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Optimization of WEDM Process by using Modified TLBO Technique

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Abstract- Wire Electrical Discharge Machining (WEDM) is a non-traditional machining process where intricate and complex shapes can be machined. The effects of various process parameters of WEDM like pulse on time (TON), pulse off time (TOFF), gap voltage (SV) and wire feed (WF) have been investigated to reveal their impact on Material Removal Rate (MRR) and Surface Roughness (Ra) of H-13 material. The optimal set of process parameters has also been predicted to maximize the material removal rate and minimize the surface roughness. The experimental studies were performed on WEDM machine. The Modified Teaching-Learning-Based optimization (TLBO) algorithm has been applied for optimization of the responses of WEDM Process. It is observed that the modified TLBO algorithm performs better optimal process response values.

Index Terms- WEDM, Material Removal Rate, Surface Roughness, TLBO.

1. INTRODUCTION

Wire electrical discharge machining (WEDM) is a specialized thermal machining process capable of accurately machining parts which have varying hardness, complex shapes and sharp edges that are very difficult to be machined by the traditional machining processes. The practical technology of the WEDM process is based on the conventional EDM sparking phenomenon utilizing the widely accepted noncontact technique of material removal. The figure 1 shows the process of wire electric discharge machining.

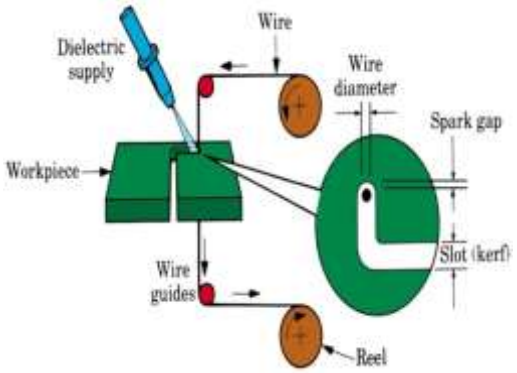

Fig 1 Schematic Representation of WEDM Process

In WEDM process, the tool i.e. wire is moved in the programmed path and material is removed from the work piece accordingly. The electrically conductive materials are cut by WEDM process by the electro-thermal mechanism. Material removal takes place by a series of discrete discharges between the wire electrode and work piece. These discharges cause sparks and result in high temperatures instantaneously, up to about 10000° C. These temperatures are huge enough to melt and vaporize the work piece metal and the eroded debris cools down swiftly in working liquid and flushed away. WEDM is a non-conventional process and is very widely used in tool steels for pattern and die making industries. The process is also used for cutting intricate shapes in components used for the electric and aerospace industries.

2. EXPERIMENTAL DETAILS

In this experimental work the performance of the WEDM process on H13 material has been studied by considering the various performance measures such as material removal rate, surface flatness by taking different input parameters such as pulse on time, pulse off time, voltage and wire feed. After literature review and based on the experienced persons review the range of input parameters has been decided, which is given in the Table I.

Table I Ranges for process parameters

SL NO.	MACHINING PARAMETERS	RANGES	
		LOWER LIMIT	***UPPER LIMIT***
1	Pulse on time	115	125
2	Pulse off time	50	60
3	Voltage	100	180
4	Wire feed	3	7

To evaluate the effects of machining parameters on performance characteristic (MRR, Ra), and to identify the performance characteristic under the optimal machining parameters, a specially designed experimental procedure is required.

3. METHODOLOGY

Teaching-Learning-Based Optimization (TLBO) algorithm Teaching-learning is an important process where every individual tries to learn something from other individuals to improve themselves. Rao and Patel proposed an algorithm, known as Teaching-Learning-Based Optimization (TLBO), which simulates the traditional teaching learning phenomenon of a classroom. The algorithm simulates two fundamental modes of learning: (i) through the teacher (known as the teacher phase) and (ii) interacting with other learners (known as the learner phase). TLBO is a population based algorithm, where a group of students (i.e. learner) is considered the population and the different subjects offered to the learners are analogous with the different design variables of the optimization problem. The results of the learner are analogous to the fitness value of the optimization problem. The best solution in the entire population is considered as the teacher. The operation of the TLBO algorithm is explained with the teacher phase and learner phase.

Modified TLBO

The modified TLBO algorithm presented for Wire electric discharge machining process is coded in MATLAB. So that when the inputs are given to the wire EDM process then the program executes and results will be displayed on the command window.

Inputs given to the code are:

Number of design variables

Ranges for each design variable

Population size

No of iterations

Outputs are:

Material removal rate

Surface roughness

4. RESULTS and DISCUSSION

In this work, the design of study is done by using Taguchi Method. Three levels of each factor have been selected and L9 orthogonal array has been prepared as suggested by Taguchi, which is given in Table III.

Table II Levels of machining parameters

SL NO.	MACHINING PARAMETERS	LEVELS		
		LEVEL 1	*LEVEL 2*	*LEVEL 3*
1	Pulse on time	115	120	125
2	Pulse off time	50	55	60
3	Voltage	100	140	180
4	Wire feed	3	5	7

Table III Design of Experiments

SL NO.	PULSE ON TIME	PULSE OFF TIME	VOLTAGE	WIRE FEED
1	115	60	100	3
2	115	55	140	5
3	115	50	180	7
4	120	60	140	7
5	120	55	180	3
6	120	50	100	5
7	125	60	180	5
8	125	55	100	7
9	125	50	140	3

By using the above design values 9 experiments done on the work piece in wire EDM machine. After doing the experiments the response parameters are calculated by using the formulae and some other equipment like Tally surf meter. Talley surf meter is used to calculate surface roughness values for each experiment and formula used to calculate MRR.

Experiment by using Modified TLBO Technique:

After generating the code in M-File we are going to execute this by using the run button. Then the program start executing from generation of population to the display of outputs i.e., MRR and Ra

INPUT:

Number of design variables = 4

Population size = 50

Number of iterations = 100

Ranges for each design variable

Pulse on time --------115 to 125

Pulse off time--------50 to 60

Voltage --------100 to 180

Wire feed --------3 to 7

Based upon this factors program generates its initial population and then fitness values are calculated by using the regression equation

Fitness=(150116.9*x1+8.24*x2+0.569*x3+80.1*x4)-(-3.02+0.0641*x1 .0046*x2+0.00199*x3+0.0013*x4)

Among those all values one value is displayed based on the objective function. The value is shown below.

OUTPUT:

OPT_VAL =125.0000 50.0000 100.0001 3.0000

Fitness =92.7356

By using this input design factor values it calculates the output parameter values i.e., MRR & Ra. Those values are

Surface roughness, Ra =4.9654, Material removal rate, MRR =97.7010

The obtained result for the optimization of Wire EDM process

Optimization Technique	fitness value	pulse on time	pulse off time	voltage	wire feed
Modified TLBO	92.7356	125.0000	50.0000	100.0001	3.0000

5. CONCLUSION

In this present work, the Modified TLBO algorithm is applied to determine the optimum process parameters for Wire EDM process for achieving better machining performance. Modified TLBO can also be successfully applied for optimizing other nontraditional machining processes. The fitness values after doing optimization by using modified TLBO is 92.7356.

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