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Investigation of Fuzzy based Optimum Drilling Process in AISI SS317 Grate Material

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ABSTRACT

The modern manufacturing, machining process is one of the key in high quality manufacturing. The machining operation is to reduced in work piece and damages of tools. In this experimental study, the tool wear of the drill hole and surface roughness have been studied during the drilling operation of AISI SS317 stainless steel material. Different level of input and output parameter values has given in various cutting conditions drilled hole was investigated. Similarly, the fuzzy logical based control system has to develop in modern manufacturing techniques to identify in better surface finish and tool flank wear of selected work piece. The fuzzy based control system was developed to part of thrust force, cutting speed, feed rate and drilling parameters to expect the drilled hole number. It has been predict that error of drill hole and number of multi response regression model, using Analysis of variance (ANOVA), Response surface methodology (RSM) and ANFIS Fuzzy logical techniques. In this techniques predict a good surface finish and to identify tool wear experimentally obtained in drilled hole.

KEYWORDS

ANOVA, Drilling, Fuzzy Logic, Surface Roughness, Stainless Steel.

Introduction

The preference of machinability information, which incorporates picking the proper machining parameters of speed, feed rate and tool assume an essential part use of machine apparatus and influences the fabricating cost. Drilling is conceded in the ultimate dealing out stage prior to manufacturing and the various drilling holes have action of stress concentration. Subsequently, expanded consideration is conceivable outcomes of administration defect in creep fracture. Practical knowledge developed in years by the expert worker have to work in optimum cutting parameters of various cutting operation [1], The machining information acquired from industry were for the most part those that are as of now being utilized as a part of creation operation [2]. Basavarajappa et al. [3] examined in impact of various output values on surface roughness, burr development of drill in Al2219-15SiCp and Al2219/15SiCp-3Gr Composite material manufactured in fluid metallurgical technique. The author performed that graphitic hybrid composite display lower thrust force, material burr thickness, good surface finish. They have been contrasted with various material. Hayajneh et al. [4] performed in impact of spindle rotational speed, selected feed rate, and division of volume in drill hole of aluminum/alu-mina/graphite hybrid mixture of composition of selected thrust force and selected torque utilizing test procedures and Artificial neural network. Riaz Ahamedet et al Fuzzy rationale control (FRC) has raised as a standout amongst the most remarkable control systems. An investigation of the accessible intelligent programming tool devices for the industry demonstrates that despite the fact that there are some product applications, the devices that can actualize coordinated intelligent frameworks have not yet made it to the survival advertise [5]. Lab professionals and academic specialists more often than not utilize these esteems to lead starting tests which decrease the scan for machining parameter values [6]. Lin and Ting [7] They utilized (Tf) Thrust force and Torque input values have been measured in drilling tool Flank wear utilizing relapse display. Mahfouz et al [8] anticipated tool wear during drilled hole utilizing (FFT) of shaking a vibration contribution to Artificial neural network. Multi destinations direct program developments for optimize drilling hole opening excellence in various spiteful performance, for ex-

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ample, input parameters was indicated by Kim and Ramulu [9]. Singh et al. [10] utilized in spread Neural network system to expectation in flank wear of fast high speed steel penetrate to copper material utilizing axle as input parameters of various Speed, Feed rate, diameter of drill hole, as information parameters and greatest flank wear as output parameter in a neural system. Panda et al. [11] utilized spread neural system forecast drilling in a mild steel work piece utilizing the spindle speed, feed rate, various drill diameter, torque and chip thickness as information parameters and most extreme tool wear of mathematical system, inferred incorporation material formation as an various limitation to organize prompts good expectation of tool wear. [12,13]. The considerable measure of writing on FLC, which has showed up, is confirmation of the expanding significance of fuzzy controllers in control framework outline. Control principles can be developed and the underlying enrollment elements of fuzzy control frameworks can be generally effectively set up utilizing an extensive variety of as of now accessible methods. A numerical optimization framework has been created in Milfelner et al. [14] Reproduction and also investigated machine. In framework gathers factors of spiteful procedure a methods for automatic process and advanced optimization techniques. Ferreiro et al. [15] utilized systematic mathematical to foresee chip height to the fast drill hole produced in dried out setting on aluminum Aluminium 7075: T6. The author demonstrates to proficiency and also legitimacy of the pre-style to specter in various chip amid in drill hole to various outcomes and various information material removal strategies. Grzenda et al. [16] performed in GA optimized in profound drill hole operation during fast circumstances fabricate in metal parts. The author were inferred to projected framework has equipped for similar to the ideal representation of control profound drill hole errands on job in mechanical utilize. Li et al. [17] planned mixed knowledge observing material utilizing a combination of mathematical framework system. Kuo et al [18] connected in changed neural system was recognized in blemished sensors utilizing participation work. Panda et al. [19] investigated melded the Fuzzy logic into BPNN shows foreseeing material wear of drilling operation. The literature [20,21] inferred concealed coating of nourish framed in ANN system has ready arranged in example glowing Leonid Sheremetov et al utilizes a vulnerability show with subjective sizes of believability esteems and multi set based fluffy polynomial math of strict monotonic operations. They were broke down in lost dissemination issue. Panda. D et al [22] explored in process forecast in drill hole utilizing next engendering ANN system spiral premise work organize in Effect of utilizing expanding maximum sensors are viability for the foreseeing in drilling wear. In this paper utilizes the improvement of fuzzy logic calculation to upgrade the machining parameters in boring of SS317 material. The ANOVA trial configuration boring parameters considered are spindle speed, feed rate, HSS drill is utilized for the drilling operation to create the better surface roughness and tool flank wear in ANFIS fuzzy logic algorithm techniques.

Selection of Material Parameters

AISI SS 317 grade metal alloy composite material was used in matrix material, the present work total dimension of material is 100mm x 100mm x 5mm respectively. This material is higher hardness, stiffness, high corrosion resistance and higher thermal properties the chemical composition as shown in Table 1.

Table 1. Percentage of Chemical elements of Stainless steel 317 Material

Composition	Cr	Ni	Mo	Mn	Si	P	C	S	Fe
Percentage %	19	13	3.50	2	1	0.045	0.080	0.030	61

Experimental Design

The drilling experiment was carried out in Response surface methodology on SS 317 with high speed steel (HSS) drill bits in various diameters. The RSM experimental study is to minimize and selected for responsible input parameters or factors. The Process of input parameters is given below in table 2.

Table 2. Drilling process Input parameters

Factors	Unit	Level - I	Level – II	Level – III
Spindle speed (SS)	RPM	500	800	1000
Feed Rate (FR)	mm/min	10	12	14
Helix Angle (HA)	Degrees	25^o	30^o	-

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The drilling experimental work has been conducted in CNC drilling machine as shown in Figure 1. The capacity is 4000rpm and 2.5kW power. The surface roughness was measured in Mitutoyo subtonic tester SI 20P.

Figure 1. CNC Drilling machine Experimental Set up

Work Piece Process

Figure 2(a). Workpiece for completed Process **Figure 2(b).** HSS Drill tool

In order to identify the selected optimum cutting parameters in drilling of SS317 material, which was totally eighteen experimental design and experiments was conducted with 10mm diameter of drill tool. The drill HSS drill tool were used as shown if figure 2(b).

In order to this work given concentrated for helix angle, spindle speed, feed rate of process parameters with two levels of helix angle and three levels of feed rate three levels spindle speed have to be measured and conducted drilling process parameters shown in figure 2(a).

Result and Discussion

a) Analysis of Variance (ANOVA) for Surface Roughness

The surface roughness every experiment was measured with the Talysurf Measurement instruments.

The output of experimental results is given below the table 3. These experiments mainly focusing on roughness of the hole in each experimental output was measured in mean surface roughness shown in given table.3.

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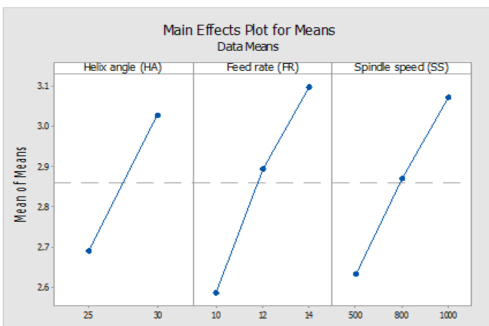
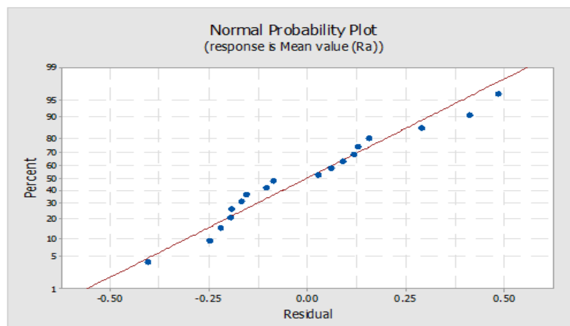
Table 3. Design of experimental results of surface roughness (Ra)

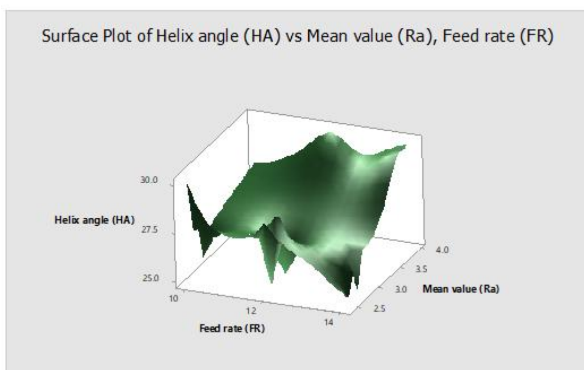
S.No	Input Parameters (DOE)			Ra1	Ra2	Ra3	Mean value (Ra)
	Helix angle (HA)	Feed rate (FR)	Spindle speed (SS)				
1	25	10	500	2.26	2.66	2.81	2.577
2	25	10	800	2.21	2.63	3.33	2.723
3	25	10	1000	2.2	2.72	3.13	2.683
4	25	12	500	2.3	2.68	3.48	2.82
5	25	12	800	2.58	2.83	3.17	2.86
6	25	12	1000	2.17	2.28	3.1	2.517
7	25	14	500	2.14	2.91	3.19	2.747
8	25	14	800	2.17	2.3	3.05	2.507
9	25	14	1000	2.61	2.77	2.97	2.783
10	30	10	500	2.18	2.37	2.68	2.41
11	30	10	800	2.18	2.39	2.79	2.453
12	30	10	1000	2.47	2.67	2.87	2.67
13	30	12	500	2.16	2.43	2.83	2.473
14	30	12	800	2.51	2.67	2.93	2.703
15	30	12	1000	3.71	3.92	4.33	3.987
16	30	14	500	2.71	2.71	2.91	2.777
17	30	14	800	3.77	3.96	4.22	3.983
18	30	14	1000	2.98	4.13	4.27	3.793



A



B



C

Figure 3. a) ANOVA design Curve b) Normal Probability residual stress of surface roughness, c) Feed rate effect and helix angle of surface in mean plot.

Figure.3 (a) and (b) is a normal probability plot of residual surface roughness that indicates various behavior of residual values. More than 95% of experimental design data of residual values are measured. Figure 3 (c) is a surface roughness 3Dimentional views based upon the rotational speed conflux the helix angle material surface smoothness. At high spindle speed and maximum helix angle of drill, in higher frictional stresses have been found to develop the rapid tool wear by the diffusion.

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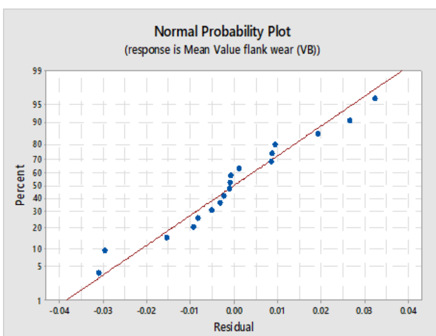
The model terms which are having in p-value is less than in 0.05 are to be considered as significant, where the p-value is 0.0038,0.0197,0.0125 are respectively. All the different three parameters are to be found in significant on the surface roughness. The R2 and adjusted R2 value are to 0.8826 and 0.8640 respectively. Because of the high spindle speed and feed rates the deformation in resistance and thermal softening in SS317 are more than more energy is required for plastic deformation of the metal.

Table 4. Design of experiment of drill flank wear

S.No	Helix angle (HA)	Feed rate (FR)	Spindle speed (SS)	Flank Wear (VB)1	Flank Wear (VB)2	Flank Wear (VB)3	Mean Value flank wear (VB)
1	25	10	500	0.1367	0.1305	0.1718	0.1578
2	25	10	800	0.1855	0.1364	0.1756	0.1682
3	25	10	1000	0.3113	0.1827	0.1718	0.2096
4	25	12	500	0.1856	0.1396	0.1766	0.1682
5	25	12	800	0.1767	0.1856	0.1768	0.1755
6	25	12	1000	0.3113	0.3127	0.1715	0.2727
7	25	14	500	0.3113	0.1966	0.1717	0.2128
8	25	14	800	0.2114	0.3113	0.1715	0.2447
9	25	14	1000	0.3013	0.3067	0.3003	0.3038
10	30	10	500	0.2132	0.1856	0.1992	0.1902
11	30	10	800	0.1516	0.1568	0.1874	0.1988
12	30	10	1000	0.1577	0.1617	0.1853	0.2013
13	30	12	500	0.1509	0.1633	0.1897	0.2014
14	30	12	800	0.1616	0.1799	0.1806	0.2064
15	30	12	1000	0.2113	0.2863	0.2887	0.2751
16	30	14	500	0.1668	0.1961	0.1898	0.2146
17	30	14	800	0.2126	0.2931	0.2923	0.2773
18	30	14	1000	0.1616	0.2866	0.3097	0.2551

A



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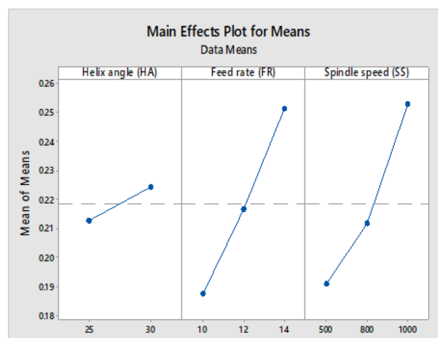

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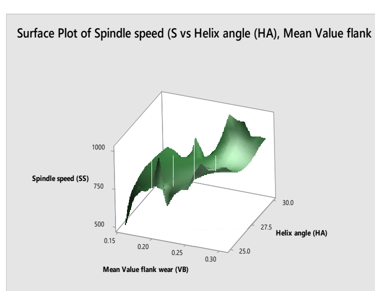

Figure. 4. a) Normal Probabilities of residual flank wear b) ANOVA design plot for flank wear c) Effect of Spindle speed and helix angle in 3D vision of flank wear.

In this flank wear session the ANOVA design plot is represented in 95% of confidence level of analyze experimental data of flank wear, it is the normal plot represents that to reduce the flank wear in a selected input parameters as

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shown in figure 4.

b) Analysis of Variance for Drill Tool Flank Wear

After the drilling hole was completed to measure the flank wear of machine vision system. There are totally four holes of flank wear to be identified in a given parameters.
were developed on the workpiece in each experiment Totally flank wear for eighteen experiments were conducted and measured in the table 4.

A Fuzzy based Modeling of Drill Hole Process

The process framework depends on connection for a selected material is investigated in surface finish in various I/P and selected drilling speed. The fuzzy particulations input and output combinations are mentioned in appeared in Table 2 and 3, individually.

Selection of Fuzzy Techniques

Selection of fuzzy procedure which is construct to produce the drill hole, Based on given input and output parameters. Sufficient skilled operator and they are as followed figure 5.

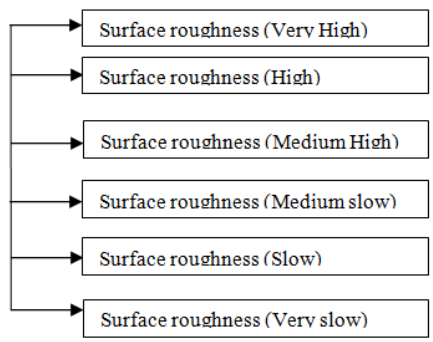

Figure 5. Fuzzy Rules Flow Chart

(ANFIS) Fuzzy Modeling

In this (ANFIS) fuzzy modeling drilling process is combines drilling process for input and output optimization membership functioning process. This technique is directly related to artificial neural network modeling process. This system (or) Interfacing process is five various layer has been used, In each layer processing of number of notes to be considered which means input parameter of present layer from the nodes in exist layers.

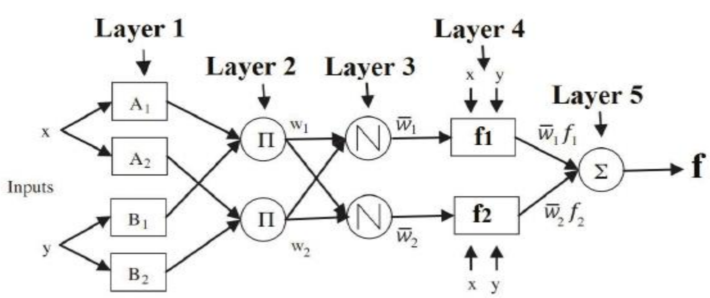

Figure 6. ANFIS Architecture design

In Figure 6 shows that ANFIS Architecture design concepts for Various input parameter function for v1, v2, d1, d2

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and O/P functions called (f). The arranged for number of design concepts layer are ANFIS input, model Fuzzification, PRODUCT LAYER, NORMALIZATION LAYER, DEFUZZIFICATION LAYER, OUTPUT LAYER.

Interface Fuzzy Logic Process

A fundamental part of fuzzy relational model has displaying is the interface framework which comprises of control technique as "IF - THEN" principles. MAMDANI and SUGENO are sorts in fuzzy derivation framework have been connected in Fuzzy techniques. In essential advancement displaying framework choose the I/P and O/P parameter of fuzzy relational are the fuzzy interface framework is intended for different data sources and single output framework. In this experiments are 3 selected input sources and single output as shown in figure.7.

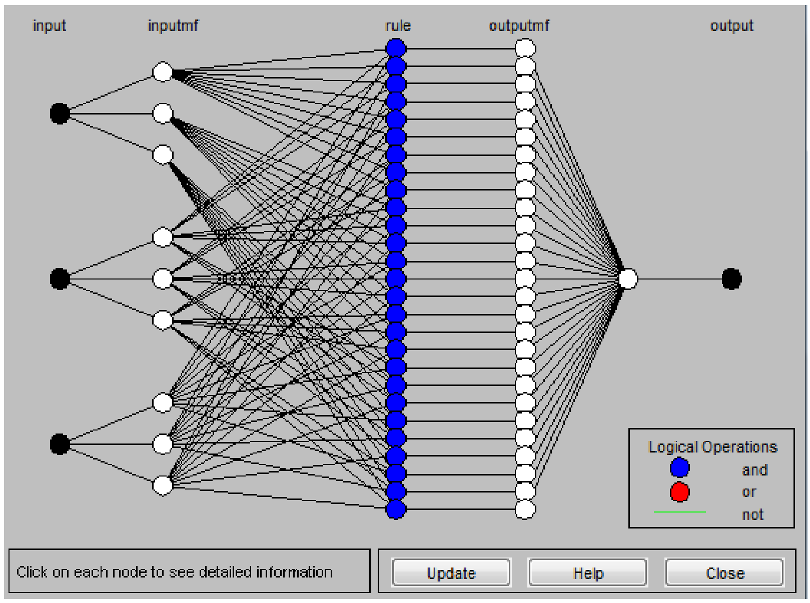

Figure 7. ANFIS Responses structure

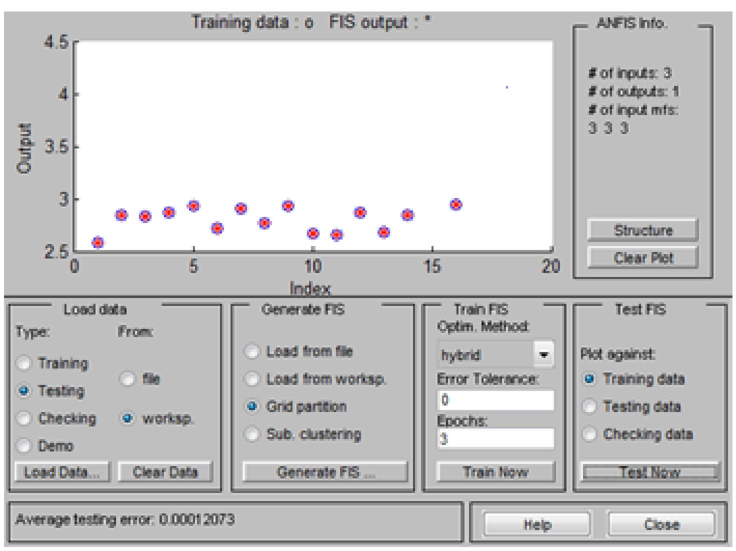

Figure 8. Training error got 3 epochs in Tri MF

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The above mentioned 18 input values which have been formed in fuzzy logical rules as shown in figure 8. The ANFIS network procedures to give the important of membership functions. It was created in ANFIS logical editing MATLAB software. Then, ANFIS a structure is developed in (RSME) purpose of zero, in higher values of error contribution is equal given in figure.8. The four types of membrane functions are developed in RMSE it has mentioned in Trap MF and Tri MF. the finally development of membership functions are framed in Tri MF has predicted better results.

The various input feed rate, speed and drilling diameter of 18 rules are loaded in C-Scan surface roughness is developed during drilling process. The figure 9. shows that 3D surface drawing shows that various input values and contribution of frame work.

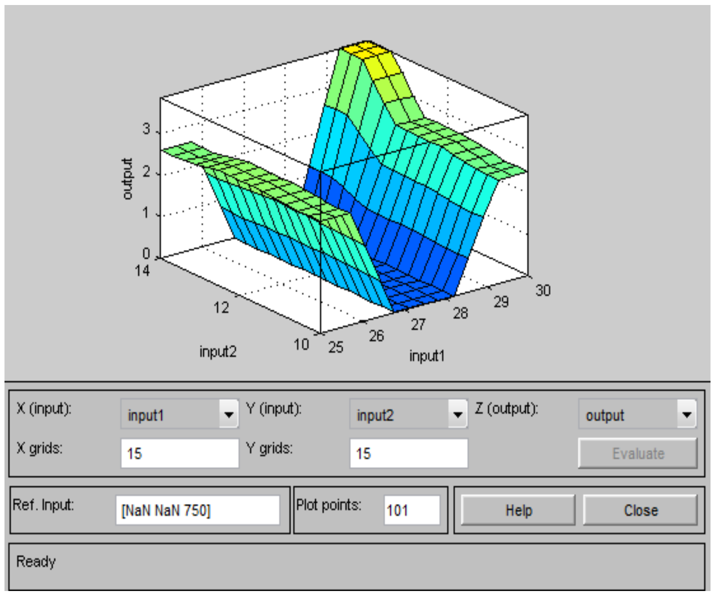

Figure 9. Effect of feed and drill diameter on surface roughness

Conclusion

In this work was executed in taguchi design of experiments and (ANFIS) Adaptive Neuro-Fuzzy Inference System in different modeling tool which is used in stainless steel material. A speed increases the surface roughness decreased to increase in helix angle of drill tool to increase in surface roughness. At the same time the speed is increasing the tool flank wear also increasing. However, Feed rate is the higher manipulate to given responsible values. It is fond that the minimum number of error. Hence ANFIS techniques are comparison of better modeling techniques in manufacturing fields. ANFIS can obtain the optimal triangular and bell shaped membership functions of the fuzzy system. A total of 50 sets of experimental data are used for training in ANFIS. After the training is completed, another 20 sets of data are used as testing data. SR values predicted by ANFIS are compared with the measurement values derived from the 20 data sets in order to determine the error of ANFIS. The error of SR values predicted by ANFIS with triangular membership functionis3.87 percent (accuracy 96.13%). In contrast, the error by ANFIS with bell-shaped membership function is2.16 percent (accuracy 97.84%). The comparison indicates that the adoption of both triangular and bell-shaped membership functions in ANFIS achieved very satisfactory accuracy.

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