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PREDICTION OF MACHINING PARAMETERS ON DB6 TOOL STEEL USING ANN

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Abstract
This project aims to optimize the machining parameters for wire cut Electrical Discharge Machining (EDM) of DB6 Tool Steel to improve surface roughness. Parameters such as pulse-on-time, pulse-off-time, and peak current are varied to study their effects on surface finish. The Taguchi method is used for systematic analysis, utilizing orthogonal arrays to design experiments. The goal is to find the optimal parameters that minimize surface roughness. Additionally, an Artificial Neural Network (ANN) model is developed to predict surface roughness, enhancing the overall optimization process for wire EDM of DB6 Tool Steel.

Keywords: DB6 Tool Steel, WEDM, Taguchi, ANN, Surface Roughness.

1.Introduction and Literature Review

Wire electrical discharge machining (WEDM) transforms electrical energy into thermal energy, allowing it to cut hard materials like alloy steel and conductive ceramics. Taguchi analysis optimizes machining parameters such as pulse on time, pulse off time, and peak current for improved surface roughness. An ANN model is trained to predict optimal WEDM parameters, aiming to minimize surface roughness in DB6 tool steel.

Ajay Kumar et al. [1] used the Taguchi L16 array to optimize WEDM parameters for D2 steel, focusing on precision and versatility. Dhruv Bhatt and Ashish Goyal et al. [2] employed the Taguchi L27 array to optimize AISI-304 parameters, validated by ANOVA for MRR and SR. M. Manjaiah et al. [3] aimed to enhance MRR and reduce surface roughness (Ra) for D2 steel by analyzing various WEDM parameters. A. S. Shivade and V. D. Shinde [4] utilized TGRA to optimize D3 tool steel parameters, targeting MRR, dimensional deviation, gap current, and machining time. Arkadeb Mukhopadhyay and Tapan Kumar Barman et al. [5] explored the use of ANN and Composite Design (CCD) to model the fractal dimensions of surfaces machined by WEDM on EN 31 steel.

2. Materials and Methods

DB6 tool steel is prized for its exceptional toughness, wear resistance, and machinability, making it ideal for dies, punches, and heavy-duty cutting tools. With maintained hardness at high temperatures, it's favored in demanding industries like automotive and aerospace for its durability and reliability.

Figure 1. After machining the workpieces

3. Taguchi

The Taguchi method utilizes orthogonal arrays to ensure each factor level combination is equally tested, promoting accurate and unbiased experimental results.

Table 1: Input parameters

Parameters	Level- 1	Level- 2	Level- 3
Pulse on Time	150	175	200
Pulse off Time	60	75	90
Peak Current	100	125	150

4. ANN

In ANN training, the Back Propagation algorithm minimizes the total squared error until reaching the minimum mean square error (MSE) between targeted and network output, with the Levenberg-Marquardt algorithm preferred for its effectiveness in training feed-forward neural networks for similar research problems

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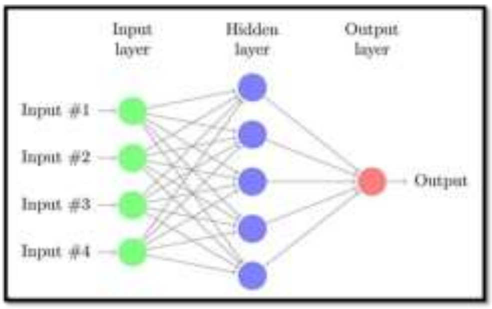


Figure 2. ANN Layers

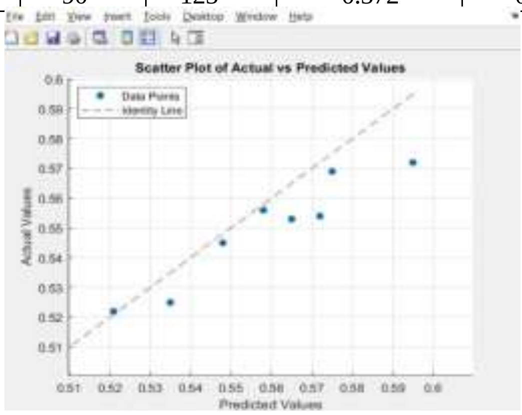
Table 2. DB6 steel results for SR

	Observations	MSE	R
Training	4	0.0001	0.9571
Validation	3	0.0000	0.9978
Test	3	0.0019	0.7732

5. Result and Discussion

Table 3: SR Experimental and SR ANN Predicted for DB6 Steel

S. No.	Pulse on Time	Pulse off Time	Peak Current	SR Experimental	SR Predicted	Error (%)
1	150	60	100	0.512	0.503	0.012
2	150	75	125	0.522	0.521	0.002
3	150	90	150	0.525	0.535	0.005
4	175	60	125	0.545	0.548	0.003
5	175	75	150	0.556	0.558	0.002
6	175	90	100	0.553	0.565	0.012
7	200	60	150	0.554	0.572	0.016
8	200	75	100	0.569	0.575	0.001
9	200	90	125	0.572	0.595	0.018



Graph No-1: DB6 comparison between Actual and Predicted SR Value

6.Conclusion

The Taguchi method successfully optimized process parameters, leading to improved surface finish in machining DB6 steel. Additionally, the ANN prediction closely matched experimental results, validating its accuracy in estimating surface roughness based on input parameters. Leveraging both techniques enhances machining efficiency and quality in DB6 steel components, advancing precision engineering in manufacturing.

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