International Journal of Scientific Engineering and Science
Volume 2, Issue 3, pp. 43-45, 2018. ISSN (Online): 2456-7361

Online Top Composition Prediction of a Distillation Column Using Feedforward Neural Network

Nasser Mohamed Ramli[1], Bawadi Abdullah[1]
[1]Chemical Engineering Department, Faculty of Engineering, Universiti Teknologi PETRONAS, Bandar Seri Iskandar, Perak, Malaysia-32610

Abstract*—The development of neural network prediction had widely discovered by the industrial world nowadays. The efficiency of predicting and manipulating the outcome of the input based on the given functions makes neural network favourable. Neural Network which inspired by the brain neural system itself also capable of dealing with the non-linear functions which make it suitable for controlling complex operation units such as distillation column. By the mean of study, this paper will be looking into feed forward neural network prediction. The main focus is to validate the efficiency of feed forward neural network in producing the expected composition as the output. The research will be conducted step by step by firstly gathering the relevant data from the distillation column. It will then be proceed with data analysis and validation of each component. This study will utilized the MATLAB software to produce the expected results. The study is expected to come with persuasive results on the effectiveness of feed forward neural network prediction.*

***Keywords*—** *Online prediction; neural network; distillation column*.

I. INTRODUCTION

Neural network prediction is one of the type of process model of the column. The network uses a different approach of modelling process behaviour as the history of the process phenomena becomes unnecessary. It is taught to replicate a process by a 'training' command with necessary data regarding the targeted subject. The network creates its own model based on the introduced input and output data during the training and optimization process. Model that has being created can use to predict the output for a given input [1]. In short, the network is capable of handling complex data such as from chemical process, manufacturing, or commercial that mostly has algorithm but with high amount of variables [2].

Feed forward neural network is one of the simplest type of neural network. Feed forward optimize the mechanism of back propagation which referred to gradient computations for nonlinear multilayer network. This type propagations has a typical structure of network. The network is consist of three basic layers which are; input, output, and hidden layer. Each layer is connected to each other with respective arrangement. The number of each layer is depended on the type of component that is to be examined and the transfer function that is used. Back propagations can be manipulated with three transfer function; pure linear, log-sigmoid, and tan-sigmoid. [3].

In oil and gas industry, the urge of maintaining product values on quality is highly depended on the efficiency of the equipment. One of the significant units in oil and gas refinery plant is distillation column. Distillation column which operates to recover n-butane from a stream is highly important as it determine the quality of the gas produced. The current practice quality control for a column usually takes one day for lab sampling and analysis. Thus, an alternative approach of using neural network prediction is subsequently recommended [4].

II. METHODOLOGY

An overview study of the research is conducted. The study mainly about neural network, types of the network, the purpose of the network, background study on distillation column, and MATLAB software.

A problem statement is to be raise to create a clear objective of the research. The problem statement is made based on literature review and other work by previous researches.

Data gathering and organizing: Data for distillation column is obtained. The data consist of the information of major component of a distillation column such as C3, n-C4, i-C4, i- C5, and n-C5.

Neural Network construction: Neural network m-file is developed in a MATLAB software. All of the important algorithm regarding neural network is taken into account.

Result which will be produced by MATLAB is analysed and justified. The result will justify the effectiveness of neural network control application in a distillation column.

III. RESULTS AND DISCUSSION

The research has been conducted for not partitioned data set. MATLAB and MICROSOFT EXCEL had been used to display the related results

A. Neural Network Development on C3,i-C4, n-C4 and n-C5 (without partitioning)

Based on the trial and method, it has been found that the feed forward neural network control for without partitioning data arrangement is highly compatible with tan sigmoid transfer function for all input, hidden layer, and output. This because, the transfer functions arrangement shows the best results as compared to the other arrangement

Neural Network for C3 Output
Optimum number of neuron = 30
Maximum number of epochs set = 100

International Journal of Scientific Engineering and Science
Volume 2, Issue 3, pp. 43-45, 2018. ISSN (Online): 2456-7361

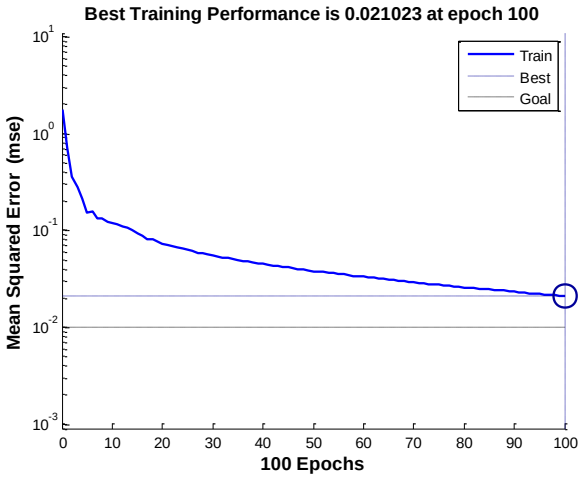

Fig. 1. MSE verses Epochs for C3 at number of neuron in the hidden layer =30, maximum epochs set = 100.

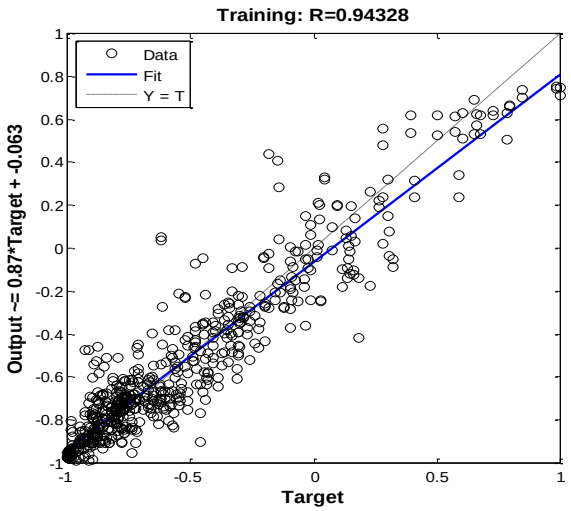

Fig. 2. Regression for Propane at number of neuron in the hidden layer= 30, maximum epochs set = 100.

Neural Network for i-C4 Output
Optimum number of neuron = 40
Maximum number of epochs set = 100

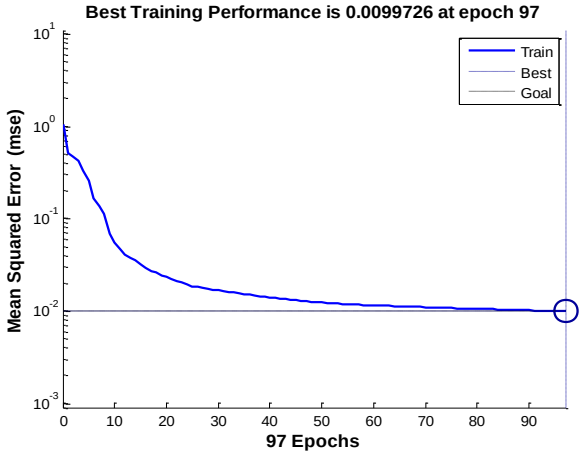

Fig. 3. MSE verses Epochs for i-C4 at number of neuron in the hidden layer=40, maximum epochs.

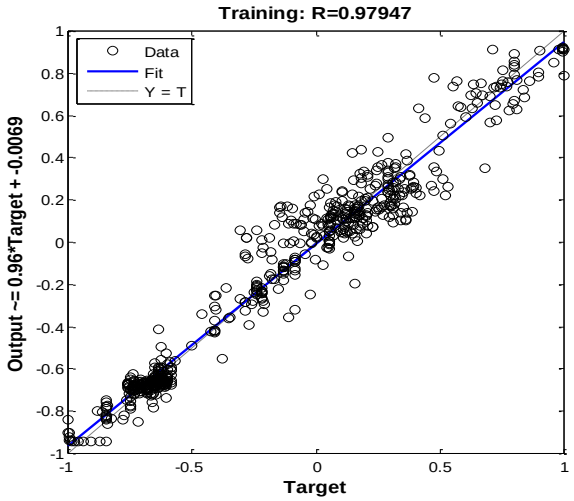

Fig. 4. Regression for i-C4 at number of neuron in the hidden layer = 40, maximum epochs set = 100.

Neural Network for n-C4 Output
Optimum number of neuron = 30
Maximum number of epochs set = 100

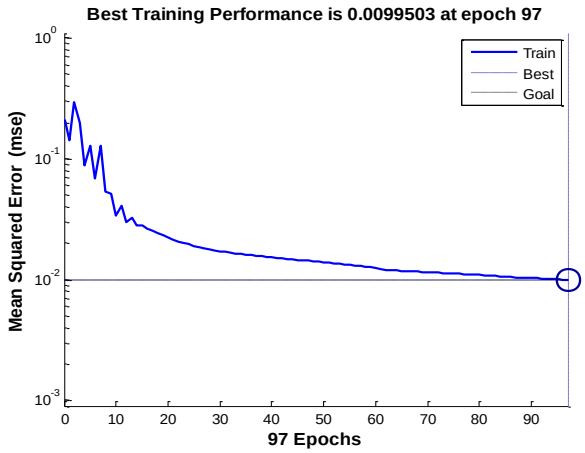

Fig. 5.MSE verses Epochs for n-C4 at number of neuron in the hidden layer =30, maximum epochs set = 100.

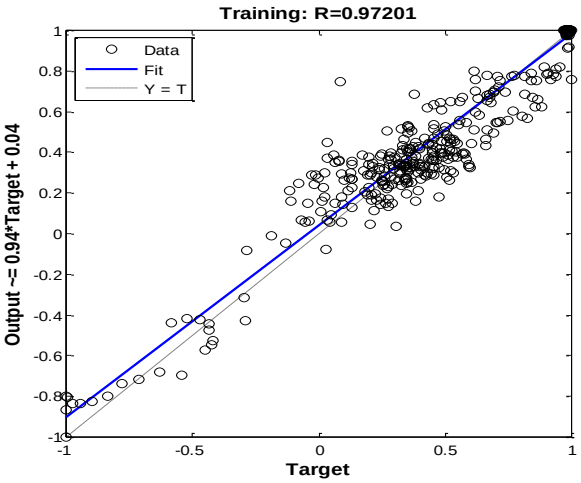

Fig. 6. Regression for n-C4 at number of neuron in the hidden layer = 30, maximum epochs set = 100.

Neural Network for n-C5 Output
Optimum number of neuron = 20
Maximum number of epochs set = 100

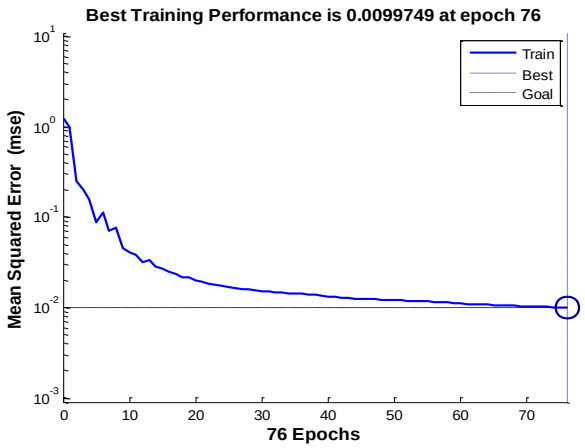

Fig. 7. MSE verses Epochs for n-C5 at number of neuron in the hidden layer =20, maximum epochs set = 100.

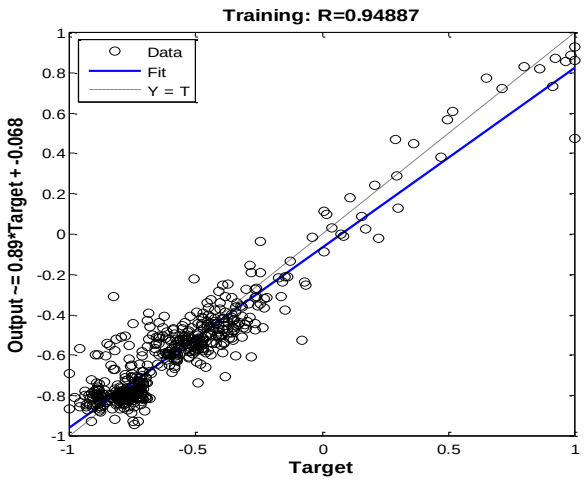

Fig. 8. Regression for n-C5 at number of neuron in the hidden layer = 20, maximum epochs set = 100.

Neural Network for i-C5 Output
Optimum number of neuron = 33
Maximum number of epochs set = 100

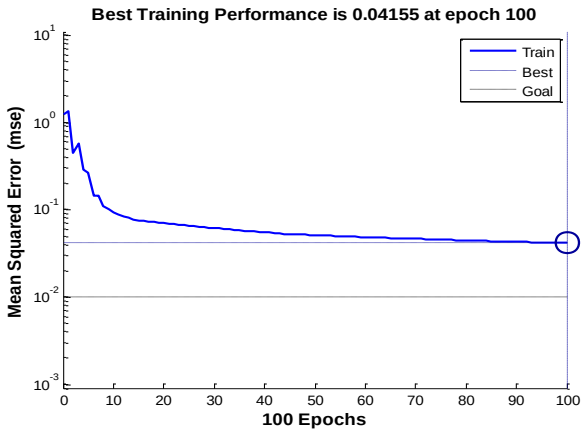

Fig. 9. MSE verses Epochs for i-C5 at number of neuron in the hidden layer =33, maximum epochs set = 100.

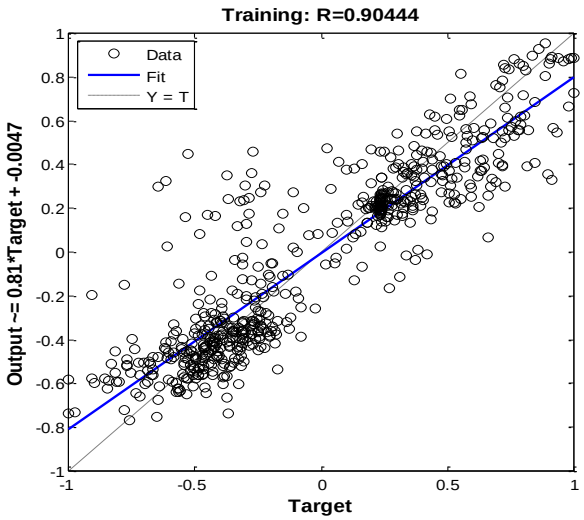

Fig. 10. Regression for i-C5 at number of neuron in the hidden layer = 33, maximum epochs set = 100.

All of the result is produced by trial and error method. The number of hidden layer is manipulated in order to obtain the best result. A good result is determined by low RMSE value and high R value (approaching to 1).

IV. CONCLUSION

Through the process, feed forward neural network control had shown a promising result. It has proven itself to be a good prediction for a distillation column by observing the results in term of Root Mean Square Error (RMSE) value and Regression value of actual against simulated data.

REFERENCES

[1] N. Sharma and K. Singh "Model predictive control and neural network predictive control of TAME reactive distillation column," *Chemical Engineering and Processing: Process Intensification*, vol 3, issue 8, pp. 104-116, 2012.

[2] Leslie Smith, "Centre of Cognitive and Computational," Neuroscience. Department of Computing and Mathematics, University of Stirling 3rd ed. Lehigh, United State of America, 2007.

[3] B. L. Yeap, D. I. Wilson, G. T. Polley, and S. J. Pugh, "Retroftting crude oil refinery heat exchanger networks to minimize fouling while maziming heat recovery," ECI Conference 2013: The Berkeley Electronic Press, 2003.

[4] N. Mohamed Ramli, M. A. Hussain, B. Mohamed Jan, and B. Abdullah, "Composition Prediction of a Debutanizer Column using Equation Based Artificial Neural Network Model," *Neurocomputing*, vol. 2, issue 3, pp. 87-97, 2014.

[5] B. M. Åkesson and H. T. Toivonen, "A neural network model predictive controller" *Journal of Process Control*, vol. 16, issue 9, pp. 76–88, 2006.

[6] S. K. Karacan, "Dynamics and control simulation of a debutanizer column using Aspen HYSYS," 2nd ed. California, United State of America, 2006.

[7] F. G. Martins and M. A. N. Coelho "Application of Feedforward Artificial Neural Networks to Improve Process Control of PID Controller," 1st ed. Los Angeles, United State of America, 2000.