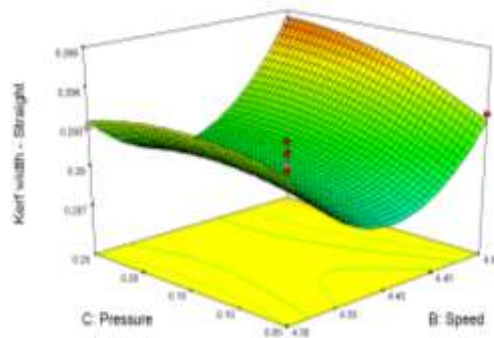


Figure 12 Speed vs Pressure

From ANOVA, model “F-value” of implies that the model is significant. There is only a 0.013% chance that a model “F-value” this large could occur due to noise. Values of “Prob > F” less than 0.01 indicate that model terms are significant B²; in this excluding those required to Lack of fit not significant.

4.5 Kerf width curved - Profile

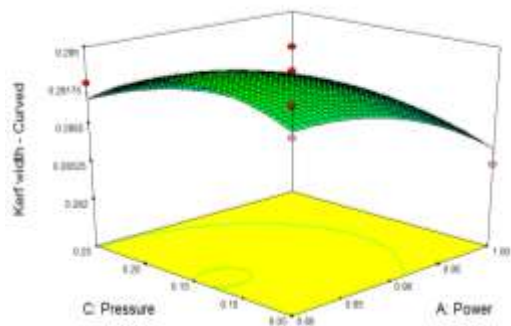


Figure 13 Pressure vs Power

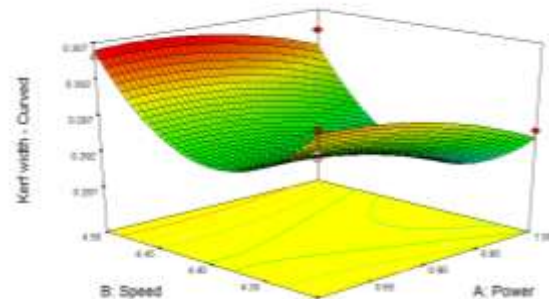


Figure 14 Speed vs Power

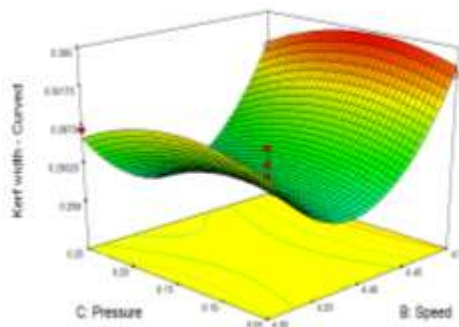


Figure 15 Speed vs Pressure

From ANOVA, model “F-value” of implies that the model is significant. There is only a 0.0044% chance that a model “F-value” this large could occur due to noise. “Prob < F” less than 0.164 indicate that model terms are significant; in this case are significant model terms. Values greater than 0.2076 indicate the model terms are not significant. If there are many in significant model terms F-2.389 excluding

5. CONCLUSION

The work presented here is an overview of research work carried out in laser Machining process of mild steel From the discussions it can be concluded that

1. Surface Roughness is reduced with increase in value of Power, cutting speed and stand-off distance. While the Surface Roughness does not varies much in Gas Pressure

2. Pressure value increases with increase in Power and at stand off distance, but roughness decreases with increase in cutting speed and pressure
3. For minimizing the Kerf Width the Power and the Cutting Speed should be at maximum value but the Gas Pressure and the Stand Off Distance does not show much difference in the Kerf Width.

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