iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 Issue: X Month of publication: October 2017

DOI: http://doi.org/10.22214/ijraset.2017.10013

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue X, October 2017- Available at www.ijraset.com

Use Of ANN for The Prediction of Performance of Diesel Engine Using Biodiesel

Suryawanshi Rakhi S[1], Prof. Bhosale N. P.[2]
[1, 2] *Department of E&TC Engineering Zeal College of Engineering and Research Pune, India.*

***Abstract:** The experimental investigation of performance of the Diesel engine using Biodiesel is very time consuming and costly. This project aims at use of Artificial Neural Network (ANN) to predict the performance of Diesel engine using Biodiesel. For proposed ANN model, the data required for training and testing was collected from single cylinder four stroke Diesel engines blended with biodiesel fuel and operated at different loads. Engine loads, Biodiesel blends and compression ratio were used as input parameters and break thermal efficiency and specific fuel consumption were used as performance parameters. Using some of the experimental data for training and testing, based on the back propagation algorithm ANN model was developed to predict the performance. ANN predictions results were compared with the experimental results. ANN results showed a good correlation between the predicted values and experimental values. This shows that ANN can be used as an alternative to classical modeling techniques.*
***Keywords:** Artificial Neural Networks, Engine Parameters and performance, Biodiesel, training, modelling.*

I. INTRODUCTION

In recent years, the Artificial Neural Network has used widely in all most every branches of engineering. The neural networks can be used to perform complex functions in various fields of application such as pattern recognition, control systems, robotics, forecasting, medicine, power systems, manufacturing and optimization, signal processing, social and psychological sciences. Artificial neural networks (ANN) are particularly used to solve problems which cannot be solved by the conventional modelling methods. A well-trained ANN model predicts much faster than the conventional modelling techniques. The cost and time can be tremendously reduced by using artificial neural networks (ANN).

Diesel engines are specially used for heavy duty operations such as in transportation, industry and agricultural areas. This is because of their high fuel efficiency, durability and ease of operation. Due to energy crises, diminishing petroleum reserves and environmental consequences of the exhaust gases, the alternative fuels for the diesel engines are becoming increasingly important. This leads the researchers' attention towards the Biodiesel as an alternative energy source. Various biodiesel are available everywhere and has proved to be a cleaner fuel and more environment friendly than the fossil fuels.

The use of ANN for modelling the operation of internal combustion engines is more recent progress. This has been used for the prediction of performance of diesel engine under varying conditions. Engine performance can be modelled by using Artificial Neural Networks (ANNs). This new modelling technique can be applied to estimate the desired output parameters when enough experimental data is provided.

In recent years, several researchers to use vegetable oils of Sunflower, Peanut, Soyabean, Rapeseed, Olive, Cottonseed, Jatropha, Pongomia, Rubber seed, Jajoba etc. as alternative fuel for diesel engine. Among these, palm oil is used for study because palm oil is edible oil.

II. LITERATURE REVIEW

K. Xu. et. al. [1] finds application of neural networks in forecasting engine systems reliability. The paper presents a comparative study of the predictive performances of neural network time series models for forecasting failures and reliability in engine systems. Hafner et. al. [2] uses ANN for Diesel engine control design. T. Hariprasad et. al. [3] deals with ANN modelling for the prediction of exhaust emission of Diesel engine. In this work feed forward neural network was used. The alternative fuel used was methyl esters of fish oil blended with Diesel. It was found that FFNN predicted values were very close to experimental values with very minimum percentage of error. Hidayet Qhuz et. al. [4] develops ANN technique to apply on automotive sector to minimise cost, cost and workforce waste. It was found that artificial intelligence model is an appropriate model to estimate the performance of the engine. Jitendra Panchbhai et. al. [5] deals with the ANN moelling to predict and optimize the performance of Diesel engine. The study showed that ANN can be used as alternative modelling technique. The alternative fuel used in this study was Cotton seed oil.

K. Prasad Rao at. al. [6] aims to study the optimization of performance parameters to improve diesel engine efficiency. Taguchi method had been used to multiple objectives of the optimization problem into a single objective function. A confirmatory test showed satisfactory result by ANN in MATLAB. Anant Garg et. al. [7] overviewed application of ANN in the field of engine. It is concluded that using ANN engine development time could be reduced. Srinath Pai et. al. [8] focused on the prediction of the exhaust emission, carried out for neural networks to define how input affects the output using biodiesel blends. The result showed that ANN can be efficiently used to predict the emission from the engine with about 10 % error. Jatindre Kumar [9] studied the application of Artificial Neural Network for the prediction of properties of Diesel – Biodiesel blends. A traditional statistical technique of linear regression (principle of least squares) was used to find the various properties of biodiesel blends. Also various neural networks are used to predict these properties. Then the results of linear regression model and ANN model are compared for the validation.

III. EXPERIMENTATION AND TEST PROCEDURE

The experimental tests were carried out on a computerized Variable Compression Ratio (VCR) engine setup. The engine is single cylinder, four strokes, water cooled, Kirolskar TV1 Diesel engine. The block diagram of engine and actual test rig is as shown in fig. 1 and fig. 2.

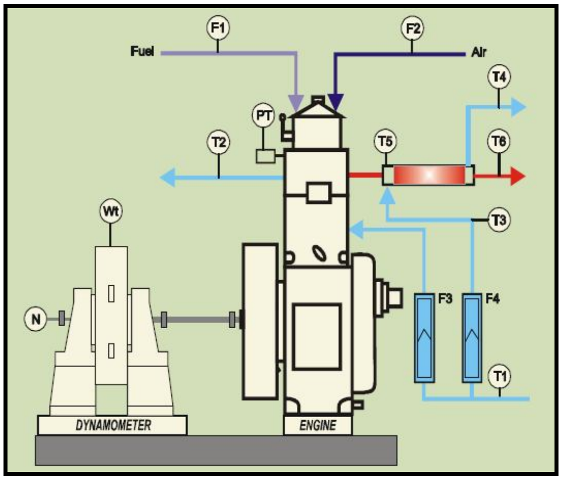


Fig. 1: Block Diagram of Diesel Engine [10]

Fig. 2: Actual Setup of Engine Test Rig. [10]

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue X, October 2017- Available at www.ijraset.com

The dynamometer used is eddy current dynamometer which is coupled to the engine crankshaft. The load is applied on engine by using this dynamometer. The specification of test engine is as shown in table 1.

TABLE I. SPECIFICATION OF TEST ENGINE [10]

Engine Type	Kirloskar Made, VCR Diesel Engine test setup (Computerized), Single Cylinder, Four Stroke.
Bore	87.5 mm
Stroke	110 mm
Rated Power	3.5 KW at 1500 RPM
Compression Ratio	17.5 (Modified to VCR engine CR range 12 to 18)
Dynamometer	Type eddy current, water cooled, with loading unit
Fuel tank	Capacity 15 lit with glass fuel metering column

The engine is constant speed engine runs always at 1500 RPM. The data acquisition system captures the signals through various sensors mounted on the engine. The computer shows many readings such as combustion pressure and crank angle, speed, load, various temperatures, fuel flow rate, air flow rate, water flow rate etc. The control panel has various indicators are fitted which controls load, water flows etc. The reading can be directly measured on the control panel. Windows based software Engine Soft is used for data acquisition, calculation, graphs, results sheet. Various sensors are mounted on the engine to measure parameters like rpm, load, crank angle; Piezosensors of range 5000 PSI, with low noise cable is used for pressure measurement, thermocouple to measure temperatures etc.

The input parameters and levels used in this study for the experimental analysis are as shown in table 2.

TABLE II. INPUT PARAMETERS MATRIX FOR EXPERIMENTATION

Parameters	Levels			
	1	2	3	4
Compression Ratio	15	16	17	-
Load (Kg)	0	6	8	10
Biodiesel (%)	0	20	30	-
Diesel Fuel (%)	100	80	70	-

The following procedures were adapted during the experimentation.

A. Initially the engine was run with pure Diesel for a compression ratio of 17. The engine was run at 0 Kg, 6 kg, 8 Kg and 10 Kg Load.

B. After reaching to steady state condition the output parameters like brake thermal efficiency and sp. fuel consumption were measured.

C. Then the engine was run for the compression ratio of 15 and 16 respectively. The same parameters were measured again.

D. Next the engine was run with blends of biodiesel B 20 and B30. The same sets of experimentation were repeated for B20 and B30.

E. Again the performance parameters were measured as that of Diesel fuel.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue X, October 2017- Available at www.ijraset.com

IV. ARTIFICIAL NEURAL NETWORK

Artificial neural networks (ANN) have been developed as generalizations of mathematical models of biological nervous systems. A first wave of interest in neural networks (also known as connectionist models or parallel distributed processing) emerged after the introduction of simplified neurons by McCulloch and Pitts (1943).

A. ANN Apporach

The various kinds of ANN approaches are available. Among these approaches Back Propagation (BP) approach is used for the study. This network is divided into three parts : Input layer, Hidden layer and Output layer. In this study one input layer, one hidden layer and one output layer is used. Each layer has a certain number of components which is called as neurons or nodes, which is connected to each other. Each neuron is linked to others with communication links accompanied by linking weight. The signals pass through neurons on the linking weights. Each neuron takes multiple inputs from other neurons in accordance with their linking weights and may generate an output signal which can also be generated by other neurons. The structure of ANN is as shown in fig. 3.

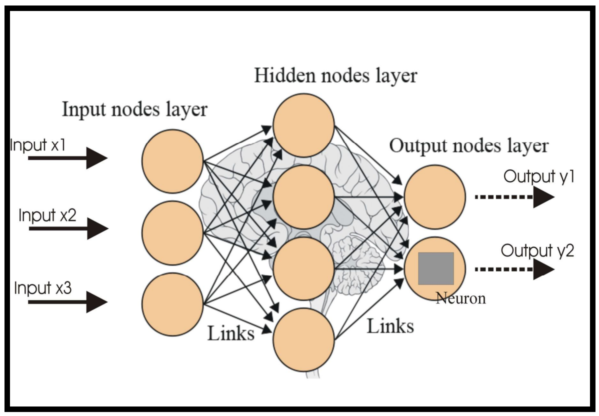


Fig. 3: Basic Structure of ANN [5]

In BP Method, the difference between the network output value and desired output value is calculated. This difference is then compared with the previously determined difference. The error is then calculated in output layer. This error is propagating backward to updates the link in the input layer. BP algorithm minimizes the error by updating the weights and thus improves the performance of the network. The training is stopped when the tasted values of mean square error starts increasing. The estimated performance is tasted by using the formula as follows.

$$\mathrm{MSE}\ (\%) = \frac{1}{n}\sum_{i=1}^{n}(E_i^2 - N_i^2) \qquad (1)$$

Where E_i is experimental value of i^{th} pattern, N_i is the predicted value of i^{th} pattern and n is the number of patterns. In the present study, for developing the ANN model, the data obtained from conducting the experimental study were used. The network was subjected to two states, training and testing. In training the network is trained to get the output values according to the input provided. In testing process, the network is tasted to stop and save the training data and is used to estimate the output. Here training sets were created by randomly selecting 70 % of data obtained by experimentation and the remaining 30 % of data for testing purpose. To enable the use of experimental data into ANN structure, normalizing process was conducted. The formula used for normalizing the data is as follows.

$$X_N = 0.8 \times \left[\frac{X_R - X_{min}}{X_{max} - X_{min}}\right] + 0.1 \qquad (2)$$

MATLAB is used for ANN study. Back propagation (BP) algorithm, Levenberg - Marquardt Back propagation (TRAINLM), training functions were used for the ANN structure. LOGSIG was preferred as the transfer function. The ANN structure used in the study is presented in fig. 4.

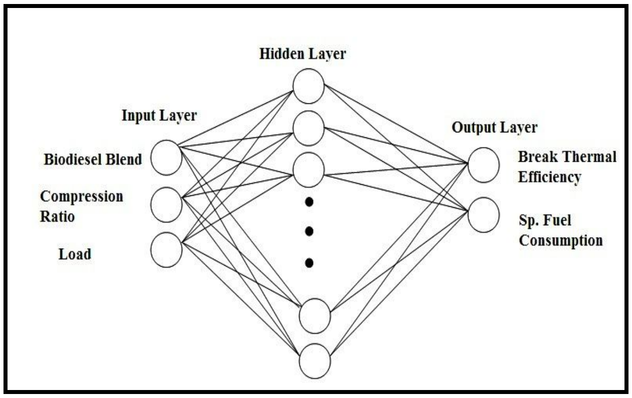


Fig. 4: Architecture of ANN Model

One input layer, one hidden layer and one output layer were selected for the study. The input values are load, compression ratio and percentage of biodiesel blend and brake thermal efficiency and specific fuel consumption are the output values. MSE was used as performance index for TrainLM algorithm and is calculated as shown in eq.1.

V. RESULT AND DISCUSSION

A. Break Thermal Efficiency

R values of training, validation data of ANN created in the study for brake thermal efficiency is shown in fig. 5.

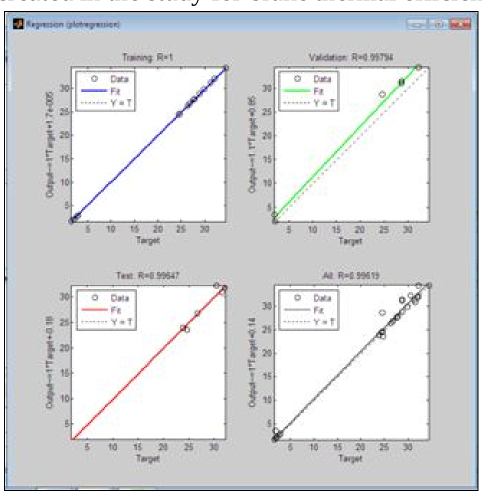


Fig. 5: R Values of Training and Validation for Brake thermal Efficiency

Also, the comparison of experimental values and predicted values through ANN is as shown in fig. 6 to fig. 9. Fig. 6 gives the result of variation of thermal efficiency (Experimental values and predicted value) with respect to percentage change in Biodiesel blends. The graph also shows the thermal efficiency for the varying compression ratio.

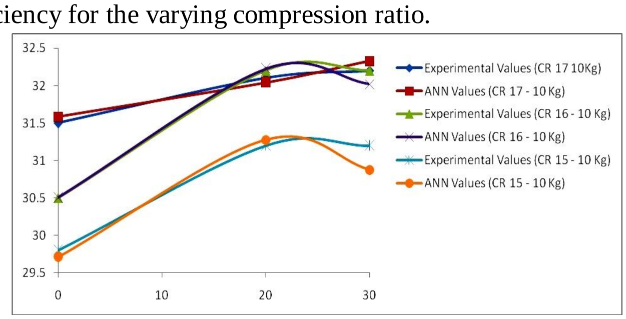


Fig. 6: Experimental values and Predicted Values Vs Blends for 10 kg Load (Br.Th.Eff.)

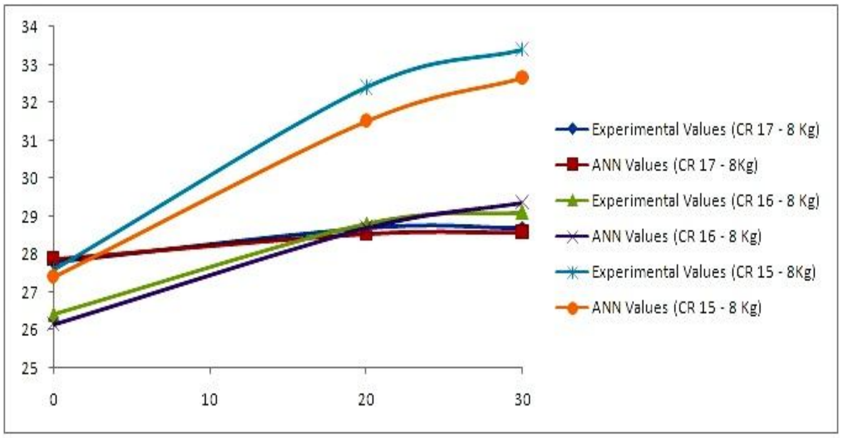


Fig. 7: Experimental values and Predicted Values Vs Blends for 8 kg Load (Br.Th.Eff.).

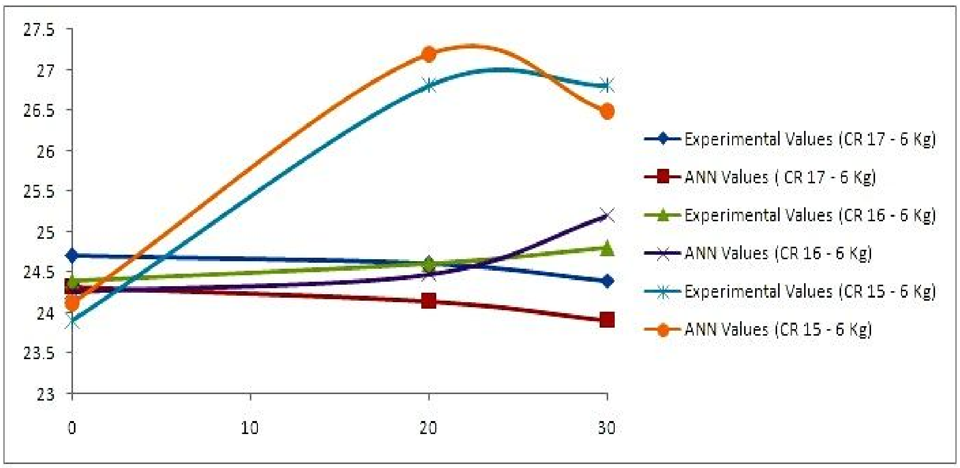


Fig. 8: Experimental values and Predicted Values Vs Blends for 6 kg Load (Br.Th.Eff.).

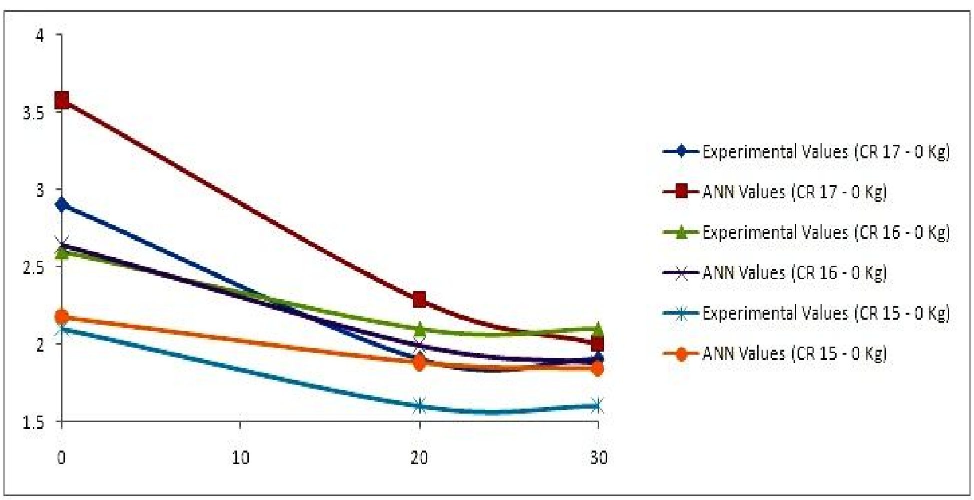


Fig. 9: Experimental values and Predicted Values Vs Blends for 0 kg Load (Br.Th.Eff.).

B. Specific Fuel Consumption

R values of training, validation data of ANN created in the study for specific fuel consumption (SFC) is shown in fig. 10.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue X, October 2017- Available at www.ijraset.com

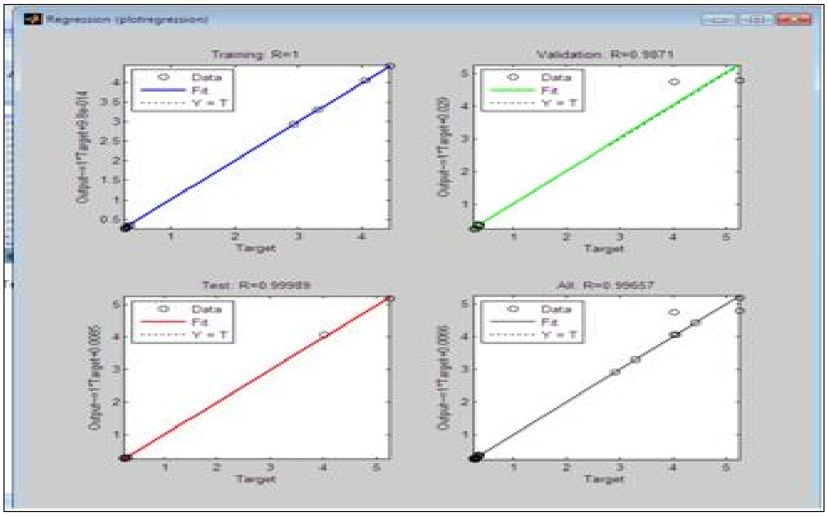


Fig. 10: R Values of Training and Validation for Specific Fuel Consumption

Fig. 11 to fig. 14 shows the variation of Sp. Fuel Consumption with respect to fuel blend. It also shows the experimental and predicted valued of ANN for various compression ratios and loads.

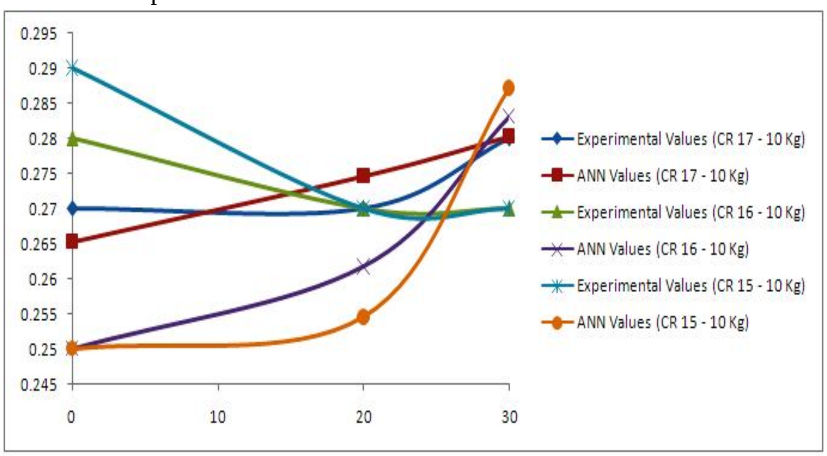


Fig. 11: Experimental values and Predicted Values Vs Blends for 10 kg Load (SFC).

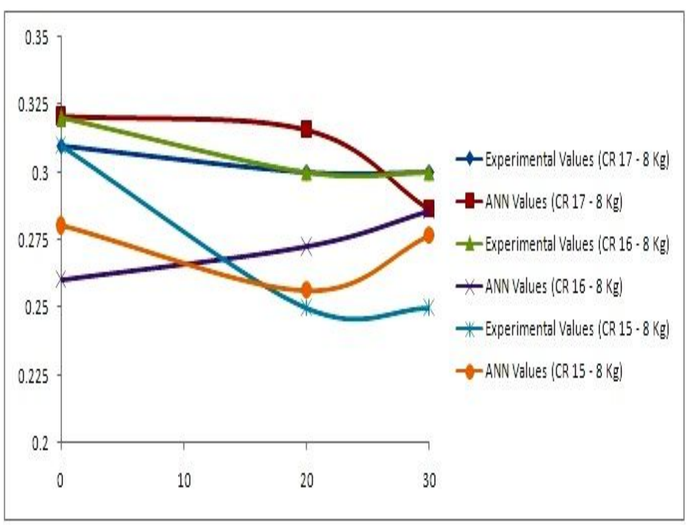


Fig. 12: Experimental values and Predicted Values Vs Blends for 8 kg Load (SFC).

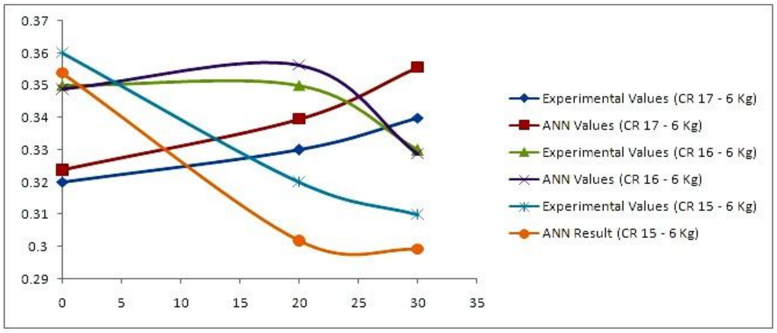


Fig. 13: Experimental values and Predicted Values Vs Blends for 6 kg Load (SFC).

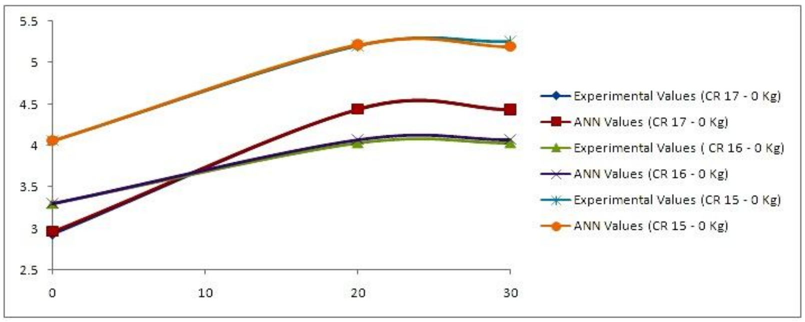


Fig. 14: Experimental values and Predicted Values Vs Blends for 0 kg Load (SFC).

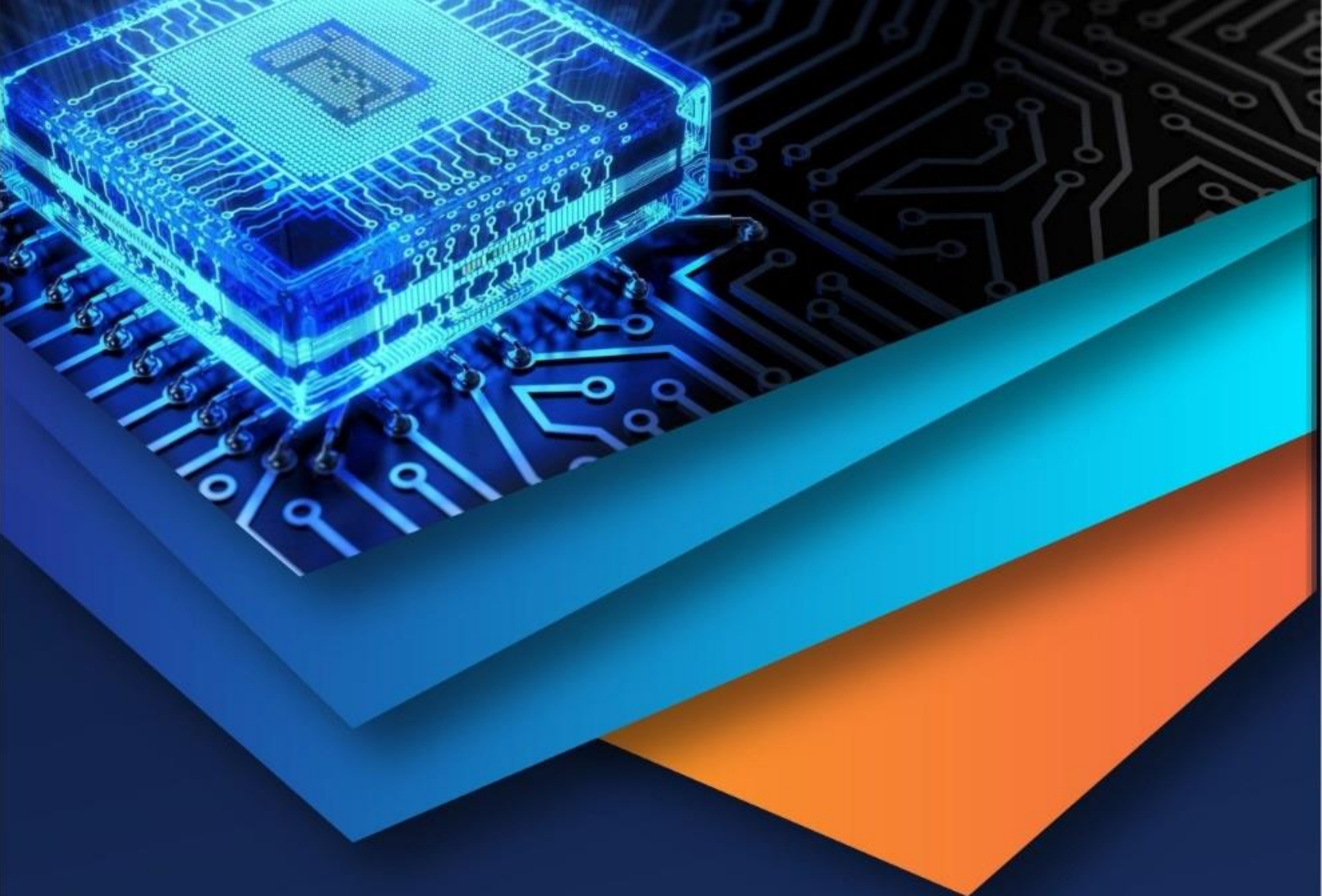
VI. CONCLUSION

An ANN approach was applied by using the data obtained by experimentation. Break thermal efficiency and specific fuel consumption in diesel engine were tried to predict by using ANN. These performance parameters were predicted for various compression ratio and loads for Diesel fuel, B20 and B30 Blends.

ANN training was performed by randomly selecting 70 % of experimental data and remaining 30 % data were utilized for testing purpose. From the results obtained, it is observed that the experimental values were substantially closed to the ANN predicted values. Hence it is concluded that ANN can be used for the prediction of performance of Diesel engine at various operating conditions and variety of fuel blends. Actual experimentation consumes time and it is costlier also. So ANN approach is a better technique which saves time and reduces cost of experimentation.

REFERENCES

[1] K. Xu, M. Xie, L.C. Tang, S.L. Ho, “Application of neural networks in forecasting engine systems reliability”, Appl. Soft Computing 2 (2003) pp. 255–268.
[2] M. Hafner, M. Schu¨ ler, O. Nelles, R. Iserman, “Fast neural networks for Diesel engine control design”, Control Eng. Pract. 8 (2000), pp. 1211–1221.
[3] T. Hariprasad, K. Hema Chandra Reddy, and M. Muralidhar Rao, “Performance and exhaust emissions analysis of a diesel engine using methyl esters of fish oil with artificial neural network aid”, International journal of engineering and technology 2.1 (2010), 23.
[4] Hidayet Oğuz, Ismail Sarıtas, and Hakan Emre Baydan, “Prediction of diesel engine performance using biofuels with artificial neural network”, Expert Systems with Applications 37.9 (2010), pp. 6579-6586.
[5] Jitendra S. Pachbhai, Prof. M. M. Deshmukh, Ravindra R. Dhanfule, “Application of ANN to optimize the performance of CT engine fuelled with cotton seed oil”, International Journal of Emerging Technology and Advanced Engineering, Volume 4, Issue 6, (2014), pp. 351-358.
[6] K. Prasada Rao, R. Umamaheshwara Rao, S. Ravibabu, Dr. V. Rambabu, “Optimiztion of performance parameters of Diesel engine using biofuels”, International Journal of Thermal Technologies, Vol. 3, No. 3, (2013), pp. 85-91.
[7] Anant Garg, Parag Dewan, Mukesh Saxena, “Artificial Neural netwrok based methodologies for optimization of engine operations”, International Journal Scientific and Engineering Reseach, Vol. 3, Issue 5, (2012), pp. 1-5.
[8] Srinath Pai , Krishnaprasad , Dr. Abdul Sharief , Dr. Shiva kumar , Dr. Shreeprakash B., “Emission Analysis of a Diesel Engine Using ANN – A Review”, National Conference on Advances in Mechanical Engineering Science, pp. 123-129.
[9] Jatinder Kumar, Ajay Bansal, “Application of Artificial neural netwrok to predict properties of Diesel-Biodiesel Blends”, Kathmandu University Journal of Science, Engineering and Technology, Vol. 6, No. II, (2010), pp. 98-103.
[10] VCR Engine test setup Instructional Manual, Apex Innovation (2014).



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY