Prediction of TBP, EFV data by using semi-empirical model and correlation of these data

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ABSTRACT

When we want to design the ADU and VDU of refinery TBP, EFV and ASTM data is play very important role. The experimental evaluation of TBP, EFV data is tedious and time consuming,; it takes nearly 5 hours for one cut while ASTM takes only 20 min for one cut. So it is required to propose one mathematical model which minimizes this tedious work. In this paper the prediction of TBP, EFV data is being done for diesel cut by using the semi-empirical model. The predicted approach and experimental approach are being compared and shown in this paper. The correlation is done by comparing the experimental and predicted ASTM data by using Edmister method. This prediction is done in this paper is by using only one experimental curve that is ASTM distillation curve.

Key word: Design of ADU, VDU of refinery, Prediction of TBP, EFV data by one ASTM experimental curve, Semi-empirical model.

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INTRODUCTION

Design of atmospheric and vacuum distillation column of petroleum refinery is based upon experience, intuition and emphericism. Because of the unpredicted nature of crude oil, this type of designing method, has been developed by Picklie which is very common method for designing this type of distillation columns. Crude, even though it contains innumerable components, they fall into small close boiling cuts and so individual separation is not possible; hence the design is significantly based upon ASTM, TBP and EFV data.
The design is basically depend on the two terms, namely, "degree of separation " and "degree of difficulty of separation". Degree of difficulty of separation is more or less connected with the purity of products. With increasing closeness of boiling points of two cuts, separation becomes a difficult task. So it is expressed as difference between the ASTM 50% boiling points of two successive cuts. Obviously larger difference renders separation easier. Degree of

separation is encountered in separation of two boiling cuts, irrespective of the attainable purity. It is closely resembling relative volatility. ASTM gap is defined as the difference between 5% boiling point of heavy fraction and 95% boiling point of preceding cut. When ASTM gap is not available TBP overlap may be taken into account. TBP overlap is the simple difference between FBP and IBP of successive fractions.

Picklie's method is based upon these gaps and overlaps. The number of plates in a particular section depends upon the gap, overlap and reflux ratio. Separation capability is denoted by'F' factor; given as: F = Reflux ratio X number of plates in that section. This F is releted to ASTM 50% difference of fractions (successive) ,the gap of these fractions and overlap of TBP by graphically which is available in literature.

So when we designing the ADU and VDU of refinery it is required that we should have ASTM, TBP and EFV data. The evaluation of TBP, EFV data is time consuming (about to take 5 hr for one cut) and tedious while ASTM data is taking only 20 min for one cut. So if we have any mathematical model available then this tedious method of evaluation of TBP and EFV could be avoided. Here in this paper one semi-empirical model is being introduced which is minimize the time by avoiding tedious evaluation of experiment which makes designing procedure easier and fast.

MATERIALS AND METHODS

Evaluation of ASTM data is done with ASTM: D86 methodology by using the standard ASTM apparatus. For evaluation of ASTM data diesel and kerosene is being purchased from the Ashram road, Ahmedabad- 380015.

Sample preparation:

The blends of different proportions are prepared like 100% diesel, 90% diesel and 10% kerosene, 80% diesel and 20% kerosene, 70% diesel and 30% kerosene, 60% diesel and 40% kerosene 50% diesel and 50% kerosene, 40% diesel and 60% kerosene, 30% diesel and 70% kerosene and 20% diesel and 80% kerosene are prepared and data are collected for this different blends. For all blends of diesel and kerosene the ASTM data is being evaluated and for one blend there is eleven temperature of all cut. There are nine blends so there will be ninety nine temperature reading. By using the proper cut of the ASTM curve the TBP, EFV data is being predicted.

Methodology

The ASTM D86 methodology is used for determining ASTM distillation data of all above mentioned blends (Fig 1.a). These ASTM distillation curves are used to predict TBP, EFV data according to Edmister's approach of mathematical modelling. The 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 (graphs are available in literature) 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.

RESULT AND DISCUSSION

The EFV data is predicted from experimental ASTM data is assumed to be an experimental approach and EFV data predicted from predicted ASTM data (which is already predicted from TBP data) is assumed to be a predicted approach, which are shown in figure 2.a, 2.b, 2.c, 2.d, 2.e, 2.f, 2.g, 2.h, 2.i. The correlation of experimental and predicted data of ASTM is shown in figure 3.a, 3.b, 3.c, 3.d, 3.e, 3.f, 3.g, 3.h, 3.i. (Correlation is done by Edmister method)

CONCLUSSION

To evaluate the TBP and EFV data experimentally, is time consuming and tedious (it takes about 5 hr for one cut while evaluation of ASTM data is taking only 20 min). Because of time consumption of evaluation of TBP, EFV data there is required to give an easier methodology by which these 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 data are shown in fig 2.a, 2.b, 2.c, 2.d, 2.e, 2.f, 2.g, 2.h, 2.i. The correlation of these by Edmister method is shown with ASTM data is shown in figure 3.a, 3.b, 3.c, 3.d, 3.e, 3.f, 3.g, 3.h, 3.i 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 which takes only 20 mins for evaluation.

This result shows that this proposed semi-empirical model for evaluation is accurate. And it is become very easier to predict TBP and EFV data by using this model compared to experimental evaluation.

Furthermore by using this model designing procedure of ADU and VDU is become fast and not become tedious because of experimental evaluation of TBP and EFV data.

ABRIVIATION

TBP	True Boiling Point
ASTM	American Standard of Testing Material
EFV	Equilibrium Flash Vaporization
ADU	Atmospheric Distillation Column
VDU	Vacuum Distillation Column

REFERENCE

[1]. **J**oshi. J. S, Puranik. S. A. Prediction of TBP,EFV data by using semi-empirical model and correlation of these data by using Artificial Neural Network (ANN). InternationalJournal of Engineering Research and Reviews. 4(4), 61-68, 2016. (petrol cut)

[2]. Bhaskararao. B. K. Modern Petroleum refinery engineering. Third Edition. Oxford and IBH publishing Co. Pvt. Ltd.

[3]. Wilur L. Nelson. Petroleum refinery engineering. McGrowhill publication. 2009.

Figures and tables

The predicted and experimental approach of semi-empirical model is shown in figure 2.a to 2.i. The correlation of experimental and predicted ASTM data is shown in fig 3.a to 3.i by Edmister method. The one of the predicted approach and experimental approach for the blend of 90% diesel and 10% kerosene is shown in table 1. One of the correlation of experimental and predicted data of ASTM are also shown in table 2 for blend of 80% diesel and 20% kerosene.

Tables and figures are shown as bellow which shows the result of this semi-empirical model.

Tables

Table. 1. Predicted and experimental approach of semi-empirical model for the bledn of 80% diesel and 20% kerosene.

Sr. No.	% Volume of distillate collected (ml)	Experimental approach of semi-empirical model (EFV data)	Predicted approach of semi-empirical model (EFV data)
1.	00	18.6500	18.6350
2.	10	170.461	170.433
3.	20	233.583	233.550
4.	30	254.255	254.233
5.	40	287.994	287.966
6.	50	301.050	301.105
7.	60	314.111	314.100
8.	70	324.872	324.844

Table. 2. Correlation of predicted and experimental ASTM data for the blend of 80% diesel and 20% kerosene.

Sr. No.	% Volume of distillate collected (ml)	Experimental ASTM data	Predicted ASTM data
1.	00	066	65.880
2.	10	190	189.88
3.	20	248	247.88
4.	30	267	266.88
5.	40	298	297.88
6.	50	310	309.96
7.	60	322	321.90
8.	70	331.88	331.77

Figures

Figure: 1.a Standard ASTM apparatus for evaluation of ASTM distillation curve.

Figure.1.b. Standard TBP apparatus for experimental evaluation of TBP distillation curve.

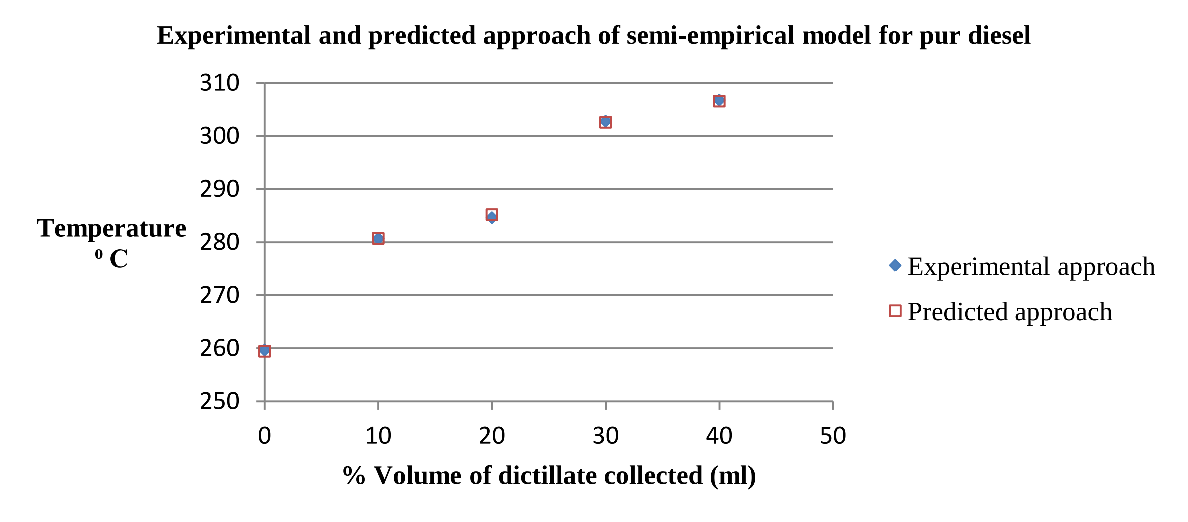

Figure 2.a Experimental and predicted approach of semi-empirical model for pure diesel.

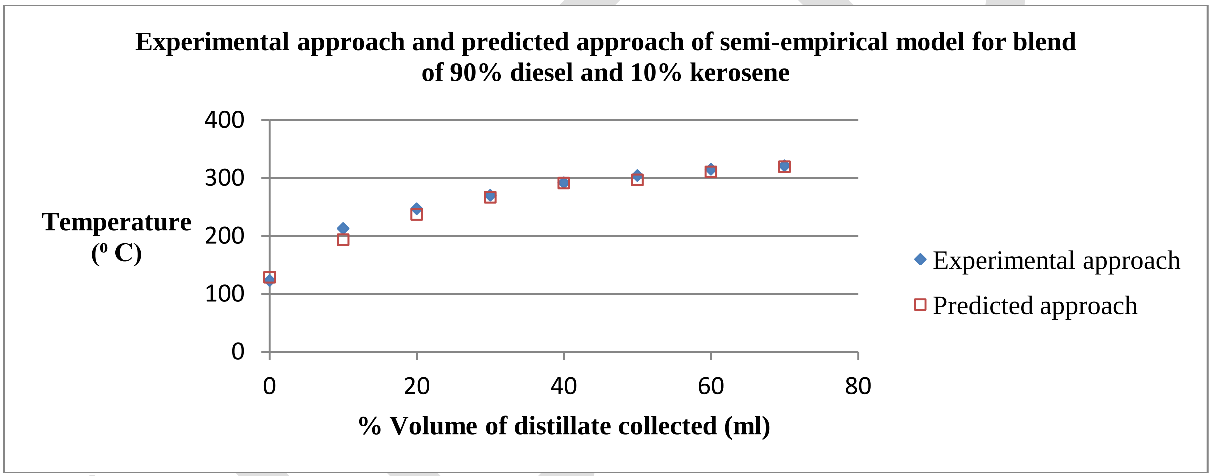

Figure. 2.b. Experimental and predicted approach of semi-empirical model for lend of 90% diesel and 10% kerosene.

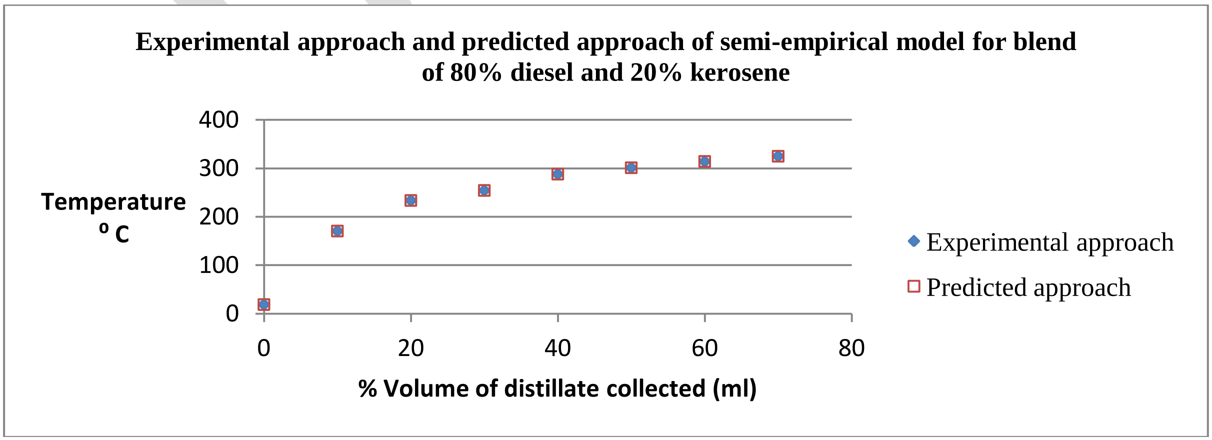

Figure 2.c. Experimental and predicted approach of semi-empirical model for blend of 80% diesel and 20% kerosene.

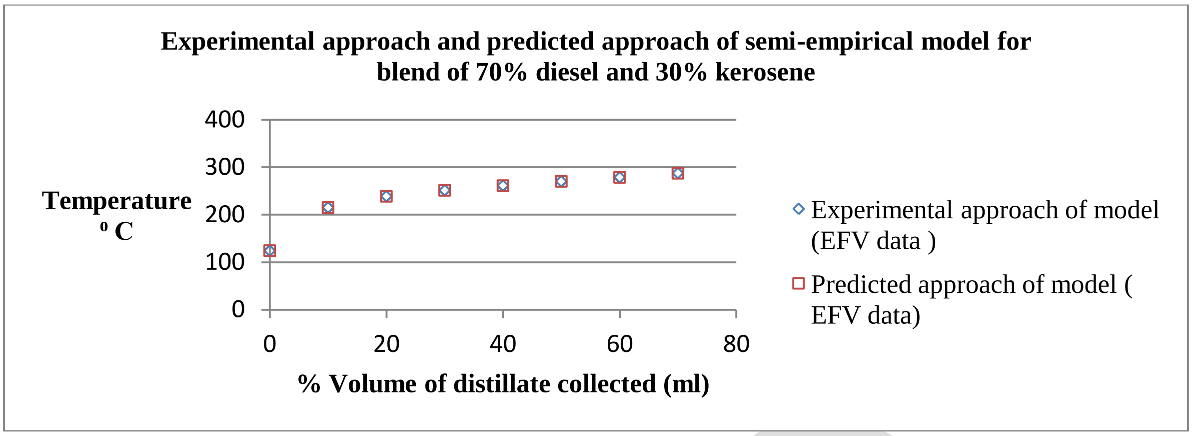

Figure: 2.d. Experimental and predicted approach of semi-empirical model for blend of 70% diesel and 30% kerosene

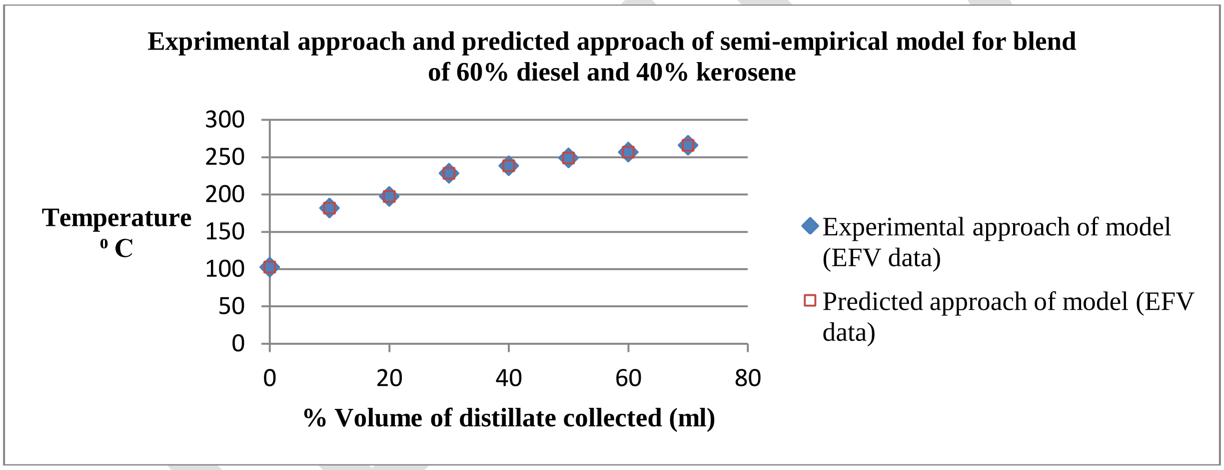

Figure: 2.e. Experimental and predicted approach of semi-empirical model for blend of 60% diesel and 40% kerosene.

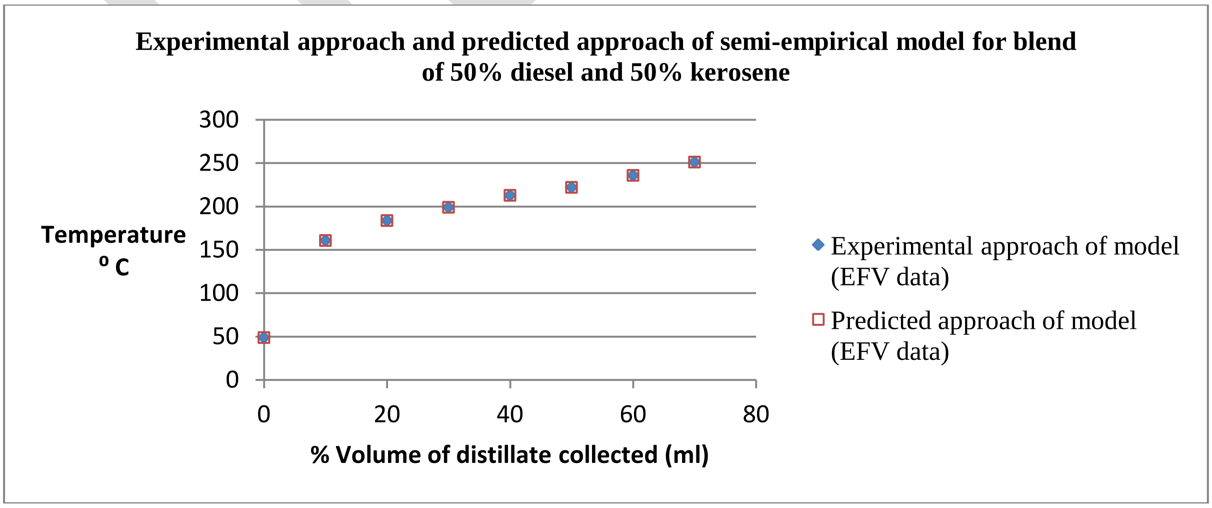

Figure: 2.f Experimental and predicted approach of semi-empirical model for blend of 50% diesel and 50% kerosene.

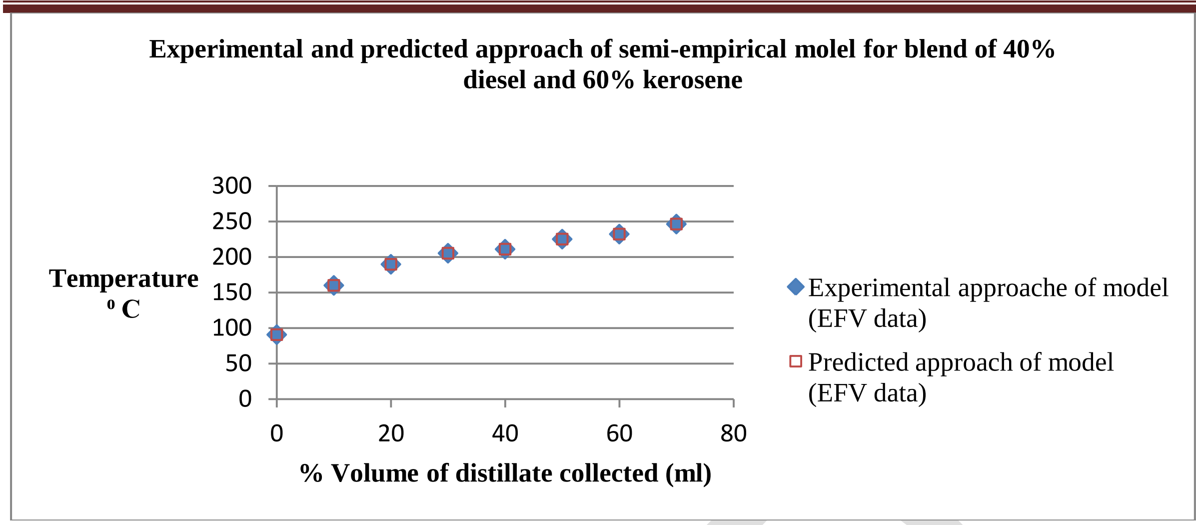

Figure 2.g Experimental and predicted approach of semi-empirical model for blend of 40% diesel and 60% kerosene.

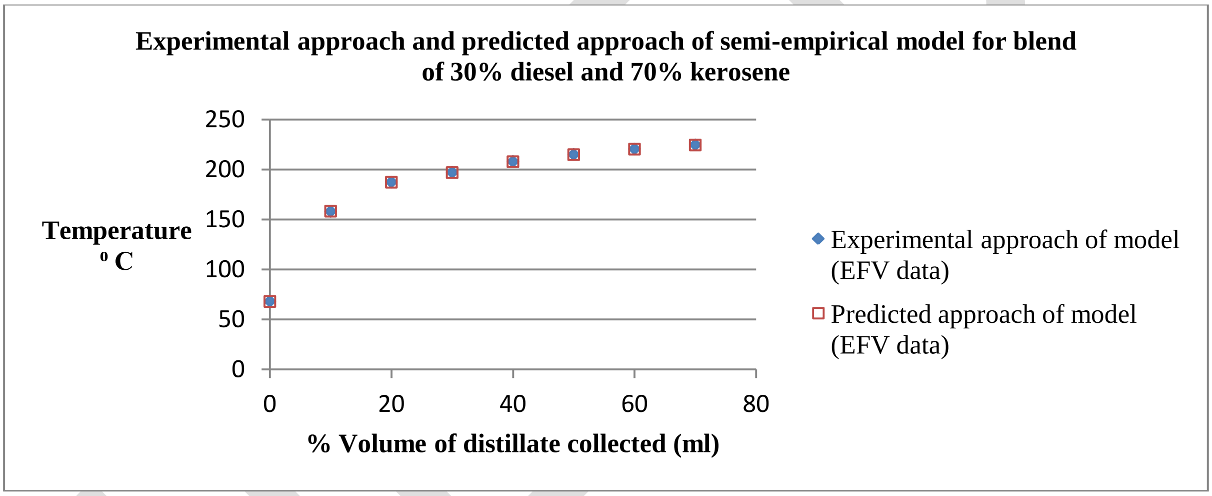

Figure. 2.h. Experimental and predicted approach of semi-empirical model for blend of 30% diesel and 70% kerosene.

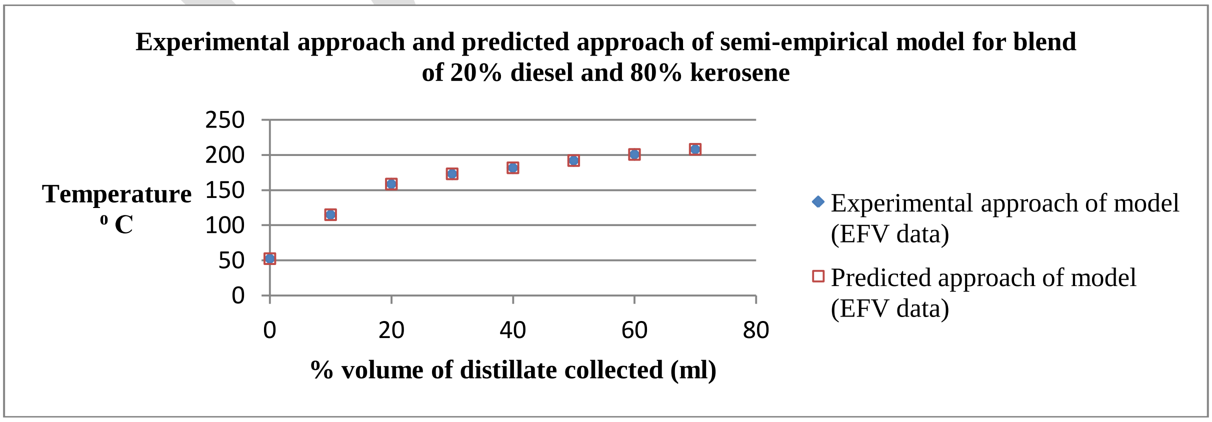

Figure 2.i. Experimental and predicted approach of semi-empirical model for blend of 20% diesel and 80% kerosene.

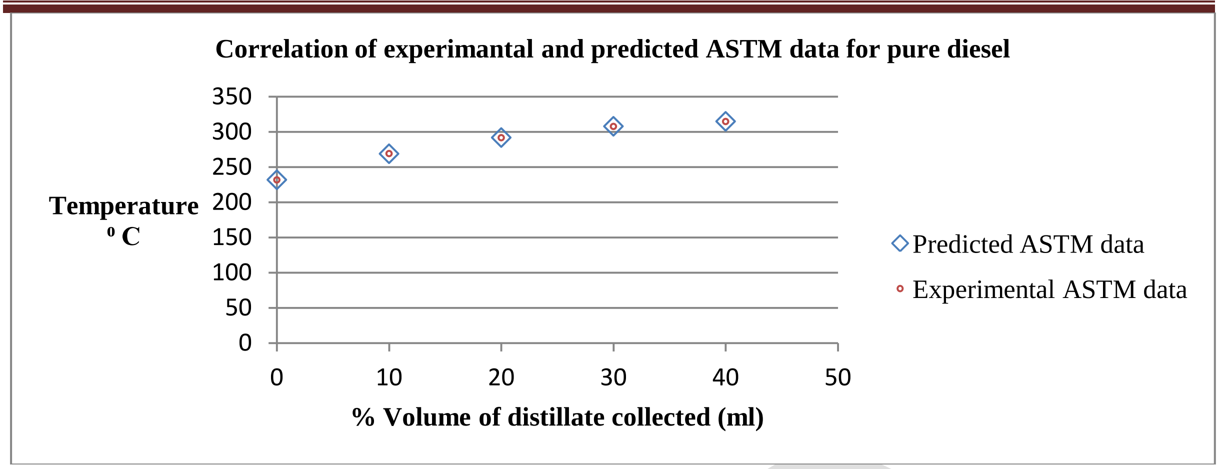

Figure: 3. a. Correlation of experimental and predicted ASTM data for pure diesel

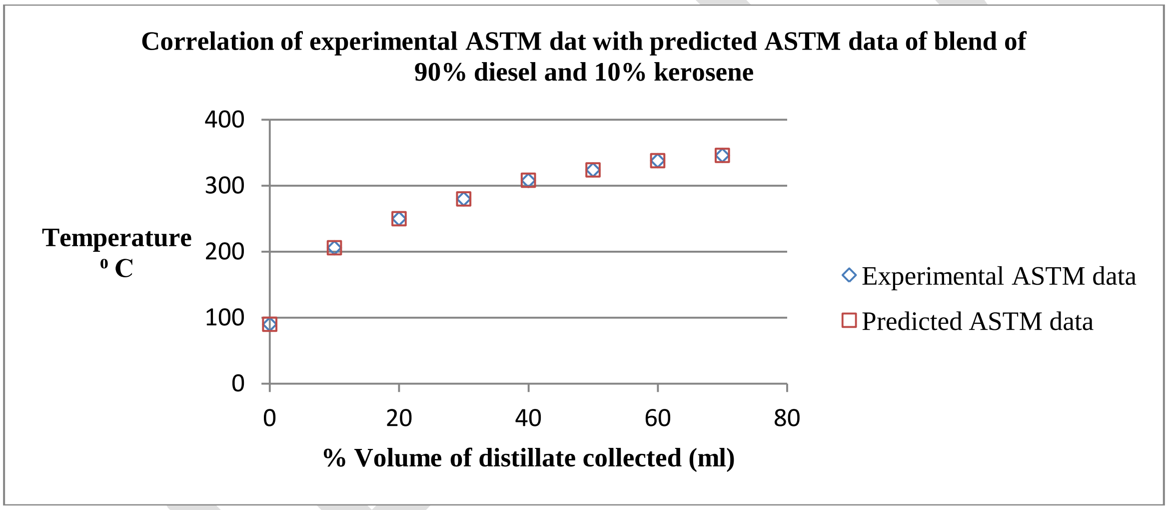

Figure. 3.b. Correlation of experimental and predicted ASTM data of blend of 90% diesel and 10% kerosene.

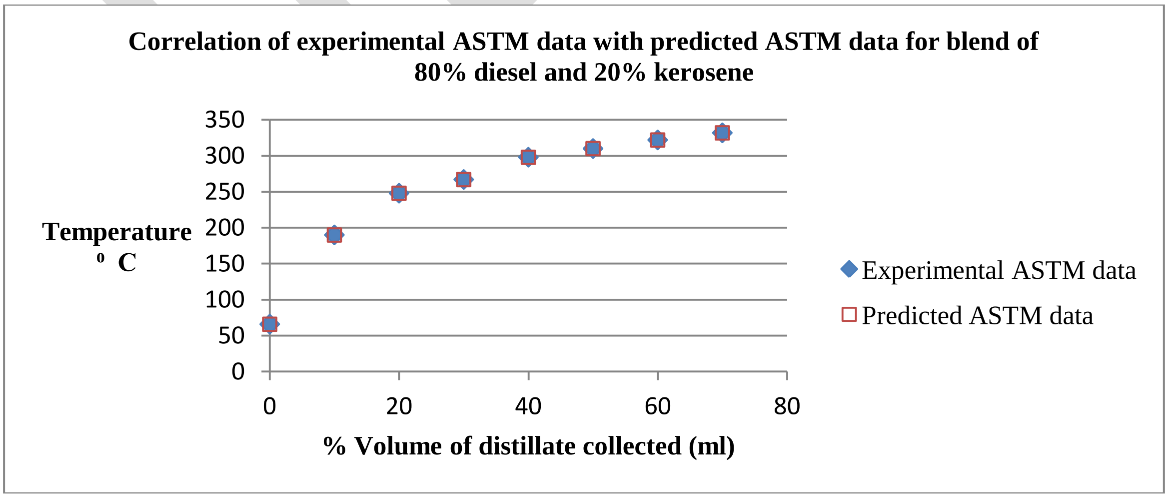

Figure: 3. c. Correlation of experimental and predicted ASTM data of blend of 80% diesel and 20% kerosene.

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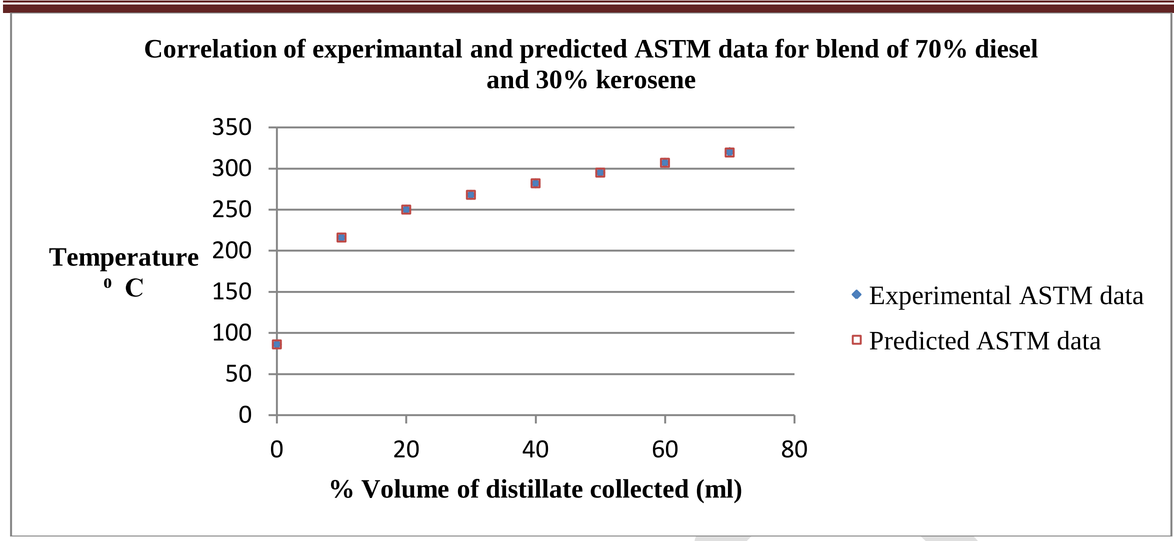

Figure: 3. d. Correlation of experimental and predicted ASTM data of blend of 70% diesel and 30% kerosene

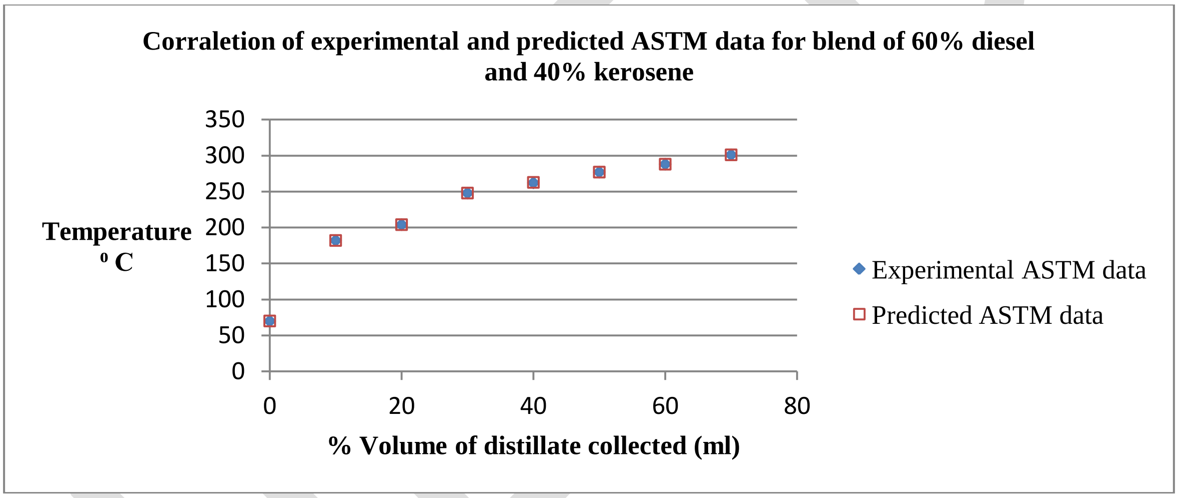

Figure: 3. e. Correlation of experimental and predicted ASTM data for blend of 60% diesel and 40% kerosene.

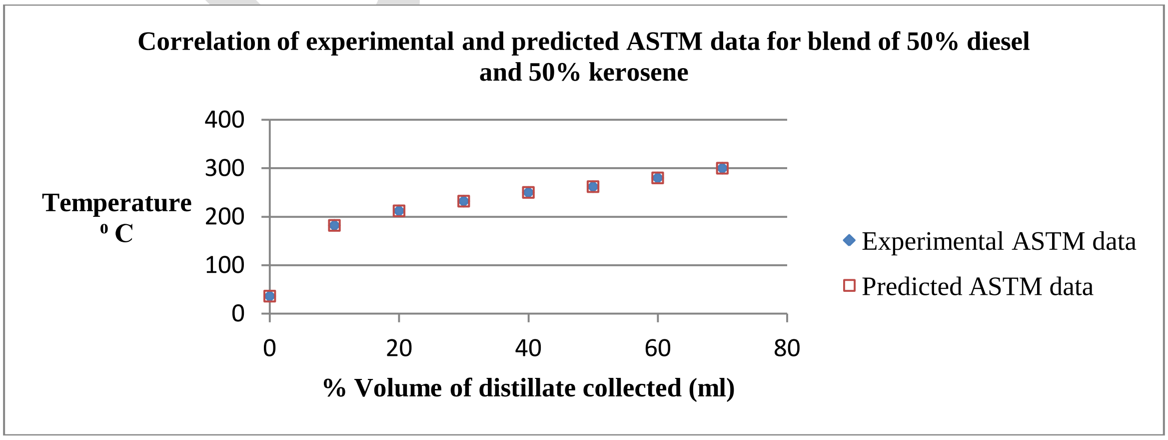

Figure. 3. f. Correlation of experimental and predicted ASTM data for blend of 50% diesel and 50% kerosene.

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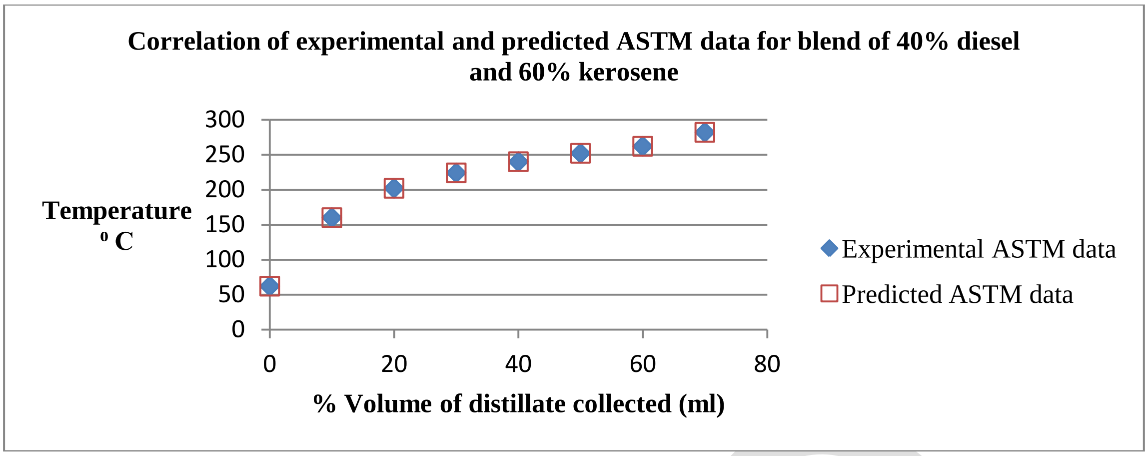
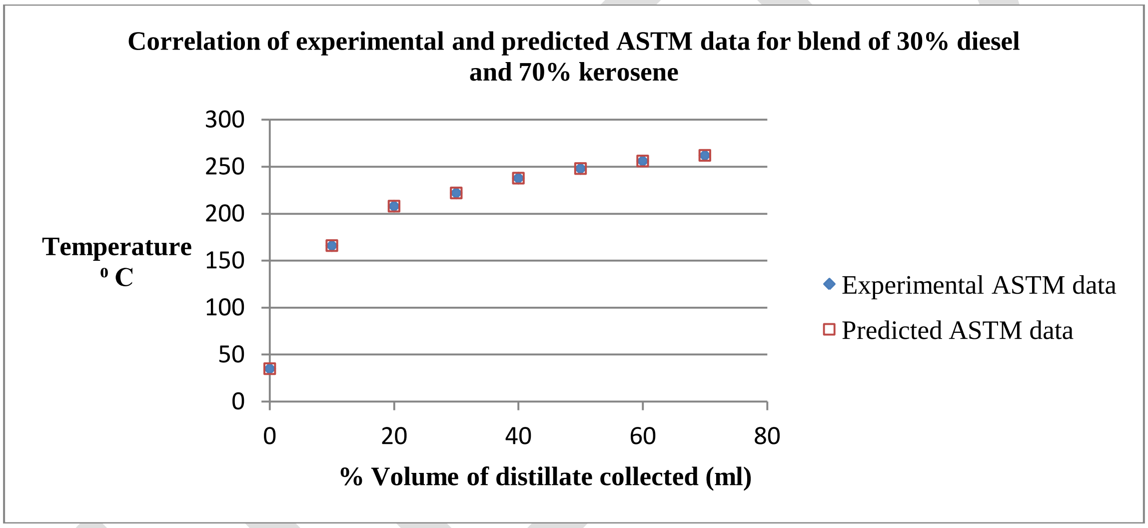


Figure: 3. g. Correlation of experimental and predicted ASTM data for blend of 40% diesel and 60% kerosene.



Figure; 3. h .Correlation of experimental and predicted ASTM data for blend of 30% diesel and 70% kerosene.

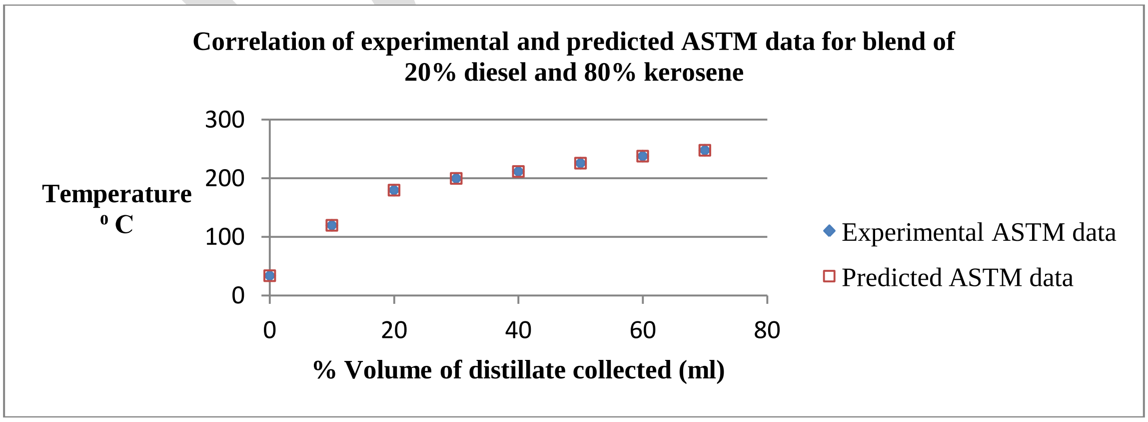


Figure: 3. i. Correlation of experimental and predicted ASTM data for blend of 20% diesel and 80% kerosene.