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Prediction of TBP, EFV Distillation Data From ASTM Data by Using Semi-Empirical Model & Correlation of These Data by Using Artificial Neural Network (ANN)

J S joshi[1], S. A. Puranic[2]

[1]Research scholar and Emeritus fellow sponsored by AICTE
[2]L.D. Engineering, Ahmedabad, Gujarat, India

***Abstract*: This paper is about the prediction of TBP, EFV distillation data from ASTM distillation data by using semi-empirical model. The correlation of these data is done by designing of Artificial Neural Network (ANN). Furthermore, the designed ANN could be used for determining the percentage of kerosene in blend of petrol and kerosene.**

***Keywords*: prediction of TBP, EFV data, semi-empirical model, Artificial Neural Network, adulteration of kerosene in petrol**.

1. INTRODUCTION

The prediction of TBP and EFV data from ASTM data is very discussable matter because this data is used in designing of the atmospheric distillation column and vacuum distillation column for different petroleum products. Furthermore, to evaluate TBP and EFV data is time consuming and tedious. There are lots of mathematical models available, like Riazi model etc. The Riazi model is a non linear model which could be used for prediction of these data. Now according to Edmister’s approach the mathematical modelling for prediction of these data is semi-empirical, i.e. at least one important observation like 50% distillation cut temperature experimental data is required. This semi-empirical model is giving good results compared to other models like Riazi model etc. The predicted TBP data could be correlated by Artificial Neural Network.

The Artificial Neural Network (ANN) is a computational method inspired by the natural neurons. One type of network sees the nodes as ‘artificial neurons’. These are called artificial neural networks (ANNs). Natural neurons receive signals through *synapses* located on the dendrites or membrane of the neuron. When the signals received are strong enough (surpass a certain *threshold*), the neuron is *activated* and emits a signal though the *axon*. This signal might be sent to another synapse, and might activate other neurons.

These basically consist of *inputs* (like synapses), which are multiplied by *weights* (strength of the respective signals), and then computed by a mathematical function which determines the *activation* of the neuron. Another function (which may be the identity) computes the *output* of the artificial neuron (sometimes in dependence of a certain *threshold*). ANNs combine artificial neurons in order to process information. The higher a weight of an artificial neuron is, the stronger the input which is multiplied by it will be. Weights can also be negative, so we can say that the signal is *inhibited* by the negative weight. Depending on the weights, the computation of the neuron will be different. By adjusting the weights of an artificial neuron we can obtain the output we want for specific inputs. But when we have an ANN of hundreds or thousands of neurons, it would be quite complicated to find by hand all the necessary weights. But we can find algorithms which can adjust the weights of the ANN in order to obtain the desired output from the network. This process of adjusting the weights is called *learning* or *training* . For learning or training the network, different functions, topology, accepted values and the learning algorithms are used.

2. MATERIAL AND METHOD

2.1. Materials:

The petrol and kerosene are used to determine the ASTM data. For determining the ASTM data, the blends of different proportions are prepared like 100% petrol, 90% petrol and 10% kerosene, 80% petrol and 20% kerosene, 70% petrol and 30% kerosene, 60% petrol and 40% kerosene.

2.2. Methodology and Mathematical modelling:

The ASTM D86 methodology is used for determining ASTM distillation data of all these above mentioned blends. These ASTM distillation curves are used to predict TBP, EFV data according to Edmister's approach of mathematical modelling. Edmister's approach of mathematical model is semi-empirical i.e. at least one important observation like 50% distillation temperature is required. Base on 10% to 90% distillation range, slope is determine for ASTM distillation curve, which is co-related graphically to % TBP distillation slopes (10% to 90%)/ also EFV distillation slopes, and 50% distillation temperature point accordingly. Based on these knowledge TBP/EFV/ASTM curves can be predicted and vice versa. Out of these three curves experimental data for the one curve is essential and remaining two curves then can be predicted. Obtaining experimental data TBP/EFV be time consuming and tedious. On the country obtaining ASTM data is relatively easy.

2.3. Correlation of data through designing of Artificial Neural Network (ANN):

For correlating data, Artificial Neural Network (ANN) is designed by using MATLEB software. The feed forward neural network is designed with two neurons and two layers. For training the network LM algorithm is used. The sigmoid function is used for output (because output function is an identity (output=activation)) means neurons are linear. For designing the ANN input is predicted TBP data which are predicted from model and output is percentage of kerosene in blend of petrol and kerosene. The TBP data from ANN is used to predict the ASTM data by model and then it is correlated with experimental ASTM data.

By using ANN, TBP data is predicted and, from this TBP data, ASTM data is predicted by using the semi-empirical model. This predicted ASTM data is correlated with experimental ASTM data, which is shown in figure (3.a, 3.b, 3.c, 3.d, 3.e).

The EFV data is predicted from experimental ASTM data is experimental approach and EFV data predicted from predicted ASTM data (which is predicted from TBP data) is predicted approach, which is shown in figure (1.a, 1.b, 1.c, 1.d, 1.e).

3. RESULT AND DISCUSSION

The experimental and predicted approach of EFV from semi-empirical model is shown in figure (1.a, 1.b, 1.c, 1.d) The correlation of experimental and predicted data of ASTM is shown in figure (2.a, 2.b, 2.c, 2.d). The TBP data which is output of ANN network is used to predict the ASTM data from semi-empirical model is correlated with experimental ASTM data. This is shown in figure (3.a, 3.b, 3.c, 3.d, 3.e). These ANN network is also gives the percentage of kerosene in blends of petrol and kerosene. The table.1 is shows the output values of percentage kerosene in blend of petrol and kerosene. The output of ANN is very accurate so this designed network could be used to determine the percentage kerosene in blend of petrol and kerosene with accuracy of 0.001 percentage of kerosene.

4. CONCLUSSION

To evaluate the TBP and EFV data experimentally is time consuming and tedious. So it is required to give easier way by which the TBP and EFV data could be evaluated. According to the Edmister's approach the mathematical modelling is semi-empirical i.e at least one experimental data of 50% ASTM distillation temperature is required. And by using this semi-empirical model the experimental approach and predicted approach of EFV and correlation of ASTM are shown in figure (1.a, 1.b, 1.c, 1.d, 1.e) and figure (2.a, 2.b, 2.c, 2.d, 2.e) respectively which is giving good result. So this semi-empirical model could be used to predict the EFV and TBP data only from one ASTM experimental curve.

Furthermore, the predicted ASTM from output of ANN is correlated with experimental ASTM in figure (3a, 3.b, 3.c, 3.d, 3.e).

This designed ANN is also used to identify percentage of kerosene in blend of petrol and kerosene. So this designed network could be used for finding the adulteration of kerosene in petrol which also shown in Table 1.

ACKNOWLEDGEMENT

I am thankful to give me kind guidance regarding this subject to my guide Dr. S. A. Puranic and all faculties of L.D. Engineering, Ahmedabad, Gujarat, India. I am also thankful to Dr. C. M. Patel to give me knowledge regarding the ANN and all the concerned students of SVNIT, Surat, Gujarat, India. I am also thankful to lab assistants of L.D engineering, Ahmedabad, Gujarat, India.

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APPENDIX – A

List of Figures:

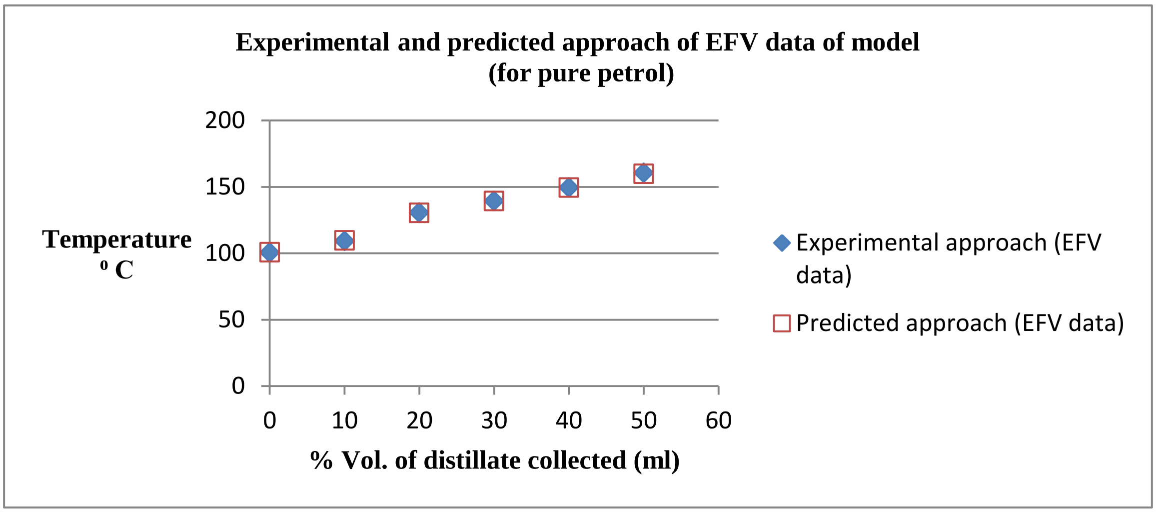


Fig. 1.a Experimental and predicted approach of EFV data of model (for pure petrol)

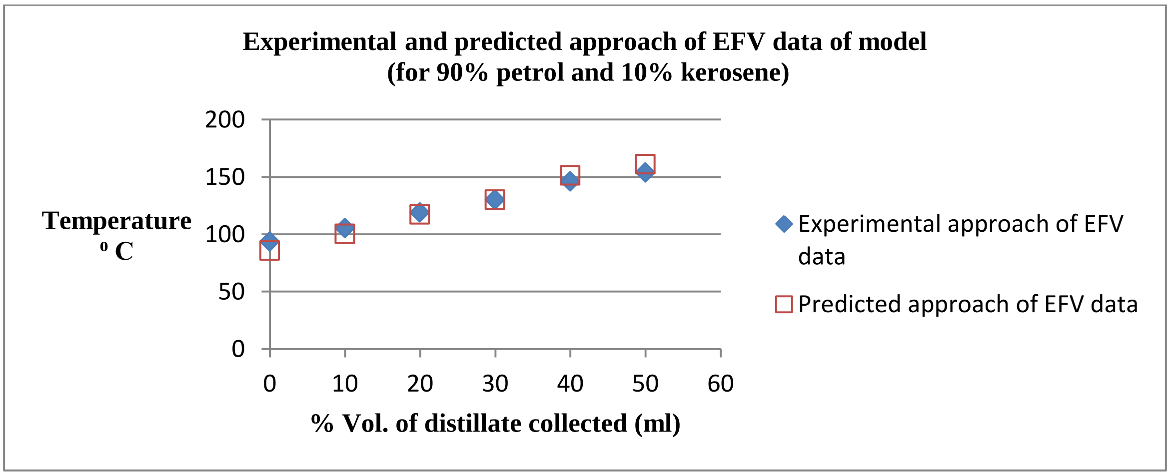
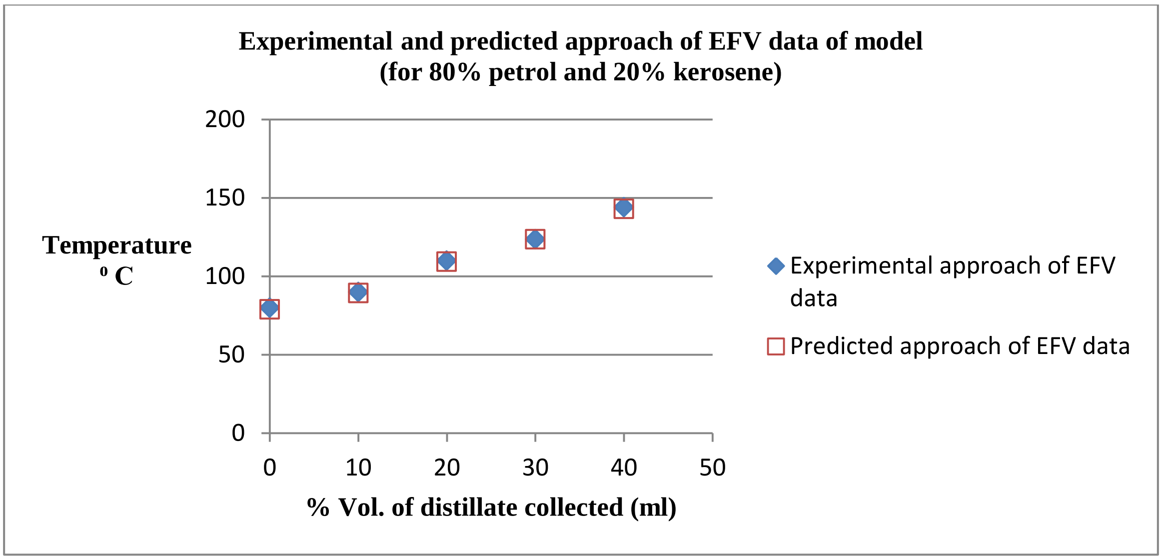


Fig. 1.b Experimental and predicted approach of EFV data of model (For 90% petrol and 10% kerosene)



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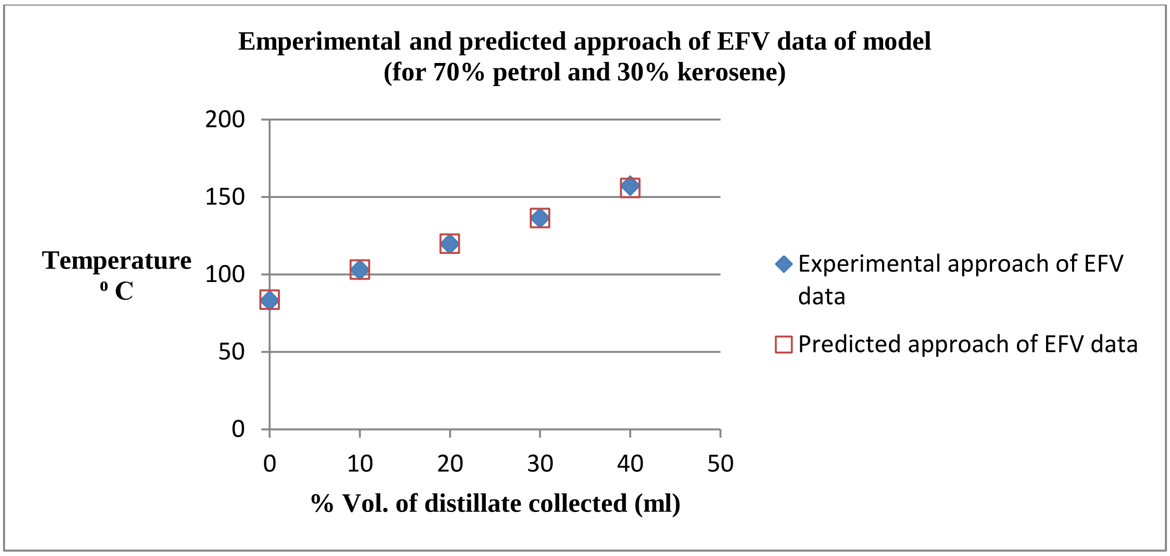

Fig.1.d. Experimental and predicted approach of EFV data of model (For 70% petrol and 30% kerosene)

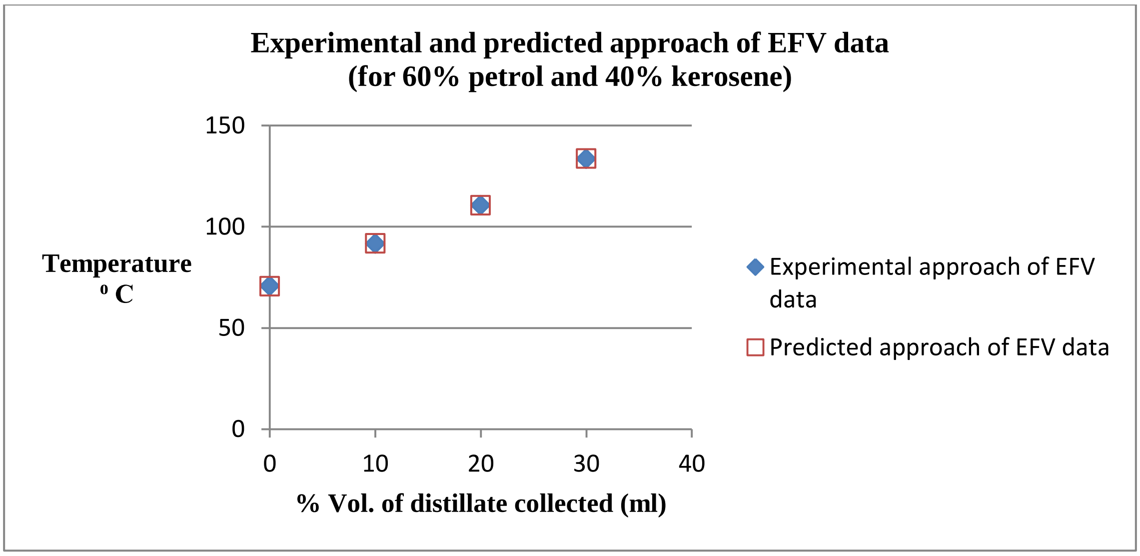

Fig.1.e. Experimental and predicted approach of EFV data of model. (For 60% petrol and 40% kerosene

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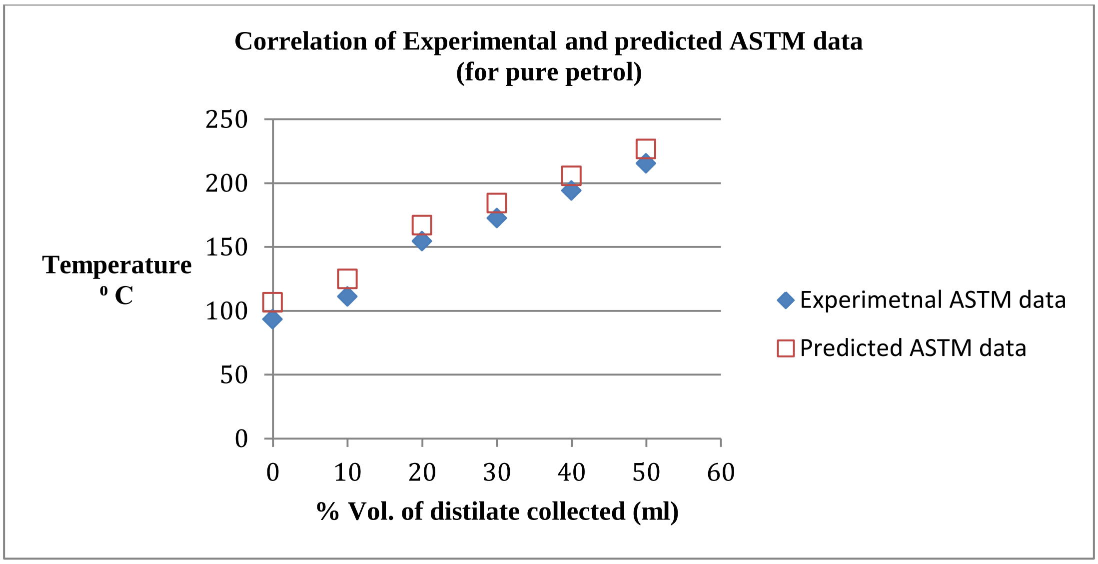


Fig .2.a. Correlation of experimental and predicted ASTM data (for pure petrol)

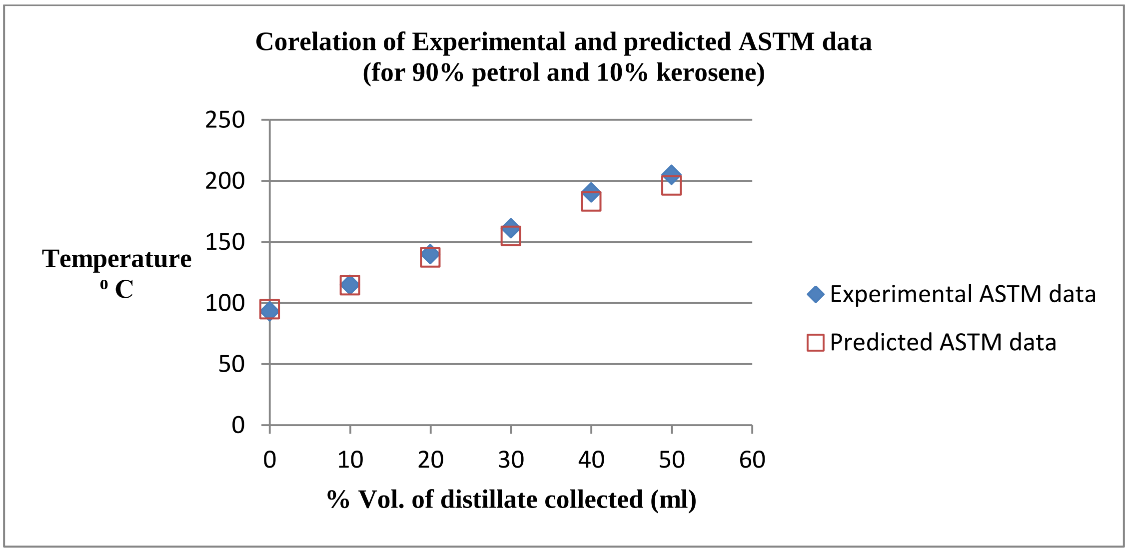


Fig.2.b. Correlation of experimental and predicted ASTM data (for 90% petrol and 10% kerosene)

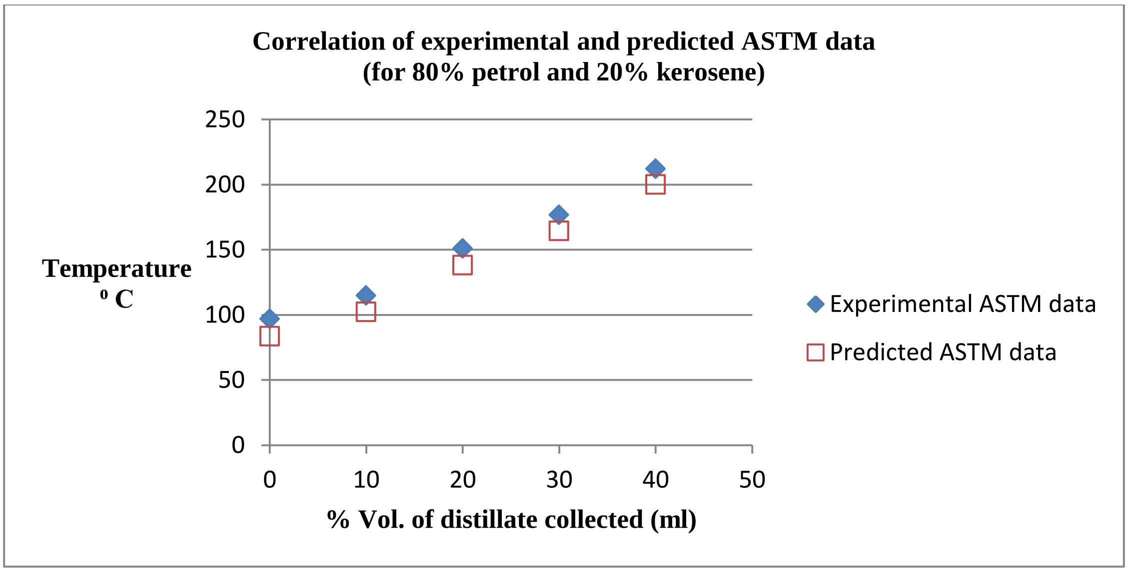


Fig.2.c. Correlation of experimental and predicted ASTM data (for 80% petrol and 20% kerosene)

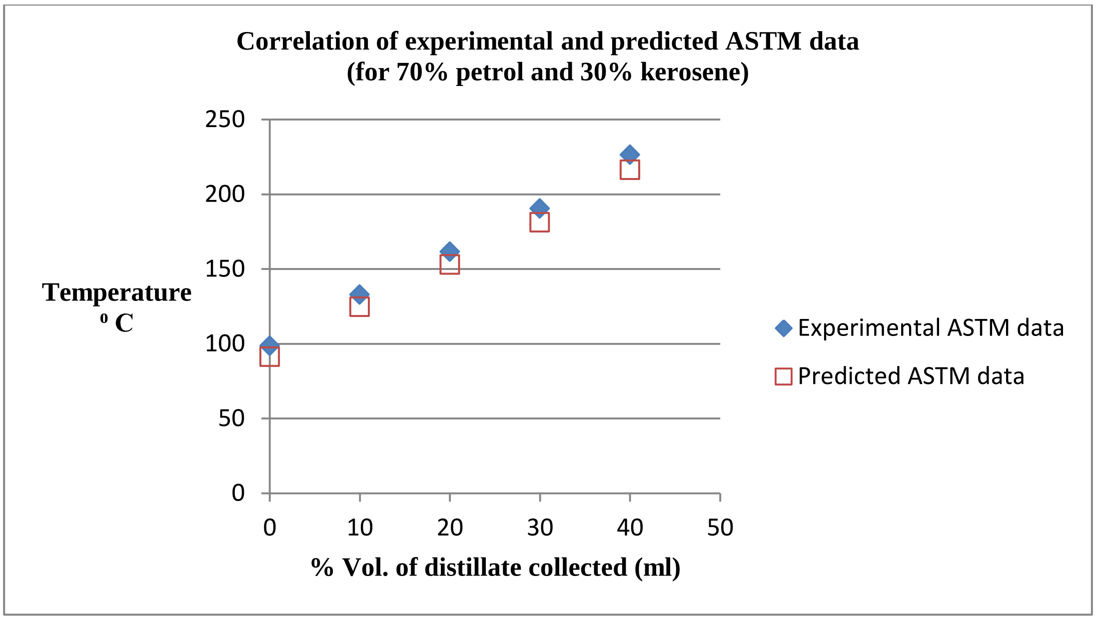
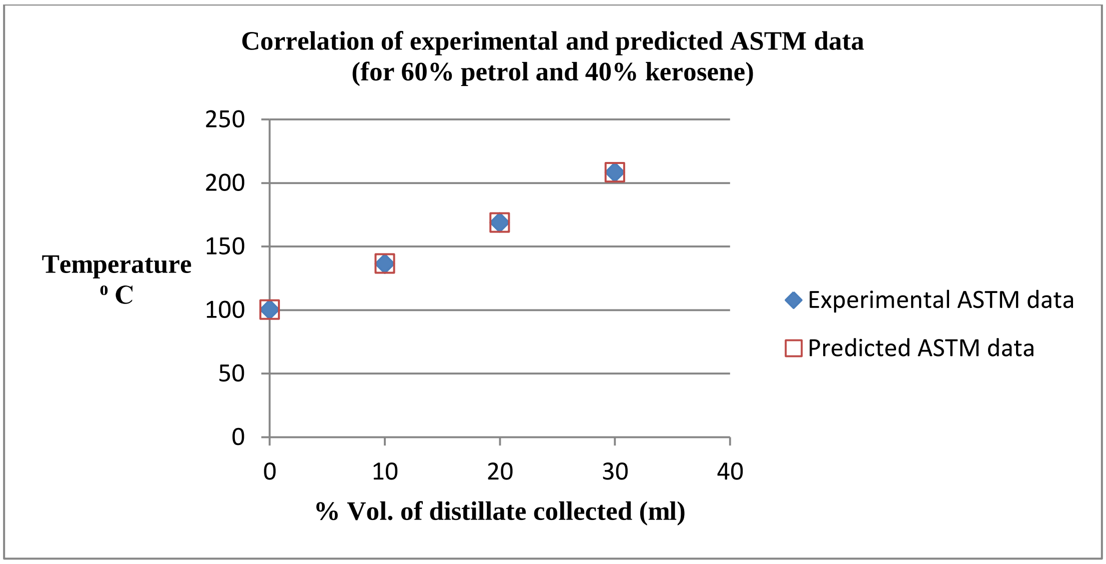


Fig.2.d. Correlation of experimental and predicted ASTM data (for 70% petrol and 30% kerosene)



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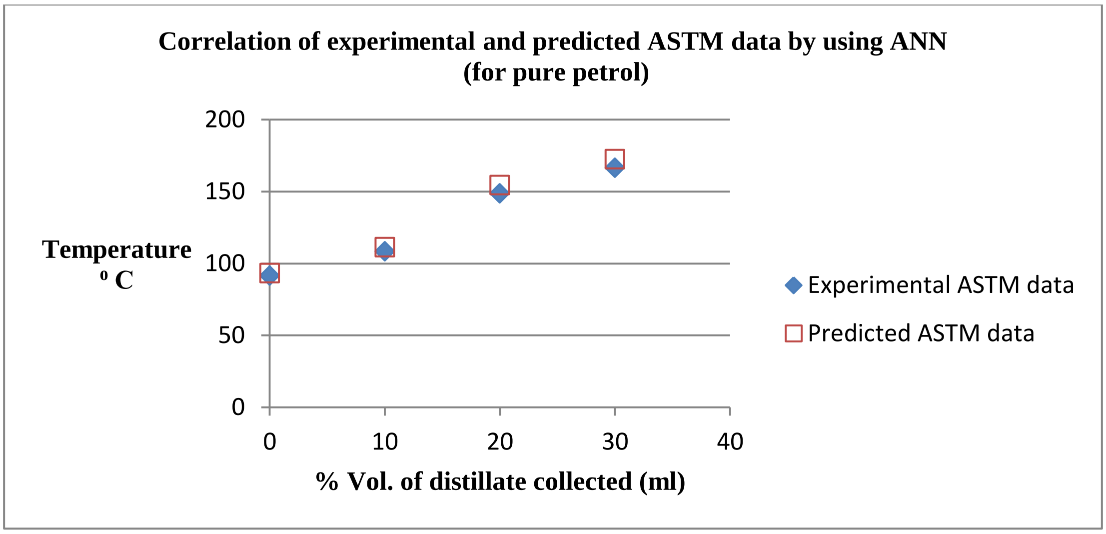
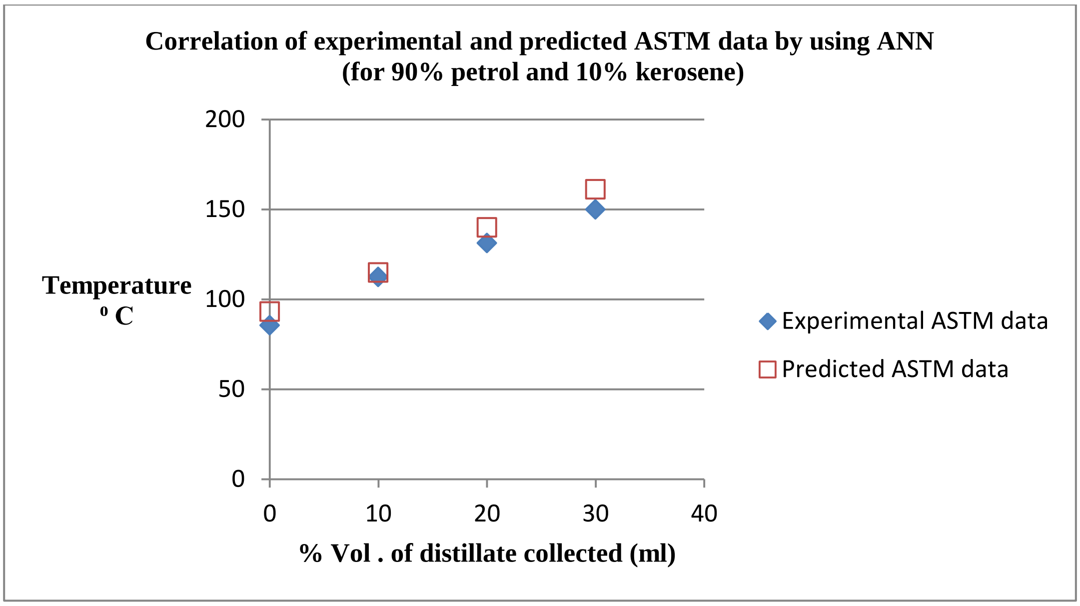


Fig.3.a Correlation of experimental predicted ASTM data (for pure petrol)



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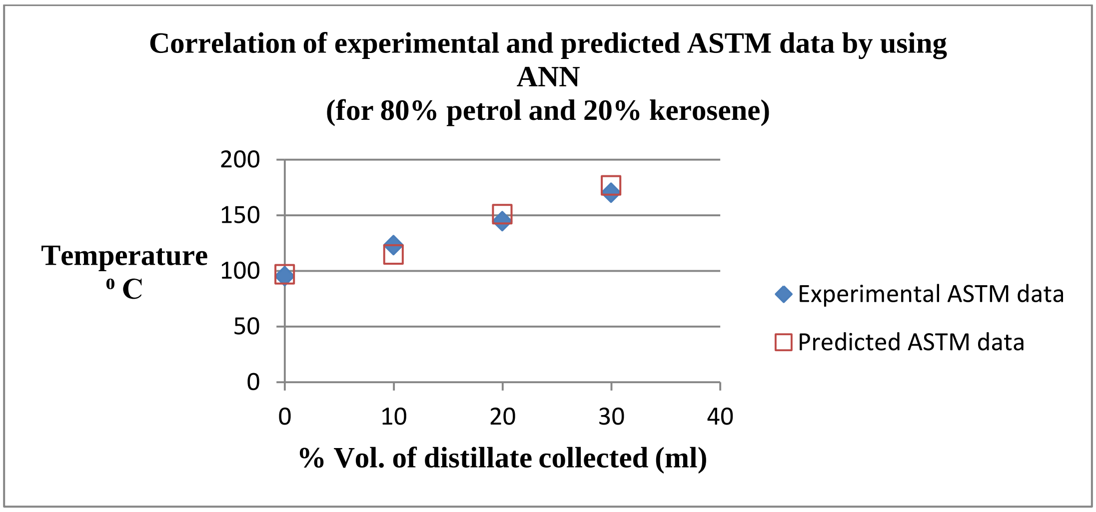

Fig.3.c. Correlation of experimental and predicted ASTM data by using ANN (for 80% petrol and 20% kerosene)

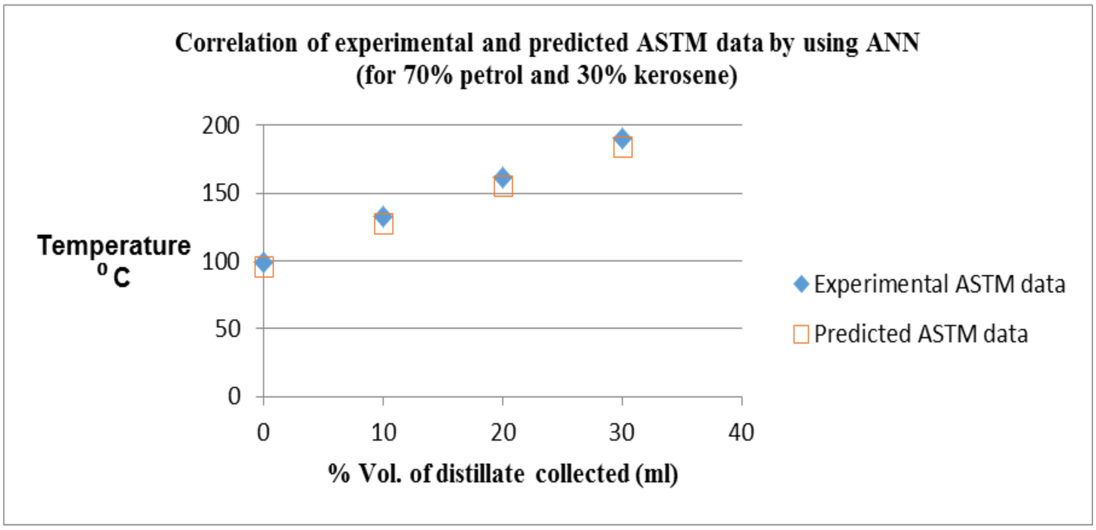

Fig.3.d. Correlation of experimental and predicted ASTM data by using ANN (for 70% petrol and 30% kerosene)

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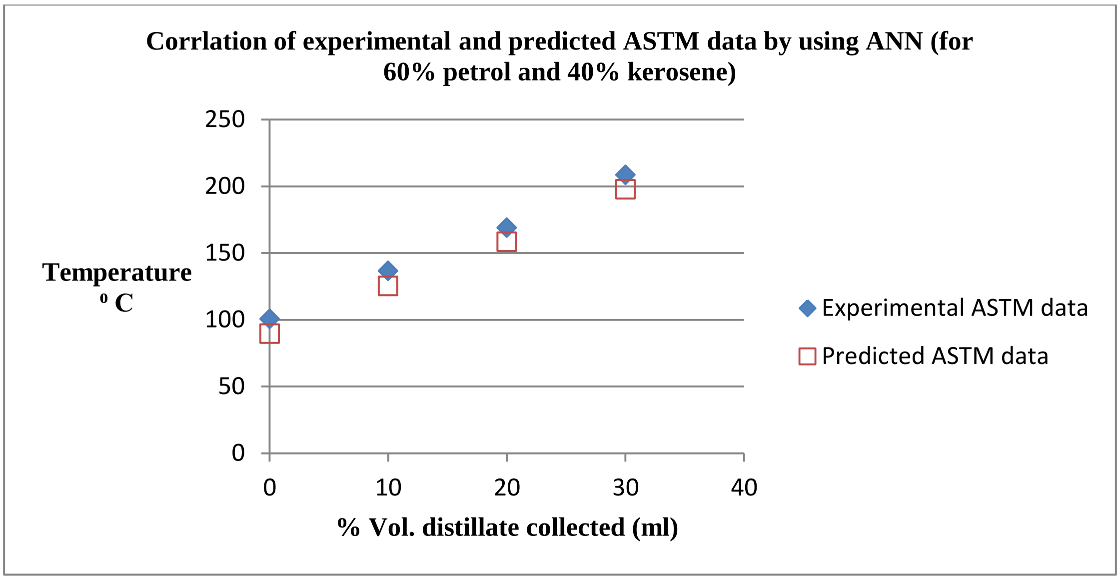

Fig.3.e. Correlation of experimental and predicted ASTM data by using ANN (for 60% petrol and 40% kerosene)

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Table.1. Input and output values of Artificial Neural Network (ANN)

Sr. No.	Input of Artificial Neural Network (ANN)				Output of ANN (percentage of kerosene in blends)	Experimental value of adulteration (percentage of kerosene in blends)
	$T_{0\%}$ (^{0} C)	$T_{10\%}$ (^{0} C)	$T_{20\%}$ (^{0} C)	$T_{30\%}$ (^{0} C)		
1.	80.98	102.76	154.90	177.96	0.200	00
2.	80.41	114.68	139.25	163.30	9.980	10
3.	79.84	115.10	142.30	174.80	20.01	20
4.	79.30	118.96	155.20	191.43	29.09	30
5.	78.71	123.96	164.46	213.71	39.90	40