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Application Of Fuzzy Logic To Develop A Model For Powder Mixed Edm

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Abstract—Determining the relationship between control and performance parameters is crucial for any system. There are numerous modeling approaches available now to determine the relationship between powder mixed EDM performance and control parameters. Using fuzzy logic, it offers a non-functional, time-saving, free-form method for capturing how control parameters, such as tool material's resistivity, powder material's resistivity, peak current, powder concentration, etc., affect performance parameters like MRR, Ra, TWR, taper, and overcut. Additionally, the outcomes of the fuzzy model are contrasted with those of the mathematical model, which was created using data fit software. The MATLAB Mamdani type fuzzy inference engine uses five membership functions for both input and output parameters.

Index Terms—**CRD, MAMDANIFIS, Modelling & Simulation**

I. Introduction

To gain valuable insight into the system under study, data from several experiments must be handled or verified in a variety of ways. In order to effectively and efficiently represent the link between the system's input and output, it is crucial to use an appropriate modeling technique or tool for Powder Mixed EDM.

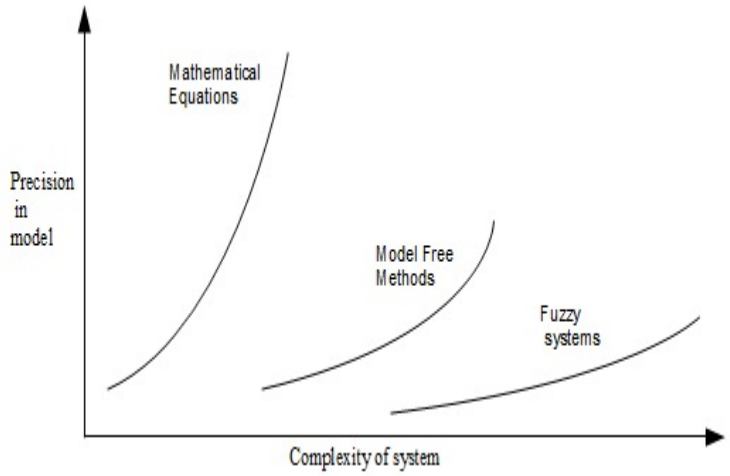


Figure 1 Complexity of system & precision level of different models

Many models and simulations have been attempted in recent years to provide a clear picture of the EDM performance under various operating conditions. Fuzzy logic is a useful technique for accurately modeling system behavior when mathematical models are unable to capture the input/output relationship within acceptable error bounds and with adequate system data. Fuzzy logic models are used to capture the nature of the process in cases where the amount of data available is likewise restricted and insufficient to provide a dependable mathematical model and artificial neural network model.

I.I. FUZZY MODELLING

Fuzzy logic is a form of mathematical logic in which truth can assume a continuum of values between 0 and 1 Fuzzy logics is designed for situations where information is inexact and traditional digital on/off decisions are not possible. It divides data into vague categories such as "hot", "medium" and "cold".

Conventional methods of reasoning through arithmetic operation or whatever the operation available in symbolic logic, particularly proposition logic and predicted logic are not sufficient to handle the situation which involve the variable which can't be determined by the words TRUE and FALSE. So that the power of reasoning used by human being in solving problem involving such deterministic variable can also be embedded into a computer system is the program under consideration and in this respect the fuzzy logic is a very power full tool which helps us in conveying our reasoning ability to the computer system. So that the computer can also solve the problems involving this type of variables like health, age, hotness or coldness, depression, etc. Fuzzy logic can be im.0-7plemented in hardware, software, or a combination of both. It provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information. Fuzzy logic approach to control problems mimics how a person would make decisions, only much faster.

Fuzzy logic is a super set of conventional or Boolean logic and contains similarities and differences with Boolean logic. Fuzzy logic is similar to Boolean logic, in Boolean logic results are returned by fuzzy logic operations when all fuzzy memberships are restricted to 0 and 1. Fuzzy logic differs from Boolean logic in that it is permissive of natural language queries and is more like human thinking; it is based on degrees of truth. The graphical representations of fuzzy and Boolean sets are different as well which is shown in Figure 2.

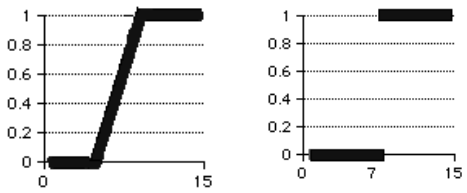


Figure - 2 Difference between Fuzzy Set and Boolean Set

Fuzzy set:

A fuzzy set is a set whose elements have degrees of membership. That is, a member of a set can be partial member (e.g. less than 100% membership and greater than 0% membership) or a full member (100% membership status). In traditional sets, an element of the set X is either a member or a non-member of the subset Y. There are no partial members in traditional sets. A fuzzy set is a set whose elements have degrees of membership.

Membership function:

The degree of an element's membership in a fuzzy set is defined by membership function. Numerous functions like trapezoidal, triangular, sinusoidal etc. are available for representing the membership of elements in fuzzy sets. The use of appropriate membership function for specific variable requires experience and skill.

Steps involved in development of fuzzy models are as under:

1) Identification of input and output parameters.

2) Fuzzyfication.

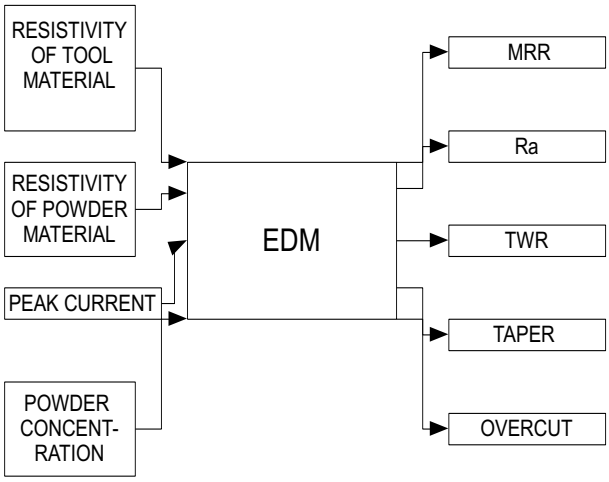
3) Applying range for input and output.

4) Rule base matrix.

5) Developing fuzzy graph.

6) Fuzzy graph interpretation.

7) Defuzzyfication.



The implementation of these steps on the software maps to following steps:

1) Creating a system block with identification of inputs and outputs.

2) Selecting the proper type of inference engine In this case, Mamdani type of inference engine is utilized.

3) Developing membership functions for the input and output parameters. This permits the real input parameters to be fuzzified into fuzzy membership values of fuzzy sets. Also the fuzzy output can be de-fuzzified using these membership functions.

4) Develop a rulebase based on the data captured from the experiments.

5) Tuning of rule base matrix till the surface viewer gives smooth curve.

6) Get output form the rule viewer

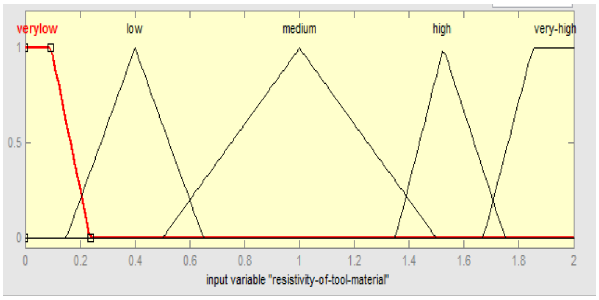
I.I.I. FUZZY MODELLING OF POWDER MIXED EDM

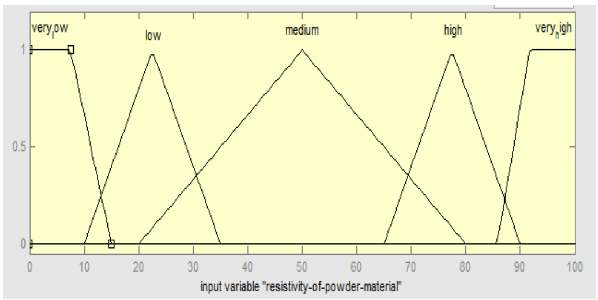
In case of powder mixed Electric Discharge Machine, tool material's resistivity, powder material's resistivity, peak current, powder concentration affecting MRR, Ra, TWR, taper, and overcut. The fuzzy model for Powder Mixed EDM process will schematically appear as indicated in Figure 3. The fuzzy block defined based on this in MATLAB is shown in Figure 4. The modeling inputs for fuzzy modeling of CRD are listed in Table 1. Five fuzzy sets are used for each input and output. The membership functions for outputs are also identical and shown in Figure 4.

Figure 3 Block Diagram of CRD

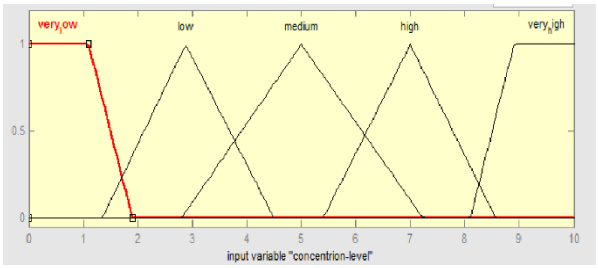
Fuzzy model	Mamdani FIS of MATLAB
Fuzzy model	Resistivity Of Tool Material, Resistivity Of Powder Material, Powder Concentration, Peak Current
Input for the fuzzy model	4
Number of inputs to the fuzzy	MRR, Ra, TWR, Taper, Overcut
Output from the fuzzy model	5
Number of outputs from the fuzzy model	5 for each input and output
Number of member ship functions	Triangular, Trapezoidal
Type of member-ship function's	Centroid

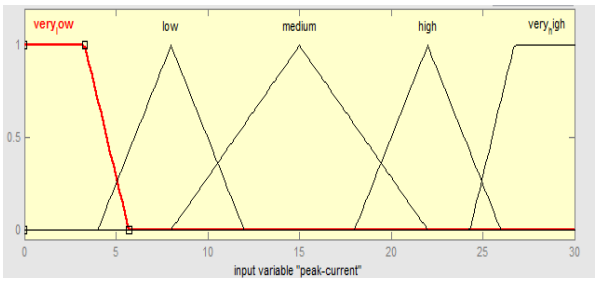
Table 1 Fuzzy modelling for Powder Mixed EDM





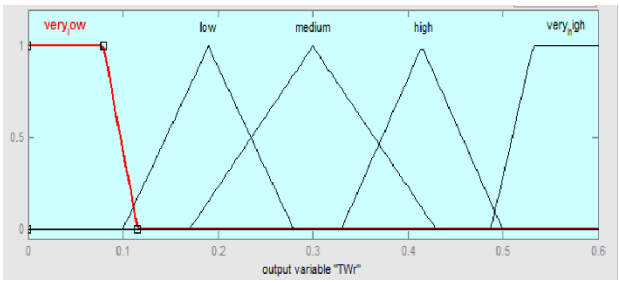
(1)

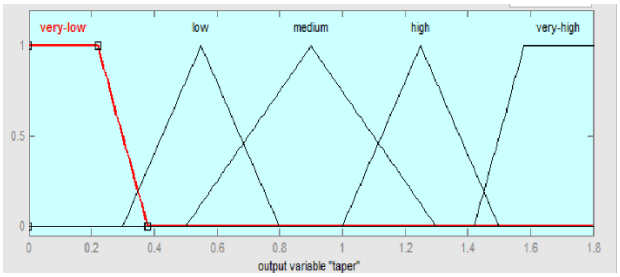


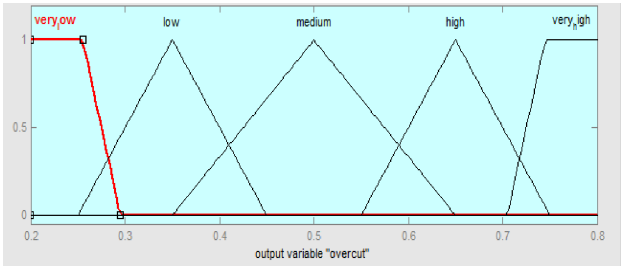


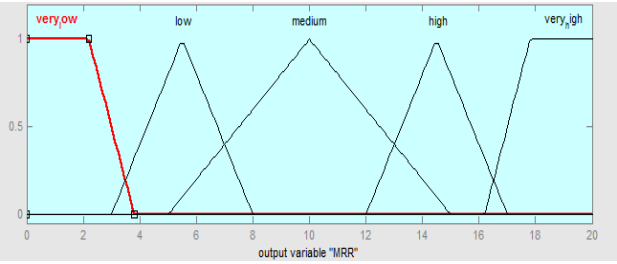
(2)

Figure 4 Membership Functions for Inputs (1) tool material's resistivity, (2) powder material's resistivity (3) powder concentration(4) peak current









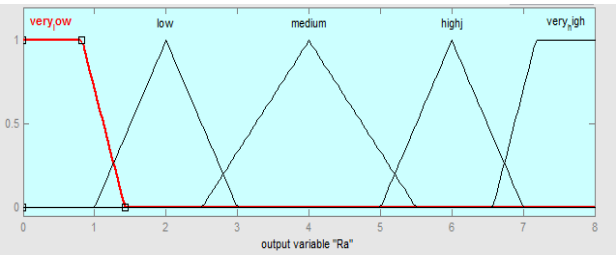
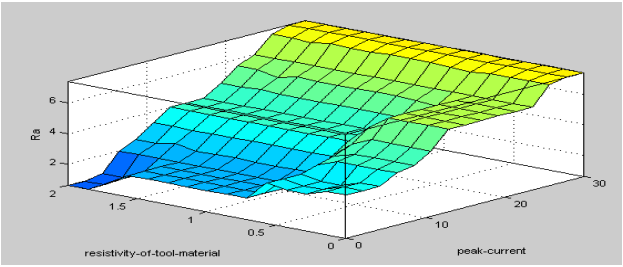


Figure 5 Membership Functions for output (1) TWR (2) OVERCUT MRR (3) Ra

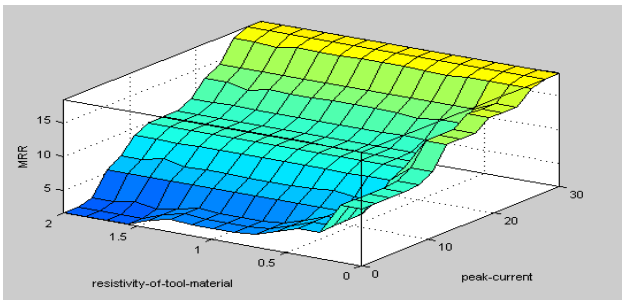
IV RESULT AND DISCUSSION:



After analysing the comparison between mathematical and programming method to relate the input and output parameters or to find out the output parameters from input parameters with the consideration of particular range of input and out parameters, we can conclude that with the help of MATLAB programming using fuzzy tool the process is quite easy, less time consuming, with negligible human error, less human effort and cost effective too.

The table developed for the calculations result of both methods shows the actual difference for the same.

In mathematical calculations we have to consider the tolerances of about 0 to 100 units of input parameters, while in the case of MATLAB programming there is no need of consideration of any tolerances. By applying the fuzzy logic and MATLAB programming method for obtaining the relationship between all the input and output parameters considered in the study.



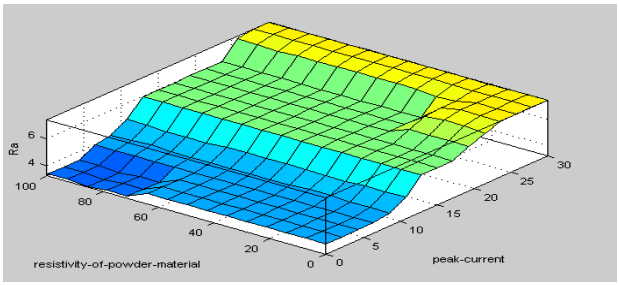
(a)

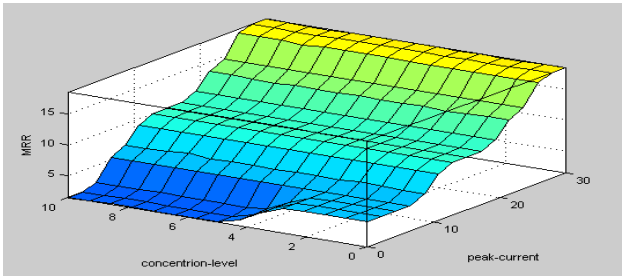
(b)

(c)

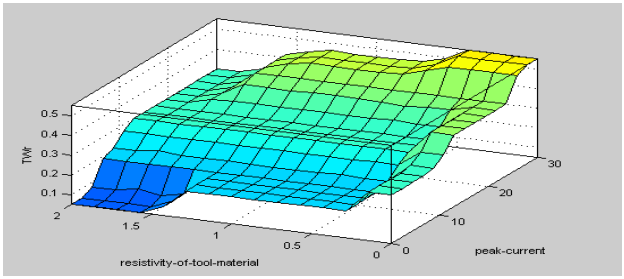
Figure 6 Response Surfaces for MRR showing effect of (a) Tool resistivity and peak current (b) powder concentration and peak current(c) powder resistivity & peak current

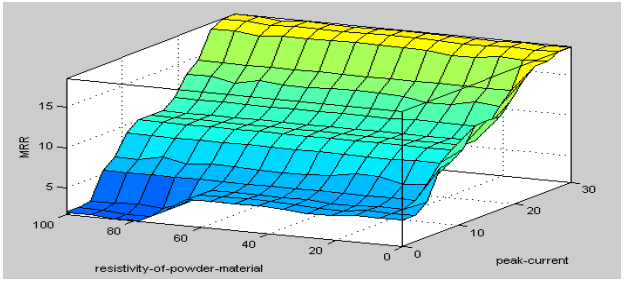
(a)





(b)

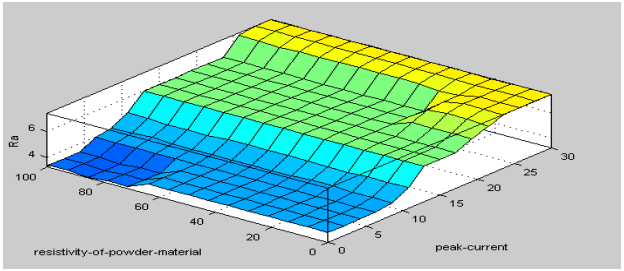


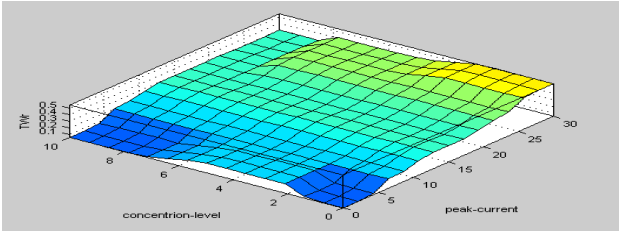


(c)

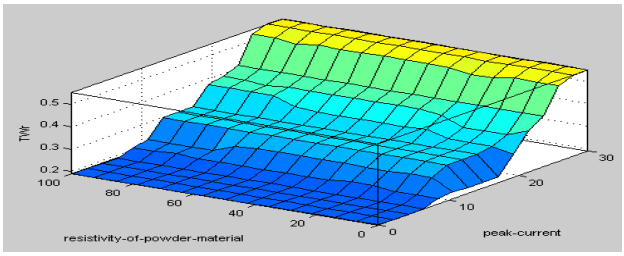
Figure 7 Response Surfaces for Surface roughness showing effect of (a) Tool resistivity and peak current (b) powder concentration and peak current (c) powder resistivity & peak current.

(a)





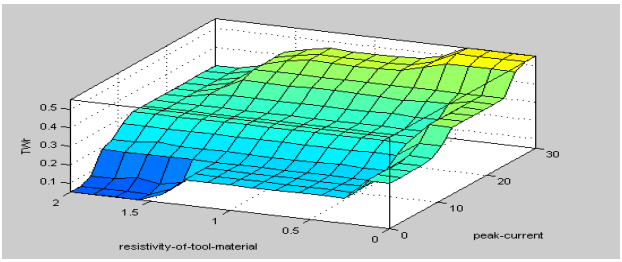
(b)

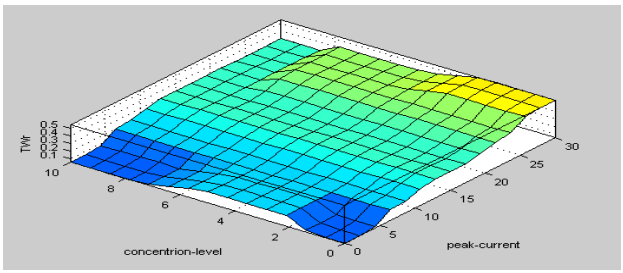


(c)

Figure 8 Response Surfaces for Surface roughness showing effect of (a) Tool resistivity and peak current (b) powder concentration and peak current (c) powder resistivity & peak current

(a)





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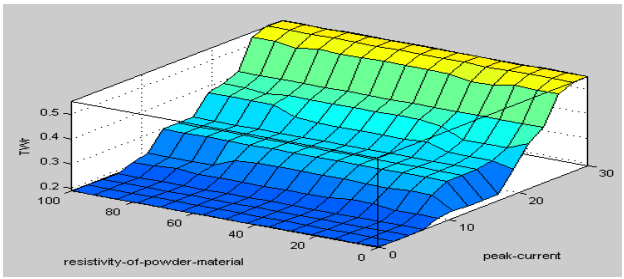

(c)

Figure 9 Response Surfaces for tool wear showing effect of (a) Tool resistivity and peak current (b) powder concentration and peak current (c) powder resistivity & peak current

V CONCLUSION

Fuzzy model for Powder Mixed EDM using Mamdani type FIS with 625 if-then rules and 5 fuzzy sets for each input and output allows development of fuzzy predictive surfaces and captures the nature of variation of the variables. However, the accuracy is found to be less. Further tuning of fuzzy model by using different fuzzy membership function and different number of fuzzy sets is essential in order to achieve accurate predictions.

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