International Journal of Current Engineering and Technology
ISSN 2277 - 4106

Available at http://inpressco.com/category/ijcet

Research Article

Application of Fuzzy Logic method for optimisation of Wear Parameters of Composite Polytetrafluroethylene (25 % carbon filled PTFE)

Bhosale K.C.[Á*] and N. D. Sadaphal[Á]

[Á]SRES's College of Engineering, Kopargaon, Ahmednagar , University of Pune(M.S.), India.

Accepted 18 March 2014, Available online 01 April 2014, **Special Issue-3, (April 2014)**

Abstract

Fuzzy logic is an optomisation technique used to predict the Behaviour of any problem. In this paper an experiment was conducted on composite Polytetrafluroethylene filled with 25% carbon material on pin-on-disk machine to find out wear parameters. In this study, the effects of varying load, sliding distance and sliding velocity on wear was experimentally examined and analyzed with the help of Design Expert 7 software. This data is optimized by using a Fuzzy Logic concept.

Keywords: *Fuzzy Logic, wear test, Composite Polytetrafluroethylene (PTFE)*

1. Introduction

The Fuzzy Logic tool was introduced in 1965, also by Lotfi Zadeh, and is a mathematical tool for dealing with uncertainty. It offers to a soft computing partnership the important concept of computing with words'. It provides atechnique to deal with imprecision and information granularity. The fuzzy theory provides a mechanism for representing linguistic constructs such as "many," "low," "medium," "often," "few."

In general, the fuzzy logic provides an inference structure that enables appropriate human reasoning capabilities. On the contrary, the traditional binary set theory describes crisp events, events that either do or do not occur. It uses probability theory to explain if an event will occur, measuring the chance with which a given event is expected to occur. The theory of fuzzy logic is based upon the notion of relative graded membership and so are the functions of mentation and cognitive processes. The utility of fuzzy sets lies in their ability to model uncertain or ambiguous data, Fig. 1.1, so often encountered in real life. It is important to observe that there is an intimate connection between Fuzziness and Complexity. As the complexity of a task (problem), or of a system for performing that task, exceeds a certain threshold, the system must necessarily become fuzzy in nature.

Real world problems (situations) are too complex, and the *complexity involves the degree of uncertainty* – as uncertainty increases, so does the complexity of the problem. Traditional system modeling and analysis techniques are too precise for such problems (systems), and in order to make complexity less daunting we introduce appropriate simplifications, assumptions, etc. (i.e., *degree of* uncertainty or *Fuzziness*) to achieve a satisfactory compromise between the information we have and the amount of uncertainty we are willing to accept. In this aspect, fuzzy systems theory is similar to other engineering theories, because almost all of them characterize the real world in an approximate manner [S. N. Sivanandam 2007].

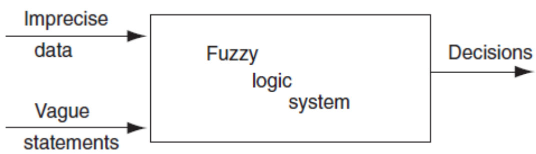

Fig. 1. A fuzzy logic system which accepts imprecise data and vague statements[S. N. Sivanandam 2007].

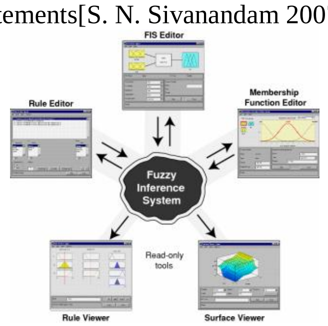

Fig. 2 Fuzzy logic toolbox graphical user interface tools

2. Experimental work

An experiment is carried on Pin On disk machine on composite Polytetrafluroethylene (PTFE). A study of the effects of varying load, sliding distance and sliding velocity on friction and wear is tested. A data of wear is

*Corresponding author: Bhosale K.C.

obtained for plain PTFE material. The number of tests to be conducted was decided by theTaguchi experimental design method [(L_9 (3^3)] orthogonal array as shown in table 1 [S.Basavarajappay, 2005].

Table 1. Cumulative Experimental Wear Data of Composite PTFE

Trail No.	Load L Kg[A]	Velocity m/s[B]	Sliding dist. Km[C]	Wear(μ)
1	1	1.57	2	36
2	1	3.14	4	45
3	1	4.71	6	60
4	2	1.57	4	64.5
5	2	3.14	6	62
6	2	4.71	2	72
7	3	1.57	6	123
8	3	3.14	2	135
9	3	4.71	4	273

In this work, trials were conducted on composite Polytetrafluroethylene (PTFE) material. For conducting the test three input parameters like load, sliding distance and sliding velocity are divided into three categories like Low, Medium and High. From these three different input parameters we get one output i.e. wear as shown in table 2.

Table2. Fizzy matrix example

Input 1	Input 2	Input 3	Output
Low	Low	Low	Low
Medium	Medium	High	Medium
High	Low	High	High

In Fuzzy Inference System (FIS) mamdani system is used. In FIS editor all input and output parameters are entered as given in table no.1. These values are shown in figure2. For input parameters Gaussian curve is selected and for output parameters triangular parameters is selected. The value of three input parameters are filled in membership function as shown in figure3 and output parameter in figure4.

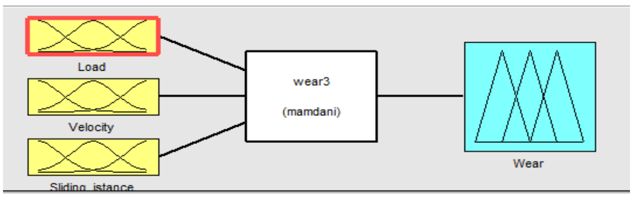

Fig.2 FIS editor for this problem

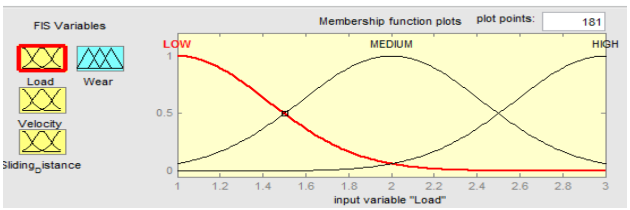

Fig.3 Input membership function of load

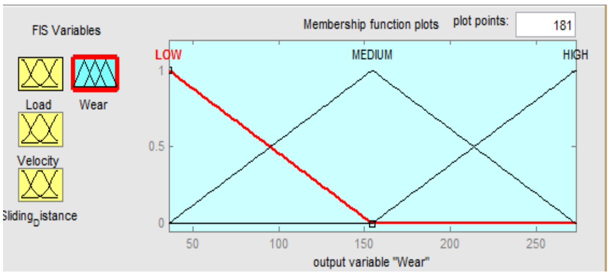

Fig.4 Output membership function of wear

Rules are applied by taking the information from table 2.Three rules are applied as shown in figure 5. The rules can be viewed in rule viewer as shown in figure 6 and the surface can be seen in figure 7. The output parameters are checked from rule viewer by changing the three input parameters from low to high values. All the values are matching with the output parameters. From this we can get information that by keeping the three input parameters at different levels we can get output in the three levels like "Low", "medium" or "high".

1. If (Load is LOW) and (Velocity is LOW) and (Sliding_Distance is LOW) then (Wear is LOW) (1)
2. If (Load is MEDIUM) and (Velocity is LOW) and (Sliding_Distance is MEDIUM) then (Wear is MEDIUM) (1)
3. If (Load is HIGH) and (Velocity is LOW) and (Sliding_Distance is HIGH) then (Wear is HIGH) (1)
4. If (Load is HIGH) and (Velocity is MEDIUM) and (Sliding_Distance is LOW) then (Wear is LOW) (1)
5. If (Load is LOW) and (Velocity is MEDIUM) and (Sliding_Distance is MEDIUM) then (Wear is LOW) (1)

Fig.5 Different rules for the function

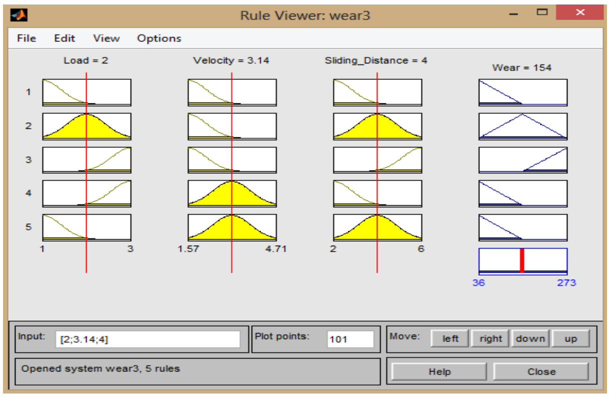

Fig.6 Rule Viewer

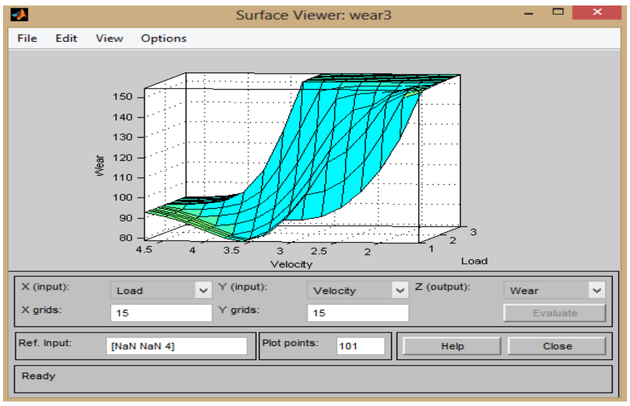

Fig.7 Surface Viewer

The graph between three parameters can be viewed from the surface viewer. A 2D graph can be plotted between input and output parameters as shown in figure 8.

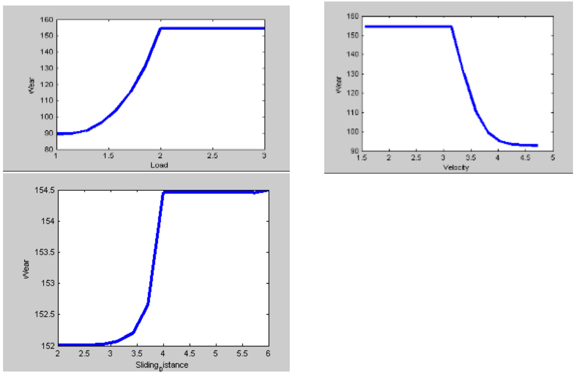

Fig.8 Wear v/s load, velocity & sliding distance

Figure 8 indiactes that as load increases wear increases upto 2kg. and beyond 2 kg it remains constant. Similarly, upto 3 m/s wear remains constant and beyond that it reduces drastically.

The output values are divided in the symmetrical way. The output wear can be grouped in three categories like “Low”, “medium” or “high”. The predicted values of Low wear is from 36-115, medium wear is from 115-194 and high wear is from 194-273 as shown in table3.

Table 3. Comparison between experimental and predicted wear values

Trail No.	Load L Kg [A]	Velocity m/s[B]	Sliding dist. Km [C]	Wear (μ)	Predicted wear
1	1	1.57	2	36	Low
2	1	3.14	4	45	Low
3	1	4.71	6	60	Low
4	2	1.57	4	64.5	Low
5	2	3.14	6	62	Low
6	2	4.71	2	72	Low
7	3	1.57	6	123	Medium
8	3	3.14	2	135	Medium
9	3	4.71	4	273	High

Conclusion

Fuzzy logic is an important tool to find optimum parameters for wear analysis. By selecting three range of different input parameters, output wear can be predicted only by forming some rules. Different output parameters are checked by changing the three input parameters like load, velocity and sliding distance. The readings are matching with the experimental values. As minimum wear is expected, six trials are giving satisfactory results.

References

S. N. Sivanandam, S. Sumathi and S. N. Deepa, “Introduction to Fuzzy Logic using MATLAB”, Springer-Verlag Berlin Heidelberg 2007.

Y. S. Tarng, W. H. Yang and S. C. Juang, “The Use of Fuzzy Logic in the Taguchi Method for the Optimisation of the Submerged Arc Welding Process”, Int J Adv Manuf Technol (2000) 16:688–694.

H. K. Narang1, U. P. Singh , M. M. Mahapatra and P. K. Jha, “Prediction of the weld pool geometry of TIG arc welding by using fuzzy logic controller”, International Journal of Engineering, Science and Technology, Vol. 3, No. 9, 2011, pp. 77-85

Talat Tevrüz, “Tribological behaviors of carbon filled Polytetrafluroethylene (PTFE) dry journal bearings”, Wear 221, 1998, Page no. 61–68.

D.S.Bajaj, G.J.Vikhe, Y.R.Kharde, “An Investigation of Tribological Behavior of PTFE+Glass Fiber against Variable Surface Roughness of Counter Surface”,

Indian Journal of Tribology, Vol.3 No.2 July-December, 2008, Page no. 47-54.

V.B.Raka, “Tribological Behaviour of PTFE and its Composites”, Innovations in Mechanical Engineering (IME’ 10), January 28-29, 2010, Page 148-155.Jaydeep Khedkar, Ioan Negulescu, Efstathios I. Meletis, “Sliding wear behavior of PTFE composites”, Wear 252 (2002) Page no. 361–369.

H. Unal, A. Mimaroglu, U. Kadıoglu, H. Ekiz, “Sliding friction and wear behaviour of Polytetrafluroethylene and its composites under dry conditions”, Materials and Design 25 (2004), Page no. 239–245.

H. Unal, U. Sen, A. Mimaroglu, “An approach to friction and wear properties of Polytetrafluroethylene composite”, Materials and Design 27 (2006) Page 694–699.

N.V.Klaasa, K.Marcusa, C.Kellock, “The tribological behaviour of glass filled Polytetrafluroethylene”, Tribology International 38 (2005) 824–833.

David L. Burris, W. Gregory Sawyer, “A low friction and ultra low wear rate PEEK/PTFE composite”, Wear 261 (2006) Page no. 410-418.

S.Basavarajappay and G.Chandramohan, “Wear Studies on Metal Matrix Composites: A Taguchi Approach”, J. Mater. Sci. Technol., Vol.21 No.6, 2005.

Ranjit K. Roy, “Design of Experiments Using the Taguchi Approach”.