

## **ABSTRACT**

The manufacturing sector is an important sector for a country's growth. A country like India having a high population mainly depends upon the agriculture, manufacturing and service sectors for its GDP. In order to increase the contribution of the manufacturing sector, first thing is to increase the volume of manufacturing and next is to improve the existing process so that the wastages, production time and production cost be reduced.

For this, unconventional machining processes are suitable and these processes have well established their capability of machining hard materials much easier than traditional machining process and find wide application in manufacturing for both low and high volumes of production with high precision and accuracy.

Wire cut Electrical Discharge Machine (WEDM) is an unconventional machining process which is widely used to produce a precise, complex irregular shaped component with internal cavities and difficult to machine electrically conductive materials due to their high strength, high bending stiffness and better fatigue characteristics. It is also used in manufacturing of moulds for plastics, dies for forgings and castings of press tools, automotive, aerospace and surgical components. The WEDM process is governed by the various process parameters such as pulse on time, pulse off time, power energy selection, working current range, working gap range, feed rate, rapid capacitor, spindle feed and electrode tube diameter, flushing

pressure. These settings of process parameters were done on a trial and error basis, which increases the job set up time and requires more skilled operator.

There were lots of research work carried out regarding the optimization and modeling of input process parameters to achieve the output response parameters or machining parameters. But research and literature lacks much to say about the setting of a job or workpiece in the WEDM. The setting of the workpiece in the WEDM is done on a trial and error basis, which consumes more setup time, which increases the production time and this also requires a highly skilled operator. This makes the process costlier.

To overcome this limitation, in this research work, a mathematical model is developed for relating the input process parameters and workpiece setting parameters of the WEDM process by using Artificial Neural Network (ANN) with Matlab Version 7.0.1; R14 package. ANN is used widely for modeling and optimising the experimental data because the ANN model is found to be capable of better calculations and predictions within the range that they have been tested. This model is developed to train using Levenberg-Marquardt algorithm which is one of the better algorithm for training 3-7-11 feed forward neural network. Testing of the algorithm is done with the collected data and the network compares its predicted value to the actual output and adjusts all the weights to improve the model. Once the Mean Square Error (MSE) of the training data reached the target value, the testing is terminated and the weights and biases are automatically saved by the

program. After testing, analysis is done by using the test data set and both the values of MSE and the  $r^2$ .

A case study is done at a small scale industry in South India, to check the validation of the developed mathematical model. In this, the values of the workpiece setting parameters like workpiece thickness, wire wear rate and time taken for machining are fed into the mathematical equations and the arrived values of the process parameters are fed into the WEDM machine and the machining is done on the mild steel work piece.

The results of the case study reveal that the proposed ANN algorithm paves the way for 57% to 62% of reduction in setup time of the workpiece on the WEDM including the machining time, when compared to the regular trial and error method. Next, there is around 60% reduction in labour costs and while machining, there is no down time in the WEDM due to the tool wire breakage. Since there is no wire breakage while machining, there is no wastage of wire electrode. This also leads to a better surface finish of the workpiece.

The outcomes of the research work leads to an increase in productivity, employability, machining quality and profit. Moreover, the ANN has proved its flexibility and effectiveness for calculating the process parameters from the job setting or machine parameters.