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PREDICTIVE MODELING & ANALYSIS OF PARAMETERS USING ARTIFICIAL NEURAL NETWORK DURING CO_2 LASER CUTTING OF ALUMINIUM

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ABSTRACT

Laser cutting is an unconventional machining process utilized to cut various types of materials. Surface roughness & kerf width are the two main responses that are affected by the input parameters like laser power,cutting speed & assist gas pressurearranged at three levels during CO_2 laser cutting of aluminium. The results show that the roughness decreases with increases in speed and assist gas pressure whereas kerf width decreases with increase in assist gas pressure alone. The present work also includes prediction of roughness & kerf width through feed forward back propagation feed forward artificial neural network. Out of 17 experiments 13 were used for training & 4 were used for testing. The mean squared error is very less and the regression is 0.99519, which indicate a good agreement between predicted & experimental values. So, the developed artificial neural network can be used for predicting roughness and kerf width during CO_2 laser cutting of aluminium.

1. Introduction

Laser acronym for Light Amplification by Stimulated Emission of Radiation.Aluminium alloys are very difficult to cut using laser, due to its high thermal conductivity and high reflectivity. During the laser cutting process, the assist gas blow the molten material from the cut zone thereby helps to produce edge quality that is generally superior to that produced by a handsaw. However, the melted material tends to flow along the edge and cling to the backside of the cut.

2. Literature review

M.Madicet.al., [2012], found that the average surface roughness is directly proportional to gas pressure but inversely proportional with cutting speed and laser power. Prof. Dhaval [2012], studied the laser cutting characteristics including power level and focal length on surface roughness and found that focal length is most significant factor for surface roughness of brass sheet. A.Riveiro et.al.,[2010], investigated the effect of Co2 laser of 2024-T3 alloy and found that good quality can be obtained using high laser powers and focusing the laser beam onto the surface or slightly underneath the upper face of the workpiece.

3. Methodology

The Response surface methodology (RSM) box-behenken design with selected parameters namely the laser power, cutting speed and assist gas pressure shown in table 1 and 2. This led to the use of 17 experiments.

Table 1.Input parameter levels

Parameters	Level 1	Level 2	Level3
Laser power (KW)	3	3.2	3.4
Cutting speed (m/min)	5	5.2	5.4
Assist gas pressure (Bar)	6	7	8

4. Results And Discussion

The below response was measured with the help of the instruments shown in table 2.

Table 2.Response Values for the experiment

Expt no	Power (kw)	Speed (m/min)	Pressure (bar)	Roughness (micro meter)	Kerf width (mm)
1	3.2	5.2	8	1.412	0.27
2	3.1	5.2	7	1.491	0.306
3	3.1	5.4	6	1.42	0.286
4	3.2	5	7	1.502	0.341
5	3.1	5.2	7	1.508	0.323
6	3.1	5	6	1.581	0.36
7	3.2	5.4	7	1.391	0.26
8	3.1	5.2	7	1.512	0.331
9	3	5.2	6	1.37	0.284
10	3.1	5.4	8	1.452	0.32
11	3.1	5.2	7	1.502	0.321
12	3	5	7	1.487	0.315
13	3	5.2	8	1.312	0.272
14	3.1	5.2	7	1.481	0.317
15	3	5.4	7	1.39	0.282
16	3.2	5.2	6	1.421	0.281
17	3.1	5	8	1.512	0.33

4.1 ANN Analysis and Discussion

The developed ANN to predict the roughness and kerf width based on the cutting parameters showed high degree of accuracy within the scope of cutting conditions investigated in the study.

13 samples were used to train the network and 4 samples were used to test the ability of the trained network to estimate the laser cutting performances. The training process was performed by adjusting the synaptic weights so as to minimize the Mean Squared Error. A successful training was attained at epoch 27 with Mean Squared Error 1.56e-09 as shown in fig 1 and R0.99519 as shown in fig 2. In the prediction step the dispersion between experimental and predicted values was quite small. The average prediction error of kerf width was 2.9008 % and the average prediction error of surface roughness was smaller than 2.85 %.

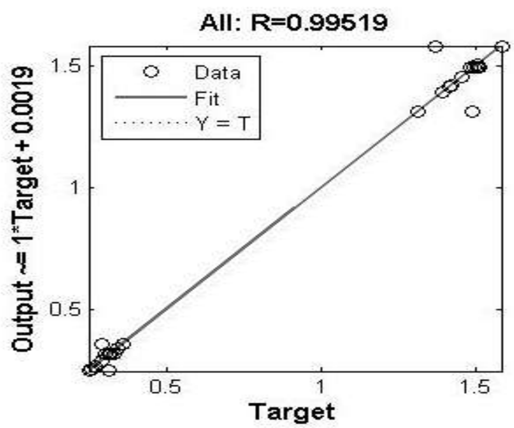

Figure 3. Coefficient of agreement

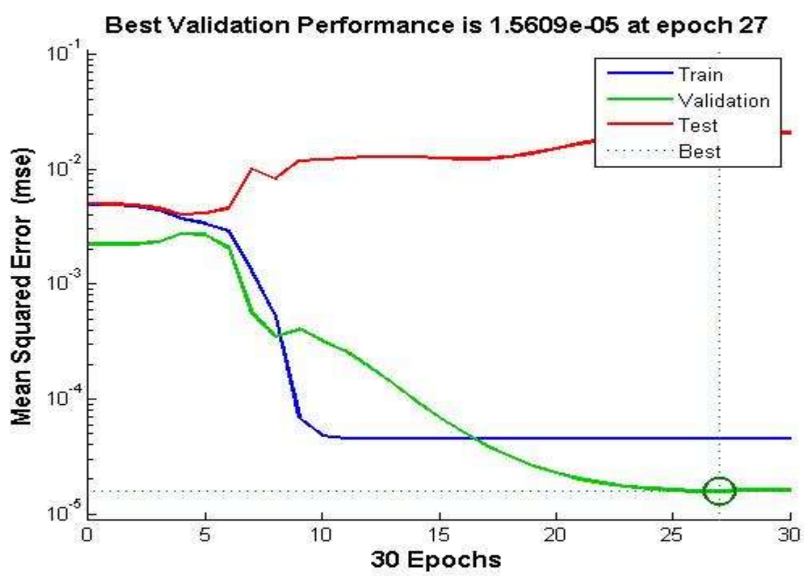

Table 4. Experimental vs ANN Predicted roughness and kerf width

Expt.	Experimental value	ANN predicted value

No	Roughness	Kerf width	Roughness	Kerf width
1	1.412	0.27	1.4051	0.27071
2	1.491	0.306	1.5001	0.32168
3	1.42	0.286	1.4213	0.2612
4	1.502	0.341	1.5102	0.34346
5	1.508	0.323	1.5001	0.32168
6	1.581	0.36	1.5701	0.34769
7	1.391	0.26	1.3918	0.26666
8	1.512	0.331	1.5001	0.32168
9	1.37	0.284	1.3752	0.28334
10	1.452	0.32	1.4543	0.31546
11	1.502	0.321	1.5001	0.32168
12	1.487	0.315	1.4884	0.32156
13	1.312	0.272	1.3782	0.29431
14	1.481	0.317	1.5001	0.32168
15	1.39	0.282	1.3426	0.30443
16	1.421	0.281	1.4722	0.28489
17	1.512	0.33	1.5619	0.32806

5. Conclusion

The work presented here is an overview of the work carried out in CO_2 laser cutting of aluminium. Prediction of roughness and kerf width using ANN was done. It was observed that the mean squared error was 1.560e-5 and the regression was 0.99519, which shows that the predicted model is in agreement with experimental model. Also the average prediction error was with in the limit which indicate that the ANN model developed can be used to predict the roughness and kerf width during CO_2 laser cutting of aluminium.

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