CERTIFICATION OF APPROVAL

NEURAL NETWORK CONTROL FOR HEAT EXCHANGER

BY
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(Chemical Engineering)

Approved by,

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CERTIFICATION OF ORIGINALITY

This certifies that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements and that the original work contained here have not been undertaken or done unspecified sources or persons

(SUJENDRAN SUPPIAH)

ABSTRACT

This and individual Final Year Research Project entitle 'Neural Network Control in Heat Exchanger' which carries four credit hours.

The main objective of this project is to develop the Neural Network system from the specified industrial scale heat exchanger and implementing it in a simple feedback control system. The four input parameters involved for the heat exchanger which are the temperatures and flow rate for both shell and tube. There are only two outlet parameters studied here in this project, the shell outlet temperature and the tube outlet temperature. There are 3 main stages of this project. The data was taken from PETRONAS Penapsian Melaka, Sdn. Bhd. First with the available data, the network was designed and tested for its performance. Then, the dynamic model of the heat exchanger was designed using ARX method. Finally, both the network and the dynamic model are integrated in a simple Internal Model Control System.

This report will highlight the data analysis used on the data obtained for this project. This report will also consist of the Neural Network architecture used for the heat exchanger as well as its performance data. The dynamic model of the heat exchanger also was constructed based on ARX Method. Full detail on the ARX method will be explained in the report. With the dynamic model and the Neural Network, a simple feedback system based on the concept of IMC system was designed and studied. This project will be an extension to the existing controlling strategies used in the industries. This will be the new age in heat exchanger control system which will eventually propagate to other applications in the production areas.

ACKNOWLEDGEMENT

First and foremost I would like to take this opportunity to acknowledge and express my gratitude to those that has contributed directly or indirectly towards the success of my Final Year Research Project. I would like to give credits to my supervisor Prof. Dr. V.R. Radhakrishnan for his endless effort in guiding me throughout this project. With his technical advise, assistance and support, I was able to complete this project in the given time.
Besides that, I would like to thank PETRONAS Penapisan Melaka's personals for helping me to obtained data on the Heat Exchanger. These data was proven much useful in this project.

I would also like to acknowledge University Technology PETRONAS (UTP) specifically the Final Year Project Committee for proper organization and management of this course.

Lastly I would like to acknowledge my parents for their endless support and confidence in me throughout this semester especially during this project. Their encouragement and advise had helped me in confronting problems faced during the completion of the project. Without the support of those related to this project, this project might not be successful.

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CHAPTER 1
INTRODUCTION

The Chemical Engineering Final Year Project is a four hour credit course which involved in modeling works. The project is entitle 'Neural Network Control in Heat Exchanger'. The supervisor of the project is Prof. Dr. V.R. Radhakrishan.

1.1 BACKGROUND OF THE STUDY

This final year research work was based on previous work by Chong Chee Keong titled "Neural Network Model of a Heat Exchanger". Based on his work, further development on the model was done and the appropriate control strategy will be devised.
Neural Network (NN) is a new age technology in the information processing that was developed based on the neuron in the human brain. Neural network consist of large number of interconnecting processing elements that normally operates in parallel. The system behaves as human brain where it has the ability to learn, recall and generalize from training patterns or sets of data.

Based on the previous work of Chong Chee Keong, the model developed will be revised and modified to suit an industrial heat exchanger. For this work, an industrial heat exchanger was chosen and the necessary data was obtained. Based on the model, further work will be done on devising the necessary control strategy integrating the Neural Network system. This study will be limited to the temperature control in the heat exchanger due to lack of data on the pressure drop in the heat exchanger.

1.2 PROBLEM STATEMENT

Heat exchanger is a very common and crucial equipment in industries especially oil and gas. It serves purpose of heating or cooling fluids via exchanging energy between one and another. The most common problems encounter with the heat exchangers is the nonlinearity in the outlet temperature of both shell and tube. This is might be due to changes in the operating parameters. It is common in oil and gas industries to change their crude based on the market value of certain crude price. The characteristic of one type of crude will not be the same as others. Thus the operating parameters will change whenever there is crude switch. Besides that, the non-linearity might be due to fouling in the heat exchanger that developed hot spots in the tube areas. Heat loss to surrounding is also a factor in non-linearity in the heat exchanger. It is often desirable to have a linear condition for heat exchanger. Data on the heat exchanger are obtained from PETRONAS Penapisan Melaka Sdn. Bhd.

Based on the study, alternative control strategies and development of predictive control strategies for predicting and controlling a complex non-linear process could be applied in the industry. The system could be designed to predict the outlet temperature of either the shell or tube or both and proper correction could be done without affecting the dynamic of the overall system.

1.3 OBJECTIVE AND SCOPE OF STUDY

1.3.1 Objective

This Final Year Project will be an open ended project where the availability of the time will decide on the development of the project. As of the problem statement, the objectives of project are:

i. To extend the function of NN model to industrial scale heat exchanger
ii. To construct and develop a Feed Forward Backpropagation (BP) NN architecture using MATLAB's "Network/Data Manager"
iii. To train, make necessary amendment and develop a suitable NN configuration using training set of data.
iv. To test the network using testing set of data to compute the tolerance and estimated error of the network via statistical analysis.
v. To develop dynamic model of the heat exchanger used
vi. To integrate the NN ability in the internal model control strategies.

1.3.2 Scope

The scope of this research work is to study on the characteristic of NN model and make the necessary modification on the NN model developed by Chong Chee Keong which was based on a laboratory heat exchanger. The model will be redefined to suit an industrial heat exchanger. Further study will be conducted to determine the compatibility and the accuracy of the NN model based on the industrial heat exchanger. The NN model training, validation and testing phase will be conducted in MATLAB NNTOOL.

The heat exchanger used for this research work belongs to PETRONAS Penapisan Melaka. It is a preheat exchanger for crude train. The data obtained from the equipment is limited to 15 days (Jan 1 to Jan 15 2004) on which the data is recorded every hour. This data will be used in developing the NN model.

Based on the data, a dynamic model of the heat exchanger will be developed. The dynamic model then will be used in term of transfer function for the heat exchanger. Based on the dynamic system, a predictive control strategy for predicting and controlling the complex non-linear process will be developed. This will be done in the MATLAB Simulink Software.

CHAPTER 2
LITERATURE REVIEW AND THEORY

2.1 HEAT EXCHANGER

The purpose of heat exchanger is to transfer heat from a hot fluid to a colder one across a heat conducting barrier separating the fluids. Each fluid flows through the heat exchanger, usually in a steady manner.The heat exchanger used in this project is a counter flow of 1 shell passes and 4 tube passes. The specification of the heat exchanger is attached in Appendix 5.1. The heat exchanger currently in service in PETRONAS Penapisan Melaka and used in the preheat train for sweet crude. The fluid in the shell side is crude oil and on the tube side is Low Sulphur Waxy Residue (LSWR). LSWR is the product from the bottom of distillation tower. The crude after passing through the preheat train, will go enter furnace then to distillation column.

2.1.1 Basic Design

The total heat transfer rate of the countercurrent heat exchanger in liquid phase can be calculated with this equation

$$Q = UA\Delta T_M \qquad (1)$$

Where, Q = heat transferred per unit time, W

U = the overall heat transfer coefficient, $W/m^2\,^0C$

A = heat transfer area, m^2

ΔT_m= the mean temperature difference

The overall heat transfer coefficient is the reciprocol of the overall resistance to heat transfer. The equation for the overall heat transfer coefficient is given by:

$$\frac{1}{U_O} = \frac{1}{h_o} + \frac{1}{h_{od}} + \frac{d_o \ln(\frac{d_o}{d_i})}{2k_w} + \frac{d_o}{d_i} x \frac{1}{h_{id}} + \frac{d_o}{d_i} x \frac{1}{h_i} \qquad (2)$$

where,

U_o = the overall coefficient based on the outside area of the tube, W/m^2 °C

h_o = outside fluid film coefficient, W/m^2 °C

h_i = inside fluid film coefficient, W/m^2 °C

h_{od} = outside dirt coefficient, W/m^2 °C

h_{id} = inside dirt coefficient, W/m^2 °C

k_w = thermal conductivity of the tube wall, W/m^2 °C

d_i = tube inside diameter, m

d_o = tube outside diameter, m

The mean temperature difference ΔT_m is calculated from the difference in the fluid temperature at the inlet and outlet of the heat exchanger.

$$\Delta T_{lm} = \frac{(T_1 - t_2) - (T_2 - t_1)}{\ln \frac{(T_1 - t_2)}{(T_2 - t_1)}} \qquad (3)$$

2.2 NEURAL NETWORK

Neural network (NN) or artificial neural network are system constructed based on the some of the organizing principles resembling human brain. They are the new promising new generation of information processing technology. NN are good at tasks such as pattern matching and classification, function approximation, optimization, vector quantization, and data clustering. NN composed of many single elements operating in parallel.

2.2.1 Architecture

Single Input Neuron

A neuron with single input and no bias is shown in figure 2.1. The scalar input **p** multiplied with its strength by the scalar weight **w**, to form the product **w*p**. The product then will be the argument for of the transfer function F, which produces the scalar output **a**. The neuron also contains a bias scalar, **b**. The bias has a constant output of 1. The transfer function net input, **n** is the sum of the weighted input **w*p** and the bias **b**. This sum becomes the argument for the transfer function **F**. The transfer function which is typically a step function or sigmoid function, takes the argument and produces the output **a**.

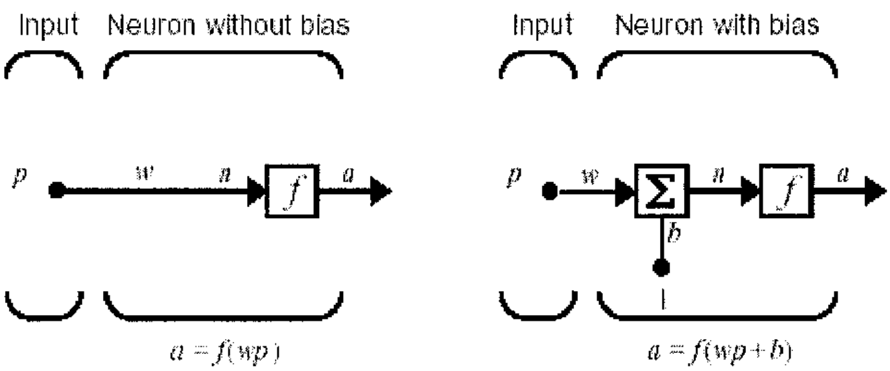

Figure 2.1: Neuron without bias and Neuron with bias

Transfer function

The commonly used transfer functions for neuron are; hard limit transfer function, linear transfer function and log-sigmoid transfer function. Hard limit transfer function take argument value between 0 and 1 and mostly used for making decision such as classification. Linear transfer function used as linear approximators. The sigmoid transfer function log-sig takes the input of any finite value and gives the output into the range 0 to 1.

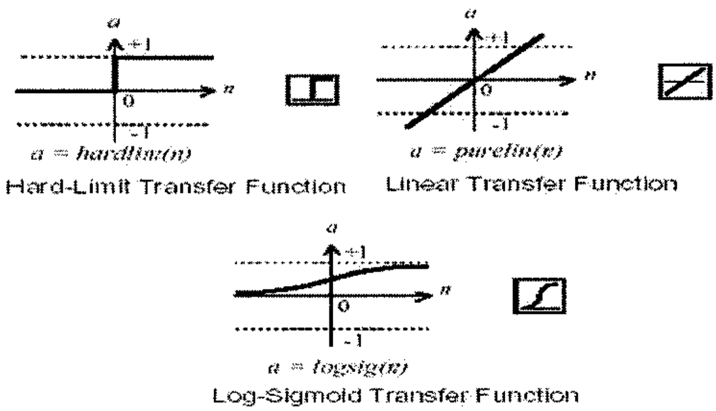

Figure 2.2 Transfer Function

Multiple Input Neuron

A single neuron with R inputs is shown as figure 2. The individual inputs p(1), p(2)..p(R) are weighted by elements w(1,1), w(1,2)..w (1,R) and the weighted values are inputs to the summing junction.

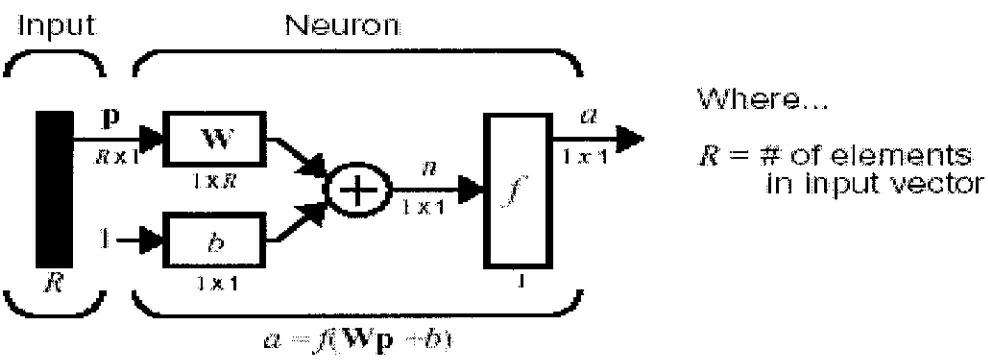

Figure 2.3: Multiple Input Neuron

2.2.2 Backpropagation

Backpropagation was created by generalizing the Widrow-Hoff learning rule to multiple-layer networks and nonlinear differentiable transfer functions. Input vectors and the corresponding output vector is used to train a network until it can approximate a function, associate input vectors with specific output vector.

Backpropagation networks often have more than one hidden layer with multiple nonlinear transfer function at layers which enables the network to learn nonlinear and linear relationship between input and output vectors. An example of a backpropagation of network is as figure 2.4.

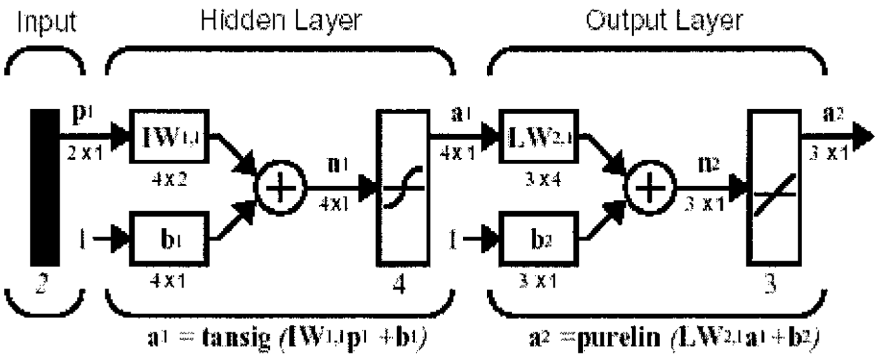

Figure 2.4: Backpropagation Network

According to 'Neural Network Toolbox' by Howard Demuth and Mark Beale, there are no rules on the amount of layers and the number of neurons used in backpropogation. Usually trial and error approach is used for determining the best configuration that able to provide the minimal error. There are a number of parameters that required to be specified before training network such as

i. Training function
ii. Adaptation leaning function
iii. Performance function
iv. Number of layers (including the hidden layers)
v. Number of neurons in each layer

vi. Transfer function of each layer

2.2.3 Training Algorithm

The NN training process requires a set of examples of proper network behavior - network inputs p and target outputs t. The weights and biases of the network are iteratively adjusted to minimize the network performance. The default performance function for feedforward networks is mean square error mse - the average squared error between the network outputs a and the target outputs t.

Back propagation Algorithm

The backpropagation learning updates the network weights and biases in the direction in which the performance function decreases most rapidly - the negative of the gradient. This algorithm can be written as:

$$\mathbf{x}_{k+1} = \mathbf{x}_k - \alpha_k \mathbf{g}_k$$

Where is a vector of current weights and biases, g_k is the current gradient, α_k is the learning rate. The algorithm that can be implemented is the incremental mode. In the incremental mode, the gradient is computed and the weights are updated after each input is applied to the network. Besides that, batch mode also could be implemented for backpropogation. In the batch mode all of the inputs are applied to the network before the weights are updated. Further information on the training algorithym can be found on the 'Neural Network Toolbox' by Howard Demuth and Mark Beale,

2.3 STATISTICAL ANALYSIS

2.3.1 Data processing

The purpose of data processing is to analyze the data obtained from PETRONAS Penapisan Melaka on the heat exchanger used for this project. Frequency test was done to identify the range for the set point for the system. Frequency test can be done on Microsoft® Excel. ANOVA: Single Factor was done to verify that the three segmented data are from the same population. ANOVA stands for Analysis of Variance. The equations used are:

$$SS_T = SS_{Treatment} + SS_E$$

$$MS_{Treatments} = \frac{SS_{Treament}}{a-1}$$

$$MS_E = \frac{SS_E}{a(n-1)}$$

$$F_o = \frac{MS_{Treatments}}{MS_E}$$

Where SS_T is the total sum of squares

$SS_{Treatments}$ is the treatment sum of squares

SS_E is the error sum of squares

$MS_{Treatment}$ is the mean square for treatment

MS_E is the error mean square

Normalization on the data was done based on this formula:

$$x_n = \frac{(x - x_{min})}{(x_{max} - x_{min})}$$

Where x_n is the normalized value

x_{min} is the minimum value

x_{max} is the maximum value

2.4 DYNAMIC MODEL OF A SYSTEM

2.4.1 The signals

Models describe relationships between measured signals. It is convenient to distinguish between **input** signals and **output** signals. The outputs are then determined by the inputs and sometimes include the disturbance. The inputs, outputs, and disturbances are denoted by **u**, **y**, and **e**.

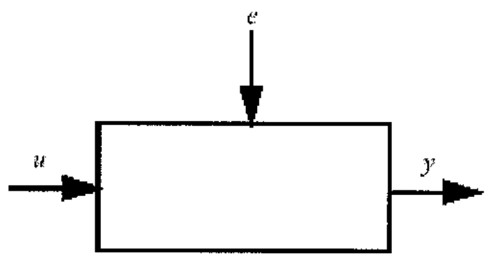

Figure 2.5 Input Signals u, Output Signals y, and Disturbances e

All these signals are functions of time, and the value of the input at time *t* will be denoted by *u(t)*.

2.4.2 Dynamic Model

For this project, ARX model was used to construct the process model of heat exchanger. The ARX model was constructed using System Identification Toolbox in Matlab Software.

Structure

The commonly used equation is the simple linear difference equation, which relates the current output *y(t)* to a finite number of past outputs *y(t-k)* and inputs *u(t-k)*.

$$y(t) + a_1 y(t-1) + \ldots + a_{na} y(t-na) = b_1 u(t-nk) + \ldots + b_{nb} u(t-nk-nb+1)$$

The structure is defined by the three integers na, nb, and nk. na is equal to the number of poles and nb is the number of zeros, while nk is the pure time-delay (the dead-time) in the system. For a system under sampled-data control, typically nk is equal to 1 if there is no dead-time.

General linear models can be described symbolically by

y=Gu+He

Where the measured output *y(t)* is a sum of one contribution that comes from the measured input *u(t)* and one contribution that comes from the noise *He*. The symbol *G* then denotes the dynamic properties of the system, that is, how the output is formed from the input. For linear systems it is called the transfer function from input to output. The symbol *H* refers to the noise properties, and is called the noise model. It describes how the disturbances at the output are formed from some standardized noise source *e(t)*.

Estimation Method

Coefficients a and b in the ARX model can be estimated by least square method and instrumental variables method. Least Squares minimizes the sum of squares of the right-hand side minus the left-hand side of the expression above, with respect to a and b. Instrumental Variables determines a and b so that the error between the right- and left- hand sides becomes uncorrelated with certain linear combinations of the inputs.

Multi-output Model

Multi-output ARX structure with NY outputs and NU inputs, the difference ARX equation above is still valid. The only change is that the coefficients *a* are NY by NY matrices and the coefficients *b* are NY by NU matrices.

For this system, the order [NA NB NK] define are:

i. NA: an NY by NY matrix whose i-j entry is the order of the polynomial (in the delay operator) that relates the j-th output to the i-th output.
ii. NB: an NY by NU matrix whose i-j entry is the order of the polynomial that relates the j-th input to the i-th output
iii. NK: an NY by NU matrix whose i-j entry is the delay from the j-th input to the i-th output

2.5 INTERNAL MODEL CONTROL USING NEURAL NETWORK

2.5.1 One degree freedom Internal Model Control

Feedback controllers normally designed to force the output of a stable system process to:

i. Respond in a desired manner to a setpoint change
ii. Counter the effects of disturbances that enters directly into the process output.

Based on the dynamic model developed using ARX method, it is then implemented in the IMC System.

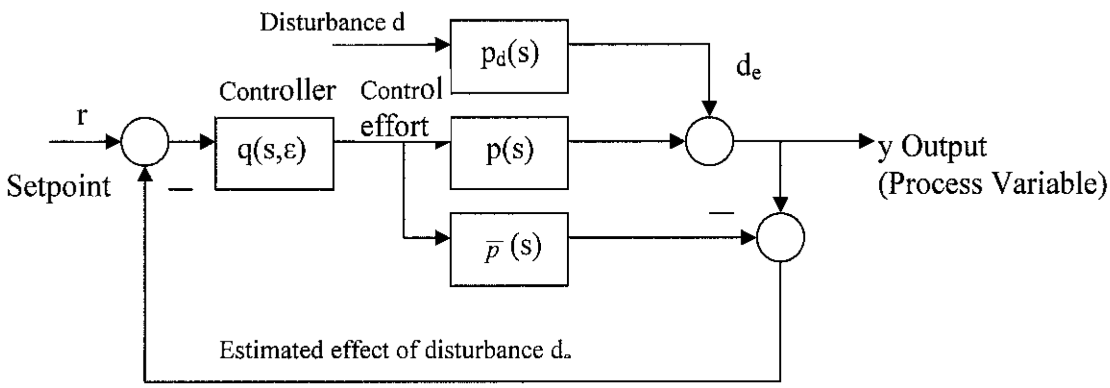

Figure 2.6: The IMC System

The IMC structure (Brosilow & Joseph, 2002) has and advantage where it concentrate on the control design without having to concern about the system stability provided that the process model $\bar{p}$ (s) is perfect representation of a stable process p(s).

2.5.2 PI and PID Parameter from IMC System

IMC controller implementation are becoming more popular but standard industrial controller remains the proportional (P), proportional plus integral (PI) and the proportional plus integral and derivative (PID) controller.

Proportional Control (P)

The mathematical representation is,

$$\frac{mv(s)}{e(s)} = k_c \quad \text{(Laplace Domain)} \qquad mv(t) = mv_{ss} + k_c e(t) \quad \text{(Time Domain)}$$

The proportional mode adjusts the output signal in direct proportion to the controller input (which is the error signal, e). The adjustable parameter to be specified is the controller gain, kc. This is not to be confused with the process gain, kp. The larger kc the more the controller output will change for a given error. The time domain expression also indicates that the controller requires calibration around the steady-state operating point. This is indicated by the c onstant term mvs. This represents the 'steady-state' signal for the mv and is used to ensure that at zero error the cv is at set point. In the Laplace domain this term disappears, because of the 'deviation variable' representation. A proportional controller reduces error but does not eliminate it (unless the process has naturally integrating properties), i.e. an offset between the actual
and desired value will normally exist.

Proportional Integral Control

The mathematical representation is,

$$\frac{mv(s)}{e(s)} = k_c\left[1 + \frac{1}{T_i s}\right] \text{ or } mv(t) = mv_{ss} + k_c\left[e(t) + \frac{1}{T_i}\int e(t)dt\right]$$

The additional integral mode (often referred to as reset) corrects for any offset (error) that may occur between the desired value (set point) and the process output automatically over time

Proportional Integral Derivative Control

The mathematical representation is,

$$\frac{mv(s)}{e(s)} = k_c\left[1 + \frac{1}{T_I s} + T_D s\right] \text{ or } mv(t) = mv_{ss} + k_c\left[e(t) + \frac{1}{T_I}\int e(t)dt + T_D\frac{de(t)}{dt}\right]$$

Derivative action (also called rate or pre-act) *anticipates* where the process is heading by looking at the time rate of change of the controlled variable (its derivative). TD is the 'rate time' and this characterizes the derivative action (with units of minutes). In theory derivative action should always improve dynamic response and it does in many loops. In others, however, the problem of noisy signals makes the use of derivative action undesirable (differentiating noisy signals can translate into excessive mv movement). Derivative action depends on the slope of the error, unlike P and I. If the error is constant derivative action has no effect.

2.6 CONTROL TUNING

The Ziegler and Nichols methods are considered "classic" methods having stood the test of time for more than 50 years. Their trial and error tuning method based on a sustained oscillation can be considered to be variations of the famous continuous cycling method that was published. The continuous cycling approach is referred as loop tuning or the ultimate gain method. The first step is to gradually increase the Kc until it gives continuous natural oscillations. At this point, the Kc is the ultimate gain, Kcu for the controller. The period of the resulting oscillation is referred to as the ultimate period, Pu. The PID settings then are calculated from the Kcu and Pu using Ziegler-Nichols (Z-N) tuning relationship. The Z-N relations were empirically developed to provide a ¼ decay ratio. This method is widely used in the industry.

Controller	K_c	T_I	T_D
P	0.5 K_{cu}	-	-
PI	0.45 K_{cu}	Pu/1.2	-
PID	0.6 K_{cu}	Pu/2	Pu/8

Table 2.0: Zigler-Nichols Controller Setting Based on the Continuous Cycling Method

CHAPTER 3
METHODOLOGY OR PROJECT WORK

3.1 PROJECT OVERVIEW

The project work will involve research, modeling and simulation work which involve application of neural network modeling and simulation software. For this project, the neural toolbox in MATLAB was used to develop the NN model for the heat exchanger. To model a NN model for heat exchanger, the process variable involved had to be identified. For a heat exchanger, the process variables are the flow rate for shell and tube, the inlet and outlet temperature of both shell and tube side, and the pressure drop across the shell and tube side. For this project work, the parameters defined are the flow rate and the temperature as the pressure drop data could not be obtained.

The data on the process variables obtained from the industry and statistical analysis performed on the data. Based on the data obtained, the data are divided into Training, Validation and Testing. With the training set of data, the neural network model was created using Matlab's Neural Network Toolbox. The network then validated with the validation set of data and finally tested with the testing set of data.

With the network model, the alternative control strategies developed to predict the outlet temperature and device a control strategy to control the complex nonlinear process.

3.1.2 Tools Required

For this project work, the modeling and simulation will utilize computer software. For modeling and simulation purpose, Matlab Version 6.1 will be used. As for data analysis, Microsoft® Excel is used. To develop the NN model, the Neural Network Toolbox's Network Data Manager" which is an extension component in the Matlab software. The processing of construction, training, validation and testing of the NN model will be done with this software. For further development of control strategy, Matlab's Simulink tool will be used to perform the task.

Microsoft® Excel used to perform basic calculation such as normalization and 'Random Number Generation' function used to segregate the data into 3 different sets. Besides that, data analysis calculations such as 'ANOVA: Single Factor' to verify segmented sets and the original set are from the same population and 'Descriptive Statistics' in testing for normal distribution of data and removal of outliers .

3.2 METHODOLOGY OF THE PROJECT

The project work can be summarized as series of major steps in the Figure 3.1. Besides these steps, there are additional work that was conducted such as interpretation of data obtained, and familiarization with NN Toolbox software.

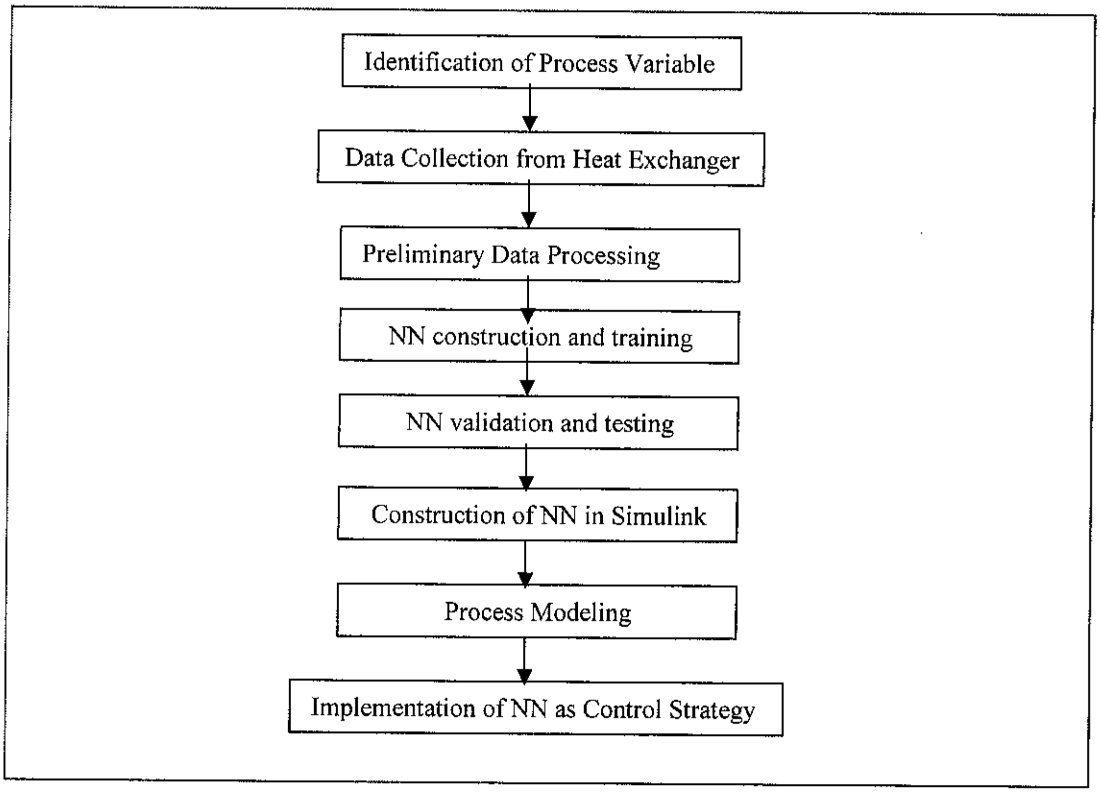

Figure 3.1: The methodology in developing NN model for heat exchanger

3.3 PROJECT WORK

3.3.1 Variable Identification

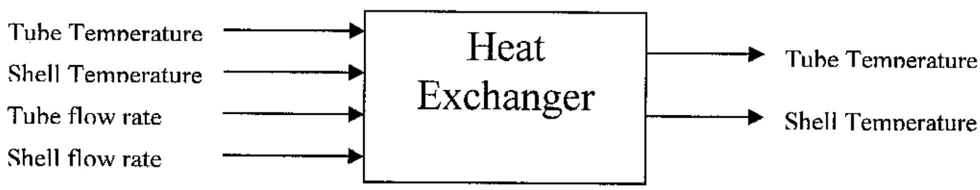

Figure 3.2 Process Variable for Heat Exchanger used in the model

3.3.2 Data Collection and Processing

Initial process variable data was recorded in the PETRONAS Refinery Melaka Sdn. Bhd. for every one hour for a period of 15 days. Based on the data, frequency analysis was done on the data to determine what would be the controlled range or set point range for temperature and flow rate for the process variable. After the frequency test, the process variable data then evaluated for its maximum, minimum, mean and standard deviation. Any outliers of the data then will be removed. Most of the evaluation was done using Microsoft Excel ®. Since the all the data was on the range, no outlier was removed. The data then segregated to three partitions.

The partitions were labeled as Training Data, Validation Data, and Testing Data. The partition was done based on the journal of Radhakrishnan and Mohamed (2000) which is 43%:43%:14%. The data segregation was done by using Microsoft Excel® Random Number Generator. A random number from 1 to 100 was specified to the data and data segregation was done based on this random number. The random number of 1 to 42 will be classified as Training Data, random number of 43 to 86 will be classified as Validation and 87 till 100 will be Testing Data. Anova test was done to verify that the original and the three of data are from the same population by comparing their means and standard deviations. Normalization then was done on the set of the data. This is because the Neural Network function will only accept the value of 0 to 1.

The testing for normal distribution was also done for all the three set of data. The test was done based on these criteria:

i. Test for skewness of the data. Skew = 0, symmetric; Skew < 0, asymmetric tail extending to positive values; Skew > 0, asymmetric tail extending to negative values.
ii. Relative Peakness or Flatness of the data is tested with Kurtosis. Kurt = 0, normal; Kurt > 0, peaked distribution; Kurt < 0, flat distribution.

These tests were selected from suggestions by journal by Radhakrishnan and Mohamed (2000). The test was done on Microsoft Excel® 'Descriptive Statistic' Toolbox. The conclusion on the distribution of each set of data was done based on the analysis. Then normalization on the data was done. This was done due to inconsistency in the unit for all the process variables. Normalization was also done because the network architecture designed by Chong Chee Keong requires the inputs of 0 to 1.

3.3.3 Neural Network Architecture

The neural network used for this project was designed by Chong Chee Keong. The design was done using Matlab 'Neural Network Toolbox'. Total number of set of data used for this project is 744. For training the neural network, the input have to be in term of matrix of 4X316, the 4 refers to the number of process variables and 316 is the sets of data. 'Network/Data Manager' is used for training and testing of the neural network. The 'Network/Data Manager' is part of Neural Network Toolbox in Matlab.

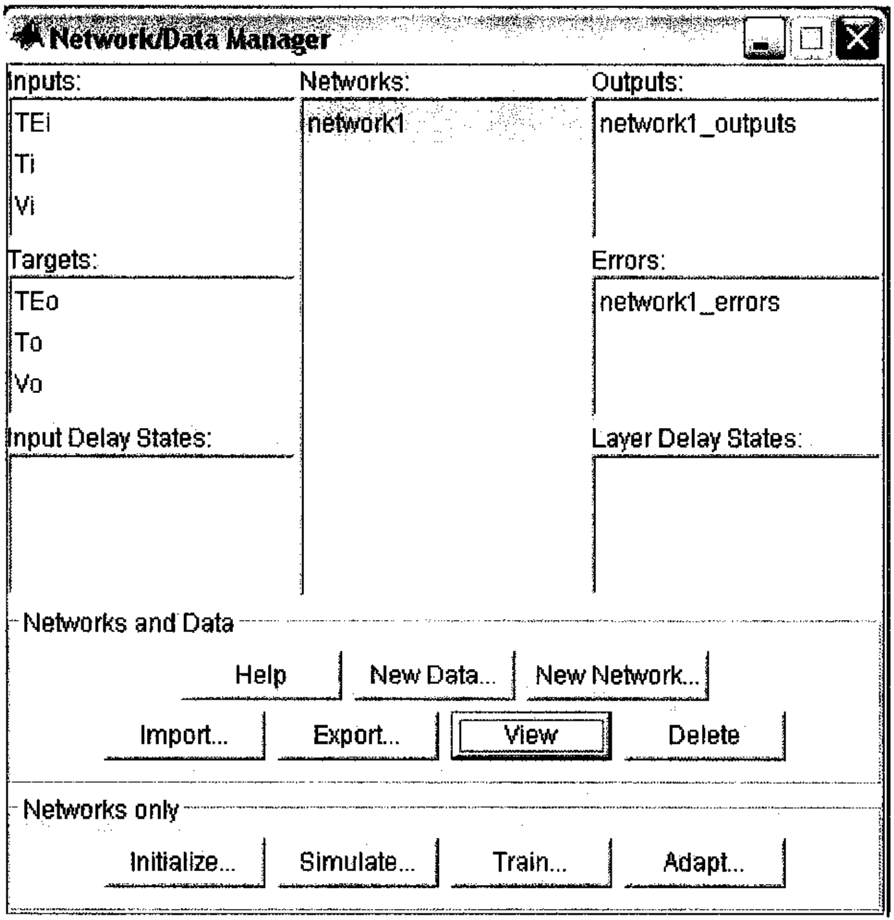

Figure 3.3 Neural Network Data Manager

The set of data is specified in the Matlab workspace and the data then imported in the 'Network/Data Manager'. The design for the network was taken from the work of Chong Chee Keong. The model then trained with the training set of data. Once the training is completed, validation process done to the model. If the result obtained is satisfactory, testing will be done to the model with testing set of data. The errors obtained in the validation set and the testing set will be compared and evaluated.

3.3.4 Neural Network in Simulink

Once the network had be created in the Neural Network Data Manager, it is the exported to Matlab's workspace. The model then generated in the Simulink with this command:

gensim (net,-1)

The second argument is -1 so the resulting network block samples continuously. The call to gensim results in the following screen. It contains a Simulink system consisting of the linear network connected to a sample input and a scope.

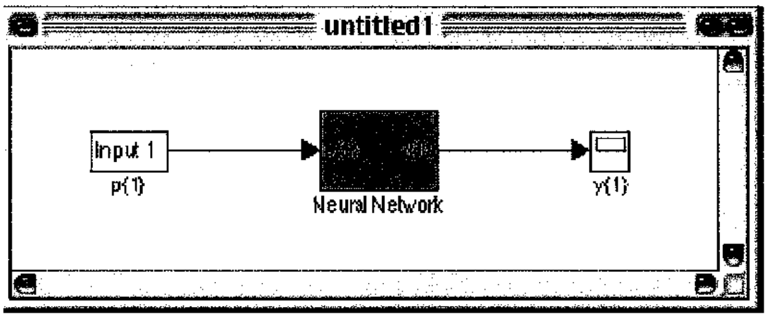

Figure 3.4: Simulink Model of Neural Network

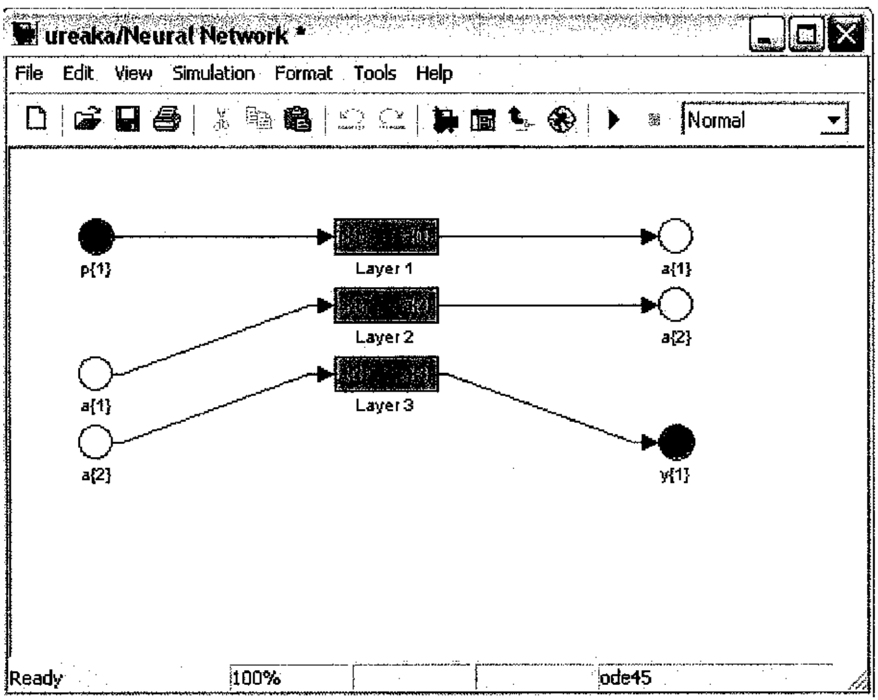

Figure 3.5 Internal Model of the Neural Network

3.3.5 Process Modeling

The process model is the crucial part of the control system. For this project, a dynamic model was created for the heat exchanger. For simplicity, the process is considered as a single output single input system (SISO). The identified process variables are the shell outlet temperature (Tco) and the manipulated variable are the tube inlet flow rate (Wh). For generating a non-linear model, Matlab's Plant Identification Toolbox was used. The toolbox helps in building mathematical models of a dynamic system based on measured data. This is done by adjusting parameters within a given model until its output coincides as well as possible with the measured output. The Most common models used are difference equations descriptions, such as ARX and ARMAX models, as well as all types of linear state-space models. The System Identification Toolbox provides a graphical user interface (GUI). The GUI covers most of the toolbox's functions and gives easy access to all variables that are created during a session. It is started by typing:

```
ident
```

in the MATLAB command window.

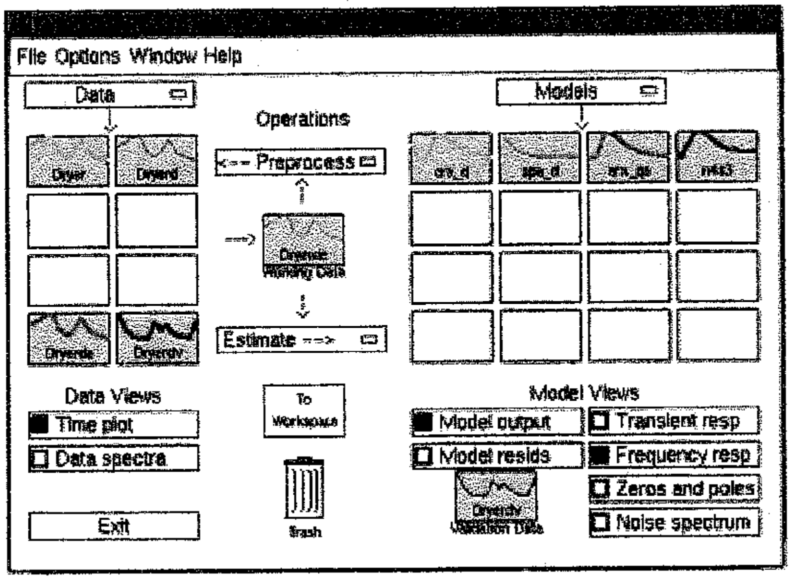

Figure 3.6 Main Ident Information Window

The workflows of the Toolbox are as below:

i. Data are important either from the workspace or from a Matlab file
ii. The data are examined using the **Data Views.**
iii. The means of the data are removed so that only perturbations are present
iv. The subsets of data for estimation and validation purposes are selected using the items in the pop-up menu **Preprocess**.
v. The model then estimated using the possibilities under the pop-up menu **Estimate**. For this project, since ARX model is used, parametric estimation was chosen.
vi. With trial and error method, the order of the system is estimated based on the output model of the system. The highest best fit graph taken as the best order estimated for the system.
vii. The model then exported to the workspace where is converted to transfer function form.

3.3.6 Fundamental Heat Exchanger Model

This fundamental model was developed to give the approximation on the properties of the process variables in a given situation. For this project, two fundamental models were developed based on the overall energy balance on the heat exchanger. The first model was developed to estimate the outlet properties of the heat exchanger which is the shell and tube outlet temperature based on the inputs. The second model was developed to estimate the tube flow rate based on the outlet property predicted by the neural network.

The energy balance used for this two models are:

Shell Side

$$w_c.c_j(t_{c_i} - t_{co}) + uA(t_{ho} - t_{co}) = m_c.c_j.\frac{dt_{co}}{d\Theta}$$

Where Wc is the shell inlet flow rate (kg/s)

Cj is the heat capacity of the fluid in the shell (J/jg)

U is the overall heat transfer coefficient (J/m^{2}K.s)

A is the area involved in the heat transfer (m^2)

Mc is the weight of fluid inside the shell (kg)

Tc is the shell inlet temperature (K)

Tco is the outlet shell temperature (K)

Θ is time (s)

Tube Side

$$w_h.c_h(t_{hi} - t_{ho}) - uA(t_{ho} - t_{co}) = m_h.c_h.\frac{dt_{ho}}{d\Theta}$$

Where Wh is the tube inlet flow rate (kg/s)

Ch is the heat capacity of the fluid in the tube (J/jg)

Mh is the weight of fluid inside the tube (kg)

Th is the tube inlet temperature (K)

Tho is the tube outlet temperature (K)

The properties of the constant are taken as below:

Ch = 4500 J/kg

Cj = 3000 J/kg

U = 200.35 $W/m^2.K$

A = 295.2 m^2

Mh = 632.79 kg

Mc = 247350 kg

3.3.7 Control Strategy using Neural Network

Based on the Internal Model Control (IMC) system, a simple PID control strategy was designed integrating the neural network in the system. The system was taken as Single Input Single output system (SISO). The process variable for this system is the shell outlet temperature (Tco) and the manipulated variable is the tube inlet flow rate (Wh).

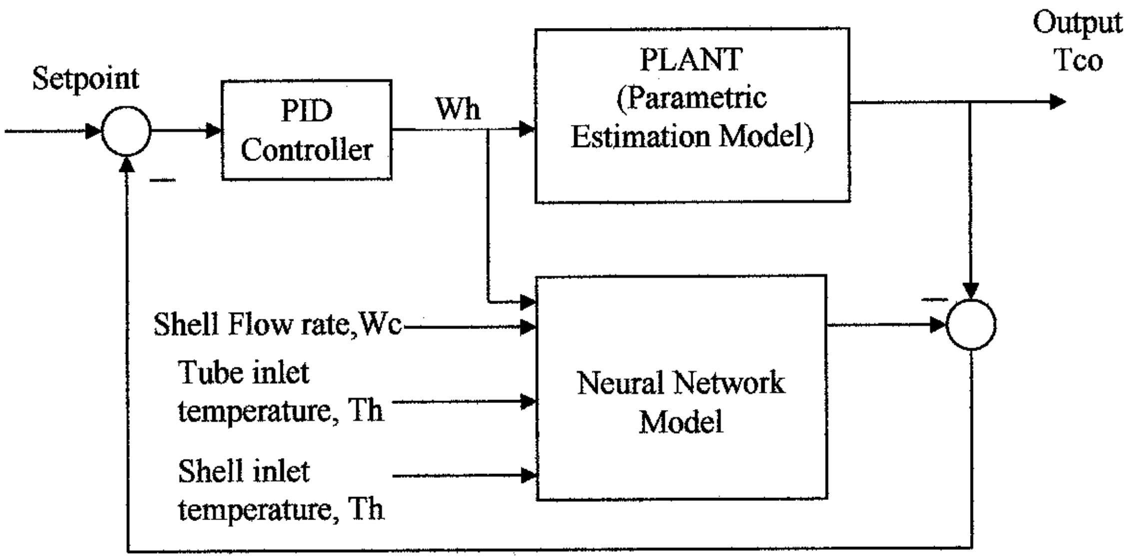

Figure 3.7: The Control Strategy

Based in the design, the PID controller then tuned using Zielger-Nichols tuning method to obtain the optimum control setting for the controller.

CHAPTER 4
RESULT AND DISCUSSIONS

4.1 DATA PROCESSING

4.1.1 Frequency Test

Based on the data obtained on the process variable of heat exchanger, frequency test was done to find the controlled variable for the heat exchanger. For the first trial, the delta temperature and delta flow rate taken at 0.1, 1 and 2. Based on the obtained result at Appendix 5.3, it is notice that the distribution was not a normal distribution with two high frequency peaks. When the delta temperature was increased to 1, referring to Appendix 5.3 the same distributed graph obtained. The range for delta temperature was again increased to 2. Here, it can be notice that a normal distribution exist for the set of data. The set point range for the shell outlet temperature (cold section) was determined as 182 Deg C to 184 deg C. For the shell flow rate, the delta is determined as 5 and for tube flow rate, the delta taken as 1. The set point range for shell could not be determined and the setpoint for tube flow rate is 61 m^3/hr.

4.1.2 Data Segmentation

Data obtained on the heat exchanger was segmented into training, validation and testing set of data. The segmentation was done by assigning random number to the data.

		Inlet Properties				Outlet Properties	
Classification	**Rand.No**	**Shell Flow rate**	**Tube Flow rate**	**Shell Temperature**	**Tube Temperature**	**Shell Temperature**	**Tube Temperature**
TE	86.9443548	292.3609	56.2667	180.2702	309.3344	182.8047	283.6898
T	1.64098422	293.7146	52.5232	180.7407	309.7653	183.5318	283.4236
T	37.238745	293.2839	55.5414	180.5103	309.5731	183.4518	284.8456
T	42.8473346	292.9318	54.8777	180.5156	309.3809	183.3717	284.1787
T	24.8055724	292.6131	54.1321	180.5208	309.1389	183.2915	283.5117
T	36.6592499	293.1930	53.7981	180.5261	308.8867	183.2115	282.8448
V	51.6260566	292.4092	53.9145	180.5313	308.6344	183.1318	282.6593

Table 4.1: Sample of the segmented of data from the original set of data

With this set of data, ANOVA test was done to confirm that the original and the segmented data are from the same population. First ANOVA test was done on the shell inlet temperature. Based on the test, the following result obtained:

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Original	745	134715.8	180.8265	6.634432
Training	317	57270.92	180.6654	6.709906
Validation	319	57683.59	180.8263	6.670304
Testing	109	19761.26	181.2959	6.132217

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	32.25073	3	10.75024	1.623497	0.182018	2.610889
Within Groups	9839.783	1486	6.621658			

Total	9872.034	1489

Table 4.2 : ANOVA Test on the segmented data

Based on the ANOVA test, it is notice that the variance for all the three sets are the nearly the same with the original set of data. This proves that the three segmented data are from the original set of data.

The testing for normal distribution was also done for all the three set of data. Skewness test and Kurtosis Test was done. The test was done on the Shell inlet temperature.

Mean	180.665362
Standard Error	0.145488469
Median	180.2231903
Mode	175.1557159
Standard Deviation	2.590348547
Sample Variance	6.709905597
Kurtosis	0.205151519
Skewness	0.357951952
Range	13.62278748
Minimum	174.875473
Maximum	188.4982605
Sum	57270.91975
Count	317
Confidence Level(95.0%)	0.286248678

Table 4.3 Distribution Test for Training data

Mean	180.8262949
Standard Error	0.144603058
Median	180.3840637
Mode	175.1557159
Standard Deviation	2.582693203
Sample Variance	6.67030418
Kurtosis	-0.189270397
Skewness	0.150888235
Range	12.68322754
Minimum	174.9994812
Maximum	187.6827087
Sum	57683.58809
Count	319
Confidence Level(95.0%)	0.284499398

Table 4.4 Distribution Test for Validation data

Mean	180.8262949
Standard Error	0.144603058
Median	180.3840637
Mode	175.1557159
Standard Deviation	2.582693203
Sample Variance	6.67030418
Kurtosis	-0.189270397
Skewness	0.150888235
Range	12.68322754
Minimum	174.9994812
Maximum	187.6827087
Sum	57683.58809
Count	319
Confidence Level(95.0%)	0.284499398

Table 4.5 Distribution Test for Testing data

4.1.3 Normalization

Since the input for the neural network has to be in the range of 0 to 1, normalization had to be done to the set of data. The data was normalized based on equation. Sample result shown in table 4.6

	Inlet Properties							
Rand.No	Shell Flow rate	Normalized	Tube Flow rate	Normalized	Shell Temperature	Normalized	Tube Temperature	Normalized
41.83172	292.3609	0.8944	56.26668	0.3565	180.2702	0.3960	309.3344	0.4646
34.98337	293.7146	0.9038	52.52322	0.1803	180.7407	0.4305	309.7653	0.4848
29.89288	292.6131	0.8961	54.1321	0.2560	180.5208	0.4144	309.1389	0.4554
42.80831	293.193	0.9002	53.79812	0.2403	180.5261	0.4148	308.8867	0.4436
32.25501	294.2624	0.9077	54.05168	0.2523	180.3500	0.4019	308.3419	0.4180
20.55422	292.1612	0.8930	53.91286	0.2457	180.1095	0.3842	307.9608	0.4001
33.36894	307.4452	1.0000	57.49141	0.4142	178.7900	0.2873	307.6789	0.3869
18.80551	291.3009	0.8869	53.23751	0.2139	179.2642	0.3222	308.0351	0.4036

Table 4.6 Sample of normalized training data

4.1.4 Removal of outliers

No data was removes as all the data was in the range with the mean and all the data was having low standard deviation expect of for shell flow rate. This is the crude flow rate into the heat exchanger.

4.1.5 NN Construction and Training

For the construction, the configuration was taken for Chong Chee Keong's configuration based on his report on Neural Network Model on Heat exchanger. The configuration is as stated:

Parameters	Variable
Network	Feed-forward backprop
Training function	TRAINRP
Adaptation learning function	LEARNGDM
Performance function	MSE
Epochs	93
Number of layers	3
Layer 1: Number of Neuron Transfer function	10 PURELIN
Layer 2: Number of Neuron Transfer function	20 PURELIN
Layer 3: Number of Neuron Transfer function	2 LOGSIG

Table 4.7 Neural Network Configuration

Based on this configuration, the performance of the NN was tested with the available set of data. Based on the three segmented, the performance curve of the neural network was obtained. The performance obtained was 0.00130665. The desired performance is 0. This performance test was done with all the three set of segmented data. The iteration (epochs) for the NN is 79 times. The performance is also due to the termination based on the validation and testing set of data.

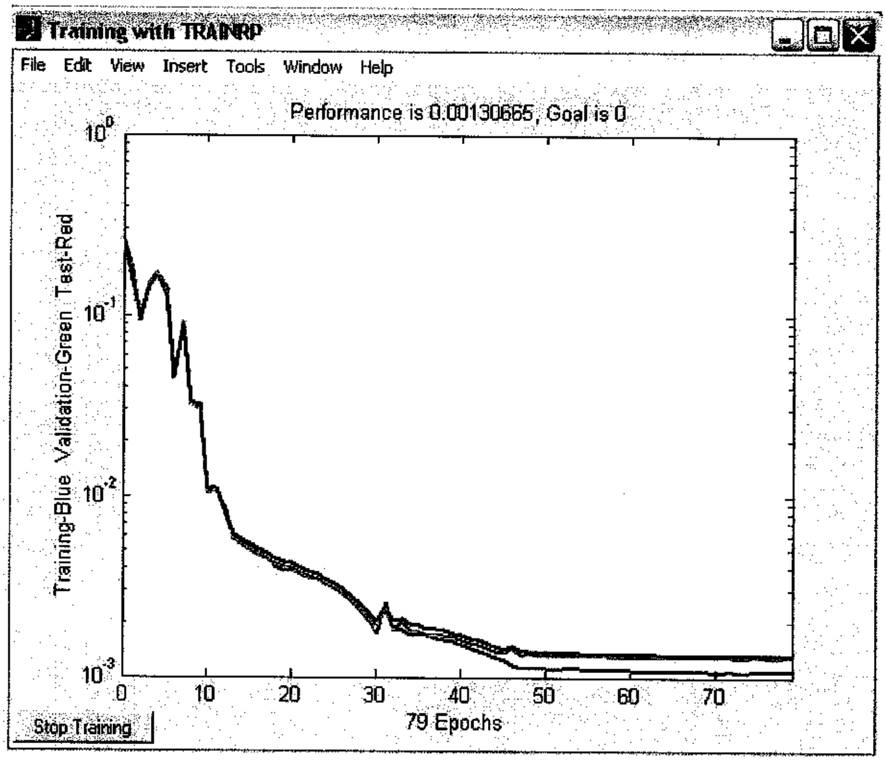

Figure 4.1:The performance of the NN

4.1.6 NN Validation and Testing

With the NN constructed, validation and testing was done with validation and testing set of data. There errors between the actual value and the predicted value by NN also measured. The result of the error of error against actual value and predicted value by NN are as Appendix 5.4. The sample result is as table 4.8.

Outlet Properties							
Shell Temperature	Shell Temperature by NN	% Error	Tube Temperature	Normalized	Normalize value by NN	Tube Temperature by NN	% Er
183.4518	183.1825	0.1468	284.845642	0.4799	0.42471	283.863389	0.3
183.3717	183.1787	0.1052	284.17868	0.4424	0.40271	283.471512	0.2
183.1318	183.1834	0.0281	282.659302	0.3571	0.34712	282.48131	0.0
183.0900	183.1002	0.0056	282.638123	0.3559	0.33558	282.275752	0.1
183.0062	182.7956	0.1151	282.612457	0.3545	0.33366	282.241552	0.1
183.0429	182.4389	0.3300	281.238159	0.2773	0.27517	281.199693	0.0
182.0023	181.2220	0.4288	281.949371	0.3173	0.30479	281.727302	0.0

Table 4.8 Sample Result of error against actual value and predicted value by NN

Based on the result, the errors between the actual temperature and the predicted temperature are below than 1%.

4.1.7 Process Modeling

ARX Model

The heat exchanger dynamic model was created using Matlab's System Identification Toolbox. The toolbox generates the ARX model based on the input and output data of the system. For this purpose, the Ident GUI was used to create the model. A set of 400 inputs and outputs of data was used with a sample time of 3600 seconds. First 200 set of data used as working data and the rest 200 set of data used as validation.

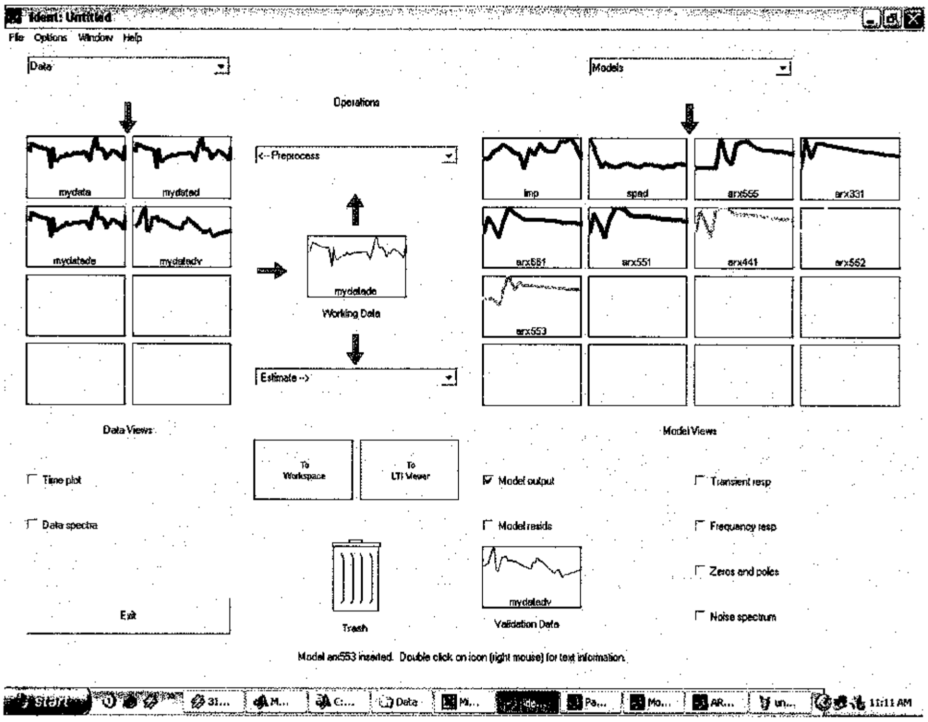

Figure 4.2 The System Ident GUI

The input and output of the system is given as:

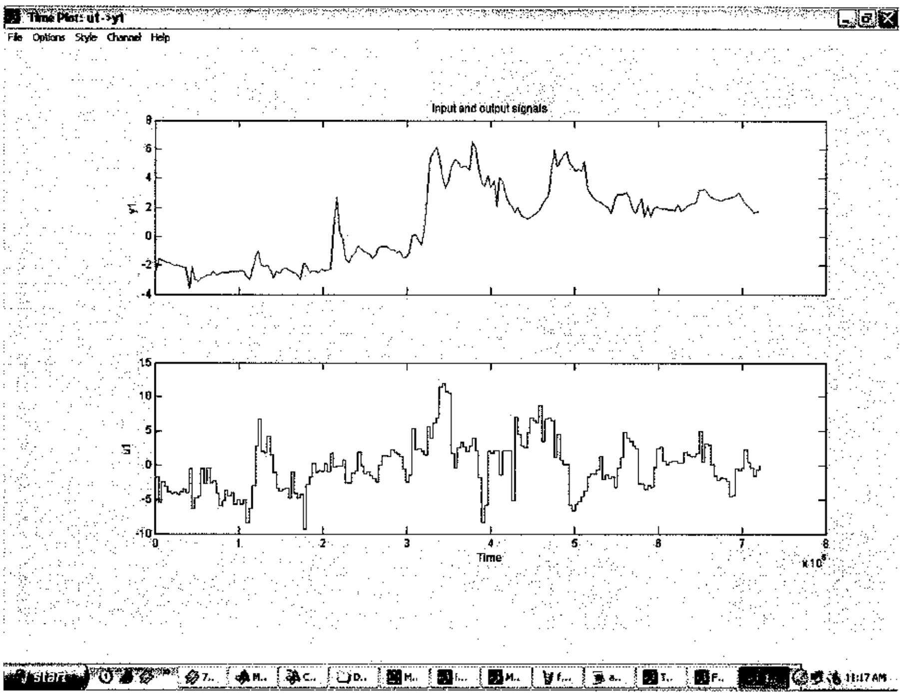

Figure 4.3 Input and output of the system

The estimation on the order of the parametric model was done by trial and error. The order was slowly increase and the output value from the model compared with the actual output of the heat exchanger. The best fit was obtained at na=5, nb=5 and nk=1. Besides that, the toolbox also contains feature where it could estimate the order of the system, but this estimation often not so accurate. Based on the data, the order the toolbox estimated was na=3, nb=3 and nk=1. The accuracy of the estimated was lesser than obtained from trial and error method. Thus, the order taken for the ARX model are na=5, nb=5 and nk=1.

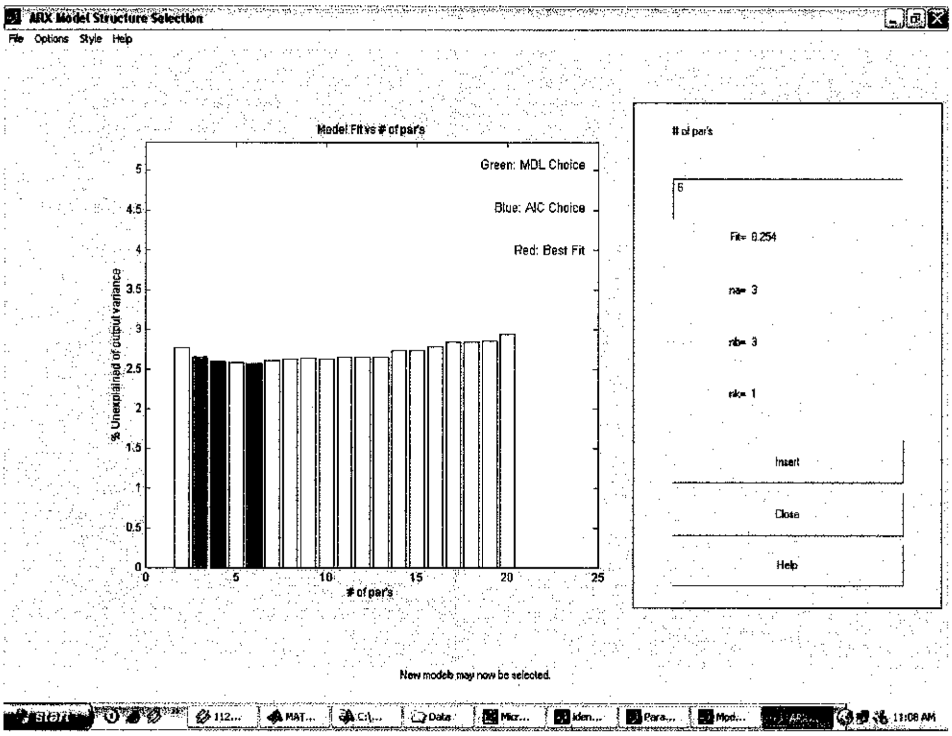

Figure 4.4 The Estimated order of the System

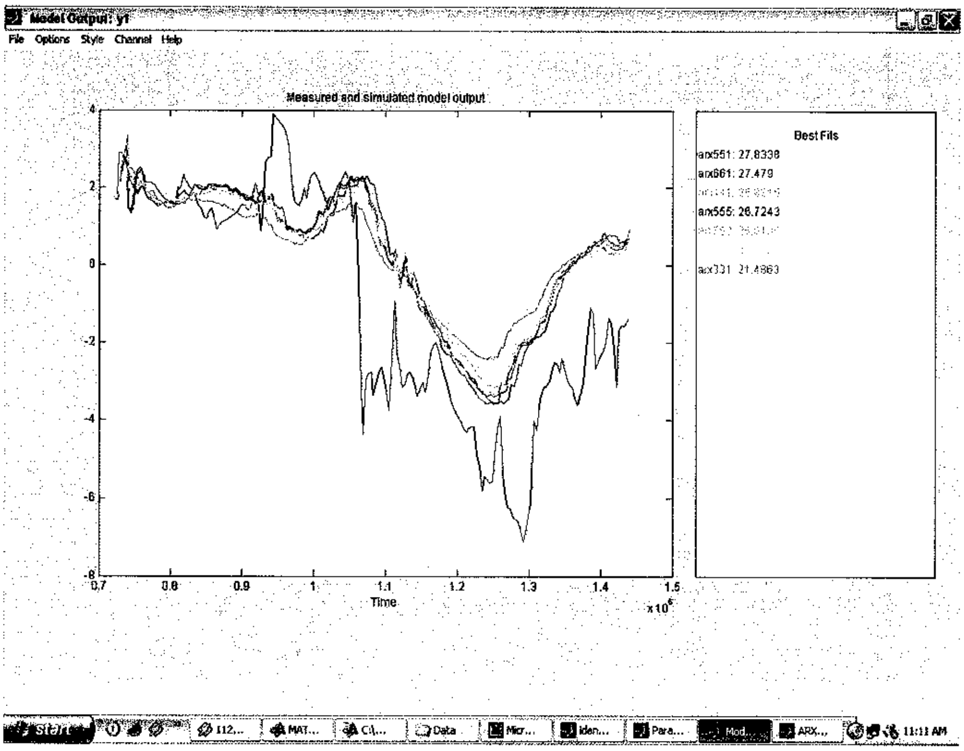

Figure 4.5: The best fit graph of the model and the actual output of the system

The ARX Model obtained from the System Identification tool is in a form of discreet-time function.

Discrete-time IDPOLY model: A(q)y(t) = B(q)u(t) + e(t)

A(q) = 1 - 1.009 q^-1 + 0.09536 q^-2 + 0.1162 q^-3 - 0.1037 q^-4 - 0.04823 q^-5

B(q) = 0.03393 q^-1 - 0.01865 q^-2 - 0.02063 q^-3 + 0.03606 q^-4 + 0.01922 q^-5

Estimated using ARX from data set mydatade

Loss function 0.397398 and FPE 0.43901

Sampling interval: 3600

Where u(t) are the inputs with respect to time

y(t) are the outputs with respect to time

e(t) are the noise source which effects the output

Since it is required that the process model will be in term of transfer function. The discreet function was converted to continuous function. This was done using Matlab command:

Mc = d2c (Th)

Where Mc will be the continuous function and Th is the discreet function. With the conversion, the result below was obtained.

Continuous-time IDPOLY model: A(s)y(t) = B(s)u(t) + C(s)e(t)
A(s) = s^5 0.0008422 s^4 +8.988e-007 s^3 + 2.333e-010 s^2 +6.042e-014 s + 6.93e-019
B(s) = 4.12e-005 s^4 - 3.334e-009 s^3 + 2.21e-011 s^2 - 2.017e-015 s + 6.781e-019
C(s) = s^5 + 0.001123 s^4 +1.131e-006 s^3 +4.868e-010 s^2+1.295e-013 s +358e-017
Estimated using ARX from data set mydatade
Loss function 0.397398 and FPE 0.43901

Based on this continous function, the transfer function was generated. This is also done with the help of Matlab software. The following transfer function was obtained:

Transfer function from input "u1" to output "y1":
4.12e-005 s^4 - 3.334e-009 s^3 + 2.21e-011 s^2 - 2.017e-015 s + 6.781e-019
----
s^5 + 0.0008422 s^4 + 8.988e-007 s^3 + 2.333e-010 s^2 + 6.042e-014 s + 6.93e-019

This transfer function then imported into the Matlab Simulink.

Fundamental Model

Based on the energy equation, the first model was developed to estimate the outlet properties based on the inlet of the heat exchanger.

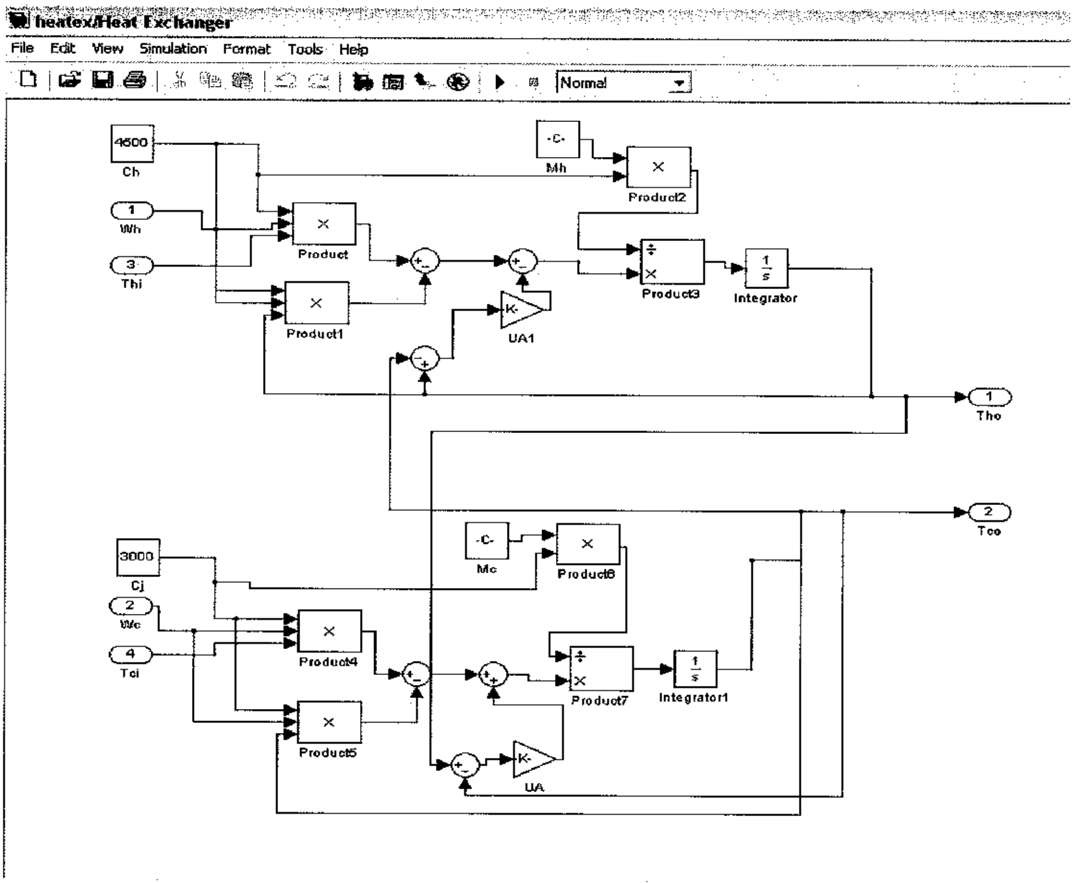

Figure 4.6 Heat Exchanger Fundamental Model 1

The second model was developed to estimated the inlet property (Wh) based on the outlet conditions predicted by the neural network.

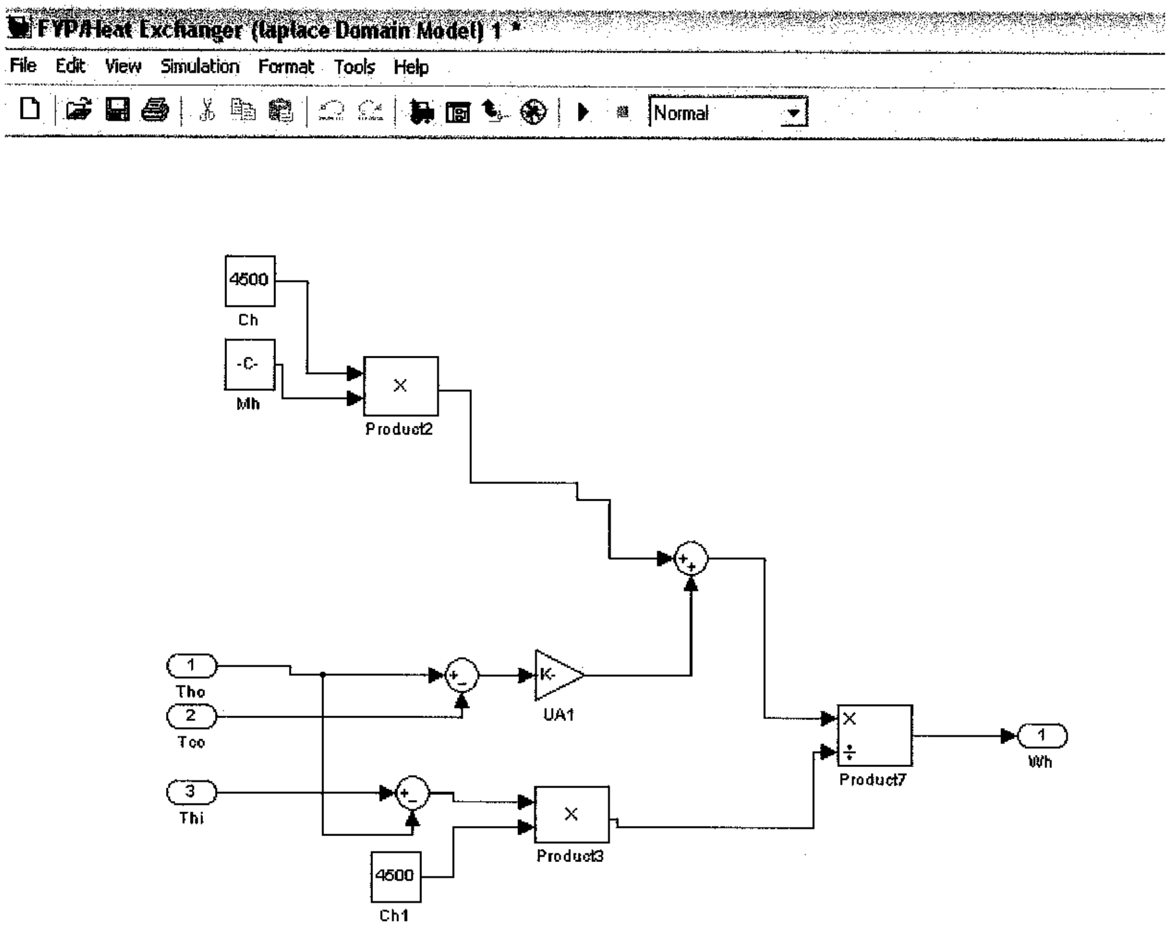

Figure 4.7 The Fundamental Model 2

4.1.8 IMC Control System

The IMC system designed for this project comprise of a dynamic model with PID control. The controller integrates the neural network, where the predicted outlet property of the dynamic model will become the feedback to the controller. Due to time limitation, the controller was only designed for a step change that occurs at the manipulated variable which is the tube flow rate. Disturbance effect was not taken into consideration. Before the controller could be fully used, tuning had to be done.

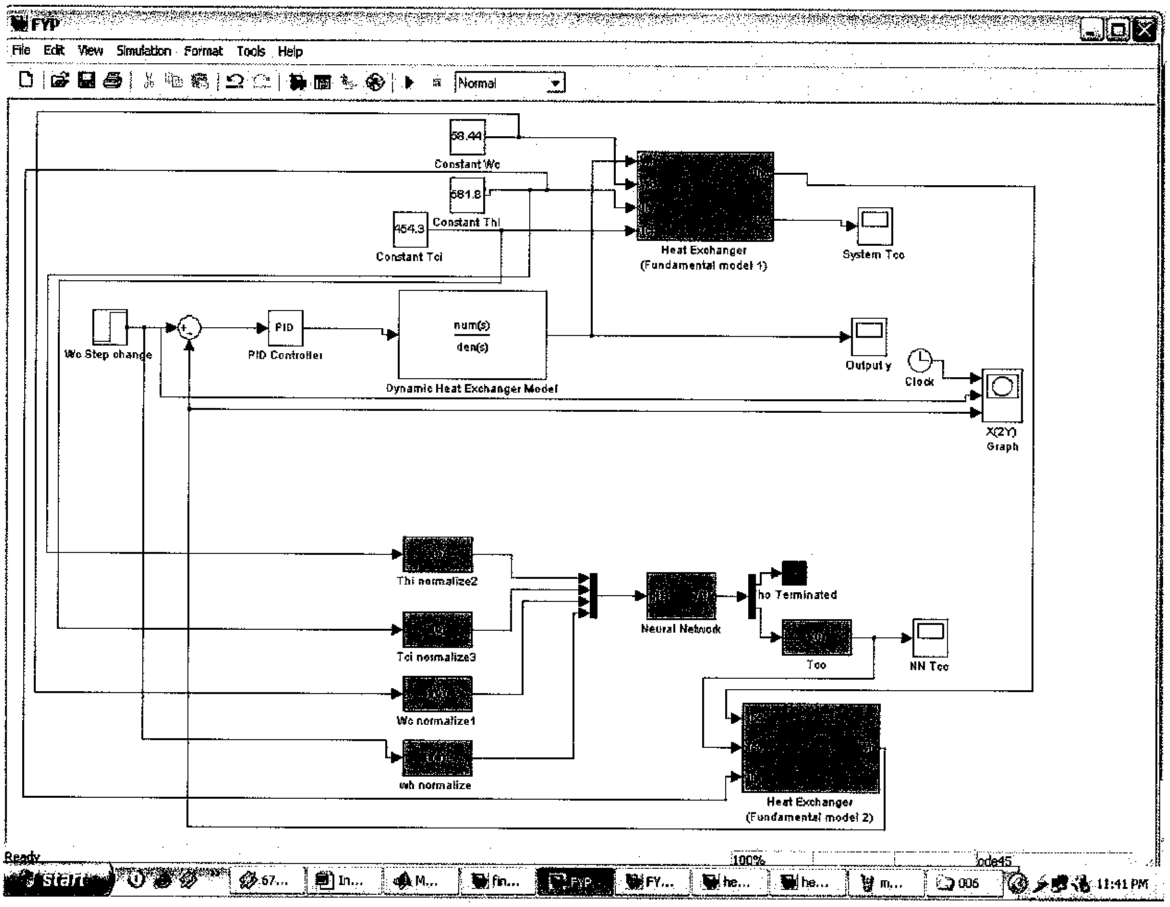

Figure 4.8 The IMC System for Heat Exchanger

4.1.9 Controller Tuning

The controller need to be tuned first before it can be fully used. Here Ziegler-Nichols method was used for tuning. The process was done on Matlab Simulink. Proportional values(P) was kept minimum and Integral value (TI)was kept maximum with Derivative value (TD)=0, set point increase was done. The initial value was 50kg/s then increased to 55 kg/s. The P value was increased slowly until natural oscillation occurs. The natural oscillation was obtained at P=40 and the natural period is 10s.

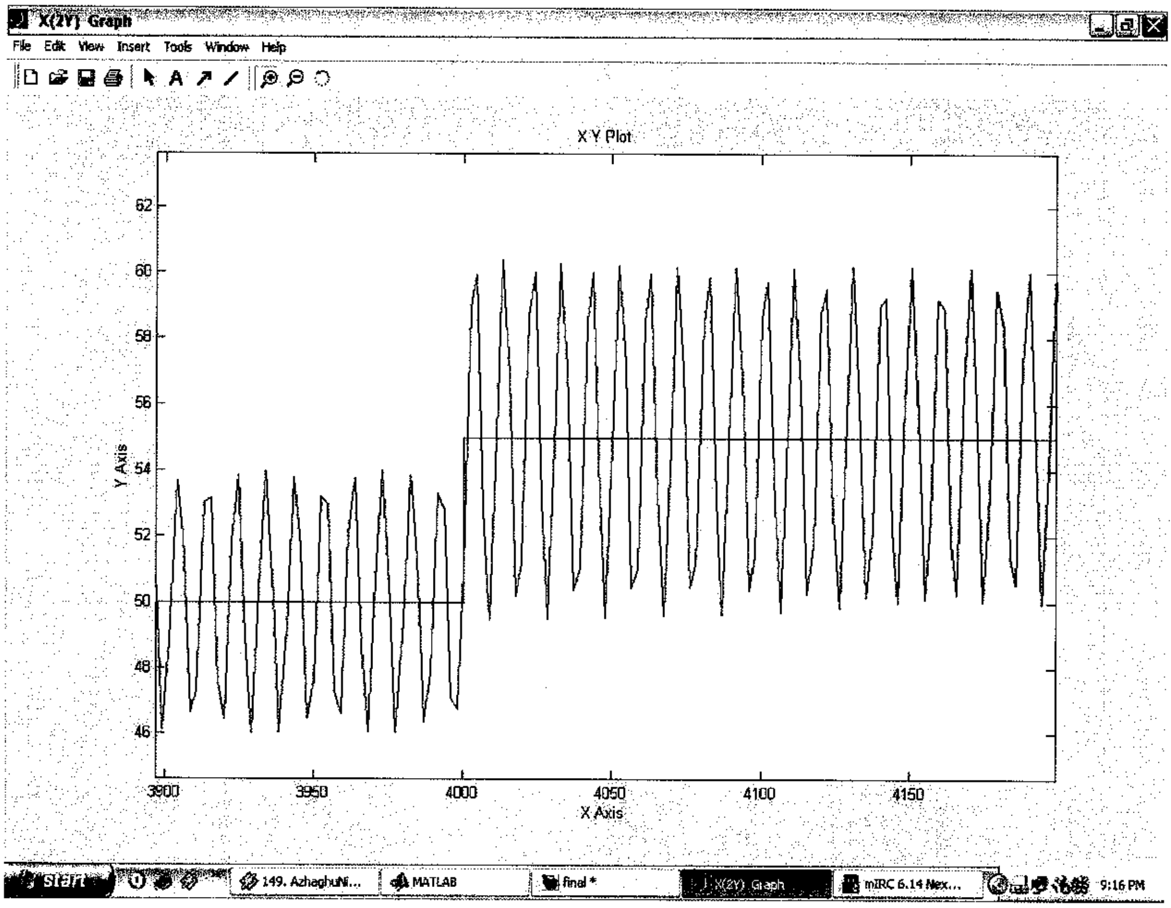

Figure 4.9 Natural Oscillation at P =40, Ti=9999 and TD=0

Based on Ziegler-Nichols tuning method, the calculated value of P, TI and TD are:

P = 0.6 (40)

= 24

Ti = Period/2

= 10/2

= 5s

TD = Period/8

= 10/8

= 1.25

Based on the calculated new controller setting, it was implemented in the system. The following result was obtained. It can observe that the manipulated variable oscillate when setpoint change at 4000s.

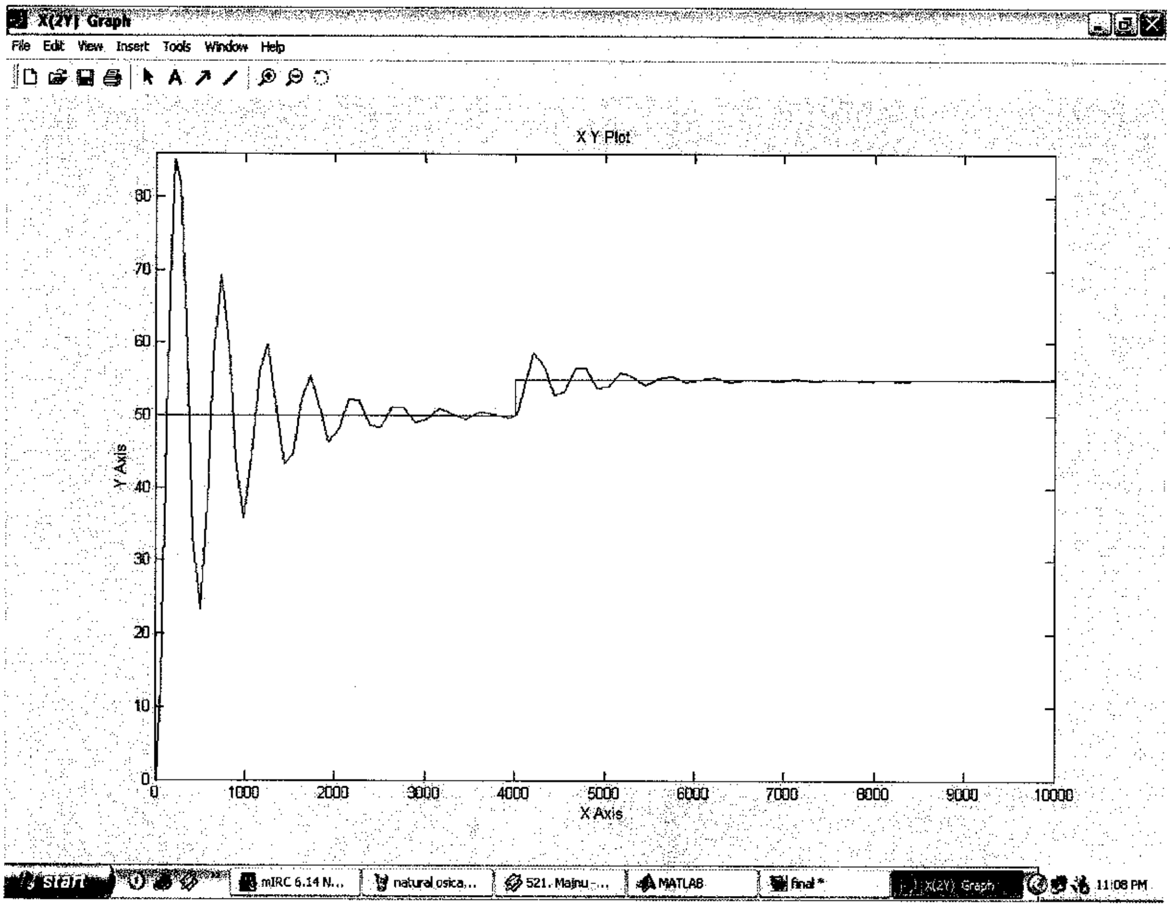

Figure 4.10 Tuned Controller Settings

4.2 DISCUSSIONS

4.2.1 Frequency Test

It was notice that for the set of data, when the delta temperature or flow rate was small, the characteristic of the distribution was not a normal distribution. Two range of setpoint appeared on the graph. This might be due to frequent crude switch, where the crude type was changed depending on the availability and the economics. When crude switch occurs, certain properties of the crude will be different, thus changing the parameter of the system. This is why it can be notice that two set point region was present at the graph. For project purpose, the range was increase to obtained only one setpoint range for the heat exchanger.

4.2.2 Data Segmentation

Data segmentation was done by assigning random number to every set of data and then segregating them into three different set, which is Training, Validation and Testing. ANOVA test was done to confirm that the three set of data are from the same original set. From the result obtained, the means and the variance of the data obtained are nearly similar with the original set. This proves that the segmented data are from the same original set of data. ANOVA: Single Factor was chosen because the nature of the set of data that violates the rules for other ANOVA tests.

Test for skewness of the data. Skew = 0, symmetric; Skew < 0, asymmetric tail extending to positive values; Skew > 0, asymmetric tail extending to negative values. From the result we obtained that skew was above 0, thus all the sets has asymmetric tail extending to negative values

Relative Peakness or Flatness of the data is tested with Kurtosis. Kurt = 0, normal; Kurt > 0, peaked distribution; Kurt < 0, flat distribution. From the data we obtained, kurtosis was above 0. All the sets has peaked distribution.

This study justify that no outliers was removes as all the data was in the range with the mean and all the data was having low standard deviation expect of for shell flow rate. This is the crude flow rate into the heat exchanger. The high in the deviation was due to frequent crude change where the flow rate was reduced so that the system could reach steady state. Then the flow will be increase to it normal capacity run. Besides that, any upset in the other production units will also affect the throughput as the crude flow rate might have to be reduced to reduce the production.

4.2.3 Neural Network Construction

Since the original configuration was taken from Chong Chee Keong's design, a modification was done on the number of the neurons at the third layers. This is because original configuration has 4 outputs while for this project, only two outputs are needed as the unavailability of the pressure drop data. Trial and error was also done by increasing and decreasing both the layers and the number of the neurons. Based on the trial and error, the optimum configuration is as stated in the result. The network diagram is as below:

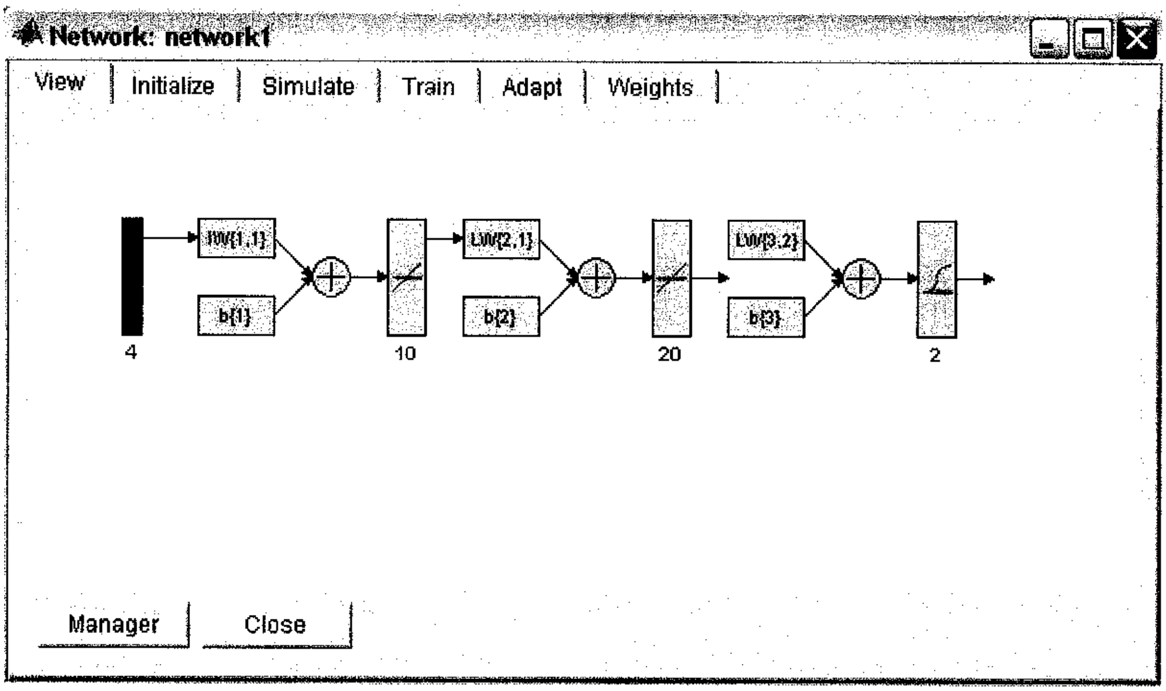

Figure 4.11 The Neural Network Configuration

4.2.4 NN Validation and Testing

From the result of validation and testing, it can be observed that the errors between the predicted outlet temperatures for both shell and tube and the actual outlet temperatures are very small, which is below 1%.

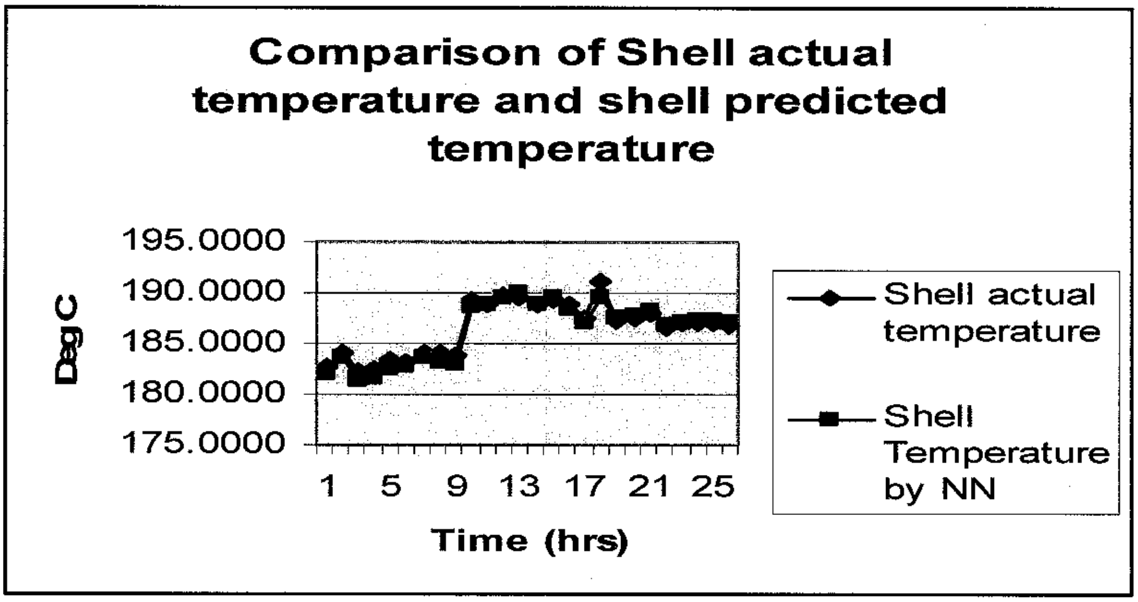

Figure 4.12 Sample of the Shell predicted and actual temperature

4.2.5 Process Modeling

To construct the dynamic model of the heat exchanger, ARX method was used. This is done by constructing the model based on the inputs and outputs of the system. The system is actually a multiple input with multiple outputs (MIMO) but for simplicity purpose, the system was taken as single output single input system (SISO). The process variable for this system is the shell outlet temperature and the manipulated variable is the tube flow rate. For the ARX model, the best fit was 27.8. The higher this number, the better the model fit with the actual data. The errors resulted from this model was not calculated due to time constraint.

Since the dynamic system is express in laplace transform function, the output of the system is in term of shell flow rate. In order to find the shell temperature, the fundamental model was used. The model also used since the output of the neural network is in term of temperature. The shell flow rate was calculated by the model based on the outlet properties of both the system and the neural network.

4.2.6 IMC System

The tuning was done based on the Ziegler-Nichols method. From the tuning, it is notice that the system reaches the new set point faster than without tuning. Further tuning could be done to improve the overall controller. The controller system here is designed for a setpoint change on the controller. In this system, the neural network will predict any changes in the system. A set point increase was done. The set point was increase from 50kg/s to 55 kg/s. The neural network here will predict the outlet temperature for the process variable which is the shell outlet temperature. With the shell outlet temperature and other outlet property, the corresponding flow rate of the manipulative variable then calculated. This value then compared with the set point and the difference will be corrected by the PID controller. For the project purpose, modification on the original proposed IMC system was done to implement the neural network in a simple feedback system.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The overall objective of this project was successfully completed within the period given. All the result obtained is also presented in this report. The neural network constructed for the specified heat exchanger is shown in Appendix Figure 5.1. The type of network used is Feed Forward Backpropogation Network. The network configuration was taken from the work of Chong Chee Keong. With the data available, the network was trained, validated and tested for its performance. The error of the predicted outlet temperatures for both shell and tube against the actual values was low, which is below 1%. The neural network then exported into the Matlab's Simulink. For the dynamic model of the heat exchanger, the ARX method was used and the order of the system are na=5, nb=5 and nk=1. Based on the discreet-time function obtained through ARX method, the function then converted to transfer function in continuous-time function and exported into Matlab Simulink. A simple feedback control using IMC concept was done. The controller was designed for a set point change at the manipulated variable, which is the shell flow rate. The controller tuning was done by using Ziegler-Nichols method to achieve the optimum controller settings. This study was aimed to better understand the Neural Network and its application in the control strategy for a heat exchanger. This study can be the reference for future expansion of neural network to other production units where system stability is the crucial element in the system.

5.2 RECOMMENDATION

Based on this study, a few recommendations had been proposed to further increase the potential of the Neural Network in the field of process control. A further study could be done in improving the performance of the network used in this system. It was highlighted by Chong Chee Keong on his report that higher training epochs and maximum time should be used to increase network performance. Naturally, increasing the epochs and higher value of time before failing will produce a better result. This recommendation was not pursued in this study as to time limitations.

It is recommended that the sample time for the data taken is reduced from one hour to every 10 minutes or 1 minute. With this, any fluctuation in the system, we could identify the changes faster. With a smaller sample time, the network developed based on the system will have higher accuracy on predicting the outlet properties of the system. With this, the performance on the network could be increase.

For this project, a single input single output system was used in developing the dynamic model of the heat exchanger. It is recommended that for future study, a multiple input multiple output (MIMO) system could be developed and implementing the system in the IMC System. This will give a better view on the actual outlet property of the heat exchanger as the dynamic model considers all the input parameters.

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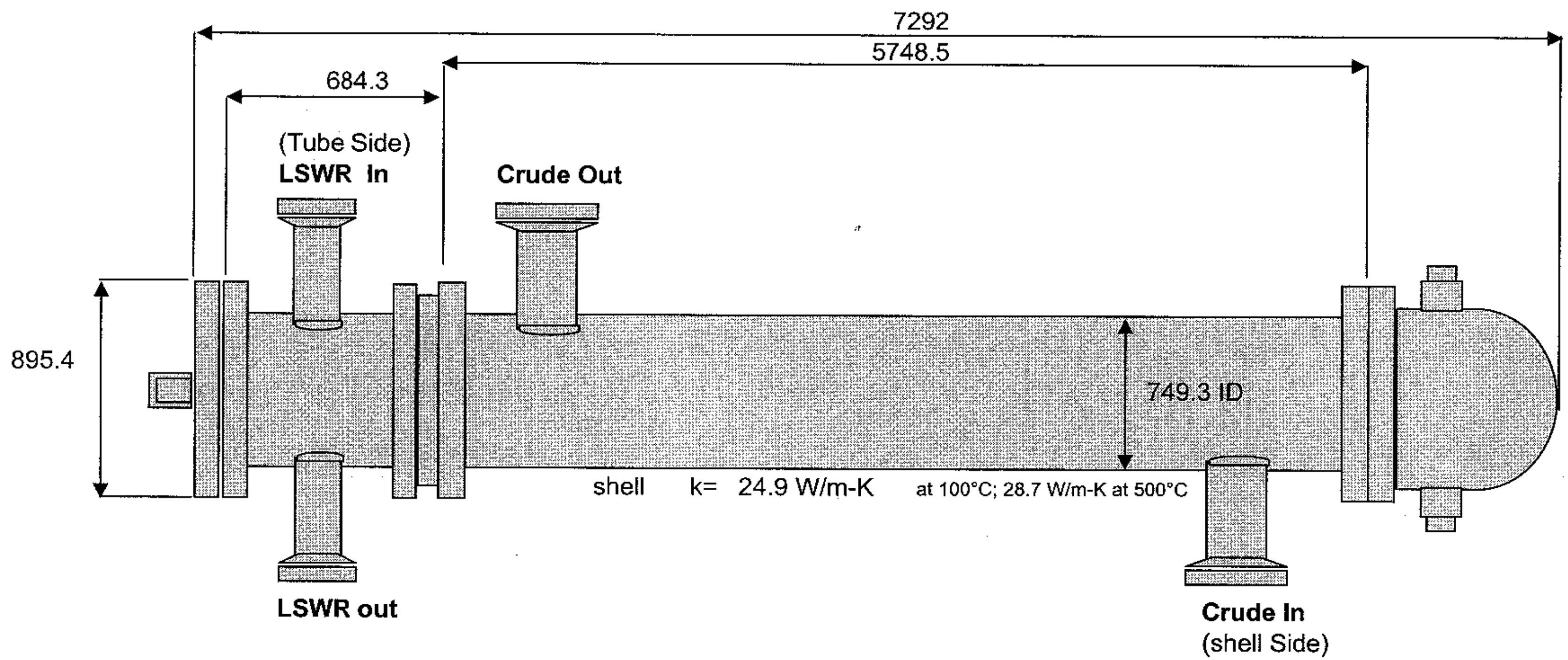
APPENDICES

Source: PETRONAS Penapisan Melaka



E-1111 A

Bare tube area = 295.2 m2
Thermal Duty = 6.21 MW
Design Temp (cold side) = 260 deg C (shell side)
Design Temp (hot side) = 365 deg C (tube side)
Number of tubes = 434
size of tube = 19.05
tube pitch = 25.4 square
tube thermal conductivity = 25-27 W/m.K at 100deg C

Heat Exchanger Data

	Cold Section crude		Hot section		Cold Section Flow rate (m3/hr)	HOt Section Flow rate (m3/hr)
	Inlet Temp (0C)	Outlet Tempv(0C)	Inlet (0C)	Outlet (0C)	The inlet	Inlet
01-Dec-03 00:00:00	180.2702	182.8047	309.3344	283.68976	292.3608742	56.26667786
01-Dec-03 01:00:00	180.7407	183.5318	309.7653	283.42361	293.7146378	52.52322006
01-Dec-03 02:00:00	180.5103	183.4518	309.5731	284.84564	293.2838554	55.54141617
01-Dec-03 03:00:00	180.5156	183.3717	309.3809	284.17868	292.9317894	54.87772369
01-Dec-03 04:00:00	180.5208	183.2915	309.1389	283.51172	292.6131477	54.13209534
01-Dec-03 05:00:00	180.5261	183.2115	308.8867	282.84479	293.1929779	53.79811859
01-Dec-03 06:00:00	180.5313	183.1318	308.6344	282.6593	292.4092026	53.91451263
01-Dec-03 07:00:00	180.4703	183.0900	308.4679	282.63812	292.4491234	53.73252106
01-Dec-03 08:00:00	180.3500	183.0480	308.3419	282.61697	294.2623672	54.05168152
01-Dec-03 09:00:00	180.2298	183.0062	308.2160	282.61246	292.611702	54.43746185
01-Dec-03 10:00:00	180.1095	182.9643	307.9608	282.80173	292.1612244	53.91285706
01-Dec-03 11:00:00	178.7900	181.5052	307.6789	283.04791	307.4452095	57.4914093
01-Dec-03 12:00:00	179.9765	183.0429	307.8886	281.23816	294.2464561	51.66366959
01-Dec-03 13:00:00	179.2642	182.1769	308.0351	282.35721	291.3008614	53.23751068
01-Dec-03 14:00:00	178.9538	182.0023	307.9701	281.94937	291.8433609	53.49425888
01-Dec-03 15:00:00	178.9189	182.1832	307.8969	283.1842	292.7552681	57.4554863
01-Dec-03 16:00:00	179.1292	182.3315	307.9095	283.02325	291.5355988	55.23656082
01-Dec-03 17:00:00	179.2737	182.3978	307.8993	283.53143	290.8743668	57.60934448
01-Dec-03 18:00:00	179.3403	182.4275	307.9493	283.03595	290.2244453	55.44581985
01-Dec-03 19:00:00	179.4729	182.6677	308.2345	283.10352	292.1855965	55.65780258
01-Dec-03 20:00:00	179.4840	182.4528	307.5091	281.65869	291.9566498	53.890728
01-Dec-03 21:00:00	179.4982	182.4891	308.2363	281.96542	290.7063141	52.01766205
01-Dec-03 22:00:00	179.5250	182.6136	308.8937	282.79623	290.7675285	52.82422256
01-Dec-03 23:00:00	179.5519	182.6247	308.1656	282.69177	291.4249458	54.32862473
02-Dec-03 00:00:00	179.5788	182.6359	307.7077	281.85254	291.6217117	53.51983643
02-Dec-03 01:00:00	179.6057	182.6513	308.1560	281.89728	291.5406151	53.97157669
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02-Dec-03 03:00:00	179.7208	182.6880	308.9420	282.25238	290.149189	52.96352005
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02-Dec-03 05:00:00	179.4941	182.7581	309.1321	282.80621	292.1537743	52.88466644
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02-Dec-03 07:00:00	179.0139	182.1307	307.2260	281.02139	289.6106758	51.71969604

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02-Dec-03 09:00:00	180.3024	183.6951	309.0938	285.79117	291.3434372	60.81352615
02-Dec-03 10:00:00	180.7255	184.0981	310.5577	287.98672	291.3673363	64.81848907
02-Dec-03 11:00:00	179.8133	183.1328	307.5566	284.06952	289.3960342	60.05712891
02-Dec-03 12:00:00	179.9100	183.0157	307.0757	283.25574	290.1434517	59.71229935
02-Dec-03 13:00:00	179.7217	183.1175	307.2032	283.89212	289.539608	62.17006302
02-Dec-03 14:00:00	179.7619	182.7987	307.3431	283.65991	290.8804512	59.56802368
02-Dec-03 15:00:00	179.0945	182.2487	307.1762	282.46292	289.2109833	56.92090988
02-Dec-03 16:00:00	179.4396	182.6555	307.0706	281.97653	291.4266357	54.59743881
02-Dec-03 17:00:00	179.3116	182.5443	307.4391	281.74823	289.5718079	54.22271729
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02-Dec-03 19:00:00	179.3380	182.9425	308.5206	282.95374	293.2008629	54.68221664
02-Dec-03 20:00:00	179.4697	182.7750	308.3992	282.90573	289.3198662	53.14311218
02-Dec-03 21:00:00	179.4998	182.6951	308.1207	283.61481	290.193615	57.08747482
02-Dec-03 22:00:00	179.2490	182.5917	307.6861	281.62457	290.2790604	53.82911301
02-Dec-03 23:00:00	178.9819	182.4458	307.2335	281.42346	291.12883	53.15127182
03-Dec-03 00:00:00	178.8401	182.1370	307.5132	281.38879	290.9122543	53.74544525
03-Dec-03 01:00:00	180.1262	183.2690	309.1120	282.06955	294.2881279	48.69265747
03-Dec-03 02:00:00	179.8130	183.1250	308.9673	283.31424	291.1126976	55.08702087
03-Dec-03 03:00:00	179.2799	182.6086	309.2953	284.44284	289.9996338	56.34115601
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03-Dec-03 07:00:00	179.5048	182.8330	309.2270	283.7164	289.1063499	57.11346054
03-Dec-03 08:00:00	179.5539	182.7565	309.0018	284.22031	290.6996574	58.17707062
03-Dec-03 09:00:00	179.6415	182.7760	308.7614	283.98267	290.1966629	57.03678513
03-Dec-03 10:00:00	179.7291	182.8843	308.5179	284.19537	289.9151306	59.75146866
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06-Dec-03 01:00:00	183.1264	186.5338	309.0068	284.36246	167.4768219	60.84241104
06-Dec-03 02:00:00	183.2019	186.4747	308.5416	283.98361	170.3065033	60.54039764
06-Dec-03 03:00:00	183.2774	186.3352	307.5923	283.66614	164.6525879	62.73735046
06-Dec-03 04:00:00	182.8703	186.4073	307.5859	284.03708	172.1621094	64.98885345
06-Dec-03 05:00:00	183.0490	186.5470	307.9539	284.97589	166.9759521	64.55982971
06-Dec-03 06:00:00	183.2819	186.7219	308.3217	285.41895	170.3976135	64.28144073
06-Dec-03 07:00:00	183.5149	186.8968	308.6896	285.63922	166.6960144	66.74577332
06-Dec-03 08:00:00	183.8957	187.2351	309.2354	285.32022	170.5953217	61.48059082
06-Dec-03 09:00:00	184.3217	187.6494	311.1350	287.94275	172.961319	64.8568573
06-Dec-03 10:00:00	184.5575	187.8859	313.0346	289.15903	166.3239441	64.97297668
06-Dec-03 11:00:00	185.5571	189.5339	314.7908	291.069	167.6777344	64.57704926
06-Dec-03 12:00:00	186.4047	191.0519	316.2984	291.5079	170.4501648	59.17990494
06-Dec-03 13:00:00	186.3920	189.9295	318.0638	293.5813	175.0079346	62.48025894
06-Dec-03 14:00:00	186.8612	190.3227	320.1248	293.58768	173.7464447	58.78244781
06-Dec-03 15:00:00	187.5760	190.6583	320.7443	294.11084	173.2468567	58.05958939
06-Dec-03 16:00:00	187.4018	190.8736	320.4355	293.99908	171.8339996	58.04926682
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06-Dec-03 23:00:00	185.1814	188.3562	315.9170	289.15332	182.0928192	56.23711395
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07-Dec-03 02:00:00	184.7225	187.5781	313.3846	287.96075	187.9584961	57.35942078
07-Dec-03 03:00:00	184.5107	187.4790	312.9735	287.63354	186.2773743	59.21325302
07-Dec-03 04:00:00	184.2988	187.3521	311.7744	285.78033	183.4051361	55.95845413
07-Dec-03 05:00:00	184.0870	187.2091	310.6594	285.45212	187.6969299	56.55913162
07-Dec-03 06:00:00	183.8762	187.0661	310.7293	285.35315	187.1741028	56.01716995
07-Dec-03 07:00:00	183.6688	186.6928	310.2838	284.8996	184.7104645	56.32956696
07-Dec-03 08:00:00	184.4433	187.6050	312.9798	286.61417	186.7402191	54.78895187
07-Dec-03 09:00:00	184.6657	187.9991	313.4608	288.1058	186.969986	57.60411835
07-Dec-03 10:00:00	184.6843	187.9614	313.7786	288.61621	187.3655396	59.1036377
07-Dec-03 11:00:00	184.8831	188.0099	313.8394	289.6904	187.0413361	62.88776779
07-Dec-03 12:00:00	184.9548	188.1336	313.5783	289.3877	183.3912354	61.96091461
07-Dec-03 13:00:00	184.6344	187.6614	313.0480	288.79504	288.4523773	61.40045929
07-Dec-03 14:00:00	183.7105	186.9486	311.4734	287.58163	289.6613159	60.76234818
07-Dec-03 15:00:00	183.3213	186.6741	308.3591	285.05771	289.5334244	60.37713242
07-Dec-03 16:00:00	184.3431	187.2342	310.8390	285.29871	288.6225967	55.29964828
07-Dec-03 17:00:00	184.5851	187.6584	312.6353	286.78714	289.3626709	55.32752991
07-Dec-03 18:00:00	183.3550	186.4480	312.4599	285.69284	290.6782608	54.43205261
07-Dec-03 19:00:00	183.9999	187.1864	311.8782	285.91257	286.8787537	55.00240707
07-Dec-03 20:00:00	183.3073	186.4315	312.1790	285.8233	287.4354477	54.76752853
07-Dec-03 21:00:00	183.6879	187.0834	312.4799	286.88669	286.4857712	57.68645477
07-Dec-03 22:00:00	183.8939	187.1393	312.7807	288.1564	287.3544769	60.36985016
07-Dec-03 23:00:00	183.5831	187.0610	312.9663	288.41962	287.9721603	60.62517166
08-Dec-03 00:00:00	183.5490	187.0292	312.4999	287.61224	286.8032532	58.67096329
08-Dec-03 01:00:00	183.5945	186.9974	312.2141	287.38474	287.0058517	58.14743423
08-Dec-03 02:00:00	183.6401	186.9656	312.3841	287.52087	287.2035294	58.5381546
08-Dec-03 03:00:00	183.6856	186.9339	312.5540	287.45496	287.6158218	58.60832977
08-Dec-03 04:00:00	183.7311	186.9021	312.7240	287.56619	287.1363373	58.55866241
08-Dec-03 05:00:00	183.7767	187.2893	312.9706	288.20349	286.2616272	58.39148331
08-Dec-03 06:00:00	183.4807	186.8996	313.3490	287.69159	286.8839035	58.41763306
08-Dec-03 07:00:00	183.6809	186.9252	313.7275	288.46442	287.1528931	59.85131454

06-Dec-03 20:00:00	186.4805	189.7141	317.8654	290.13577	167.9629517	52.73172379
06-Dec-03 21:00:00	186.3467	189.5880	317.9262	290.16122	167.5900726	53.41143799
06-Dec-03 22:00:00	187.3817	190.3038	317.5847	290.55334	174.1007385	54.21728134
06-Dec-03 23:00:00	185.1814	188.3562	315.9170	289.15332	182.0928192	56.23711395
07-Dec-03 00:00:00	185.0547	188.0352	314.4530	288.19449	181.3664856	56.69898605
07-Dec-03 01:00:00	184.8910	187.7142	313.6917	287.77917	186.8203735	56.71099472
07-Dec-03 02:00:00	184.7225	187.5781	313.3846	287.96075	187.9584961	57.35942078
07-Dec-03 03:00:00	184.5107	187.4790	312.9735	287.63354	186.2773743	59.21325302
07-Dec-03 04:00:00	184.2988	187.3521	311.7744	285.78033	183.4051361	55.95845413
07-Dec-03 05:00:00	184.0870	187.2091	310.6594	285.45212	187.6969299	56.55913162
07-Dec-03 06:00:00	183.8762	187.0661	310.7293	285.35315	187.1741028	56.01716995
07-Dec-03 07:00:00	183.6688	186.6928	310.2838	284.8996	184.7104645	56.32956696
07-Dec-03 08:00:00	184.4433	187.6050	312.9798	286.61417	186.7402191	54.78895187
07-Dec-03 09:00:00	184.6657	187.9991	313.4608	288.1058	186.969986	57.60411835
07-Dec-03 10:00:00	184.6843	187.9614	313.7786	288.61621	187.3655396	59.1036377
07-Dec-03 11:00:00	184.8831	188.0099	313.8394	289.6904	187.0413361	62.88776779
07-Dec-03 12:00:00	184.9548	188.1336	313.5783	289.3877	183.3912354	61.96091461
07-Dec-03 13:00:00	184.6344	187.6614	313.0480	288.79504	288.4523773	61.40045929
07-Dec-03 14:00:00	183.7105	186.9486	311.4734	287.58163	289.6613159	60.76234818
07-Dec-03 15:00:00	183.3213	186.6741	308.3591	285.05771	289.5334244	60.37713242
07-Dec-03 16:00:00	184.3431	187.2342	310.8390	285.29871	288.6225967	55.29964828
07-Dec-03 17:00:00	184.5851	187.6584	312.6353	286.78714	289.3626709	55.32752991
07-Dec-03 18:00:00	183.3550	186.4480	312.4599	285.69284	290.6782608	54.43205261
07-Dec-03 19:00:00	183.9999	187.1864	311.8782	285.91257	286.8787537	55.00240707
07-Dec-03 20:00:00	183.3073	186.4315	312.1790	285.8233	287.4354477	54.76752853
07-Dec-03 21:00:00	183.6879	187.0834	312.4799	286.88669	286.4857712	57.68645477
07-Dec-03 22:00:00	183.8939	187.1393	312.7807	288.1564	287.3544769	60.36985016
07-Dec-03 23:00:00	183.5831	187.0610	312.9663	288.41962	287.9721603	60.62517166
08-Dec-03 00:00:00	183.5490	187.0292	312.4999	287.61224	286.8032532	58.67096329
08-Dec-03 01:00:00	183.5945	186.9974	312.2141	287.38474	287.0058517	58.14743423
08-Dec-03 02:00:00	183.6401	186.9656	312.3841	287.52087	287.2035294	58.5381546
08-Dec-03 03:00:00	183.6856	186.9339	312.5540	287.45496	287.6158218	58.60832977
08-Dec-03 04:00:00	183.7311	186.9021	312.7240	287.56619	287.1363373	58.55866241
08-Dec-03 05:00:00	183.7767	187.2893	312.9706	288.20349	286.2616272	58.39148331
08-Dec-03 06:00:00	183.4807	186.8996	313.3490	287.69159	286.8839035	58.41763306
08-Dec-03 07:00:00	183.6809	186.9252	313.7275	288.46442	287.1528931	59.85131454

		Inlet Properties								Outlet Properties			
clasification	Rand.No	Shell Flow rate	Normalized	Tube Flow rate	Normalized	Shell Temperature	Normalized	Tube Temperature	Normalized	Shell Temperature	Normalized	Tube Temperature	Normalized
T	41.83172	292.3609	0.8944	56.26668	0.3565	180.2702	0.3960	309.3344	0.4646	182.8047	0.4066	283.689758	0.4150
T	34.98337	293.7146	0.9038	52.52322	0.1803	180.7407	0.4305	309.7653	0.4848	183.5318	0.4553	283.423615	0.4000
T	29.89288	292.6131	0.8961	54.1321	0.2560	180.5208	0.4144	309.1389	0.4554	183.2915	0.4392	283.511719	0.4050
T	42.80831	293.193	0.9002	53.79812	0.2403	180.5261	0.4148	308.8867	0.4436	183.2115	0.4338	282.844788	0.3675
T	32.25501	294.2624	0.9077	54.05168	0.2523	180.3500	0.4019	308.3419	0.4180	183.0480	0.4229	282.616974	0.3547
T	20.55422	292.1612	0.8930	53.91286	0.2457	180.1095	0.3842	307.9608	0.4001	182.9643	0.4173	282.801727	0.3651
T	33.36894	307.4452	1.0000	57.49141	0.4142	178.7900	0.2873	307.6789	0.3869	181.5052	0.3196	283.047913	0.3789
T	18.80551	291.3009	0.8869	53.23751	0.2139	179.2642	0.3222	308.0351	0.4036	182.1769	0.3645	282.357208	0.3402
T	12.82693	290.8744	0.8840	57.60934	0.4197	179.2737	0.3229	307.8993	0.3972	182.3978	0.3793	283.531433	0.4061
T	4.412976	291.9566	0.8915	53.89073	0.2447	179.4840	0.3383	307.5091	0.3789	182.4528	0.3830	281.658691	0.3009
T	35.7036	290.7675	0.8832	52.82422	0.1945	179.5250	0.3413	308.8937	0.4439	182.6136	0.3938	282.796234	0.3648
T	17.10562	291.6217	0.8892	53.51984	0.2272	179.5788	0.3453	307.7077	0.3882	182.6359	0.3953	281.852539	0.3118
T	17.75567	291.5406	0.8886	53.97158	0.2485	179.6057	0.3472	308.1560	0.4093	182.6513	0.3963	281.897278	0.3143
T	12.57973	290.1492	0.8789	52.96352	0.2010	179.7208	0.3557	308.9420	0.4461	182.6880	0.3988	282.25238	0.3343
T	31.80334	292.1538	0.8929	52.88467	0.1973	179.4941	0.3390	309.1321	0.4551	182.7581	0.4035	282.806213	0.3654
T	5.264443	289.6107	0.8751	51.7197	0.1425	179.0139	0.3038	307.2260	0.3656	182.1307	0.3615	281.021393	0.2652
T	38.45943	289.5718	0.8748	54.22272	0.2603	179.3116	0.3256	307.4391	0.3756	182.5443	0.3892	281.74823	0.3060
T	9.622486	293.2009	0.9002	54.68222	0.2819	179.3380	0.3276	308.5206	0.4264	182.9425	0.4158	282.953735	0.3736
T	38.81649	289.3199	0.8731	53.14311	0.2095	179.4697	0.3372	308.3992	0.4207	182.7750	0.4046	282.905731	0.3709
T	4.641865	290.1936	0.8792	57.08747	0.3952	179.4998	0.3395	308.1207	0.4076	182.6951	0.3992	283.614807	0.4108
T	30.30488	290.2791	0.8798	53.82911	0.2418	179.2490	0.3210	307.6861	0.3872	182.5917	0.3923	281.624573	0.2990
T	11.75573	294.2881	0.9079	48.69266	0.0000	180.1262	0.3854	309.1120	0.4541	183.2690	0.4377	282.06955	0.3240
T	1.690725	291.1127	0.8856	55.08702	0.3010	179.8130	0.3624	308.9673	0.4473	183.1250	0.4280	283.31424	0.3939
T	19.80651	291.698	0.8897	58.17545	0.4464	179.6228	0.3485	309.6440	0.4791	182.7525	0.4031	284.989197	0.4879
T	14.9205	290.0802	0.8784	56.88169	0.3855	179.5835	0.3456	309.5854	0.4763	182.6656	0.3973	284.543671	0.4629
T	19.81262	290.6519	0.8824	57.16333	0.3987	179.5442	0.3427	309.4523	0.4701	182.6041	0.3932	284.744019	0.4741
T	14.05988	289.1063	0.8716	57.11346	0.3964	179.5048	0.3398	309.2270	0.4595	182.8330	0.4085	283.7164	0.4165
T	15.61327	290.6997	0.8827	58.17707	0.4465	179.5539	0.3434	309.0018	0.4490	182.7565	0.4034	284.220306	0.4447
T	5.413984	289.9151	0.8772	59.75147	0.5206	179.7291	0.3563	308.5179	0.4262	182.8843	0.4119	284.195374	0.4433
T	39.76867	289.1854	0.8721	57.70455	0.4242	180.7212	0.4291	308.8246	0.4406	185.6130	0.5947	284.281128	0.4482
T	5.926695	290.2802	0.8798	57.86896	0.4320	182.3240	0.5468	312.1536	0.5969	185.4287	0.5823	287.432617	0.6251
T	40.43703	285.7518	0.8481	58.72878	0.4724	181.5802	0.4922	310.9484	0.5403	184.8627	0.5444	286.848267	0.5923
T	35.19395	289.6552	0.8754	56.83606	0.3833	180.3983	0.4054	307.4394	0.3756	183.7345	0.4689	282.904388	0.3709
T	4.709006	291.1637	0.8860	57.20492	0.4007	180.7473	0.4310	309.5970	0.4769	183.9786	0.4852	285.213562	0.5005
T	4.071169	290.3073	0.8800	59.85497	0.5254	181.0478	0.4531	311.3461	0.5590	184.4417	0.5162	286.940857	0.5975
T	7.428205	293.1066	0.8996	57.9594	0.4362	181.0107	0.4504	310.2690	0.5084	184.3522	0.5102	286.129761	0.5519
T	27.40867	293.0326	0.8991	59.35658	0.5020	180.9195	0.4437	310.9994	0.5427	184.3924	0.5129	286.519257	0.5738
T	42.25593	293.6492	0.9034	59.61584	0.5142	180.7574	0.4318	310.8082	0.5337	183.9702	0.4846	287.181732	0.6110

T	7.876827	290.9567	0.8845	55.47027	0.3190	180.0646	0.3809	308.8817	0.4433	183.6513	0.4633	283.820282	0.4223
T	17.24601	290.3415	0.8802	60.24548	0.5438	181.7529	0.5048	312.7423	0.6245	185.1969	0.5668	288.879669	0.7063
T	30.92746	292.2589	0.8936	60.36524	0.5495	181.3231	0.4733	311.9317	0.5864	184.9227	0.5484	287.936096	0.6534
T	21.21952	286.0365	0.8501	59.51906	0.5096	181.3518	0.4754	310.0839	0.4997	185.5381	0.5897	285.371643	0.5094
T	29.72503	282.7126	0.8268	63.6642	0.7048	183.8207	0.6566	311.8166	0.5810	188.3939	0.7809	289.176239	0.7230
T	16.96829	284.2905	0.8378	64.10209	0.7254	186.2415	0.8343	314.1794	0.6919	190.8522	0.9456	291.303345	0.8424
T	12.20435	285.2612	0.8446	64.92808	0.7643	186.6039	0.8609	315.2747	0.7433	191.1826	0.9677	292.968292	0.9359
T	21.1951	290.2411	0.8795	60.04632	0.5345	186.2397	0.8342	311.6025	0.5710	189.9180	0.8830	287.998596	0.6569
T	21.32328	287.2011	0.8582	61.966	0.6248	188.4983	1.0000	318.2792	0.8843	191.6652	1.0000	292.800812	0.9265
T	33.549	283.5124	0.8324	56.12828	0.3500	186.1118	0.8248	316.9960	0.8241	189.8271	0.8769	289.302704	0.7301
T	35.8562	281.8131	0.8205	52.17543	0.1639	185.1156	0.7517	312.1476	0.5966	188.5516	0.7915	283.989349	0.4318
T	20.34669	167.0743	0.0170	59.80857	0.5233	184.8594	0.7329	314.8560	0.7237	188.4887	0.7873	288.030396	0.6586
T	32.0719	168.0778	0.0240	65.08726	0.7717	183.0218	0.5980	309.7666	0.4848	186.7321	0.6696	285.639648	0.5244
T	42.16132	167.4768	0.0198	60.84241	0.5719	183.1264	0.6057	309.0068	0.4492	186.5338	0.6563	284.362457	0.4527
T	6.411939	170.3065	0.0396	60.5404	0.5577	183.2019	0.6112	308.5416	0.4274	186.4747	0.6524	283.983612	0.4315
T	5.731376	164.6526	0.0000	62.73735	0.6611	183.2774	0.6167	307.5923	0.3828	186.3352	0.6430	283.666138	0.4136
T	16.87063	172.1621	0.0526	64.98885	0.7671	182.8703	0.5869	307.5859	0.3825	186.4073	0.6479	284.037079	0.4345
T	17.35282	170.3976	0.0402	64.28144	0.7338	183.2819	0.6171	308.3217	0.4170	186.7219	0.6689	285.418945	0.5120
T	4.440443	170.5953	0.0416	61.48059	0.6020	183.8957	0.6621	309.2354	0.4599	187.2351	0.7033	285.320221	0.5065
T	9.067049	167.6777	0.0212	64.57705	0.7477	185.5571	0.7841	314.7908	0.7206	189.5339	0.8573	291.069	0.8292
T	8.908353	175.0079	0.0725	62.48026	0.6490	186.3920	0.8454	318.0638	0.8742	189.9295	0.8838	293.581299	0.9703
T	6.131169	173.7464	0.0637	58.78245	0.4750	186.8612	0.8798	320.1248	0.9709	190.3227	0.9101	293.587677	0.9706
T	5.178991	171.834	0.0503	58.04927	0.4404	187.4018	0.9195	320.4355	0.9855	190.8736	0.9470	293.999084	0.9937
T	11.67028	167.868	0.0225	52.20779	0.1655	186.5180	0.8546	319.1158	0.9236	190.1743	0.9001	289.829041	0.7596
T	28.94986	165.6119	0.0067	51.45341	0.1300	186.4468	0.8494	317.7438	0.8592	189.9615	0.8859	288.467682	0.6832
T	14.46883	169.0054	0.0305	52.28011	0.1689	186.3422	0.8417	317.8046	0.8620	189.5737	0.8599	289.017456	0.7141
T	33.27738	174.1007	0.0662	54.21728	0.2601	187.3817	0.9180	317.5847	0.8517	190.3038	0.9088	290.553345	0.8003
T	25.50737	182.0928	0.1221	56.23711	0.3551	185.1814	0.7565	315.9170	0.7735	188.3562	0.7784	289.15332	0.7217
T	36.33229	186.8204	0.1552	56.71099	0.3774	184.8910	0.7352	313.6917	0.6690	187.7142	0.7354	287.779175	0.6445
T	24.70473	186.2774	0.1514	59.21325	0.4952	184.5107	0.7073	312.9735	0.6353	187.4790	0.7196	287.633545	0.6364
T	6.466872	187.1741	0.1577	56.01717	0.3448	183.8762	0.6607	310.7293	0.5300	187.0661	0.6920	285.353149	0.5083
T	13.4434	186.97	0.1563	57.60412	0.4195	184.6657	0.7187	313.4608	0.6582	187.9991	0.7545	288.105804	0.6629
T	33.05765	187.3655	0.1591	59.10364	0.4901	184.6843	0.7200	313.7786	0.6731	187.9614	0.7519	288.616211	0.6915
T	21.75359	287.4354	0.8599	54.76753	0.2860	183.3073	0.6189	312.1790	0.5981	186.4315	0.6495	285.823303	0.5347
T	2.575762	286.4858	0.8532	57.68645	0.4234	183.6879	0.6469	312.4799	0.6122	187.0834	0.6931	286.886688	0.5944
T	9.933775	287.3545	0.8593	60.36985	0.5497	183.8939	0.6620	312.7807	0.6263	187.1393	0.6969	288.156403	0.6657
T	16.58071	287.2035	0.8582	58.53815	0.4635	183.6401	0.6434	312.3841	0.6077	186.9656	0.6853	287.520874	0.6300
T	30.30793	287.1827	0.8581	59.49474	0.5085	183.8070	0.6556	313.9081	0.6792	187.1939	0.7005	288.976318	0.7118
T	39.28037	286.5266	0.8535	59.26312	0.4976	183.9435	0.6656	314.0887	0.6877	187.2975	0.7075	289.140381	0.7210
T	19.53185	283.6012	0.8330	59.79501	0.5226	184.5098	0.7072	315.2417	0.7418	187.4135	0.7153	290.003693	0.7694
T	20.76785	286.8822	0.8560	61.18782	0.5882	185.1653	0.7553	316.3382	0.7932	188.3903	0.7807	291.751617	0.8676
T	3.521836	287.8928	0.8631	58.16393	0.4458	184.5384	0.7093	314.7700	0.7196	187.8077	0.7417	289.264252	0.7279

T	1.498459	287.0914	0.8575	56.37516	0.3616	184.4433	0.7023	314.0863	0.6876	187.6831	0.7333	287.702942	0.6403
T	35.3679	287.186	0.8581	55.72338	0.3310	184.3950	0.6988	313.4027	0.6555	187.6070	0.7282	287.538025	0.6310
T	23.42296	285.7161	0.8478	55.68956	0.3294	184.4843	0.7053	313.4260	0.6566	187.6748	0.7328	287.488098	0.6282
T	24.23475	285.1395	0.8438	53.48973	0.2258	184.5761	0.7121	313.8543	0.6767	187.7458	0.7375	287.514038	0.6297
T	23.77087	285.6959	0.8477	58.43064	0.4584	184.0732	0.6752	314.0440	0.6856	187.2713	0.7057	288.791718	0.7014
T	13.24198	287.418	0.8597	57.54628	0.4168	183.8909	0.6618	313.5363	0.6617	187.0436	0.6905	287.880524	0.6502
T	30.70772	289.1232	0.8717	59.27269	0.4980	185.1669	0.7555	314.5185	0.7078	188.3366	0.7771	289.934235	0.7655
T	19.33958	283.3897	0.8315	62.01969	0.6273	183.2924	0.6179	312.9828	0.6358	186.5532	0.6576	289.435272	0.7375
T	12.21961	285.7696	0.8482	58.15636	0.4455	183.8343	0.6576	311.2973	0.5567	187.4818	0.7198	287.019562	0.6019
T	17.41386	287.5105	0.8604	61.1334	0.5856	183.4713	0.6310	311.2040	0.5523	186.8692	0.6788	287.543671	0.6313
T	6.115909	288.0052	0.8639	59.91477	0.5283	183.3745	0.6239	311.5897	0.5704	186.6979	0.6673	287.95224	0.6543
T	32.02918	288.291	0.8659	59.23811	0.4964	183.5947	0.6400	313.8998	0.6788	187.2766	0.7061	289.946777	0.7662
T	3.674429	288.4232	0.8668	60.1567	0.5396	183.4787	0.6315	312.7448	0.6246	186.6446	0.6638	289.506195	0.7415
T	34.64156	288.9575	0.8705	60.08986	0.5365	183.0346	0.5989	311.4831	0.5654	186.2771	0.6391	287.818512	0.6468
T	27.1981	287.0804	0.8574	59.55301	0.5112	182.7788	0.5802	312.0023	0.5898	186.2977	0.6405	288.174377	0.6667
T	14.82894	288.4766	0.8672	59.42421	0.5052	182.8244	0.5835	311.6834	0.5748	186.0258	0.6223	287.729706	0.6418
T	0.234993	286.4525	0.8530	60.71151	0.5658	183.1514	0.6075	311.7394	0.5774	186.1836	0.6329	288.152069	0.6655
T	6.234931	286.5905	0.8540	59.17319	0.4934	183.0838	0.6025	311.9767	0.5886	186.2697	0.6386	288.053345	0.6599
T	32.28248	287.0143	0.8569	57.66692	0.4224	183.1480	0.6073	312.4475	0.6106	186.4052	0.6477	288.07666	0.6612
T	2.850429	284.6648	0.8405	58.46727	0.4601	183.2519	0.6149	312.6167	0.6186	186.4636	0.6516	288.229095	0.6698
T	10.43733	284.4211	0.8388	58.55224	0.4641	183.3847	0.6246	312.9552	0.6345	186.6479	0.6640	288.837982	0.7040
T	34.95895	181.1272	0.1154	60.78881	0.5694	183.2743	0.6165	311.4398	0.5634	186.5520	0.6576	287.530243	0.6306
T	32.37709	181.4308	0.1175	59.06585	0.4883	183.5599	0.6375	311.7440	0.5776	186.9344	0.6832	287.558441	0.6322
T	7.013153	179.0706	0.1010	56.35029	0.3605	182.7182	0.5757	311.3326	0.5583	185.9951	0.6203	286.836761	0.5916
T	34.92843	181.188	0.1158	58.12849	0.4442	184.5519	0.7103	313.4472	0.6576	187.8763	0.7463	289.240234	0.7266
T	2.856532	169.1934	0.0318	55.28032	0.3101	184.6051	0.7142	314.7248	0.7175	187.9235	0.7494	289.666016	0.7505
T	25.61419	167.6065	0.0207	55.79354	0.3343	185.7681	0.7996	314.8062	0.7213	188.9863	0.8206	289.958801	0.7669
T	15.88794	167.6069	0.0207	58.24535	0.4497	185.4147	0.7736	314.7360	0.7180	188.7465	0.8045	290.569977	0.8012
T	14.99374	168.4527	0.0266	57.92683	0.4347	185.2016	0.7580	314.5073	0.7073	188.5094	0.7886	290.234039	0.7824
T	4.483169	168.8624	0.0295	58.29493	0.4520	184.8909	0.7352	314.0823	0.6874	188.1758	0.7663	289.968231	0.7674
T	42.31086	178.5838	0.0976	59.52594	0.5100	183.2338	0.6136	309.8879	0.4905	186.6248	0.6624	286.74292	0.5864
T	35.88366	177.3622	0.0890	61.32541	0.5947	183.6525	0.6443	310.9300	0.5394	187.0880	0.6935	288.382629	0.6784
T	18.14936	170.0722	0.0380	61.89871	0.6216	184.4453	0.7025	311.1324	0.5489	187.4442	0.7173	288.959106	0.7108
T	18.10663	179.9491	0.1071	63.98133	0.7197	184.4710	0.7044	310.9908	0.5423	187.4800	0.7197	288.950592	0.7103
T	7.998901	178.8815	0.0996	61.84528	0.6191	184.0782	0.6755	310.5142	0.5199	187.1753	0.6993	288.527069	0.6865
T	7.870724	181.3332	0.1168	61.40783	0.5985	183.6614	0.6449	309.7552	0.4843	186.5089	0.6547	287.608917	0.6350
T	19.74548	179.5363	0.1042	61.6437	0.6096	183.4635	0.6304	311.2146	0.5528	186.6188	0.6620	288.362671	0.6773
T	34.34248	176.2459	0.0812	61.15074	0.5864	183.6831	0.6465	311.7429	0.5776	186.9148	0.6819	288.470337	0.6833
T	32.43812	178.3679	0.0961	61.65397	0.6101	183.9027	0.6627	312.2527	0.6015	187.1930	0.7005	289.698914	0.7523
T	42.01178	171.0693	0.0449	61.1771	0.5877	182.9659	0.5939	312.5748	0.6166	186.2016	0.6341	288.962372	0.7110
T	38.43196	189.3127	0.1727	57.01627	0.3918	182.6339	0.5695	311.0934	0.5471	184.7723	0.5384	287.179779	0.6109
T	22.05573	196.5119	0.2231	56.44394	0.3649	179.9320	0.3712	309.5382	0.4741	181.8900	0.3453	284.556549	0.4636

T	16.05274	190.4893	0.1809	52.1755	0.1639	178.9872	0.3018	308.9259	0.4454	180.7293	0.2676	281.838013	0.3110
T	2.343822	191.2179	0.1860	51.34908	0.1250	180.6160	0.4214	309.5545	0.4749	182.1161	0.3605	282.51651	0.3491
T	35.66698	185.2167	0.1440	53.75586	0.2383	179.9827	0.3749	308.3935	0.4204	181.7408	0.3353	282.188629	0.3307
T	37.8399	187.1709	0.1577	54.59776	0.2780	180.0196	0.3776	309.4643	0.4707	181.8306	0.3414	284.747742	0.4744
T	17.67327	193.5414	0.2023	54.76936	0.2860	181.3443	0.4748	310.5825	0.5231	182.8432	0.4092	285.583008	0.5212
T	36.23463	190.0229	0.1777	54.38382	0.2679	180.3546	0.4022	308.9338	0.4458	181.9233	0.3476	283.494873	0.4040
T	21.90313	186.6828	0.1543	51.5523	0.1346	180.5208	0.4144	308.8293	0.4409	182.0026	0.3529	282.62149	0.3550
T	34.76669	183.8218	0.1342	54.39531	0.2684	180.5689	0.4179	309.5246	0.4735	182.1998	0.3661	284.176025	0.4423
T	23.55113	184.8356	0.1413	54.50467	0.2736	180.3522	0.4020	308.4405	0.4226	181.8863	0.3451	283.230408	0.3892
T	5.331584	184.2072	0.1369	52.94102	0.2000	180.2037	0.3911	308.5888	0.4296	181.8094	0.3399	282.737335	0.3615
T	38.14814	184.8164	0.1412	52.46072	0.1774	180.7734	0.4329	309.2458	0.4604	182.2767	0.3712	283.086761	0.3811
T	18.57356	189.2668	0.1724	54.26206	0.2622	181.5072	0.4868	311.2107	0.5526	183.0951	0.4260	286.118622	0.5513
T	41.23356	188.0472	0.1638	53.28405	0.2161	181.2905	0.4709	310.5988	0.5239	182.8742	0.4112	284.986053	0.4877
T	15.44237	185.0873	0.1431	52.48154	0.1784	180.8571	0.4391	309.3750	0.4665	182.3545	0.3764	283.417542	0.3997
T	28.40968	187.781	0.1620	53.57109	0.2296	180.5080	0.4135	308.7896	0.4390	182.0946	0.3590	283.580566	0.4088
T	23.80749	189.5607	0.1744	53.60425	0.2312	180.0069	0.3767	308.2140	0.4120	181.6196	0.3272	282.917358	0.3716
T	32.28858	188.1461	0.1645	53.52689	0.2276	179.9123	0.3697	308.3130	0.4166	181.4130	0.3134	283.010193	0.3768
T	30.21638	185.1744	0.1437	52.41509	0.1752	179.6967	0.3539	308.1378	0.4084	181.2358	0.3015	282.765106	0.3631
T	1.489303	185.6838	0.1473	53.28704	0.2163	179.0920	0.3095	307.7873	0.3920	181.0737	0.2907	282.274872	0.3355
T	28.09229	185.2561	0.1443	51.40114	0.1275	179.0516	0.3065	307.6121	0.3837	180.8583	0.2762	281.463745	0.2900
T	14.25825	183.1545	0.1296	52.44854	0.1768	178.9528	0.2993	307.4369	0.3755	180.7843	0.2713	281.682129	0.3023
T	10.33052	180.1661	0.1086	53.37644	0.2205	179.0709	0.3080	306.9938	0.3547	180.9064	0.2795	282.272308	0.3354
T	7.275613	187.9669	0.1633	62.2969	0.6404	179.1608	0.3146	308.3803	0.4198	180.8502	0.2757	285.881409	0.5380
T	35.31602	188.0043	0.1635	57.95596	0.4361	179.6573	0.3510	309.2064	0.4586	181.1821	0.2979	286.156464	0.5534
T	38.67	181.1805	0.1157	62.66552	0.6577	178.0483	0.2329	306.6620	0.3392	179.7036	0.1989	284.627594	0.4676
T	25.22965	182.6605	0.1261	55.66852	0.3284	176.8633	0.1459	302.9357	0.1643	178.5796	0.1236	279.469269	0.1780
T	14.21247	179.2109	0.1020	56.94688	0.3886	176.9612	0.1531	303.2265	0.1779	178.5031	0.1185	279.892242	0.2018
T	30.3415	174.1152	0.0663	59.66825	0.5167	178.5433	0.2692	305.0417	0.2631	181.0568	0.2895	282.493347	0.3478
T	35.05051	188.6411	0.1680	63.07584	0.6771	179.3570	0.3290	304.8328	0.2533	181.7458	0.3357	283.640625	0.4122
T	42.72286	187.5989	0.1607	59.35043	0.5017	179.5628	0.3441	304.3442	0.2304	182.0920	0.3589	281.813324	0.3096
T	42.76559	187.8138	0.1622	59.45787	0.5068	180.2232	0.3926	303.8882	0.2090	182.5437	0.3891	281.96933	0.3184
T	18.31111	191.1046	0.1852	61.10776	0.5844	179.8123	0.3624	303.8219	0.2059	182.3270	0.3746	282.022095	0.3213
T	39.01791	187.9854	0.1634	60.31273	0.5470	179.6354	0.3494	301.1634	0.0811	182.1308	0.3615	279.167633	0.1611
T	20.86245	187.621	0.1609	59.46143	0.5069	179.6371	0.3495	300.1933	0.0356	181.9908	0.3521	278.41391	0.1188
T	21.59795	182.3821	0.1242	58.76291	0.4740	179.7529	0.3580	299.4349	0.0000	181.9321	0.3481	277.665314	0.0767
T	18.82992	177.8028	0.0921	60.32658	0.5476	179.1433	0.3133	299.7018	0.0125	181.6561	0.3297	277.671112	0.0771
T	41.16947	179.2518	0.1022	62.47731	0.6489	181.6042	0.4939	307.9411	0.3992	184.0049	0.4870	285.232361	0.5016
T	13.86456	178.5499	0.0973	58.5029	0.4618	181.4040	0.4792	308.3040	0.4162	183.8363	0.4757	284.628174	0.4676
T	20.39857	178.1491	0.0945	55.97163	0.3426	179.9625	0.3734	304.3377	0.2301	182.5943	0.3925	280.184113	0.2182
T	39.79919	179.3796	0.1031	58.98759	0.4846	180.9960	0.4493	307.7599	0.3907	183.6240	0.4615	284.041901	0.4347
T	24.75051	184.3581	0.1380	62.44629	0.6474	180.4691	0.4106	307.1579	0.3624	182.9489	0.4162	284.417114	0.4558
T	5.041658	179.8421	0.1064	62.55104	0.6524	181.1387	0.4598	308.2714	0.4147	183.6342	0.4621	285.652161	0.5251

T	36.83889	178.3036	0.0956	63.62125	0.7027	181.7984	0.5082	311.7050	0.5758	184.3637	0.5110	288.940125	0.7097
T	30.99155	181.9031	0.1208	60.4971	0.5557	181.0109	0.4504	311.2538	0.5546	183.7032	0.4668	287.768768	0.6440
T	35.88977	182.8365	0.1273	58.84039	0.4777	181.2192	0.4657	310.7840	0.5326	183.8985	0.4798	286.651917	0.5813
T	20.10254	178.6078	0.0977	58.3947	0.4567	181.1607	0.4614	310.9263	0.5393	183.7717	0.4714	286.202423	0.5560
T	10.86764	178.3384	0.0958	57.46796	0.4131	181.3221	0.4732	310.6555	0.5266	184.0374	0.4891	285.489288	0.5160
T	30.64058	179.4181	0.1034	57.93547	0.4351	181.3866	0.4780	310.5419	0.5212	184.0678	0.4912	285.644348	0.5247
T	35.41063	178.3251	0.0958	56.651	0.3746	181.7374	0.5037	311.2771	0.5557	184.2134	0.5009	286.141418	0.5526
T	28.30592	180.0773	0.1080	58.27495	0.4511	180.3523	0.4020	307.4646	0.3768	182.9205	0.4143	282.810791	0.3656
T	40.44313	179.9071	0.1068	57.13166	0.3972	180.0535	0.3801	307.3923	0.3734	182.6260	0.3946	282.762604	0.3629
T	8.691671	180.369	0.1101	56.54695	0.3697	180.0055	0.3766	306.6852	0.3402	182.3746	0.3778	281.673523	0.3018
T	34.55916	180.0246	0.1077	55.51772	0.3213	179.8698	0.3666	306.6339	0.3378	182.3880	0.3787	281.394104	0.2861
T	30.84201	180.6063	0.1117	55.31589	0.3118	179.9287	0.3709	306.4287	0.3282	182.3690	0.3774	281.151428	0.2725
T	16.31825	180.0539	0.1079	54.29201	0.2636	179.9947	0.3758	306.4982	0.3315	182.3479	0.3760	281.240906	0.2775
T	27.24387	176.8161	0.0852	57.02765	0.3924	179.4095	0.3328	303.4135	0.1867	181.7702	0.3373	279.562866	0.1833
T	39.71984	178.4628	0.0967	58.91151	0.4810	178.9560	0.2995	303.3618	0.1843	181.4767	0.3176	280.085114	0.2126
T	30.35676	176.3139	0.0817	56.46494	0.3659	178.0110	0.2302	299.9145	0.0225	180.6875	0.2648	276.298157	0.0000
T	41.59673	179.2324	0.1021	57.43816	0.4117	178.7647	0.2855	301.2415	0.0848	181.2898	0.3051	278.076538	0.0998
T	21.9245	180.5556	0.1114	59.66716	0.5166	178.5934	0.2729	300.7465	0.0615	181.1253	0.2941	277.950714	0.0928
T	37.08304	179.6763	0.1052	59.15805	0.4926	178.3877	0.2578	300.2654	0.0390	180.9163	0.2801	277.824921	0.0857
T	31.13804	179.6778	0.1052	59.40411	0.5042	178.1836	0.2428	300.8018	0.0641	180.7028	0.2658	277.913116	0.0907
T	29.45036	181.0861	0.1151	63.94765	0.7181	178.0405	0.2323	301.8912	0.1153	180.8790	0.2776	280.016083	0.2087
T	25.63555	180.6363	0.1119	63.37377	0.6911	178.0534	0.2333	301.3003	0.0875	180.8622	0.2765	278.958374	0.1493
T	37.94977	179.2241	0.1020	56.13494	0.3503	178.7345	0.2833	302.2717	0.1331	181.3776	0.3110	278.325531	0.1138
T	29.95697	177.2379	0.0881	56.69153	0.3765	178.9772	0.3011	302.5132	0.1445	181.5980	0.3258	278.325531	0.1138
T	24.79629	178.5449	0.0973	57.73357	0.4256	178.8285	0.2902	301.5845	0.1009	181.3990	0.3124	277.967438	0.0937
T	32.89285	171.6893	0.0493	59.0223	0.4862	179.1494	0.3137	301.9351	0.1173	181.6770	0.3311	278.340332	0.1146
T	27.88171	176.5203	0.0831	60.48608	0.5552	179.9202	0.3703	304.4320	0.2345	182.6257	0.3946	281.18222	0.2742
T	7.437361	175.9554	0.0792	59.26645	0.4977	180.2014	0.3910	305.6804	0.2931	182.8571	0.4101	282.553223	0.3512
T	35.77074	175.9583	0.0792	61.908	0.6221	180.3421	0.4013	306.1890	0.3170	182.9738	0.4179	283.36087	0.3965
T	35.61815	186.8934	0.1558	64.35807	0.7374	180.5891	0.4194	306.0197	0.3090	182.9808	0.4184	284.138641	0.4402
T	22.07099	189.9714	0.1773	62.55943	0.6528	180.3049	0.3986	305.7339	0.2956	182.5370	0.3887	282.866211	0.3687
T	3.894162	193.0733	0.1990	63.17527	0.6817	180.0207	0.3777	305.6730	0.2927	182.2399	0.3688	283.195923	0.3872
T	42.68319	187.1058	0.1572	62.04852	0.6287	180.2725	0.3962	306.7330	0.3425	182.5405	0.3889	283.87915	0.4256
T	31.98645	190.6363	0.1820	65.81261	0.8059	180.2759	0.3964	306.9392	0.3522	182.4630	0.3837	284.787689	0.4766
T	31.00375	188.6746	0.1682	62.91233	0.6694	179.9242	0.3706	306.0386	0.3099	182.2412	0.3688	283.147858	0.3845
T	6.509598	187.3207	0.1587	60.51189	0.5564	180.5729	0.4182	305.8657	0.3018	182.8654	0.4107	282.042938	0.3225
T	34.56526	290.0022	0.8778	60.99483	0.5791	181.1293	0.4591	305.2711	0.2739	183.2038	0.4333	282.011261	0.3207
T	31.70568	289.7634	0.8762	60.21966	0.5426	181.0776	0.4553	305.3501	0.2776	183.1057	0.4267	282.123383	0.3270
T	39.86633	290.4416	0.8809	59.82418	0.5240	180.9483	0.4458	305.8652	0.3018	182.9679	0.4175	282.347626	0.3396
T	16.01917	290.4371	0.8809	60.09165	0.5366	180.6161	0.4214	305.4214	0.2809	182.6655	0.3973	281.834961	0.3108
T	37.03726	290.5764	0.8819	60.18588	0.5410	180.5157	0.4140	305.4061	0.2802	182.5652	0.3906	282.098328	0.3256
T	13.68755	290.7125	0.8828	59.84231	0.5248	180.4655	0.4103	305.4110	0.2804	182.5151	0.3872	282.230042	0.3330

		Inlet Properties								Outlet Properties			
clasification	Rand.No	Shell Flow rate	Normalized	Tube Flow rate	Normalized	Shell Temperature	Normalized	Tube Temperature	Normalized	Shell Temperature	Normalized	Tube Temperature	Normalized
V	66.64022	293.2839	0.9008	55.54142	0.3224	180.5103	0.4136	309.5731	0.4758	183.4518	0.4499	284.845642	0.4799
V	56.25477	292.9318	0.8984	54.87772	0.2911	180.5156	0.4140	309.3809	0.4667	183.3717	0.4446	284.17868	0.4424
V	68.73379	292.4092	0.8947	53.91451	0.2458	180.5313	0.4152	308.6344	0.4317	183.1318	0.4285	282.659302	0.3571
V	48.45729	292.4491	0.8950	53.73252	0.2372	180.4703	0.4107	308.4679	0.4239	183.0900	0.4257	282.638123	0.3559
V	75.58519	292.6117	0.8961	54.43746	0.2704	180.2298	0.3930	308.2160	0.4121	183.0062	0.4201	282.612457	0.3545
V	83.91064	294.2465	0.9076	51.66367	0.1399	179.9765	0.3744	307.8886	0.3967	183.0429	0.4225	281.238159	0.2773
V	44.17859	291.8434	0.8907	53.49426	0.2260	178.9538	0.2994	307.9701	0.4005	182.0023	0.3529	281.949371	0.3173
V	59.08994	292.7553	0.8971	57.45549	0.4125	178.9189	0.2968	307.8969	0.3971	182.1832	0.3650	283.184204	0.3866
V	47.66076	291.5356	0.8886	55.23656	0.3080	179.1292	0.3122	307.9095	0.3977	182.3315	0.3749	283.023254	0.3775
V	82.25959	290.2244	0.8794	55.44582	0.3179	179.3403	0.3277	307.9493	0.3996	182.4275	0.3813	283.03595	0.3783
V	56.47755	292.1856	0.8931	55.6578	0.3279	179.4729	0.3375	308.2345	0.4129	182.6677	0.3974	283.103516	0.3821
V	44.47462	290.7063	0.8828	52.01766	0.1565	179.4982	0.3393	308.2363	0.4130	182.4891	0.3855	281.965424	0.3182
V	64.01868	291.9843	0.8917	52.27645	0.1687	179.6379	0.3496	308.6043	0.4303	182.6696	0.3975	281.976227	0.3188
V	58.89462	290.2628	0.8797	52.34344	0.1719	179.7638	0.3588	309.0370	0.4506	182.7398	0.4022	282.529297	0.3498
V	63.98816	291.2443	0.8865	49.53323	0.0396	179.2243	0.3192	308.6953	0.4346	182.3480	0.3760	281.606384	0.2980
V	46.22028	291.5213	0.8885	55.03487	0.2985	179.6196	0.3482	308.2685	0.4145	182.7884	0.4055	282.854095	0.3680
V	44.18165	291.3434	0.8872	60.81353	0.5706	180.3024	0.3984	309.0938	0.4533	183.6951	0.4662	285.791168	0.5329
V	58.67489	289.396	0.8736	60.05713	0.5350	179.8133	0.3625	307.5566	0.3811	183.1328	0.4286	284.069519	0.4363
V	67.38792	290.1435	0.8788	59.7123	0.5187	179.9100	0.3696	307.0757	0.3586	183.0157	0.4207	283.255737	0.3906
V	47.63024	289.5396	0.8746	62.17006	0.6344	179.7217	0.3557	307.2032	0.3645	183.1175	0.4275	283.89212	0.4263
V	47.66991	290.8805	0.8840	59.56802	0.5119	179.7619	0.3587	307.3431	0.3711	182.7987	0.4062	283.659912	0.4133
V	47.28233	291.4266	0.8878	54.59744	0.2780	179.4396	0.3350	307.0706	0.3583	182.6555	0.3966	281.976532	0.3188
V	78.37764	291.0021	0.8848	54.46784	0.2719	179.3734	0.3302	307.9006	0.3973	182.8296	0.4083	282.211853	0.3320
V	83.8435	291.1288	0.8857	53.15127	0.2099	178.9819	0.3014	307.2335	0.3660	182.4458	0.3826	281.423462	0.2877
V	81.80792	290.9123	0.8842	53.74545	0.2378	178.8401	0.2910	307.5132	0.3791	182.1370	0.3619	281.388794	0.2858
V	74.81307	290.1967	0.8792	57.03679	0.3928	179.6415	0.3499	308.7614	0.4377	182.7760	0.4047	283.982666	0.4314
V	56.01978	288.1322	0.8647	57.84605	0.4309	182.8053	0.5821	309.6511	0.4794	187.8352	0.7435	285.085114	0.4933
V	65.98102	290.4885	0.8812	57.8635	0.4317	181.0100	0.4503	311.1510	0.5498	184.2415	0.5028	286.345581	0.5641
V	83.89538	292.5234	0.8955	56.01484	0.3447	180.2999	0.3982	309.9492	0.4934	183.6046	0.4602	284.64389	0.4685
V	57.08487	290.1203	0.8787	55.52938	0.3218	180.4996	0.4128	309.9578	0.4938	183.8217	0.4747	284.51767	0.4614
V	56.74612	291.2911	0.8869	59.35889	0.5021	180.9651	0.4470	310.8889	0.5375	184.4268	0.5152	286.949829	0.5980
V	50.55391	292.7624	0.8972	59.22327	0.4957	180.9435	0.4454	311.1098	0.5479	184.3423	0.5096	286.877991	0.5939
V	52.82144	293.8532	0.9048	60.26791	0.5449	180.9713	0.4475	311.0975	0.5473	184.1467	0.4965	287.327484	0.6192
V	49.63225	291.0621	0.8853	59.9464	0.5297	180.7873	0.4340	310.9529	0.5405	184.1791	0.4986	286.841797	0.5919
V	83.53221	289.9601	0.8775	59.24094	0.4965	180.7529	0.4314	310.1522	0.5029	184.0983	0.4932	286.094086	0.5499
V	47.322	294.9641	0.9126	57.49158	0.4142	180.2360	0.3935	309.2180	0.4591	183.6423	0.4627	284.858307	0.4806
V	76.04602	292.7325	0.8970	56.60201	0.3723	180.6903	0.4268	309.9693	0.4944	183.9739	0.4849	284.881317	0.4819
V	55.21104	293.1148	0.8996	63.41647	0.6931	181.7799	0.5068	313.2476	0.6482	185.1180	0.5615	289.384583	0.7347

V	45.3444	287.8773	0.8630	60.08818	0.5364	180.8214	0.4365	310.9480	0.5403	184.5259	0.5219	286.475311	0.5713
V	65.27604	284.7931	0.8414	62.00862	0.6268	185.8792	0.8077	313.5472	0.6623	190.5219	0.9234	290.542206	0.7997
V	49.52544	286.3795	0.8525	69.45708	0.9774	186.0832	0.8227	315.2833	0.7437	190.5654	0.9263	293.877899	0.9869
V	44.19691	297.1841	0.9281	68.81512	0.9472	184.5795	0.7123	311.5676	0.5694	188.4135	0.7822	289.408142	0.7360
V	59.86206	293.7789	0.9043	57.61702	0.4201	186.5265	0.8553	312.7479	0.6247	190.3746	0.9136	288.244385	0.6707
V	48.45119	290.3178	0.8801	60.49144	0.5554	186.5620	0.8579	312.6190	0.6187	190.2769	0.9070	288.620056	0.6917
V	53.70037	290.3738	0.8804	61.32348	0.5946	186.1440	0.8272	312.0495	0.5920	189.8674	0.8796	288.069427	0.6608
V	72.30445	290.4375	0.8809	60.63294	0.5621	186.1919	0.8307	311.6025	0.5710	189.8927	0.8813	287.701355	0.6402
V	63.11533	288.1813	0.8651	60.18661	0.5411	187.6827	0.9401	320.0320	0.9666	191.0605	0.9595	293.656403	0.9745
V	62.33406	169.8681	0.0365	60.21889	0.5426	185.6108	0.7880	316.4927	0.8005	188.9435	0.8177	290.417267	0.7926
V	53.1724	179.1078	0.1012	60.15846	0.5397	183.9552	0.6665	314.1834	0.6921	187.1956	0.7007	289.075378	0.7173
V	69.07865	169.5394	0.0342	56.52974	0.3689	185.7022	0.7948	312.7860	0.6265	189.1691	0.8328	286.985596	0.6000
V	72.4723	167.615	0.0207	60.13663	0.5387	184.4931	0.7060	314.4696	0.7055	187.9608	0.7519	289.284058	0.7290
V	72.06946	167.1223	0.0173	52.85841	0.1961	183.4869	0.6321	310.5894	0.5235	187.1978	0.7008	283.114197	0.3827
V	52.89468	165.2916	0.0045	62.49868	0.6499	183.8260	0.6570	309.2814	0.4621	187.1157	0.6953	285.375641	0.5096
V	50.27009	166.976	0.0163	64.55983	0.7469	183.0490	0.6000	307.9539	0.3998	186.5470	0.6572	284.975891	0.4872
V	61.0889	166.696	0.0143	66.74577	0.8498	183.5149	0.6342	308.6896	0.4343	186.8968	0.6806	285.639221	0.5244
V	72.13965	172.9613	0.0582	64.85686	0.7609	184.3217	0.6934	311.1350	0.5491	187.6494	0.7310	287.942749	0.6537
V	61.48259	166.3239	0.0117	64.97298	0.7664	184.5575	0.7107	313.0346	0.6382	187.8859	0.7469	289.159027	0.7220
V	85.4152	173.2469	0.0602	58.05959	0.4409	187.5760	0.9323	320.7443	1.0000	190.6583	0.9326	294.11084	1.0000
V	53.02286	167.963	0.0232	52.73172	0.1901	186.4805	0.8519	317.8654	0.8649	189.7141	0.8693	290.135773	0.7768
V	80.49867	167.5901	0.0206	53.41144	0.2221	186.3467	0.8421	317.9262	0.8678	189.5880	0.8609	290.161224	0.7783
V	78.49361	181.3665	0.1171	56.69899	0.3769	185.0547	0.7472	314.4530	0.7048	188.0352	0.7569	288.194489	0.6679
V	45.00565	187.9585	0.1632	57.35942	0.4080	184.7225	0.7228	313.3846	0.6546	187.5781	0.7263	287.960754	0.6547
V	61.54973	183.4051	0.1313	55.95845	0.3420	184.2988	0.6917	311.7744	0.5791	187.3521	0.7111	285.780334	0.5323
V	75.9209	184.7105	0.1405	56.32957	0.3595	183.6688	0.6455	310.2838	0.5091	186.6928	0.6670	284.899597	0.4829
V	83.96558	183.3912	0.1312	61.96091	0.6246	184.9548	0.7399	313.5783	0.6637	188.1336	0.7635	289.387695	0.7348
V	60.38087	288.4524	0.8670	61.40046	0.5982	184.6344	0.7164	313.0480	0.6388	187.6614	0.7319	288.795044	0.7016
V	48.1399	289.6613	0.8755	60.76235	0.5682	183.7105	0.6485	311.4734	0.5649	186.9486	0.6841	287.581635	0.6335
V	55.15915	288.6226	0.8682	55.29965	0.3110	184.3431	0.6950	310.8390	0.5352	187.2342	0.7032	285.298706	0.5053
V	49.36979	289.3627	0.8734	55.32753	0.3123	184.5851	0.7127	312.6353	0.6195	187.6584	0.7317	286.78714	0.5888
V	61.93121	290.6783	0.8826	54.43205	0.2702	183.3550	0.6225	312.4599	0.6112	186.4480	0.6506	285.692841	0.5274
V	50.35249	286.8788	0.8560	55.00241	0.2970	183.9999	0.6698	311.8782	0.5839	187.1864	0.7000	285.912567	0.5398
V	83.65429	287.9722	0.8636	60.62517	0.5617	183.5831	0.6392	312.9663	0.6350	187.0610	0.6916	288.419617	0.6805
V	46.53462	287.1363	0.8578	58.55866	0.4644	183.7311	0.6501	312.7240	0.6236	186.9021	0.6810	287.566193	0.6326
V	45.04837	286.2616	0.8516	58.39148	0.4566	183.7767	0.6534	312.9706	0.6352	187.2893	0.7069	288.203491	0.6684
V	60.25575	287.1529	0.8579	59.85131	0.5253	183.6809	0.6464	313.7275	0.6707	186.9252	0.6825	288.464417	0.6830
V	81.2891	287.4496	0.8600	59.20787	0.4950	184.2267	0.6864	314.3826	0.7015	187.3555	0.7114	289.326935	0.7314
V	48.87234	287.7175	0.8618	63.00335	0.6736	184.8540	0.7325	316.1007	0.7821	188.2711	0.7727	291.594391	0.8587
V	68.03797	287.9427	0.8634	58.48989	0.4612	184.7710	0.7264	316.2449	0.7889	188.3027	0.7748	291.343292	0.8446
V	76.11316	286.6263	0.8542	56.14981	0.3510	184.3123	0.6927	313.2981	0.6506	187.5632	0.7253	287.474792	0.6275
V	71.01352	286.7179	0.8548	57.22545	0.4017	184.6947	0.7208	314.7252	0.7175	188.1165	0.7623	289.622162	0.7480

V	61.36967	286.2984	0.8519	57.64228	0.4213	184.3795	0.6977	314.5333	0.7085	187.7843	0.7401	289.648682	0.7495
V	73.09488	287.6012	0.8610	56.38934	0.3623	183.8673	0.6601	313.1533	0.6438	186.7621	0.6716	287.950439	0.6542
V	72.77749	287.137	0.8578	57.26928	0.4037	183.8438	0.6583	313.0379	0.6384	186.7884	0.6734	288.567261	0.6888
V	45.78997	288.0194	0.8640	58.04592	0.4403	183.7966	0.6549	312.9512	0.6343	186.8855	0.6799	287.973022	0.6554
V	65.77654	288.1333	0.8648	58.32095	0.4532	183.9644	0.6672	313.2404	0.6479	186.9921	0.6870	288.14389	0.6650
V	64.5497	286.0923	0.8505	57.29557	0.4050	184.2424	0.6876	313.7468	0.6716	187.4609	0.7184	289.127472	0.7202
V	85.35722	286.9672	0.8566	57.74849	0.4263	183.1177	0.6050	311.6918	0.5752	186.4317	0.6495	286.856445	0.5927
V	60.47853	284.663	0.8405	56.49195	0.3671	182.9467	0.5925	310.7189	0.5295	186.8377	0.6767	285.425323	0.5124
V	58.92209	287.9544	0.8635	57.5	0.4146	183.7880	0.6542	310.7229	0.5297	187.4650	0.7187	286.597656	0.5782
V	63.72875	287.9853	0.8637	59.17869	0.4936	184.0333	0.6722	311.4410	0.5634	187.2374	0.7035	287.410919	0.6239
V	53.54167	289.8563	0.8768	58.75346	0.4736	183.9642	0.6672	310.8429	0.5354	187.2091	0.7016	287.045166	0.6033
V	55.43687	286.7779	0.8553	58.69731	0.4709	183.9297	0.6646	310.8898	0.5376	187.1768	0.6994	287.083588	0.6055
V	63.37779	289.3923	0.8736	59.03898	0.4870	183.7731	0.6531	310.9817	0.5419	187.0648	0.6919	287.122009	0.6076
V	67.17734	288.7783	0.8693	59.50597	0.5090	183.5955	0.6401	311.0736	0.5462	186.9529	0.6844	287.160431	0.6098
V	60.90579	289.9319	0.8774	61.80988	0.6175	183.5229	0.6348	311.4820	0.5653	186.7496	0.6708	288.037262	0.6590
V	74.97177	289.2094	0.8723	60.36016	0.5492	183.2262	0.6130	311.6832	0.5748	186.6462	0.6639	287.817993	0.6467
V	79.28404	287.9644	0.8636	61.51326	0.6035	184.1564	0.6813	313.3900	0.6549	187.0924	0.6937	289.796143	0.7578
V	58.15607	288.3836	0.8665	63.27553	0.6865	183.6347	0.6430	314.3646	0.7006	187.0752	0.6926	290.833557	0.8160
V	81.90558	288.943	0.8704	60.34423	0.5485	183.9123	0.6634	314.2526	0.6954	187.4306	0.7164	290.405731	0.7920
V	60.07263	288.402	0.8666	60.04175	0.5342	183.9705	0.6676	313.4185	0.6562	187.1837	0.6999	290.333405	0.7879
V	63.10923	287.5729	0.8608	60.34721	0.5486	183.6917	0.6472	312.9371	0.6336	187.0815	0.6930	289.585663	0.7460
V	75.2739	286.9757	0.8566	60.40928	0.5515	183.6363	0.6431	312.6200	0.6187	186.9695	0.6855	289.257202	0.7275
V	76.6747	287.8456	0.8627	61.18532	0.5881	183.5809	0.6390	312.6824	0.6217	186.8437	0.6771	289.433594	0.7374
V	44.43495	285.6596	0.8474	59.96056	0.5304	183.2689	0.6161	312.7873	0.6266	186.5542	0.6577	288.675171	0.6948
V	60.71047	288.8884	0.8700	60.67836	0.5642	183.1772	0.6094	311.7986	0.5802	186.3367	0.6431	288.04538	0.6595
V	79.29624	288.0612	0.8643	60.05829	0.5350	182.9217	0.5906	311.6784	0.5746	186.4708	0.6521	288.008514	0.6574
V	82.77841	284.3806	0.8385	58.93657	0.4822	183.1852	0.6100	311.6208	0.5719	186.1167	0.6284	287.50824	0.6293
V	70.39705	286.4956	0.8533	58.60793	0.4667	183.0500	0.6001	312.1090	0.5948	186.3127	0.6415	287.91217	0.6520
V	80.9595	286.974	0.8566	58.95795	0.4832	183.0441	0.5996	312.2782	0.6027	186.3558	0.6444	287.994354	0.6566
V	46.76351	285.2257	0.8444	58.93533	0.4822	183.3217	0.6200	312.7860	0.6265	186.5557	0.6578	288.654633	0.6937
V	67.7694	181.0314	0.1147	61.84834	0.6193	183.0805	0.6023	312.3690	0.6070	186.5307	0.6561	289.138763	0.7209
V	64.9678	180.3151	0.1097	61.95567	0.6243	183.7771	0.6534	312.3586	0.6065	187.2035	0.7012	289.867279	0.7618
V	77.18436	181.2661	0.1163	61.08393	0.5833	183.5723	0.6384	312.7432	0.6245	186.9175	0.6820	289.237854	0.7264
V	78.78658	188.4878	0.1669	55.60641	0.3255	182.6988	0.5743	311.9346	0.5866	186.4006	0.6474	286.719391	0.5850
V	47.61498	183.6867	0.1333	54.27161	0.2626	184.0287	0.6719	312.2806	0.6028	187.7636	0.7387	286.943054	0.5976
V	79.24741	167.0435	0.0167	58.03996	0.4400	185.6499	0.7909	314.7828	0.7202	188.9100	0.8155	290.669037	0.8068
V	48.57631	169.0451	0.0308	58.85425	0.4783	185.3082	0.7658	314.7126	0.7169	188.6280	0.7966	290.612183	0.8036
V	73.25968	172.54	0.0552	56.42305	0.3639	184.0720	0.6751	313.0802	0.6403	187.2600	0.7050	288.901184	0.7075
V	77.80694	173.314	0.0607	58.79646	0.4756	183.4984	0.6330	310.6360	0.5256	186.6920	0.6669	287.355621	0.6208
V	61.67486	178.6047	0.0977	62.37265	0.6440	183.9368	0.6652	311.4157	0.5622	186.8196	0.6755	289.066589	0.7168
V	53.08695	178.9125	0.0999	58.5151	0.4624	183.9877	0.6689	311.2740	0.5556	187.2418	0.7038	287.800873	0.6458
V	43.67199	177.078	0.0870	62.5439	0.6520	184.1926	0.6839	310.7598	0.5314	187.3277	0.7095	288.294891	0.6735

V	75.24339	179.4991	0.1040	63.29429	0.6873	183.8286	0.6572	310.2200	0.5061	186.7975	0.6740	288.327148	0.6753
V	48.61599	176.9086	0.0858	59.21713	0.4954	183.5042	0.6334	309.7840	0.4857	186.6427	0.6636	286.570892	0.5767
V	48.34742	179.5721	0.1045	61.41647	0.5989	183.3717	0.6237	310.4060	0.5148	186.8590	0.6781	287.638092	0.6366
V	77.66961	178.3027	0.0956	60.14459	0.5391	184.1196	0.6786	312.4378	0.6102	187.3590	0.7116	289.468323	0.7394
V	77.87103	178.7994	0.0991	63.75998	0.7093	184.3004	0.6919	312.6228	0.6189	187.5235	0.7226	290.995789	0.8251
V	56.27918	179.2246	0.1021	62.17777	0.6348	184.2172	0.6857	312.7698	0.6258	187.3002	0.7077	290.297638	0.7859
V	74.00128	178.2783	0.0954	59.46662	0.5072	183.8152	0.6562	312.8222	0.6282	186.9763	0.6860	289.260315	0.7277
V	84.36232	169.9466	0.0371	55.90636	0.3396	183.5106	0.6339	310.8103	0.5338	186.7228	0.6690	286.528442	0.5743
V	79.9646	181.8967	0.1208	51.33147	0.1242	180.6160	0.4214	310.1148	0.5012	182.3108	0.3735	283.37204	0.3971
V	63.5548	189.4678	0.1738	56.12898	0.3500	180.9780	0.4480	309.9312	0.4926	182.3290	0.3747	285.564301	0.5202
V	84.02661	182.3772	0.1241	51.57951	0.1359	180.0574	0.3804	308.8095	0.4399	182.0202	0.3540	281.995331	0.3198
V	46.36067	186.5794	0.1536	55.23086	0.3078	180.5332	0.4153	310.5934	0.5236	182.1953	0.3658	286.036072	0.5467
V	72.75918	189.0927	0.1712	56.06356	0.3470	179.5060	0.3399	308.3313	0.4175	181.3417	0.3086	283.404297	0.3989
V	51.79296	194.6817	0.2103	69.84821	0.9959	181.3342	0.4741	308.8283	0.4408	182.7025	0.3997	288.678375	0.6950
V	77.71538	194.0025	0.2055	50.58152	0.0889	182.6791	0.5728	310.6773	0.5276	184.1612	0.4974	285.127472	0.4957
V	74.25153	179.5033	0.1040	53.78311	0.2396	180.7802	0.4334	309.0382	0.4507	182.5003	0.3862	283.972015	0.4308
V	62.154	189.5352	0.1743	56.06253	0.3469	180.7227	0.4292	310.2254	0.5064	182.3320	0.3749	285.266998	0.5035
V	44.45021	185.8776	0.1486	54.77522	0.2863	180.4077	0.4061	308.8238	0.4406	181.9567	0.3498	283.137024	0.3839
V	63.0665	186.7554	0.1548	54.15894	0.2573	180.2464	0.3943	308.4644	0.4237	181.7135	0.3335	282.993195	0.3759
V	65.11124	183.7181	0.1335	51.98135	0.1548	180.4067	0.4060	308.4166	0.4215	182.0641	0.3570	282.391449	0.3421
V	84.68276	188.5194	0.1671	52.16155	0.1633	181.3886	0.4781	310.5204	0.5202	182.8030	0.4065	284.791351	0.4768
V	43.89782	188.5737	0.1675	54.88912	0.2917	181.5191	0.4877	311.0700	0.5460	183.0065	0.4201	286.540741	0.5750
V	72.19764	186.6132	0.1538	53.21342	0.2128	181.0738	0.4550	309.9869	0.4952	182.6143	0.3938	284.236237	0.4456
V	58.01263	182.8063	0.1271	53.3063	0.2172	180.1197	0.3850	308.2112	0.4119	181.8348	0.3416	282.884796	0.3698
V	52.90384	182.2041	0.1229	51.88279	0.1502	179.0603	0.3072	307.2568	0.3671	180.8962	0.2788	281.703278	0.3034
V	73.57402	185.9125	0.1489	52.51462	0.1799	179.0815	0.3087	306.7307	0.3424	180.9166	0.2801	281.853577	0.3119
V	60.44191	181.82	0.1202	53.76247	0.2387	178.7309	0.2830	306.5959	0.3360	180.2293	0.2341	281.48465	0.2912
V	70.60457	175.8088	0.0781	53.41374	0.2222	178.3739	0.2568	306.6364	0.3379	179.9381	0.2146	281.849091	0.3116
V	76.19556	188.6182	0.1678	54.2339	0.2608	177.6642	0.2047	306.4596	0.3297	179.2817	0.1706	281.804382	0.3091
V	56.03809	178.9697	0.1003	54.01637	0.2506	178.0708	0.2346	306.0840	0.3120	179.6471	0.1951	281.030609	0.2657
V	62.14179	187.4543	0.1597	55.97827	0.3430	177.9943	0.2289	305.7084	0.2944	179.5707	0.1900	281.071991	0.2680
V	50.42879	178.0935	0.0941	53.72995	0.2371	177.9252	0.2239	305.3976	0.2798	179.4886	0.1845	281.041321	0.2663
V	85.26872	186.4273	0.1525	55.63017	0.3266	178.2133	0.2450	306.6002	0.3363	179.5512	0.1887	282.492157	0.3477
V	73.22306	183.6883	0.1333	54.35374	0.2665	178.5487	0.2696	307.5364	0.3802	180.2007	0.2322	282.583405	0.3529
V	81.96051	187.8239	0.1623	62.49134	0.6495	177.4187	0.1867	304.2241	0.2247	179.1000	0.1585	282.205933	0.3317
V	70.4825	185.2879	0.1445	58.81254	0.4764	177.0123	0.1569	303.4965	0.1906	178.8099	0.1391	280.804047	0.2530
V	76.23524	182.3694	0.1241	58.39498	0.4567	176.2864	0.1036	303.0130	0.1679	178.2822	0.1037	279.811096	0.1972
V	65.52019	179.7981	0.1061	57.88132	0.4325	176.3819	0.1106	301.6927	0.1060	177.9716	0.0829	278.45929	0.1213
V	48.3169	183.7118	0.1335	57.75587	0.4266	176.6390	0.1295	303.2842	0.1806	178.3112	0.1057	279.908142	0.2027
V	67.83044	182.4307	0.1245	57.08506	0.3951	176.8906	0.1479	304.6794	0.2461	178.6374	0.1275	281.068481	0.2678
V	84.24635	187.8786	0.1627	63.18199	0.6821	178.4717	0.2640	304.9768	0.2601	180.8349	0.2747	283.265137	0.3911
V	61.22929	186.0689	0.1500	62.24628	0.6380	179.0394	0.3057	304.8758	0.2553	181.4254	0.3142	283.694641	0.4152

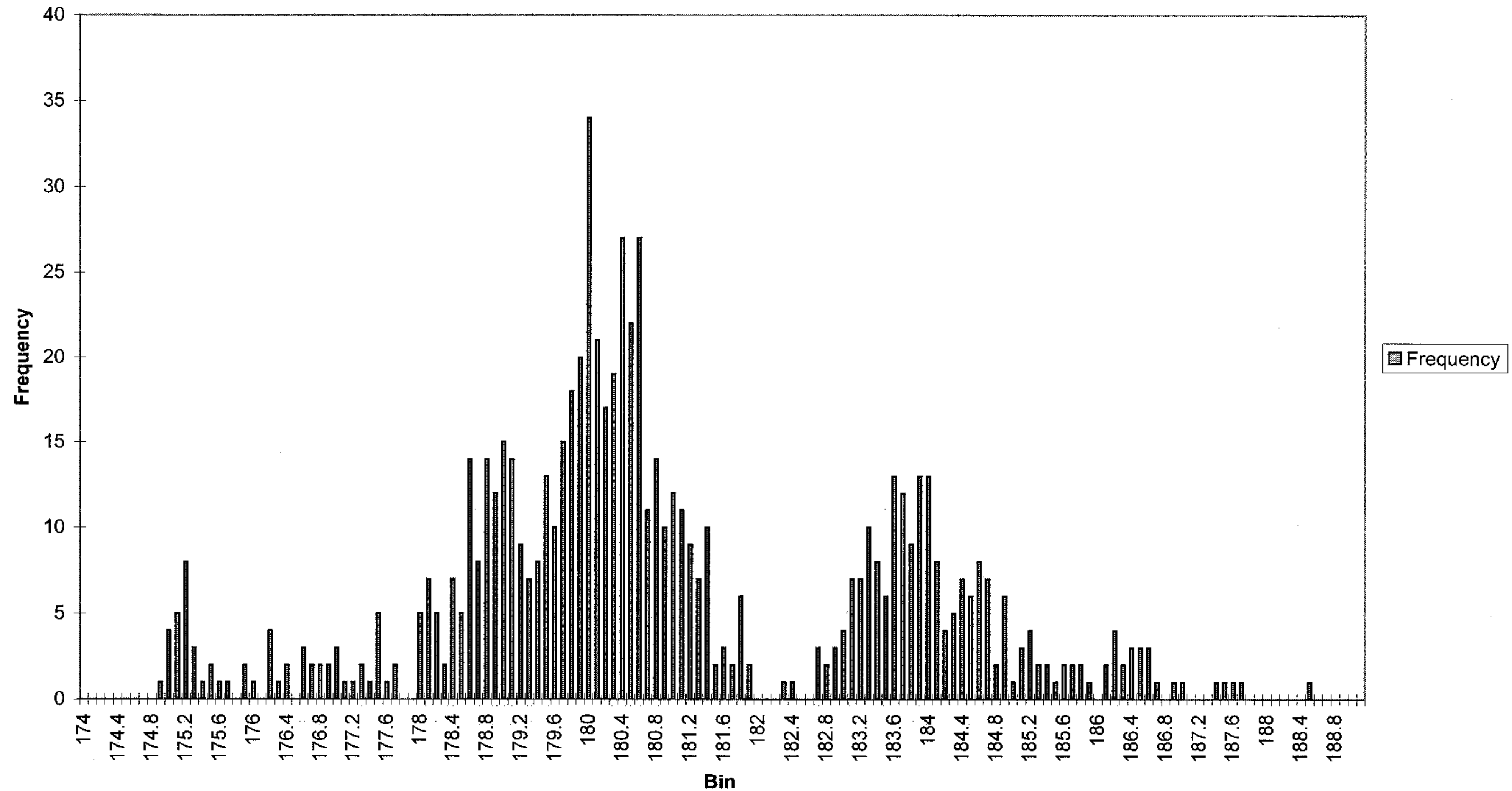
V	56.00757	190.9109	0.1839	60.58283	0.5597	179.9482	0.3724	304.0405	0.2161	182.3292	0.3747	282.438934	0.3447
V	74.6147	188.1323	0.1644	59.38284	0.5032	180.3337	0.4007	304.4196	0.2339	182.5663	0.3906	282.740601	0.3617
V	45.95782	188.4939	0.1670	58.93367	0.4821	180.1705	0.3887	302.9939	0.1670	182.6684	0.3975	280.626984	0.2430
V	67.30247	188.6502	0.1681	60.30399	0.5466	179.9030	0.3690	302.1659	0.1282	182.3996	0.3795	280.405518	0.2306
V	64.10413	179.5242	0.1041	58.12368	0.4439	179.0399	0.3057	300.4840	0.0492	181.4928	0.3187	277.819794	0.0854
V	61.46428	177.9624	0.0932	60.18914	0.5412	179.3689	0.3298	301.8356	0.1127	181.7630	0.3368	279.240723	0.1652
V	51.40538	179.1561	0.1016	60.23739	0.5434	180.1388	0.3864	305.2854	0.2745	182.6520	0.3964	282.115417	0.3266
V	85.95538	178.3758	0.0961	59.25885	0.4974	179.8789	0.3673	304.0342	0.2158	182.4309	0.3816	281.201202	0.2753
V	51.21311	178.2837	0.0955	56.87228	0.3850	180.1040	0.3838	305.3253	0.2764	182.7577	0.4034	280.897186	0.2582
V	47.48985	177.9406	0.0931	55.80362	0.3347	180.3359	0.4008	305.9118	0.3039	182.9211	0.4144	281.258728	0.2785
V	69.01456	179.1052	0.1012	55.7921	0.3342	180.5679	0.4179	306.4983	0.3315	183.0845	0.4253	281.694427	0.3029
V	46.11042	178.3875	0.0962	60.41372	0.5517	180.9968	0.4493	304.9621	0.2594	183.4030	0.4467	281.51886	0.2931
V	73.65337	179.1919	0.1018	62.64524	0.6568	181.1388	0.4598	306.5307	0.3330	183.5314	0.4553	284.14917	0.4408
V	71.92907	177.6065	0.0907	62.44832	0.6475	181.2697	0.4694	308.2608	0.4142	183.7362	0.4690	285.579346	0.5210
V	72.39601	179.9679	0.1073	55.4338	0.3173	181.1031	0.4571	307.8130	0.3932	183.6092	0.4605	284.098145	0.4379
V	50.1999	179.6074	0.1047	57.9481	0.4357	181.2705	0.4694	308.4069	0.4210	183.9313	0.4820	285.33905	0.5076
V	81.45085	178.5349	0.0972	62.03445	0.6280	181.8154	0.5094	310.2353	0.5068	184.2993	0.5067	286.915833	0.5961
V	43.92529	178.8954	0.0997	63.07877	0.6772	181.7814	0.5069	311.7050	0.5758	184.4281	0.5153	289.463562	0.7391
V	59.90783	178.8521	0.0994	59.75253	0.5206	181.0664	0.4545	310.8899	0.5376	183.5731	0.4580	286.987671	0.6001
V	60.65554	179.1783	0.1017	57.23504	0.4021	181.4505	0.4826	310.7356	0.5303	183.9271	0.4818	285.481506	0.5156
V	72.26478	179.3201	0.1027	57.34403	0.4072	181.3027	0.4718	310.6710	0.5273	183.9519	0.4834	286.080597	0.5492
V	49.11954	178.0859	0.0941	58.30243	0.4524	181.3092	0.4723	310.8826	0.5372	183.9764	0.4851	286.007782	0.5451
V	81.93915	178.13	0.0944	56.16274	0.3516	181.1933	0.4638	310.9674	0.5412	183.8119	0.4740	284.990662	0.4880
V	80.98697	181.0412	0.1148	57.54821	0.4169	179.9088	0.3695	307.4520	0.3762	182.5619	0.3903	282.782501	0.3640
V	44.85611	180.0732	0.1080	58.17088	0.4462	179.8090	0.3622	307.3064	0.3694	182.4978	0.3860	282.998505	0.3762
V	53.05643	180.4375	0.1105	56.97309	0.3898	179.6094	0.3475	306.1800	0.3165	182.3695	0.3774	282.234833	0.3333
V	53.68816	179.6745	0.1052	58.35336	0.4548	179.2418	0.3205	306.3846	0.3261	181.5796	0.3245	282.260468	0.3347
V	76.5801	180.4405	0.1106	56.95628	0.3890	180.1413	0.3865	306.5893	0.3357	182.5271	0.3880	281.785278	0.3080
V	66.65853	180.6529	0.1121	55.5917	0.3248	179.7413	0.3572	306.5826	0.3354	182.4016	0.3796	281.458954	0.2897
V	62.30659	180.4	0.1103	56.06591	0.3471	179.7834	0.3603	306.5313	0.3330	182.4151	0.3805	281.451965	0.2893
V	70.51302	180.695	0.1123	54.5951	0.2778	179.8677	0.3665	306.4287	0.3282	182.3900	0.3788	281.208038	0.2756
V	44.01074	181.1491	0.1155	57.76643	0.4271	180.0902	0.3828	306.7066	0.3412	182.6162	0.3940	282.775543	0.3636
V	61.95868	179.4386	0.1035	56.15475	0.3513	179.7006	0.3542	305.9684	0.3066	182.2516	0.3696	281.037842	0.2661
V	69.2526	179.3522	0.1029	54.11715	0.2553	180.0001	0.3762	305.3330	0.2768	182.6073	0.3934	280.327942	0.2262
V	45.57024	179.2175	0.1020	61.15092	0.5864	179.8449	0.3648	305.4727	0.2833	182.5168	0.3873	282.22052	0.3325
V	84.6675	178.0064	0.0935	54.24534	0.2614	179.3198	0.3262	302.8087	0.1583	181.8009	0.3394	278.157013	0.1044
V	52.07984	177.3454	0.0889	55.41308	0.3164	179.1486	0.3137	303.9131	0.2102	181.7265	0.3344	279.544891	0.1823
V	78.19452	178.4183	0.0964	57.75694	0.4267	178.8784	0.2938	301.1791	0.0819	181.2739	0.3041	277.654205	0.0761
V	84.167	178.5233	0.0971	57.89324	0.4331	178.8743	0.2935	301.7953	0.1108	181.3941	0.3121	278.44101	0.1203
V	56.50502	182.2855	0.1235	63.90612	0.7161	178.0168	0.2306	301.3465	0.0897	180.8850	0.2780	279.70813	0.1914
V	71.92907	181.7052	0.1194	64.39862	0.7393	178.0828	0.2354	302.1799	0.1288	180.8242	0.2740	280.140167	0.2157
V	45.40849	180.2065	0.1089	60.20609	0.5420	178.4333	0.2612	301.2656	0.0859	181.0014	0.2858	278.519653	0.1247

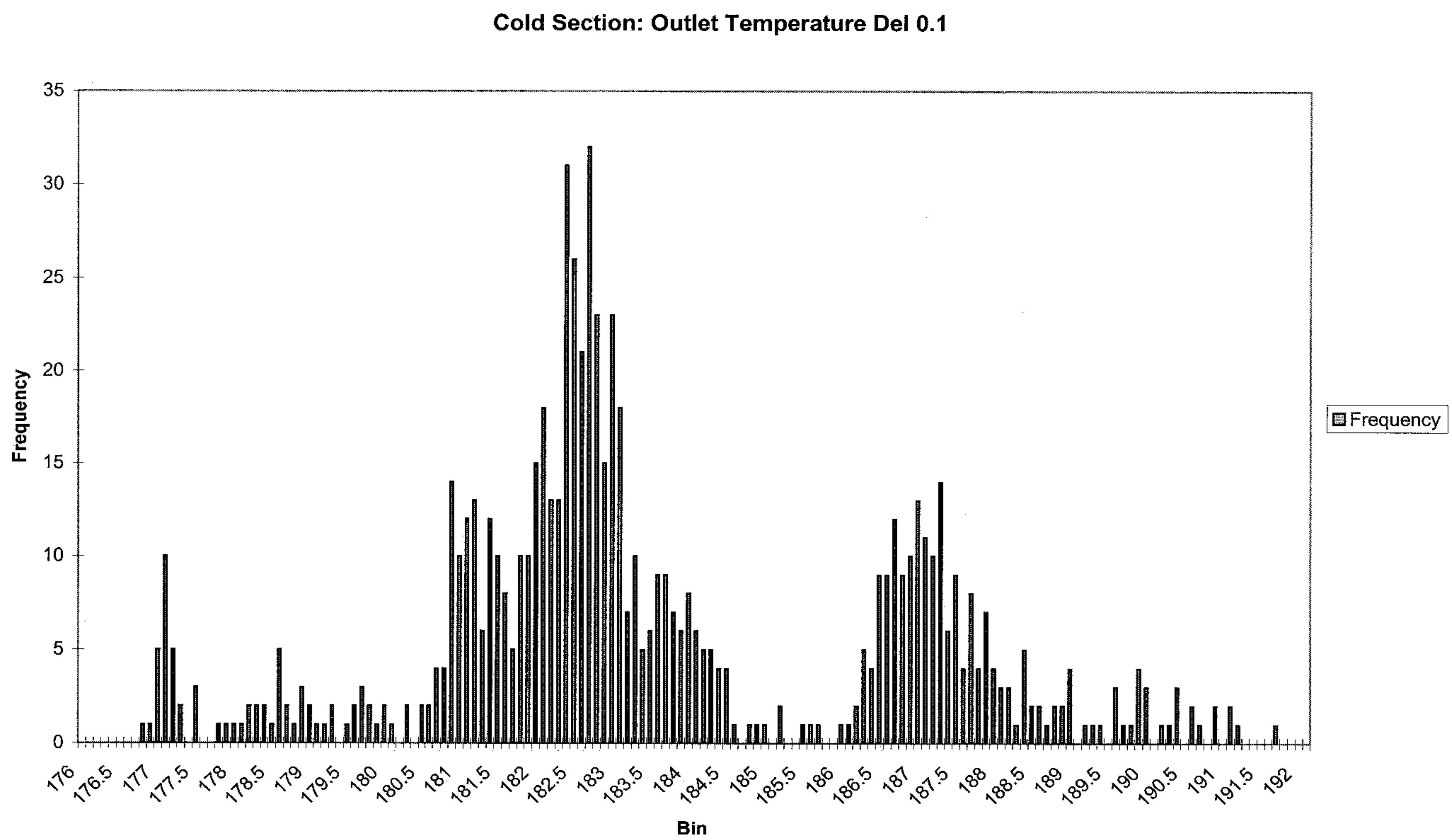
		Inlet Properties								Outlet Properties			
clasification	Rand.No	Shell Flow rate	Normalized	Tube Flow rate	Normalized	Shell Temperature	Normalized	Tube Temperature	Normalized	Shell Temperature	Normalized	Tube Temperature	Normalized
TE	88.68068	291.4249	0.8878	54.32862	0.2653	179.5519	0.3433	308.1656	0.4097	182.6247	0.3945	282.6917725	0.3589
TE	92.28492	291.3673	0.8874	64.81849	0.7591	180.7255	0.4294	310.5577	0.5220	184.0981	0.4932	287.9867249	0.6562
TE	95.51683	289.211	0.8723	56.92091	0.3873	179.0945	0.3097	307.1762	0.3633	182.2487	0.3694	282.4629211	0.3461
TE	88.56166	289.9996	0.8778	56.34116	0.3600	179.2799	0.3233	309.2953	0.4627	182.6086	0.3935	284.4428406	0.4572
TE	93.52702	286.3779	0.8525	55.33918	0.3129	180.0941	0.3831	307.9765	0.4008	183.5114	0.4539	283.0357361	0.3782
TE	86.42232	296.9891	0.9268	55.40791	0.3161	180.1212	0.3851	307.3138	0.3697	183.2743	0.4380	281.8987732	0.3144
TE	99.03867	289.254	0.8726	56.63256	0.3738	180.8863	0.4412	310.9560	0.5407	184.1077	0.4939	286.0369873	0.5467
TE	97.1923	289.5968	0.8750	57.09114	0.3953	180.5434	0.4161	310.7610	0.5315	183.9926	0.4861	285.620575	0.5234
TE	99.76806	290.9142	0.8842	56.42517	0.3640	180.2992	0.3981	309.9408	0.4930	183.8775	0.4784	284.394165	0.4545
TE	96.56667	292.4922	0.8953	69.93616	1.0000	185.0002	0.7432	313.0129	0.6372	189.2178	0.8361	291.3448181	0.8447
TE	87.73461	293.8195	0.9046	68.56979	0.9357	185.3014	0.7653	311.6166	0.5717	188.9666	0.8193	289.004425	0.7133
TE	89.77935	293.6162	0.9032	59.81921	0.5238	186.1196	0.8254	313.3664	0.6538	189.8697	0.8798	288.5340576	0.6869
TE	87.1395	287.0706	0.8573	60.79442	0.5697	186.9622	0.8872	311.7692	0.5788	189.6559	0.8654	286.5456238	0.5753
TE	98.25129	290.3119	0.8800	49.60875	0.0431	185.2809	0.7638	313.5023	0.6601	188.7811	0.8068	283.998291	0.4323
TE	98.76095	286.4286	0.8528	60.09717	0.5368	186.0993	0.8239	312.5238	0.6142	189.3174	0.8428	286.9387207	0.5974
TE	89.64507	166.1675	0.0106	60.21505	0.5424	185.0592	0.7475	315.4859	0.7532	188.8568	0.8119	289.6897278	0.7518
TE	92.32154	169.7122	0.0354	60.10506	0.5372	183.7670	0.6527	311.4575	0.5642	187.3997	0.7143	286.6018677	0.5784
TE	90.70101	170.4502	0.0406	59.1799	0.4937	186.4047	0.8463	316.2984	0.7914	191.0519	0.9589	291.5079041	0.8539
TE	93.85357	187.6969	0.1614	56.55913	0.3703	184.0870	0.6762	310.6594	0.5267	187.2091	0.7016	285.4521179	0.5139
TE	88.00317	186.7402	0.1547	54.78895	0.2870	184.4433	0.7023	312.9798	0.6356	187.6050	0.7281	286.6141663	0.5791
TE	93.38664	187.0413	0.1568	62.88777	0.6682	184.8831	0.7346	313.8394	0.6760	188.0099	0.7552	289.6903992	0.7518
TE	99.42625	289.5334	0.8746	60.37713	0.5500	183.3213	0.6200	308.3591	0.4188	186.6741	0.6657	285.0577087	0.4918
TE	89.31852	286.8033	0.8554	58.67096	0.4697	183.5490	0.6367	312.4999	0.6131	187.0292	0.6895	287.6122437	0.6352
TE	99.24924	287.0059	0.8569	58.14743	0.4451	183.5945	0.6400	312.2141	0.5997	186.9974	0.6874	287.3847351	0.6224
TE	89.57488	287.6158	0.8611	58.60833	0.4668	183.6856	0.6467	312.5540	0.6157	186.9339	0.6831	287.4549561	0.6263
TE	99.6704	286.8839	0.8560	58.41763	0.4578	183.4807	0.6317	313.3490	0.6530	186.8996	0.6808	287.6915894	0.6396
TE	86.51997	287.5462	0.8606	60.92683	0.5759	184.8729	0.7339	315.8607	0.7708	188.0330	0.7567	291.4238586	0.8492
TE	99.63073	285.304	0.8449	56.03533	0.3456	184.3926	0.6986	313.2234	0.6471	187.6037	0.7280	287.5601807	0.6322
TE	89.52605	284.2606	0.8376	53.61932	0.2319	184.6813	0.7198	314.2826	0.6968	187.8169	0.7423	288.133606	0.6644
TE	87.49657	291.6752	0.8896	57.44629	0.4121	184.6823	0.7199	314.7109	0.7169	187.8747	0.7461	289.6138611	0.7475
TE	97.99799	288.876	0.8700	60.28827	0.5458	184.0847	0.6760	314.3414	0.6995	187.4791	0.7196	289.9619446	0.7671
TE	93.96954	287.2938	0.8589	58.16475	0.4459	183.8202	0.6566	312.9225	0.6329	186.8148	0.6752	288.1533813	0.6656
TE	86.7214	287.2962	0.8589	58.81261	0.4764	184.2565	0.6886	314.2532	0.6954	187.8511	0.7446	289.836792	0.7601
TE	96.22181	287.632	0.8612	57.45372	0.4124	184.1024	0.6773	311.7250	0.5767	187.5675	0.7256	287.2745667	0.6162
TE	93.1547	287.4139	0.8597	58.30784	0.4526	184.0679	0.6748	311.7400	0.5775	187.2515	0.7044	287.4946289	0.6286
TE	93.41105	288.2036	0.8652	60.46064	0.5540	183.9988	0.6697	311.1419	0.5494	187.2232	0.7025	287.1040039	0.6066
TE	98.35505	289.3758	0.8735	61.20599	0.5890	183.6713	0.6457	311.3430	0.5588	186.8013	0.6743	288.0498047	0.6597
TE	95.7091	287.221	0.8584	60.28487	0.5457	183.5142	0.6341	312.0496	0.5920	186.6298	0.6628	288.1021118	0.6627

TE	91.8302	288.4893	0.8672	60.30066	0.5464	182.9740	0.5945	311.9289	0.5863	186.5703	0.6588	288.7772827	0.7006
TE	92.48634	287.4904	0.8603	59.21081	0.4951	183.1176	0.6050	311.8581	0.5830	186.2266	0.6358	288.1141663	0.6633
TE	96.42018	181.0681	0.1150	61.09126	0.5836	183.2792	0.6169	312.8750	0.6307	186.6210	0.6622	289.1523743	0.7216
TE	98.1048	166.504	0.0130	58.79138	0.4754	185.5317	0.7822	314.7594	0.7191	188.8336	0.8104	290.4915466	0.7968
TE	94.79659	174.5375	0.0692	58.51159	0.4622	183.7630	0.6524	311.6710	0.5742	186.7592	0.6714	288.1954956	0.6679
TE	89.00113	177.048	0.0868	61.22517	0.5899	183.3660	0.6233	310.4089	0.5150	186.7824	0.6730	287.6039734	0.6347
TE	89.96246	179.3905	0.1032	63.17	0.6815	183.9782	0.6682	310.5660	0.5224	187.0229	0.6891	288.8875122	0.7068
TE	94.81491	187.2736	0.1584	56.68216	0.3761	180.3572	0.4024	309.6792	0.4807	182.2995	0.3728	284.5986328	0.4660
TE	95.00107	184.8357	0.1413	54.84044	0.2894	180.8936	0.4418	310.4205	0.5155	182.4446	0.3825	285.6827698	0.5269
TE	99.79858	187.344	0.1589	52.10664	0.1607	180.6277	0.4222	309.1828	0.4574	182.2198	0.3674	283.4251709	0.4001
TE	93.43242	183.0745	0.1290	52.59015	0.1835	179.4073	0.3327	307.9626	0.4002	181.1206	0.2938	282.519989	0.3493
TE	94.72335	183.017	0.1286	57.79898	0.4287	177.3232	0.1797	303.4821	0.1899	178.8655	0.1428	280.684021	0.2462
TE	92.39784	185.9473	0.1491	56.94909	0.3887	176.9475	0.1521	303.2379	0.1785	178.5512	0.1217	279.9733887	0.2063
TE	95.97461	195.2422	0.2142	56.59682	0.3721	176.7008	0.1340	304.8606	0.2546	178.9732	0.1500	281.1150208	0.2704
TE	86.73055	188.9001	0.1698	63.07388	0.6770	179.4410	0.3351	304.8010	0.2518	181.9246	0.3476	283.5866089	0.4092
TE	99.92065	188.6193	0.1678	60.65482	0.5631	179.4954	0.3391	304.6523	0.2448	181.9783	0.3512	282.1576538	0.3289
TE	87.59423	177.6958	0.0913	59.54814	0.5110	179.6978	0.3540	303.2576	0.1794	182.0332	0.3549	280.1403809	0.2157
TE	92.87698	177.6224	0.0908	60.23865	0.5435	180.8612	0.4394	306.7099	0.3414	183.4320	0.4486	284.1199646	0.4391
TE	93.84136	179.0749	0.1010	58.76043	0.4739	180.9830	0.4483	307.2979	0.3690	183.7324	0.4687	284.3128967	0.4499
TE	99.0051	182.5723	0.1255	62.4313	0.6467	179.6770	0.3525	305.1143	0.2665	181.9627	0.3502	282.79245	0.3646
TE	99.04172	178.0925	0.0941	57.91703	0.4342	181.0077	0.4501	308.0993	0.4066	183.5323	0.4553	284.4847107	0.4596
TE	90.93295	179.5777	0.1045	61.39299	0.5978	181.7245	0.5028	311.6176	0.5717	184.2759	0.5051	288.292511	0.6734
TE	98.86776	177.5518	0.0903	59.52292	0.5098	181.2009	0.4643	310.5260	0.5205	183.7509	0.4700	286.4967346	0.5725
TE	99.0875	178.1335	0.0944	58.13754	0.4446	181.3156	0.4727	310.7690	0.5319	184.0069	0.4871	285.6878967	0.5271
TE	90.5179	180.238	0.1091	56.82442	0.3828	181.8491	0.5119	312.0070	0.5900	184.4111	0.5142	286.7586365	0.5872
TE	92.49855	178.5214	0.0971	52.4722	0.1779	181.6778	0.4993	310.1470	0.5027	184.1919	0.4995	283.8494873	0.4239
TE	91.26255	179.6991	0.1054	58.77521	0.4746	180.9920	0.4490	309.3559	0.4656	183.6427	0.4627	284.8620911	0.4808
TE	98.91659	179.2775	0.1024	56.51571	0.3683	180.6510	0.4240	307.7321	0.3894	183.2816	0.4385	282.9677124	0.3744
TE	97.69585	180.5187	0.1111	58.24614	0.4497	179.7092	0.3548	306.6035	0.3364	182.4337	0.3817	282.2169189	0.3323
TE	86.38264	180.2717	0.1094	54.76865	0.2860	179.8256	0.3634	306.4800	0.3306	182.4110	0.3802	281.3424072	0.2832
TE	96.56056	180.7767	0.1129	54.61628	0.2788	180.0607	0.3806	306.5677	0.3347	182.4401	0.3822	281.5220642	0.2933
TE	87.58812	179.4022	0.1033	55.65255	0.3276	180.1267	0.3855	306.6371	0.3380	182.6053	0.3932	282.1550598	0.3288
TE	98.58699	180.7296	0.1126	64.04382	0.7226	178.1346	0.2392	302.1229	0.1261	180.8516	0.2758	280.3232117	0.2260
TE	87.09983	181.414	0.1174	61.07767	0.5830	178.8836	0.2942	303.3879	0.1855	181.3085	0.3064	281.0824585	0.2686
TE	87.35923	194.6028	0.2097	61.89656	0.6215	180.3816	0.4042	306.2030	0.3176	182.5061	0.3866	283.3691406	0.3970
TE	98.73348	290.7588	0.8831	60.08977	0.5365	181.1539	0.4609	305.5191	0.2855	183.3707	0.4445	282.1765747	0.3300
TE	87.99707	290.8583	0.8838	60.27707	0.5453	181.2327	0.4667	305.4842	0.2839	183.3999	0.4465	281.9978638	0.3200
TE	87.37449	289.8906	0.8771	59.76396	0.5212	180.8115	0.4357	306.3803	0.3259	182.8303	0.4083	282.5718689	0.3522
TE	92.07739	283.5517	0.8327	64.03301	0.7221	182.2082	0.5383	306.7801	0.3447	184.2556	0.5038	284.596405	0.4659
TE	93.78643	290.7752	0.8833	67.14426	0.8686	180.5430	0.4160	305.7043	0.2942	182.6861	0.3986	283.7802734	0.4200
TE	96.28895	293.5592	0.9028	61.28234	0.5926	180.0128	0.3771	303.6548	0.1980	182.4196	0.3808	280.0960388	0.2132
TE	88.08557	290.2902	0.8799	60.62669	0.5618	180.3354	0.4008	303.6951	0.1999	182.6150	0.3939	280.696991	0.2469

TE	98.08954	292.1746	0.8931	62.71252	0.6600	180.1341	0.3860	303.1214	0.1730	182.4789	0.3848	280.3017273	0.2248
TE	97.74773	289.2878	0.8728	62.22539	0.6370	179.8463	0.3649	302.3663	0.1376	182.2066	0.3665	279.8068237	0.1970
TE	91.72338	292.1394	0.8928	62.4763	0.6488	179.8258	0.3634	302.4966	0.1437	182.4311	0.3816	279.5237427	0.1811
TE	94.1435	290.9997	0.8848	67.47445	0.8841	180.4518	0.4093	303.1012	0.1720	182.7234	0.4011	281.1178284	0.2706
TE	90.88717	289.348	0.8733	61.3574	0.5962	180.3293	0.4003	304.9049	0.2567	182.9235	0.4145	280.3164368	0.2256
TE	97.81487	290.2868	0.8798	61.43182	0.5997	180.3567	0.4024	305.6680	0.2925	182.9523	0.4165	281.1292419	0.2712
TE	94.61653	288.9115	0.8702	59.81766	0.5237	180.5224	0.4145	305.1303	0.2673	182.9280	0.4148	280.5166931	0.2368
TE	87.07846	286.9806	0.8567	60.93468	0.5763	180.2751	0.3964	304.8502	0.2541	182.7277	0.4014	280.239624	0.2213
TE	92.59621	288.2211	0.8654	61.75939	0.6151	180.6120	0.4211	306.7200	0.3419	183.3816	0.4452	282.6355591	0.3558
TE	93.53618	287.8382	0.8627	58.82276	0.4769	180.1025	0.3837	304.1003	0.2189	182.3783	0.3780	279.316925	0.1695
TE	99.28587	291.0604	0.8853	61.60502	0.6078	179.9158	0.3700	306.1727	0.3162	182.0681	0.3573	281.728241	0.3048
TE	92.80068	289.5932	0.8750	60.22714	0.5430	179.9108	0.3696	306.0796	0.3118	182.0154	0.3537	281.5811157	0.2966
TE	89.95025	290.6682	0.8825	59.0502	0.4876	179.9377	0.3716	305.9465	0.3056	182.2878	0.3720	281.3312378	0.2826
TE	90.95737	290.4634	0.8811	57.82335	0.4298	179.8165	0.3627	304.2720	0.2270	182.0772	0.3579	279.9243774	0.2036
TE	99.13938	289.1162	0.8716	60.30618	0.5467	179.7799	0.3600	305.3061	0.2755	181.9939	0.3523	281.6988525	0.3032
TE	98.00104	287.2685	0.8587	60.61902	0.5614	179.5665	0.3444	306.6461	0.3384	182.0009	0.3528	282.6329956	0.3556
TE	99.83825	292.5033	0.8954	62.72768	0.6607	178.9686	0.3005	307.4229	0.3749	181.7078	0.3331	284.0133667	0.4331
TE	92.62062	290.813	0.8835	60.11537	0.5377	178.7240	0.2825	308.6606	0.4329	181.0396	0.2884	283.9932861	0.4320
TE	90.71322	291.9976	0.8918	60.29713	0.5463	179.0915	0.3095	308.6049	0.4303	181.5365	0.3217	284.5533142	0.4634
TE	93.8139	289.6072	0.8751	57.82751	0.4300	178.6570	0.2776	307.9855	0.4013	181.1235	0.2940	283.3556519	0.3962
TE	94.05499	289.282	0.8728	57.5404	0.4165	178.5472	0.2695	308.4438	0.4228	181.0351	0.2881	283.4374695	0.4008
TE	96.13941	289.9055	0.8772	59.2335	0.4962	177.2972	0.1778	304.9128	0.2571	179.6146	0.1929	281.0512085	0.2668
TE	93.24625	288.6279	0.8682	64.09062	0.7248	178.8686	0.2931	306.5198	0.3325	181.1588	0.2964	284.0961609	0.4378
TE	92.60231	293.2487	0.9006	65.20367	0.7772	178.7796	0.2866	306.4538	0.3294	180.8508	0.2757	284.3575134	0.4525
TE	98.13837	295.9515	0.9195	61.25093	0.5912	178.5567	0.2702	304.9655	0.2595	181.1921	0.2986	281.7120361	0.3039
TE	87.2219	287.9322	0.8633	59.01365	0.4858	178.5708	0.2713	305.5558	0.2872	180.9940	0.2853	281.5289307	0.2937
TE	94.34187	293.9926	0.9058	58.20737	0.4479	177.9972	0.2291	306.1216	0.3138	180.4348	0.2479	282.1641541	0.3293
TE	91.18625	288.4342	0.8669	54.30061	0.2640	175.2572	0.0280	305.6297	0.2907	177.1940	0.0308	279.4415588	0.1765
TE	98.04987	289.7068	0.8758	54.94756	0.2944	176.5173	0.1205	309.2975	0.4628	178.5190	0.1196	283.0288086	0.3779

Cold Section: Inlet Temperature at Del 0.1




Cold Section: Outlet Temperature Del 0.1
Frequency
0
5
10
15
20
25
30
35
176
176.5
177
177.5
178
178.5
179
179.5
180
180.5
181
181.5
182
182.5
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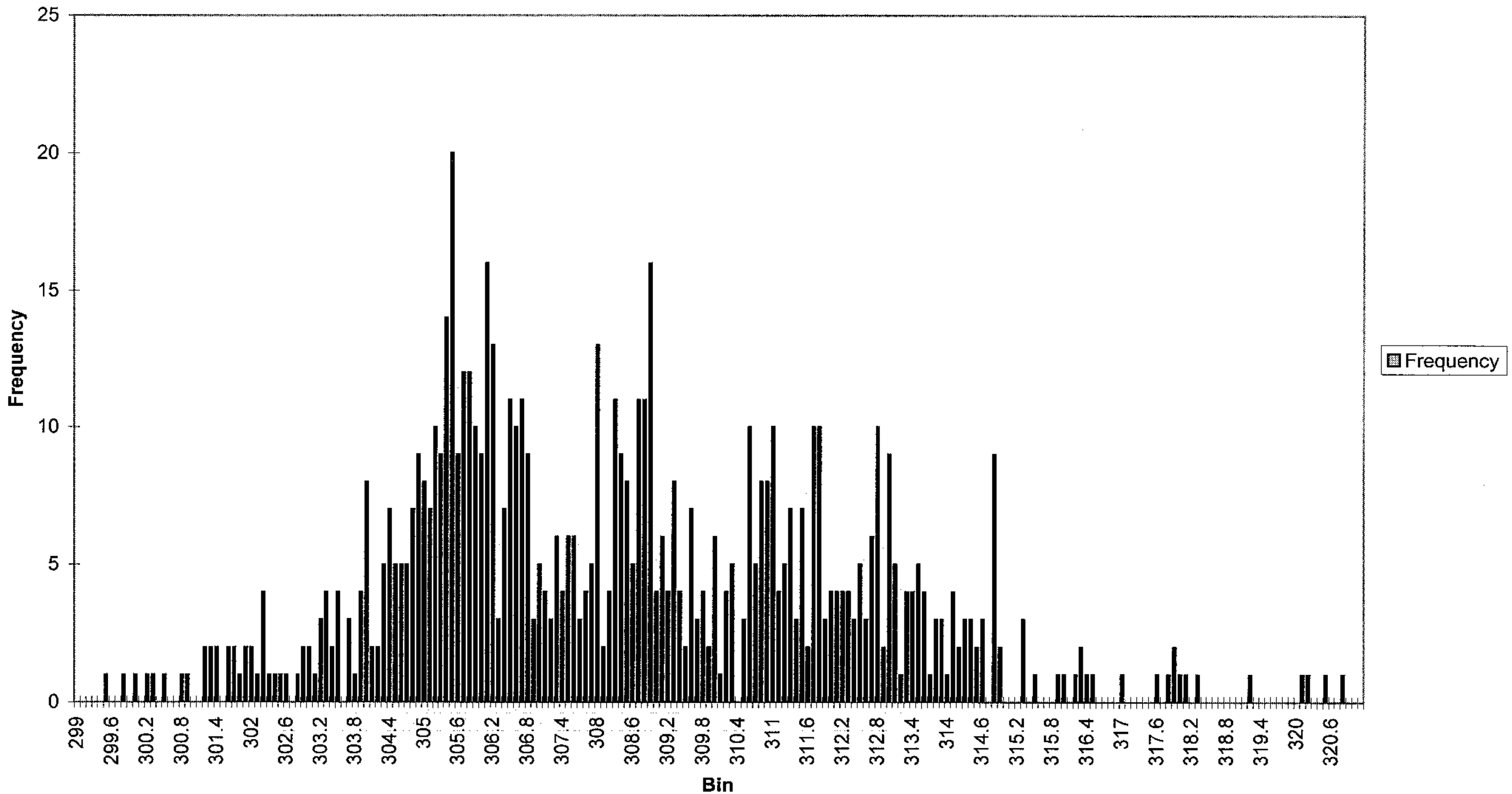
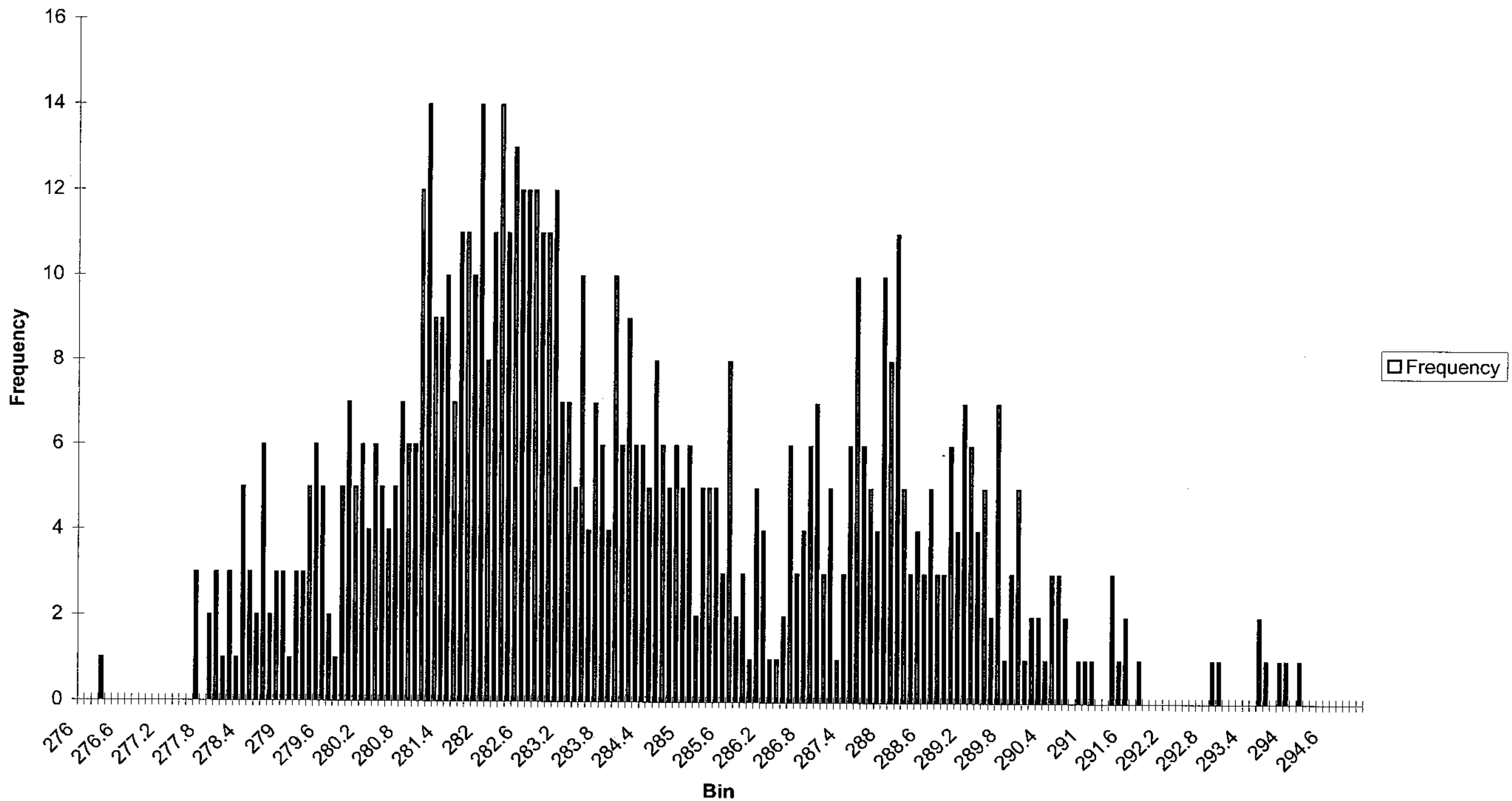
183.5
184
184.5
185
185.5
186
186.5
187
187.5
188
188.5
189
189.5
190
190.5
191
191.5
192
Bin
Frequency

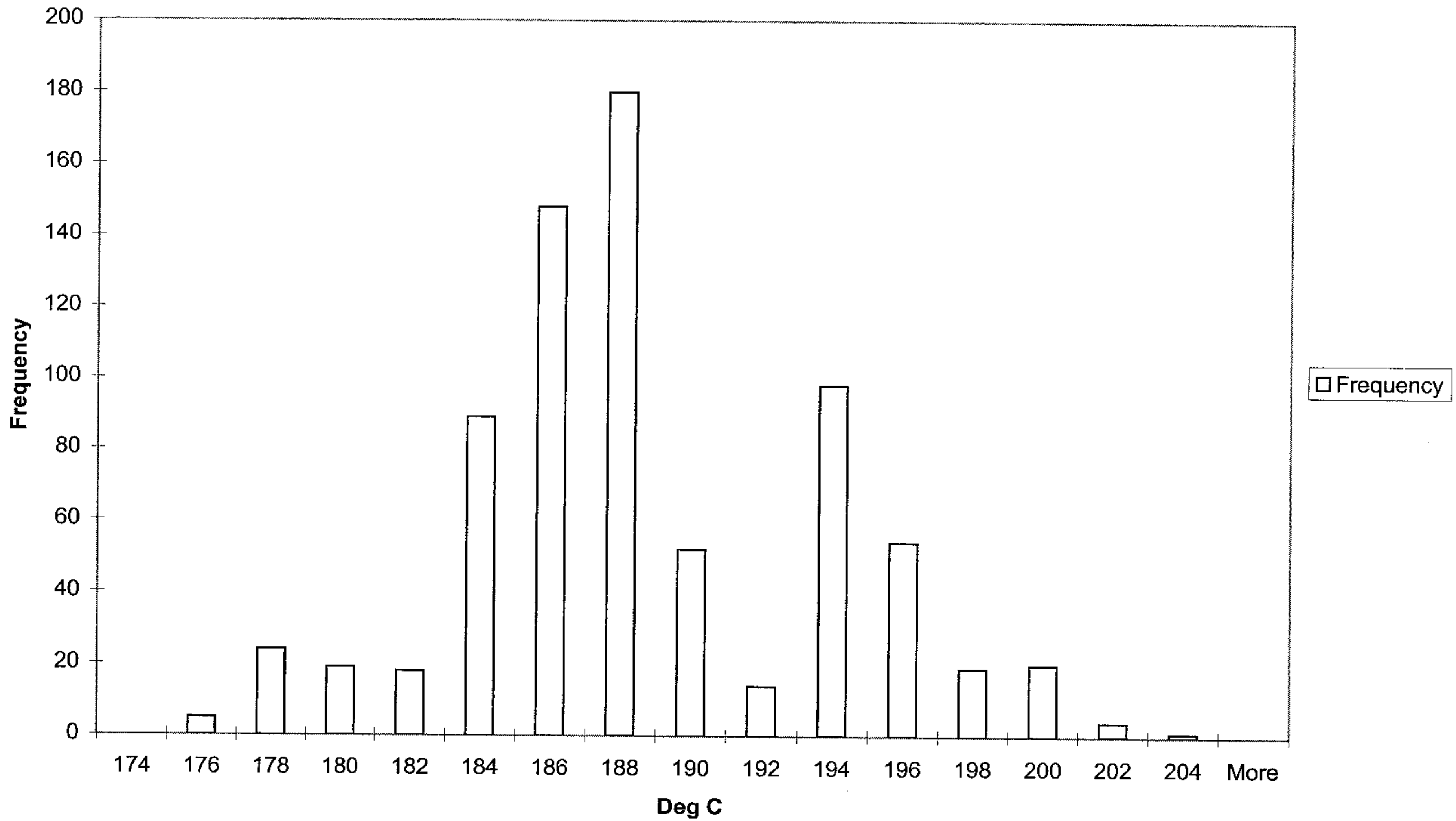
Hot Section: Inlet Temperature Del 0.1



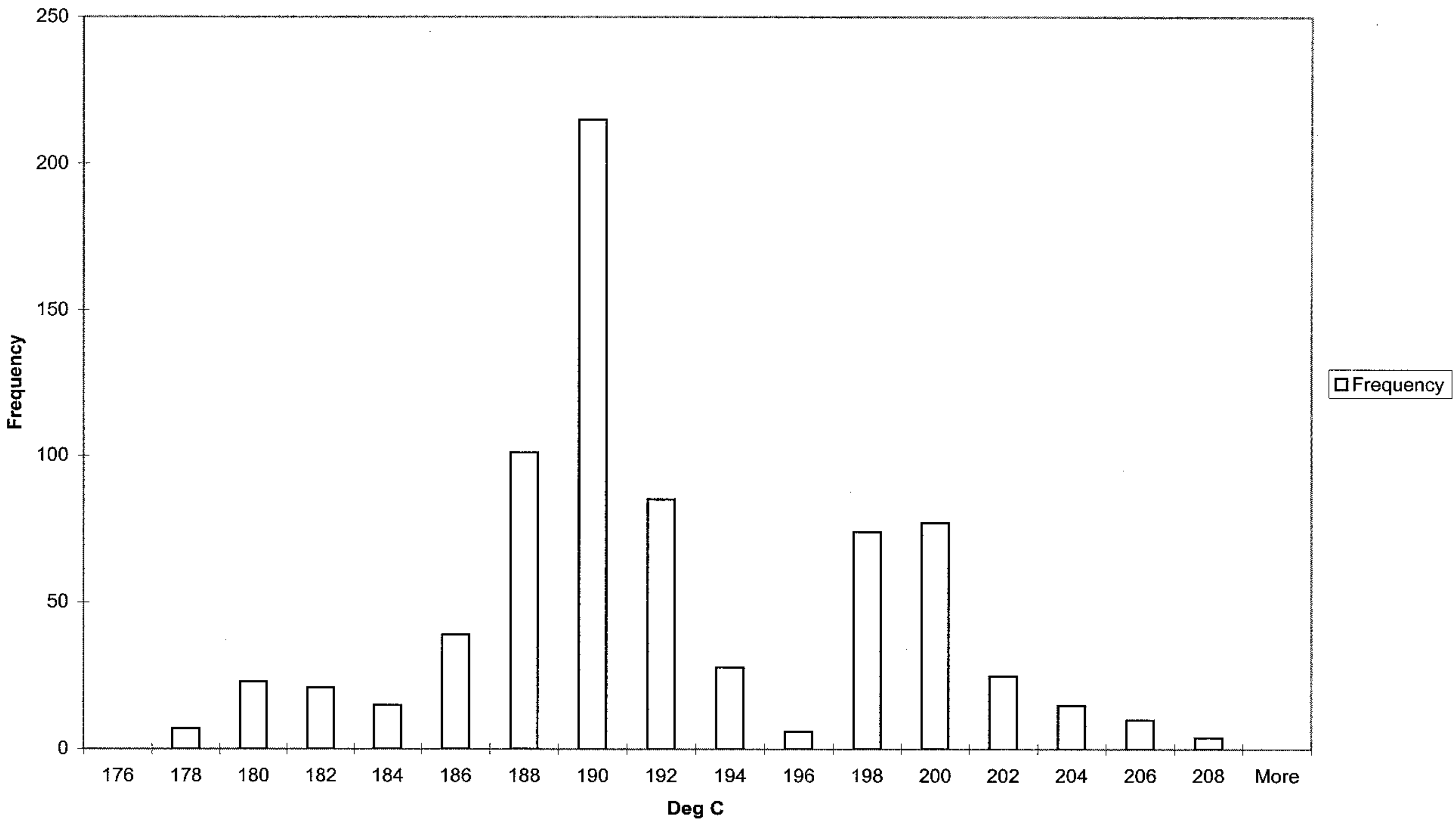
Hot Section: Outlet Temperature Del 0.1

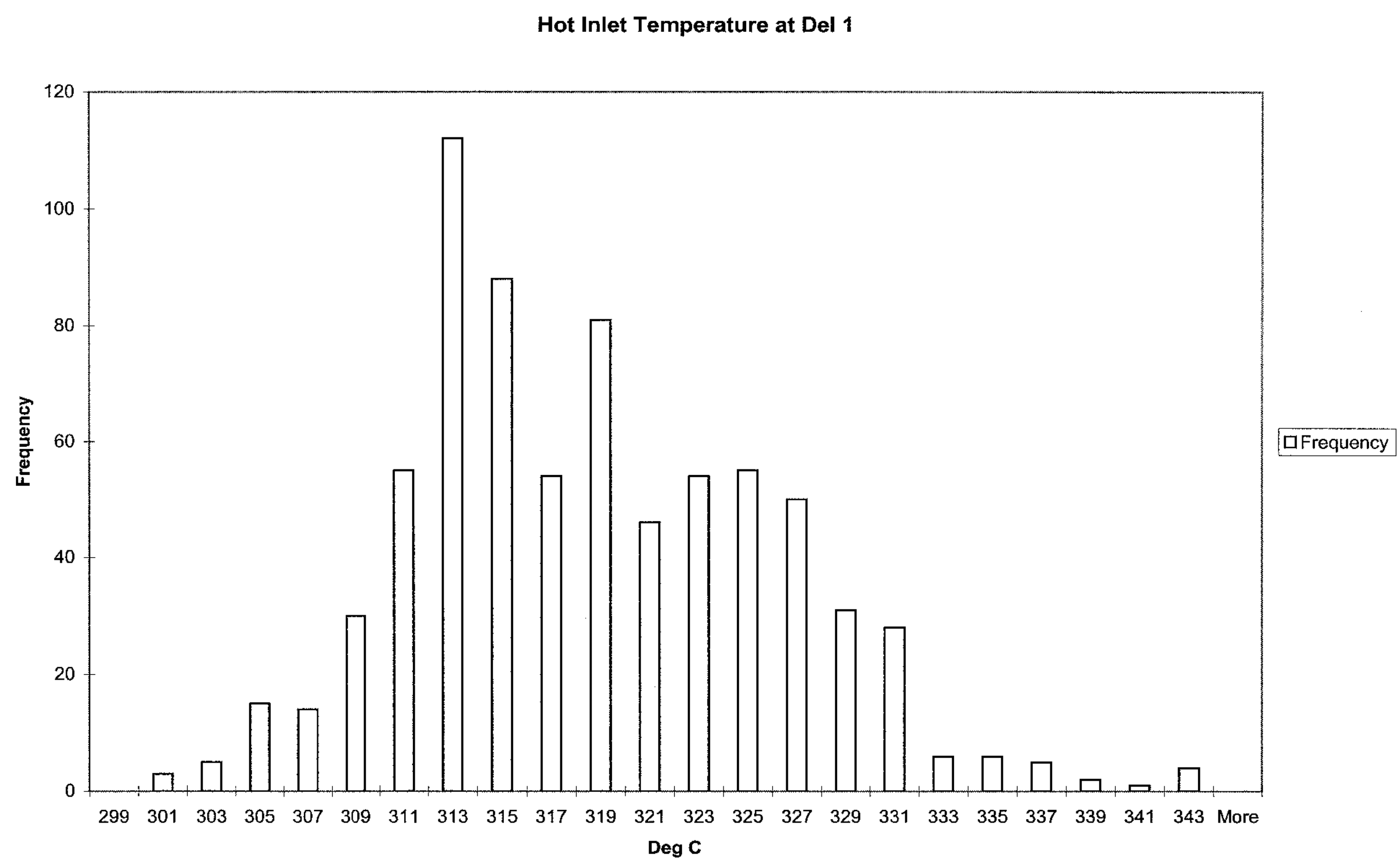


Cold Inlet Temperature Del 1

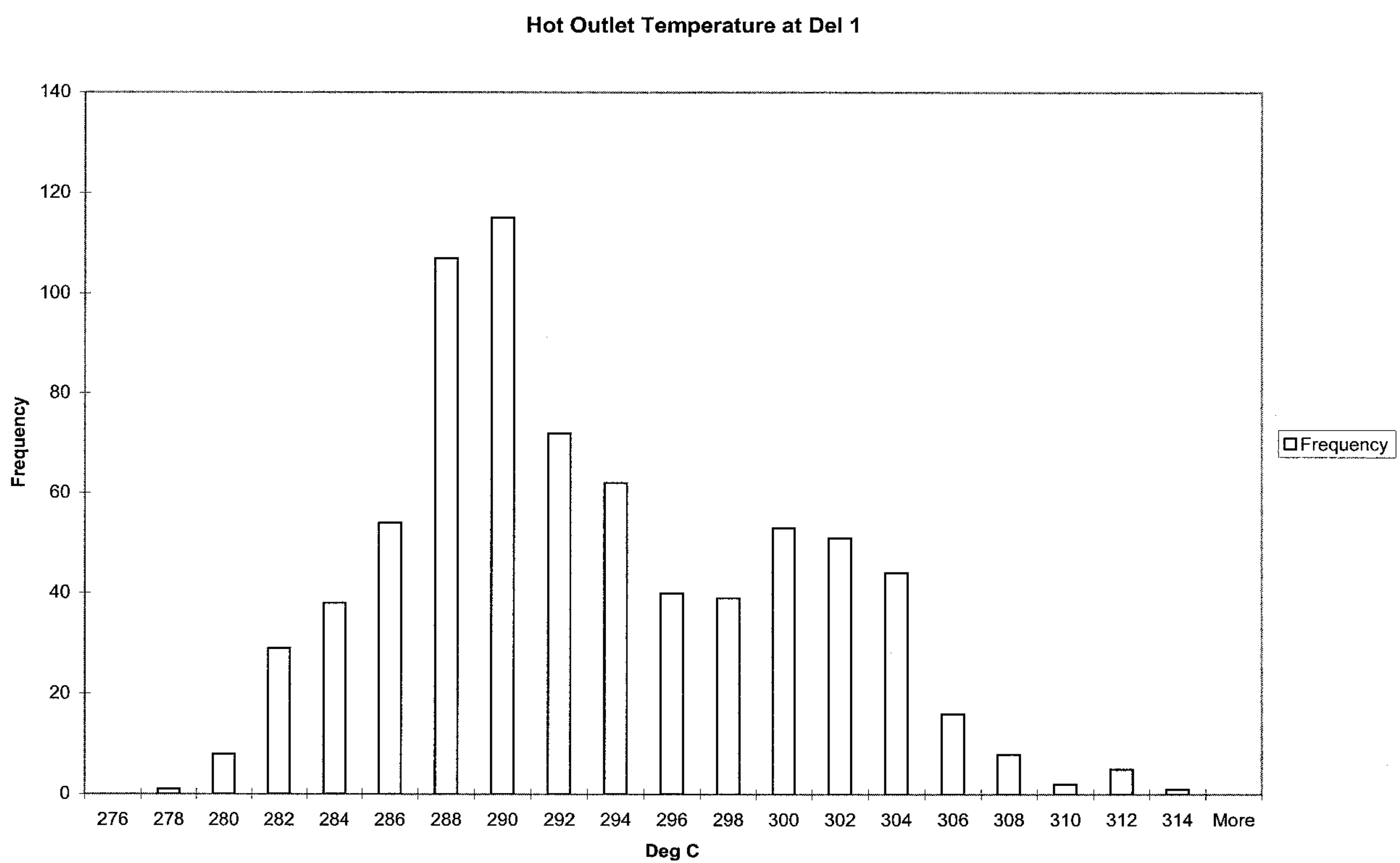


Cold Outlet Temperature Del 1

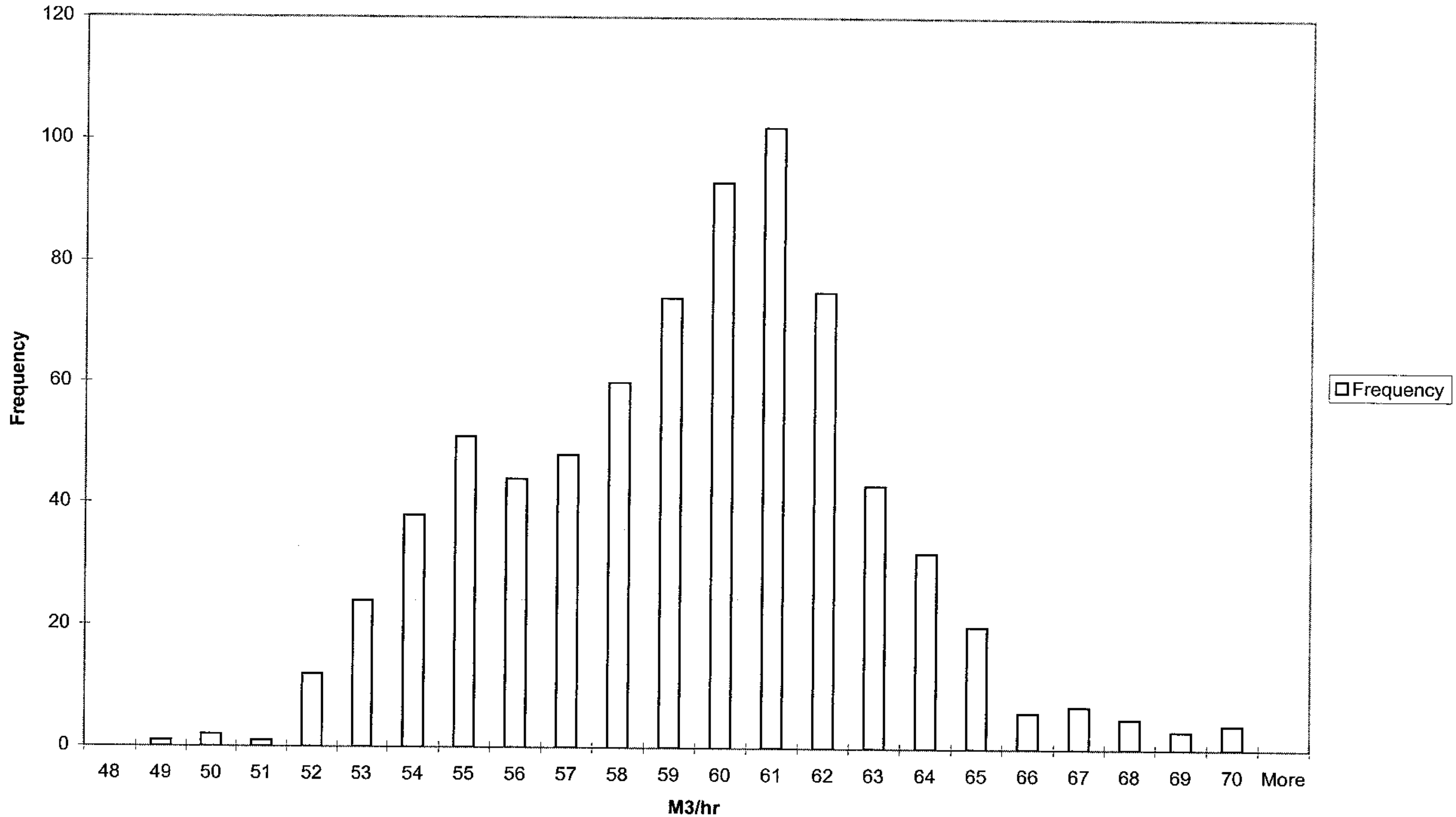




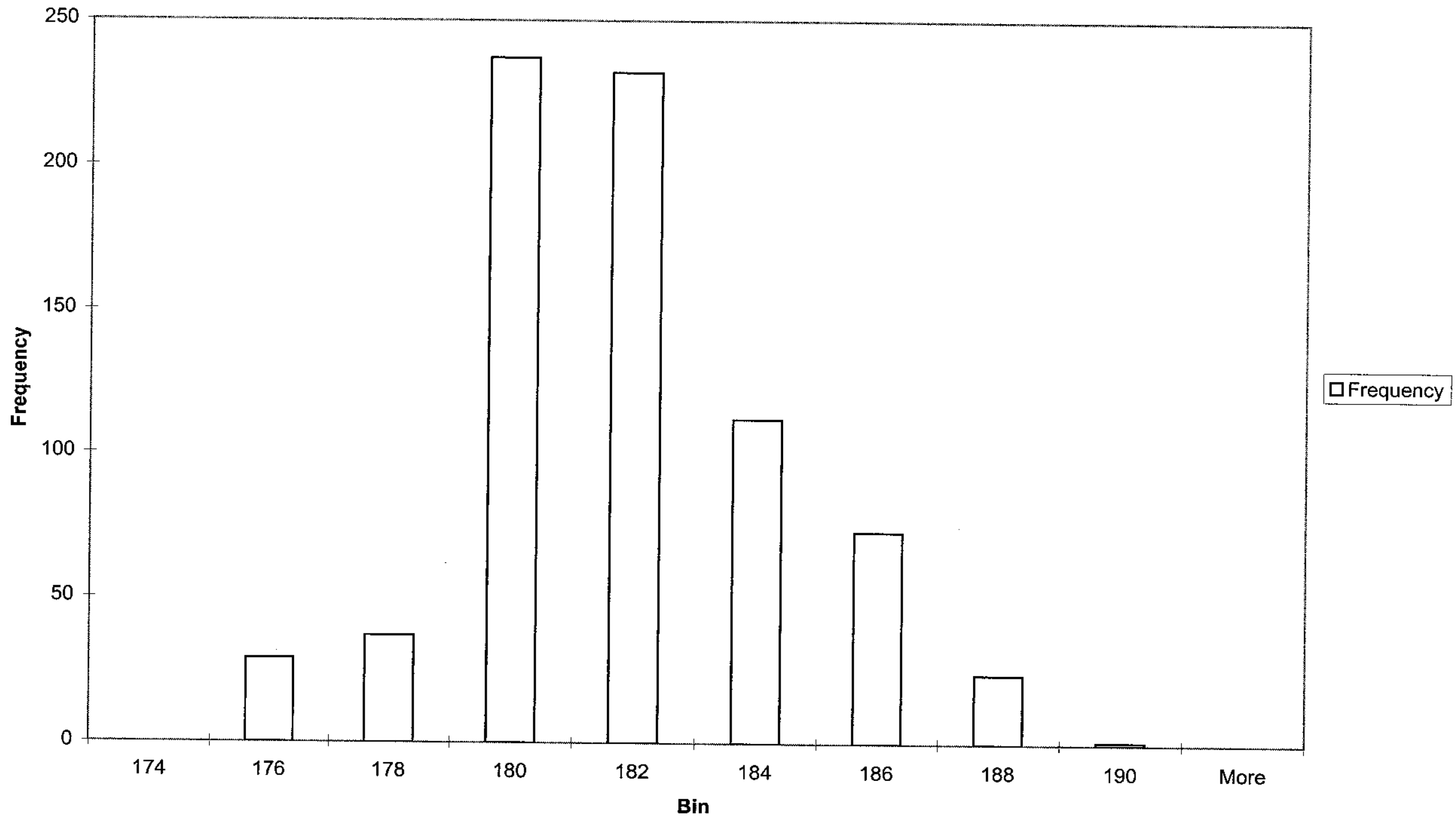
Hot Inlet Temperature at Del 1
Frequency
120
100
80
60
40
20
0
299
301
303
305
307
309
311
313
315
317
319
321
323
325
327
329
331
333
335
337
339
341
343
More
Deg C
Frequency


Hot Outlet Temperature at Del 1
Frequency
140
120
100
80
60
40
20
0
276
278
280
282
284
286
288
290
292
294
296
298
300
302
304
306
308
310
312
314
More
Deg C
Frequency

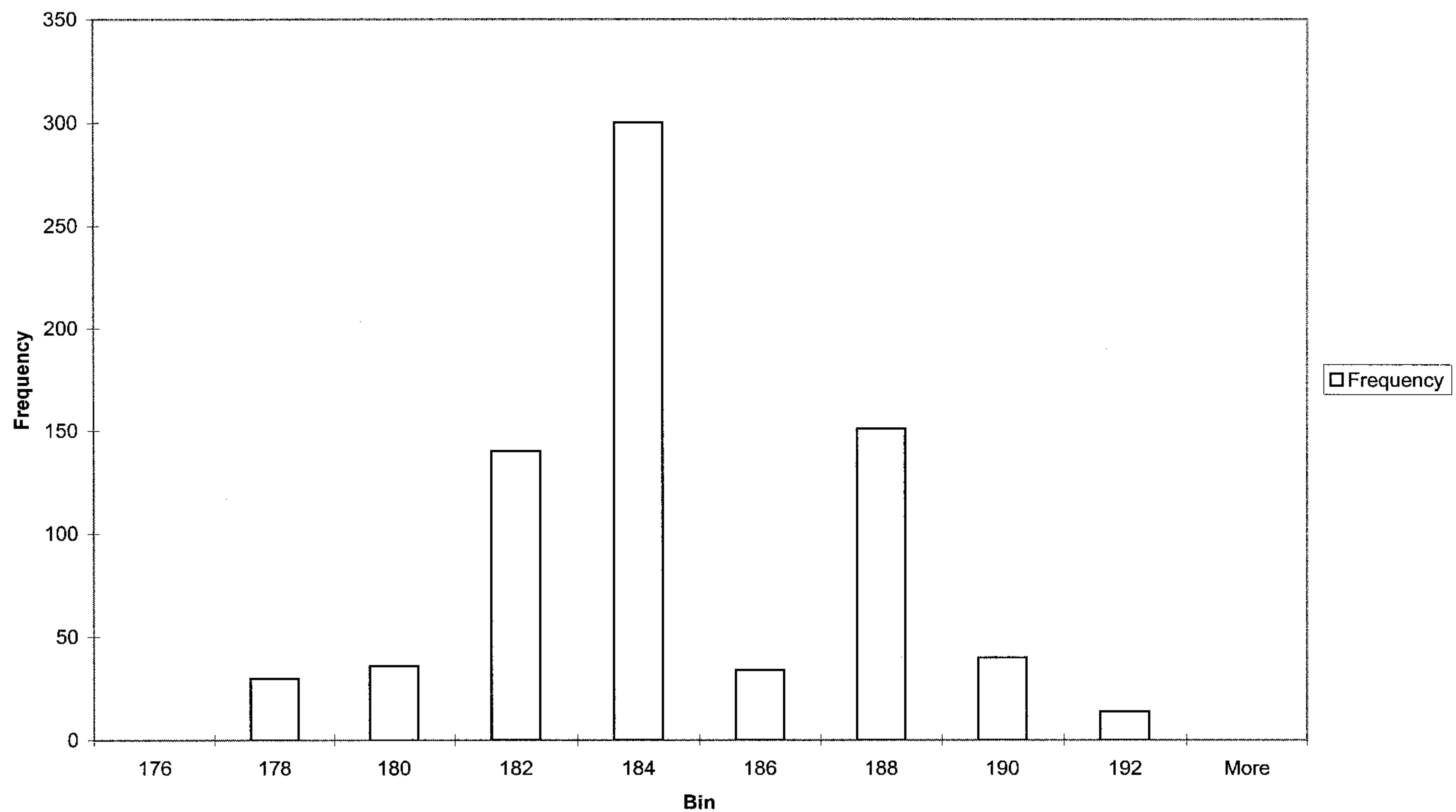
Tube Flow Rate at Del 1



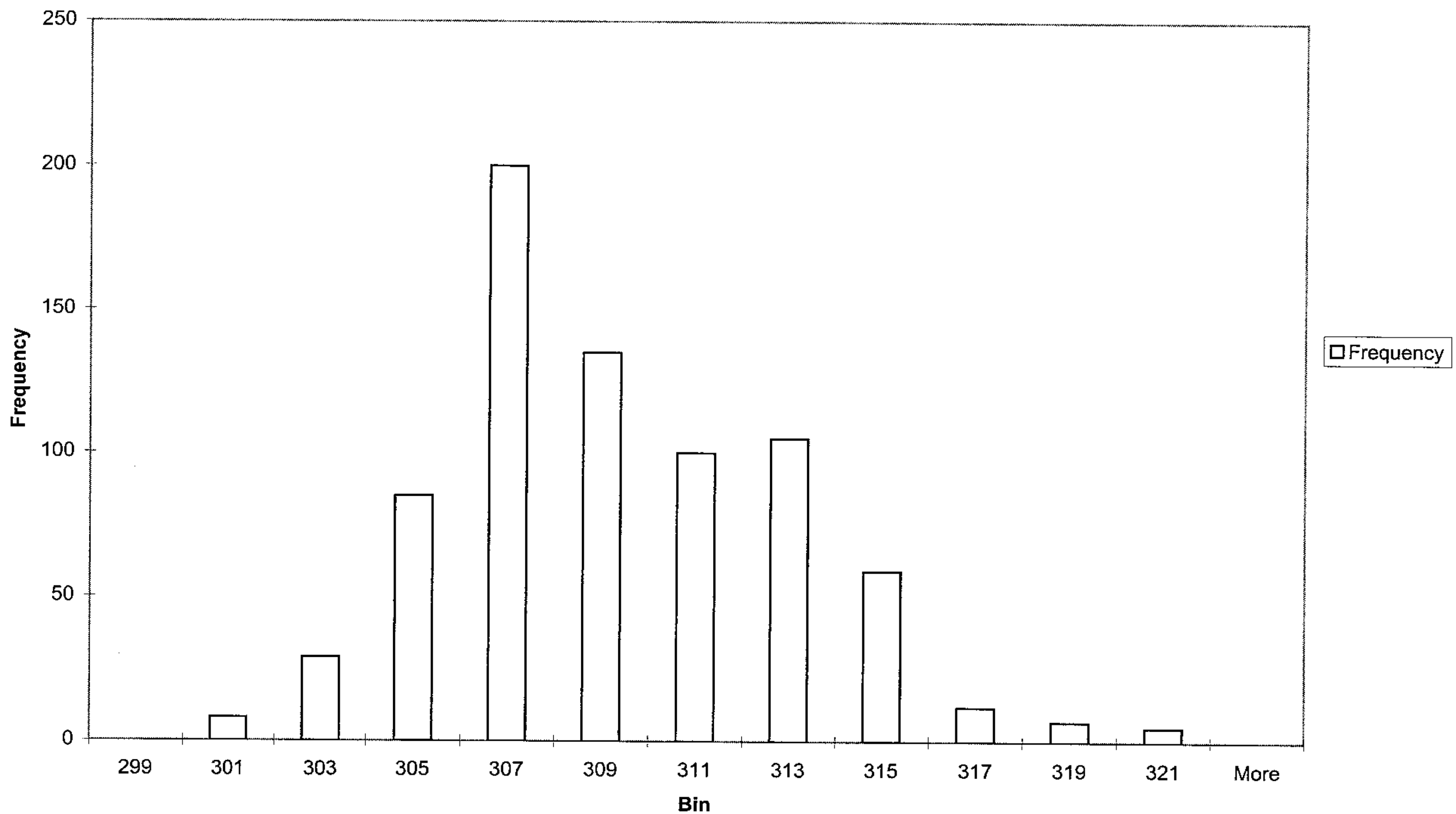
Cold Inlet Temperature at Del 2

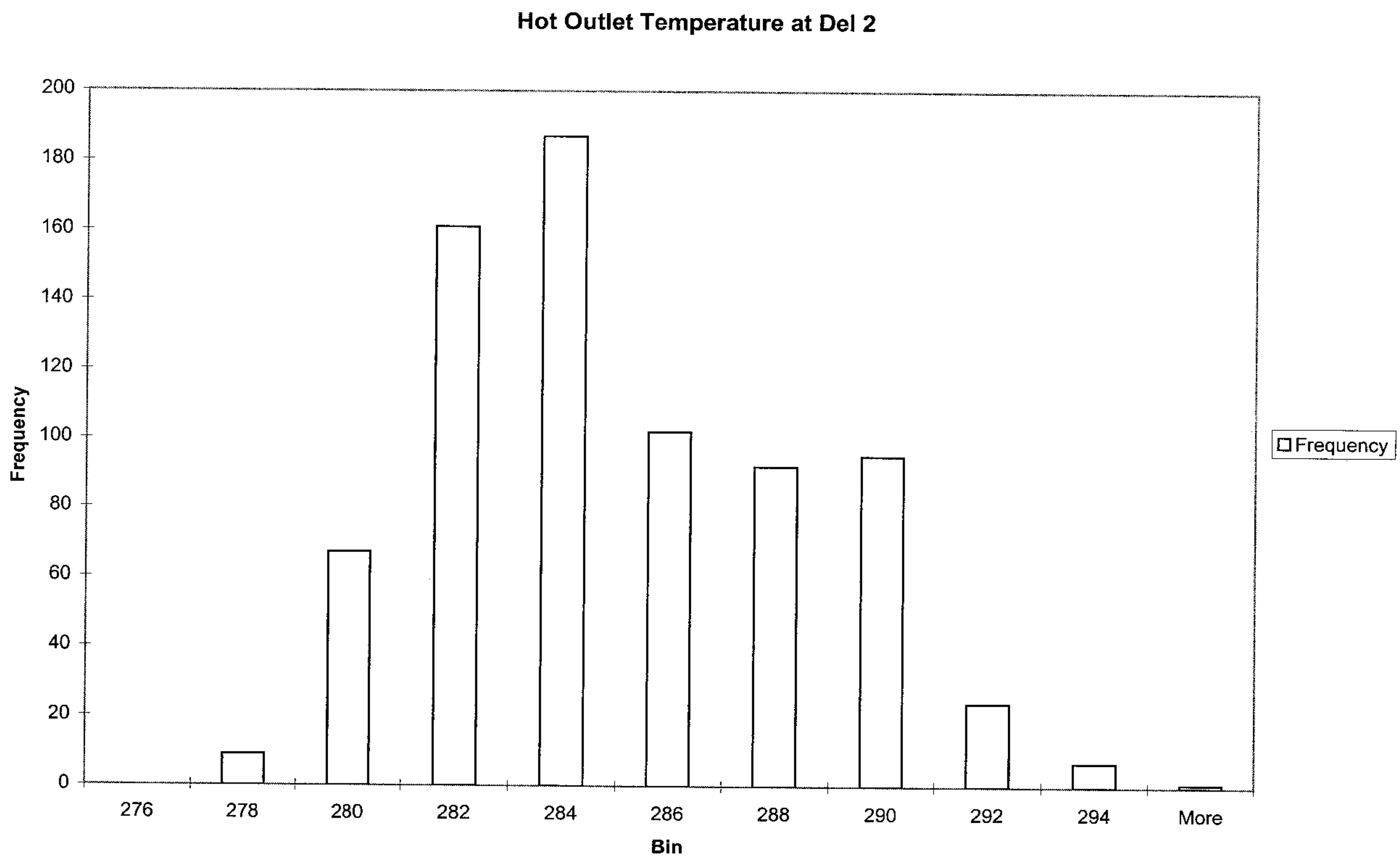


Cold Outlet Temperature at Del 2



Hot Inlet Temperature at Del 2




Hot Outlet Temperature at Del 2
Frequency
200
180
160
140
120
100
80
60
40
20
0
276
278
280
282
284
286
288
290
292
294
More
Bin
Frequency

Temperature	Normalized	value by NN	by NN	% Error	Temperature	Normalized	NN	by NN	% Error
183.4518	0.4499	0.4319	183.1825	0.1468	284.845642	0.4799	0.42471	283.863389	0.3448
183.3717	0.4446	0.4316	183.1787	0.1052	284.17868	0.4424	0.40271	283.471512	0.2488
183.1318	0.4285	0.4320	183.1834	0.0281	282.659302	0.3571	0.34712	282.48131	0.0630
183.0900	0.4257	0.4264	183.1002	0.0056	282.638123	0.3559	0.33558	282.275752	0.1282
183.0062	0.4201	0.4060	182.7956	0.1151	282.612457	0.3545	0.33366	282.241552	0.1312
183.0429	0.4225	0.3821	182.4389	0.3300	281.238159	0.2773	0.27517	281.199693	0.0137
182.0023	0.3529	0.3006	181.2220	0.4288	281.949371	0.3173	0.30479	281.727302	0.0788
182.1832	0.3650	0.3012	181.2311	0.5226	283.184204	0.3866	0.36394	282.780918	0.1424
182.3315	0.3749	0.3154	181.4423	0.4876	283.023254	0.3775	0.32924	282.16282	0.3040
182.4275	0.3813	0.3319	181.6893	0.4046	283.03595	0.3783	0.33525	282.269874	0.2707
182.6677	0.3974	0.3432	181.8582	0.4432	283.103516	0.3821	0.35305	282.586938	0.1825
182.4891	0.3855	0.3419	181.8388	0.3564	281.965424	0.3182	0.29637	281.57732	0.1376
182.6696	0.3975	0.3539	182.0172	0.3572	281.976227	0.3188	0.31802	281.962963	0.0047
182.7398	0.4022	0.3640	182.1689	0.3124	282.529297	0.3498	0.34136	282.378709	0.0533
182.3480	0.3760	0.3182	181.4854	0.4731	281.606384	0.2980	0.28058	281.296059	0.1102
182.7884	0.4055	0.3545	182.0275	0.4163	282.854095	0.3680	0.34507	282.444794	0.1447
183.6951	0.4662	0.4178	182.9727	0.3933	285.791168	0.5329	0.4916	285.054874	0.2576
183.1328	0.4286	0.3744	182.3247	0.4413	284.069519	0.4363	0.39221	283.28448	0.2764
183.0157	0.4207	0.3824	182.4441	0.3123	283.255737	0.3906	0.36085	282.725877	0.1871
183.1175	0.4275	0.3686	182.2367	0.4810	283.89212	0.4263	0.40916	283.586403	0.1077
182.7987	0.4062	0.3700	182.2584	0.2956	283.659912	0.4133	0.37205	282.925378	0.2589
182.6555	0.3966	0.3393	181.8003	0.4682	281.976532	0.3188	0.27992	281.284303	0.2455
182.8296	0.4083	0.3339	181.7193	0.6073	282.211853	0.3320	0.31729	281.94996	0.0928
182.4458	0.3826	0.3022	181.2464	0.6574	281.423462	0.2877	0.26598	281.035995	0.1377
182.1370	0.3619	0.2920	181.0938	0.5727	281.388794	0.2858	0.28698	281.41006	0.0076
182.7760	0.4047	0.3578	182.0763	0.3828	283.982666	0.4314	0.40517	283.515331	0.1646
187.8352	0.7435	0.6355	186.2230	0.8583	285.085114	0.4933	0.4759	284.775216	0.1087
184.2415	0.5028	0.4782	183.8732	0.1999	286.345581	0.5641	0.55664	286.213406	0.0462
183.6046	0.4602	0.4137	182.9107	0.3779	284.64389	0.4685	0.45383	284.382092	0.0920
183.8217	0.4747	0.4302	183.1578	0.3611	284.51767	0.4614	0.44671	284.255267	0.0922
184.4268	0.5152	0.4757	183.8359	0.3204	286.949829	0.5980	0.56813	286.418072	0.1853
184.3423	0.5096	0.4740	183.8106	0.2884	286.877991	0.5939	0.57757	286.586223	0.1017
184.1467	0.4965	0.4777	183.8663	0.1523	287.327484	0.6192	0.59485	286.894025	0.1509
184.1791	0.4986	0.4602	183.6052	0.3116	286.841797	0.5919	0.58167	286.659255	0.0636
184.0983	0.4932	0.4561	183.5441	0.3011	286.094086	0.5499	0.5246	285.64269	0.1578
183.6423	0.4627	0.4099	182.8544	0.4290	284.858307	0.4806	0.43832	284.105819	0.2642
183.9739	0.4849	0.4488	183.4342	0.2933	284.881317	0.4819	0.46615	284.601543	0.0982

190.5654	0.9263	0.8558	189.9116	0.5529	293.877899	0.9869	0.88501	292.062529	0.6177
188.4135	0.7822	0.7765	188.3274	0.0457	289.408142	0.7360	0.75575	289.760072	0.1216
190.3746	0.9136	0.8702	189.7263	0.3405	288.244385	0.6707	0.64865	287.852343	0.1360
190.2769	0.9070	0.8724	189.7599	0.2717	288.620056	0.6917	0.68868	288.565381	0.0189
189.8674	0.8796	0.8550	189.5007	0.1931	288.069427	0.6608	0.67286	288.283586	0.0743
189.8927	0.8813	0.8568	189.5273	0.1924	287.701355	0.6402	0.63892	287.679026	0.0078
191.0605	0.9595	0.9111	190.3372	0.3786	293.656403	0.9745	0.92149	292.712333	0.3215
188.9435	0.8177	0.8124	188.8645	0.0418	290.417267	0.7926	0.85435	291.516395	0.3785
187.1956	0.7007	0.7062	187.2783	0.0442	289.075378	0.7173	0.77181	290.046143	0.3358
189.1691	0.8328	0.8150	188.9030	0.1407	286.985596	0.6000	0.66058	288.064847	0.3761
187.9608	0.7519	0.7427	187.8227	0.0735	289.284058	0.7290	0.78552	290.290354	0.3479
187.1978	0.7008	0.6611	186.6045	0.3169	283.114197	0.3827	0.47238	284.712516	0.5645
187.1157	0.6953	0.6950	187.1106	0.0027	285.375641	0.5096	0.5718	286.483445	0.3882
186.5470	0.6572	0.6346	186.2097	0.1808	284.975891	0.4872	0.53201	285.774681	0.2803
186.8968	0.6806	0.6744	186.8035	0.0499	285.639221	0.5244	0.61201	287.199689	0.5463
187.6494	0.7310	0.7348	187.7048	0.0295	287.942749	0.6537	0.70565	288.867661	0.3212
187.8859	0.7469	0.7501	187.9332	0.0252	289.159027	0.7220	0.78948	290.360891	0.4156
190.6583	0.9326	0.8976	190.1365	0.2737	294.11084	1.0000	0.93021	292.867659	0.4227
189.7141	0.8693	0.8520	189.4550	0.1365	290.135773	0.7768	0.82522	290.997514	0.2970
189.5880	0.8609	0.8461	189.3671	0.1165	290.161224	0.7783	0.83396	291.153196	0.3419
188.0352	0.7569	0.7795	188.3721	0.1792	288.194489	0.6679	0.73849	289.452627	0.4366
187.5781	0.7263	0.7597	188.0772	0.2661	287.960754	0.6547	0.69718	288.716788	0.2625
187.3521	0.7111	0.7287	187.6144	0.1400	285.780334	0.5323	0.59144	286.833284	0.3684
186.6928	0.6670	0.6820	186.9171	0.1202	284.899597	0.4829	0.51309	285.437667	0.1889
188.1336	0.7635	0.7769	188.3334	0.1062	289.387695	0.7348	0.77109	290.033318	0.2231
187.6614	0.7319	0.7738	188.2878	0.3338	288.795044	0.7016	0.71962	289.116503	0.1113
186.9486	0.6841	0.7100	187.3345	0.2064	287.581635	0.6335	0.62979	287.516397	0.0227
187.2342	0.7032	0.7505	187.9404	0.3772	285.298706	0.5053	0.5005	285.213406	0.0299
187.6584	0.7317	0.7668	188.1833	0.2797	286.78714	0.5888	0.6016	287.01426	0.0792
186.4480	0.6506	0.6781	186.8593	0.2206	285.692841	0.5274	0.57366	286.516576	0.2883
187.1864	0.7000	0.7262	187.5776	0.2090	285.912567	0.5398	0.55357	286.158721	0.0861
187.0610	0.6916	0.7001	187.1878	0.0678	288.419617	0.6805	0.70274	288.815827	0.1374
186.9021	0.6810	0.7095	187.3269	0.2273	287.566193	0.6326	0.65912	288.038841	0.1644
187.2893	0.7069	0.7125	187.3730	0.0447	288.203491	0.6684	0.66918	288.218036	0.0050
186.9252	0.6825	0.7068	187.2874	0.1938	288.464417	0.6830	0.72691	289.246357	0.2711
187.3555	0.7114	0.7455	187.8650	0.2719	289.326935	0.7314	0.74751	289.613297	0.0990
188.2711	0.7727	0.7885	188.5070	0.1253	291.594391	0.8587	0.85216	291.477385	0.0401
188.3027	0.7748	0.7807	188.3901	0.0464	291.343292	0.8446	0.81148	290.752769	0.2027
187.5632	0.7253	0.7489	187.9163	0.1883	287.474792	0.6275	0.65065	287.887968	0.1437

186.7884	0.6754	0.7108	187.4387	0.3471	288.567261	0.6888	0.6545	287.956547	0.2116
186.8855	0.6799	0.7141	187.3963	0.2733	287.973022	0.6554	0.66232	288.095841	0.0426
186.9921	0.6870	0.7265	187.5817	0.3154	288.14389	0.6650	0.68139	288.435528	0.1012
187.4609	0.7184	0.7449	187.8565	0.2110	289.127472	0.7202	0.6912	288.610269	0.1789
186.4317	0.6495	0.6611	186.6045	0.0927	286.856445	0.5927	0.58967	286.801756	0.0191
186.8377	0.6767	0.6455	186.3714	0.2496	285.425323	0.5124	0.51326	285.440695	0.0054
187.4650	0.7187	0.7128	187.3769	0.0470	286.597656	0.5782	0.53238	285.781272	0.2849
187.2374	0.7035	0.7318	187.6612	0.2264	287.410919	0.6239	0.60223	287.025482	0.1341
187.2091	0.7016	0.7269	187.5876	0.2022	287.045166	0.6033	0.56125	286.295522	0.2612
187.1768	0.6994	0.7238	187.5413	0.1947	287.083588	0.6055	0.5636	286.337381	0.2599
187.0648	0.6919	0.7132	187.3825	0.1698	287.122009	0.6076	0.57373	286.517823	0.2104
186.9529	0.6844	0.7002	187.1881	0.1258	287.160431	0.6098	0.58676	286.749921	0.1430
186.7496	0.6708	0.6967	187.1369	0.2074	288.037262	0.6590	0.64716	287.825802	0.0734
186.6462	0.6639	0.6724	186.7733	0.0681	287.817993	0.6467	0.63333	287.579454	0.0829
187.0924	0.6937	0.7423	187.8174	0.3875	289.796143	0.7578	0.7359	289.406492	0.1345
187.0752	0.6926	0.7063	187.2797	0.1093	290.833557	0.8160	0.79694	290.493773	0.1168
187.4306	0.7164	0.7245	187.5522	0.0649	290.405731	0.7920	0.75645	289.772541	0.2180
187.1837	0.6999	0.7283	187.6082	0.2268	290.333405	0.7879	0.7158	289.048459	0.4426
187.0815	0.6930	0.7080	187.3051	0.1195	289.585663	0.7460	0.69744	288.72142	0.2984
186.9695	0.6855	0.7037	187.2416	0.1455	289.257202	0.7275	0.68307	288.465453	0.2737
186.8437	0.6771	0.7004	187.1910	0.1859	289.433594	0.7374	0.6977	288.726051	0.2445
186.5542	0.6577	0.6748	186.8096	0.1369	288.675171	0.6948	0.68396	288.481306	0.0672
186.3367	0.6431	0.6687	186.7182	0.2048	288.04538	0.6595	0.64461	287.78038	0.0920
186.4708	0.6521	0.6473	186.3986	0.0387	288.008514	0.6574	0.62773	287.479703	0.1836
186.1167	0.6284	0.6669	186.6920	0.3091	287.50824	0.6293	0.60706	287.111517	0.1380
186.3127	0.6415	0.6563	186.5326	0.1180	287.91217	0.6520	0.62684	287.46385	0.1557
186.3558	0.6444	0.6562	186.5316	0.0944	287.994354	0.6566	0.64143	287.723736	0.0940
186.5557	0.6578	0.6781	186.8580	0.1620	288.654633	0.6937	0.66798	288.196661	0.1587
186.5307	0.6561	0.6386	186.2684	0.1407	289.138763	0.7209	0.71497	289.033675	0.0363
187.2035	0.7012	0.6942	187.0988	0.0559	289.867279	0.7618	0.71736	289.076247	0.2729
186.9175	0.6820	0.6778	186.8549	0.0335	289.237854	0.7264	0.72178	289.154978	0.0287
186.4006	0.6474	0.6024	185.7284	0.3606	286.719391	0.5850	0.58968	286.801934	0.0288
187.7636	0.7387	0.7079	187.3034	0.2451	286.943054	0.5976	0.58931	286.795343	0.0515
188.9100	0.8155	0.8128	188.8700	0.0211	290.669037	0.8068	0.77359	290.077849	0.2034
188.6280	0.7966	0.7942	188.5916	0.0193	290.612183	0.8036	0.78012	290.194166	0.1438
187.2600	0.7050	0.7106	187.3443	0.0450	288.901184	0.7075	0.67007	288.233889	0.2310
186.6920	0.6669	0.6682	186.7111	0.0102	287.355621	0.6208	0.57921	286.615436	0.2576
186.8196	0.6755	0.7061	187.2773	0.2450	289.066589	0.7168	0.67934	288.399012	0.2309
187.2418	0.7038	0.7070	187.2906	0.0260	287.800873	0.6458	0.60875	287.14162	0.2291

186.8590	0.6781	0.6815	186.6110	0.1327	287.638092	0.6366	0.61012	287.166024	0.1641
187.3590	0.7116	0.7180	187.4544	0.0509	289.468323	0.7394	0.69515	288.680629	0.2721
187.5235	0.7226	0.7337	187.6892	0.0884	290.995789	0.8251	0.75519	289.750097	0.4281
187.3002	0.7077	0.7268	187.5852	0.1522	290.297638	0.7859	0.73985	289.476852	0.2827
186.9763	0.6860	0.6948	187.1078	0.0703	289.260315	0.7277	0.70272	288.81547	0.1538
186.7228	0.6690	0.6661	186.6799	0.0230	286.528442	0.5743	0.53875	285.894738	0.2212
182.3108	0.3735	0.4115	182.8783	0.3113	283.37204	0.3971	0.40943	283.591213	0.0773
182.3290	0.3747	0.4496	183.4465	0.6129	285.564301	0.5202	0.48283	284.898658	0.2331
182.0202	0.3540	0.3640	182.1685	0.0815	281.995331	0.3198	0.34315	282.410594	0.1473
182.1953	0.3658	0.4089	182.8398	0.3537	286.036072	0.5467	0.50406	285.276819	0.2654
181.3417	0.3086	0.3243	181.5763	0.1294	283.404297	0.3989	0.38997	283.24458	0.0564
182.7025	0.3997	0.4953	184.1285	0.7805	288.678375	0.6950	0.65992	288.053091	0.2166
184.1612	0.4974	0.5974	185.6530	0.8100	285.127472	0.4957	0.42838	283.928762	0.4204
182.5003	0.3862	0.4274	183.1160	0.3374	283.972015	0.4308	0.39399	283.316186	0.2309
182.3320	0.3749	0.4269	183.1084	0.4258	285.266998	0.5035	0.49775	285.164422	0.0360
181.9567	0.3498	0.3973	182.6657	0.3897	283.137024	0.3839	0.39708	283.371227	0.0827
181.7135	0.3335	0.3831	182.4537	0.4073	282.993195	0.3759	0.36692	282.833999	0.0563
182.0641	0.3570	0.3942	182.6194	0.3050	282.391449	0.3421	0.33003	282.176892	0.0760
182.8030	0.4065	0.4826	183.9390	0.6214	284.791351	0.4768	0.44633	284.248498	0.1906
183.0065	0.4201	0.4969	184.1532	0.6266	286.540741	0.5750	0.52639	285.674575	0.3023
182.6143	0.3938	0.4548	183.5242	0.4983	284.236237	0.4456	0.435	284.046681	0.0667
181.8348	0.3416	0.3707	182.2688	0.2387	282.884796	0.3698	0.34053	282.363925	0.1841
180.8962	0.2788	0.2856	180.9974	0.0559	281.703278	0.3034	0.27146	281.133608	0.2022
180.9166	0.2801	0.2883	181.0379	0.0670	281.853577	0.3119	0.2564	280.865351	0.3506
180.2293	0.2341	0.2632	180.6635	0.2409	281.48465	0.2912	0.26807	281.073224	0.1462
179.9381	0.2146	0.2378	180.2838	0.1921	281.849091	0.3116	0.26563	281.029761	0.2907
179.2817	0.1706	0.1970	179.6745	0.2191	281.804382	0.3091	0.26557	281.028692	0.2753
179.6471	0.1951	0.2194	180.0095	0.2018	281.030609	0.2657	0.24888	280.7314	0.1065
179.5707	0.1900	0.2173	179.9779	0.2267	281.071991	0.2680	0.25762	280.887082	0.0658
179.4886	0.1845	0.2102	179.8719	0.2135	281.041321	0.2663	0.2174	280.170659	0.3098
179.5512	0.1887	0.2307	180.1779	0.3491	282.492157	0.3477	0.2935	281.526198	0.3419
180.2007	0.2322	0.2515	180.4890	0.1600	282.583405	0.3529	0.32031	282.003754	0.2051
179.1000	0.1585	0.1877	179.5359	0.2434	282.205933	0.3317	0.28241	281.328656	0.3109
178.8099	0.1391	0.1641	179.1841	0.2093	280.804047	0.2530	0.20393	279.930724	0.3110
178.2822	0.1037	0.1308	178.6866	0.2268	279.811096	0.1972	0.18179	279.536353	0.0982
177.9716	0.0829	0.1342	178.7369	0.4300	278.45929	0.1213	0.13743	278.746186	0.1030
178.3112	0.1057	0.1458	178.9107	0.3362	279.908142	0.2027	0.18434	279.581775	0.1166
178.6374	0.1275	0.1571	179.0787	0.2470	281.068481	0.2678	0.22866	280.371229	0.2481
180.8349	0.2747	0.2529	180.5105	0.1794	283.265137	0.3911	0.33093	282.192924	0.3785

182.6664	0.3975	0.3805	182.4154	0.1385	280.626984	0.2430	0.19081	279.697022	0.3314
182.3996	0.3795	0.3592	182.0968	0.1660	280.405518	0.2306	0.17707	279.452277	0.3400
181.4928	0.3187	0.2875	181.0271	0.2566	277.819794	0.0854	0.11192	278.291786	0.1699
181.7630	0.3368	0.3139	181.4204	0.1885	279.240723	0.1652	0.16622	279.25901	0.0065
182.6520	0.3964	0.3771	182.3650	0.1572	282.115417	0.3266	0.3052	281.734606	0.1350
182.4309	0.3816	0.3543	182.0236	0.2232	281.201202	0.2753	0.23548	280.492711	0.2520
182.7577	0.4034	0.3711	182.2748	0.2642	280.897186	0.2582	0.25839	280.900798	0.0013
182.9211	0.4144	0.3899	182.5547	0.2003	281.258728	0.2785	0.26975	281.103149	0.0553
183.0845	0.4253	0.4102	182.8590	0.1231	281.694427	0.3029	0.29668	281.582842	0.0396
183.4030	0.4467	0.4519	183.4814	0.0427	281.51886	0.2931	0.29412	281.537242	0.0065
183.5314	0.4553	0.4671	183.7076	0.0960	284.14917	0.4408	0.41102	283.619535	0.1864
183.7362	0.4690	0.4785	183.8780	0.0772	285.579346	0.5210	0.5052	285.297126	0.0988
183.6092	0.4605	0.4576	183.5661	0.0235	284.098145	0.4379	0.35719	282.660683	0.5060
183.9313	0.4820	0.4749	183.8245	0.0581	285.33905	0.5076	0.43267	284.005178	0.4675
184.2993	0.5067	0.5277	184.6125	0.1699	286.915833	0.5961	0.60871	287.140908	0.0784
184.4281	0.5153	0.5258	184.5853	0.0852	289.463562	0.7391	0.70038	288.773789	0.2383
183.5731	0.4580	0.4584	183.5782	0.0028	286.987671	0.6001	0.6035	287.048104	0.0211
183.9271	0.4818	0.4906	184.0592	0.0719	285.481506	0.5156	0.55165	286.124521	0.2252
183.9519	0.4834	0.4774	183.8626	0.0485	286.080597	0.5492	0.54963	286.088539	0.0028
183.9764	0.4851	0.4786	183.8805	0.0521	286.007782	0.5451	0.57864	286.605283	0.2089
183.8119	0.4740	0.4663	183.6961	0.0630	284.990662	0.4880	0.54536	286.01248	0.3585
182.5619	0.3903	0.3563	182.0535	0.2785	282.782501	0.3640	0.37086	282.904181	0.0430
182.4978	0.3860	0.3484	181.9355	0.3081	282.998505	0.3762	0.37363	282.953522	0.0159
182.3695	0.3774	0.3312	181.6792	0.3786	282.234833	0.3333	0.29739	281.595489	0.2265
181.5796	0.3245	0.3035	181.2656	0.1729	282.260468	0.3347	0.32814	282.143227	0.0415
182.5271	0.3880	0.3750	182.3323	0.1067	281.785278	0.3080	0.3178	281.959044	0.0617
182.4016	0.3796	0.3408	181.8216	0.3179	281.458954	0.2897	0.29592	281.569305	0.0392
182.4151	0.3805	0.3445	181.8778	0.2945	281.451965	0.2893	0.30074	281.655161	0.0722
182.3900	0.3788	0.3502	181.9629	0.2342	281.208038	0.2756	0.27445	281.186868	0.0075
182.6162	0.3940	0.3715	182.2812	0.1834	282.775543	0.3636	0.33618	282.28644	0.1730
182.2516	0.3696	0.3376	181.7746	0.2618	281.037842	0.2661	0.27595	281.213587	0.0625
182.6073	0.3934	0.3603	182.1135	0.2704	280.327942	0.2262	0.22232	280.258297	0.0248
182.5168	0.3873	0.3534	182.0109	0.2772	282.22052	0.3325	0.32802	282.141089	0.0281
181.8009	0.3394	0.3055	181.2954	0.2780	278.157013	0.1044	0.13955	278.783948	0.2254
181.7265	0.3344	0.2935	181.1158	0.3360	279.544891	0.1823	0.18456	279.585693	0.0146
181.2739	0.3041	0.2754	180.8452	0.2365	277.654205	0.0761	0.12561	278.535641	0.3175
181.3941	0.3121	0.2753	180.8436	0.3035	278.44101	0.1203	0.14294	278.844333	0.1449
180.8850	0.2780	0.2225	180.0555	0.4586	279.70813	0.1914	0.18659	279.621853	0.0308
180.8242	0.2740	0.2269	180.1217	0.3885	280.140167	0.2157	0.2232	280.273972	0.0478

Testing Result									
Outlet Properties									
Shell Temperature	Normalized	normalize value by NN	Shell Temperature by NN	% Error	Tube Temperature	Normalized	Normalized value by NN	Tube temperature by NN	% Error
182.6247	0.3945	0.3483	181.9343	0.3780	282.6917725	0.3589	0.3285	282.1496391	0.1918
184.0981	0.4932	0.4592	183.5902	0.2758	287.9867249	0.6562	0.6431	287.7534831	0.0810
182.2487	0.3694	0.3134	181.4132	0.4584	282.4629211	0.3461	0.3198	281.9946695	0.1658
182.6086	0.3935	0.3279	181.6297	0.5360	284.4428406	0.4572	0.4217	283.8097734	0.2226
183.5114	0.4539	0.3936	182.6107	0.4908	283.0357361	0.3782	0.3372	282.3046087	0.2583
183.2743	0.4380	0.3983	182.6809	0.3238	281.8987732	0.3144	0.3032	281.6989803	0.0709
184.1077	0.4939	0.4656	183.6858	0.2292	286.0369873	0.5467	0.5238	285.6284399	0.1428
183.9926	0.4861	0.4355	183.2364	0.4110	285.620575	0.5234	0.5202	285.5643145	0.0197
183.8775	0.4784	0.4136	182.9094	0.5265	284.394165	0.4545	0.4611	284.5115899	0.0413
189.2178	0.8361	0.8017	188.7043	0.2714	291.3448181	0.8447	0.8243	290.9811262	0.1248
188.9666	0.8193	0.8177	188.9432	0.0124	289.004425	0.7133	0.7563	289.7698694	0.2649
189.8697	0.8798	0.8537	189.4807	0.2049	288.5340576	0.6869	0.7126	288.9914588	0.1585
189.6559	0.8654	0.8874	189.9839	0.1729	286.5456238	0.5753	0.6524	287.9191402	0.4793
188.7811	0.8068	0.8055	188.7610	0.0107	283.998291	0.4323	0.5506	286.1058176	0.7421
189.3174	0.8428	0.8520	189.4553	0.0729	286.9387207	0.5974	0.678	288.3751428	0.5006
188.8568	0.8119	0.7796	188.3743	0.2555	289.6897278	0.7518	0.8235	290.9668761	0.4409
187.3997	0.7143	0.6897	187.0320	0.1962	286.6018677	0.5784	0.6469	287.8211709	0.4254
191.0519	0.9589	0.8517	189.4509	0.8380	291.5079041	0.8539	0.8398	291.2572215	0.0860
187.2091	0.7016	0.7145	187.4023	0.1032	285.4521179	0.5139	0.5385	285.8902851	0.1535
187.6050	0.7281	0.7388	187.7651	0.0853	286.6141663	0.5791	0.6357	287.6216698	0.3515
188.0099	0.7552	0.7736	188.2847	0.1462	289.6903992	0.7518	0.7918	290.4022167	0.2457
186.6741	0.6657	0.6796	186.8811	0.1109	285.0577087	0.4918	0.449	284.2960574	0.2672
187.0292	0.6895	0.6957	187.1215	0.0494	287.6122437	0.6352	0.6492	287.8621399	0.0869
186.9974	0.6874	0.6988	187.1678	0.0911	287.3847351	0.6224	0.6256	287.4417626	0.0198
186.9339	0.6831	0.7062	187.2783	0.1843	287.4549561	0.6263	0.651	287.8942026	0.1528
186.8996	0.6808	0.6904	187.0424	0.0764	287.6915894	0.6396	0.6876	288.5461438	0.2970
188.0330	0.7567	0.7883	188.5042	0.2506	291.4238586	0.8492	0.8247	290.9882612	0.1495
187.6037	0.7280	0.7540	187.9921	0.2070	287.5601807	0.6322	0.6454	287.794452	0.0815
187.8169	0.7423	0.7711	188.2474	0.2292	288.133606	0.6644	0.6613	288.0776724	0.0194
187.8747	0.7461	0.7750	188.3056	0.2294	289.6138611	0.7475	0.7374	289.4332112	0.0624
187.4791	0.7196	0.7367	187.7337	0.1358	289.9619446	0.7671	0.7597	289.8304322	0.0454
186.8148	0.6752	0.7158	187.4217	0.3248	288.1533813	0.6656	0.663	288.1079538	0.0158

187.8511	0.7446	0.7472	187.8905	0.0210	289.836792	0.7601	0.7365	289.4171799	0.1448
187.5675	0.7256	0.7354	187.7143	0.0783	287.2745667	0.6162	0.5881	286.7737901	0.1743
187.2515	0.7044	0.7336	187.6874	0.2328	287.4946289	0.6286	0.6037	287.0516666	0.1541
187.2232	0.7025	0.7303	187.6382	0.2216	287.1040039	0.6066	0.6079	287.1264795	0.0078
186.8013	0.6743	0.7073	187.2947	0.2641	288.0498047	0.6597	0.6303	287.5254818	0.1820
186.6298	0.6628	0.6944	187.1021	0.2531	288.1021118	0.6627	0.6522	287.9155777	0.0647
186.5703	0.6588	0.6519	186.4675	0.0551	288.7772827	0.7006	0.6449	287.7855457	0.3434
186.2266	0.6358	0.6624	186.6243	0.2136	288.1141663	0.6633	0.6235	287.4043561	0.2464
186.6210	0.6622	0.6543	186.5034	0.0630	289.1523743	0.7216	0.7274	289.2550852	0.0355
188.8336	0.8104	0.8066	188.7774	0.0297	290.4915466	0.7968	0.7819	290.2258719	0.0915
186.7592	0.6714	0.6891	187.0230	0.1413	288.1954956	0.6679	0.6305	287.5290443	0.2312
186.7824	0.6730	0.6603	186.5930	0.1014	287.6039734	0.6347	0.6076	287.1211358	0.1679
187.0229	0.6891	0.7099	187.3336	0.1661	288.8875122	0.7068	0.6491	287.8603587	0.3556
182.2995	0.3728	0.3950	182.6316	0.1822	284.5986328	0.4660	0.4778	284.8090603	0.0739
182.4446	0.3825	0.4399	183.3021	0.4700	285.6827698	0.5269	0.4885	284.9996551	0.2391
182.2198	0.3674	0.4144	182.9213	0.3850	283.4251709	0.4001	0.3711	282.9084559	0.1823
181.1206	0.2938	0.3125	181.3998	0.1542	282.519989	0.3493	0.3155	281.9180753	0.2131
178.8655	0.1428	0.1792	179.4094	0.3041	280.684021	0.2462	0.1926	279.7289068	0.3403
178.5512	0.1217	0.1601	179.1242	0.3209	279.9733887	0.2063	0.1743	279.4029362	0.2038
178.9732	0.1500	0.1495	178.9660	0.0040	281.1150208	0.2704	0.2271	280.3434415	0.2745
181.9246	0.3476	0.3244	181.5775	0.1908	283.5866089	0.4092	0.322	282.0338572	0.5475
181.9783	0.3512	0.3267	181.6118	0.2014	282.1576538	0.3289	0.2786	281.2607904	0.3179
182.0332	0.3549	0.3395	181.8029	0.1265	280.1403809	0.2157	0.2086	280.0139084	0.0451
183.4320	0.4486	0.4397	183.2991	0.0725	284.1199646	0.4391	0.3793	283.0545192	0.3750
183.7324	0.4687	0.4496	183.4469	0.1554	284.3128967	0.4499	0.3856	283.1667386	0.4031
181.9627	0.3502	0.3415	181.8328	0.0714	282.79245	0.3646	0.3293	282.1638892	0.2223
183.5323	0.4553	0.4509	183.4663	0.0359	284.4847107	0.4596	0.415	283.690429	0.2792
184.2759	0.5051	0.5193	184.4876	0.1149	288.292511	0.6734	0.6698	288.2290795	0.0220
183.7509	0.4700	0.4699	183.7500	0.0005	286.4967346	0.5725	0.5802	286.6330705	0.0476
184.0069	0.4871	0.4791	183.8874	0.0650	285.6878967	0.5271	0.5695	286.4424757	0.2641
184.4111	0.5142	0.5265	184.5951	0.0998	286.7586365	0.5872	0.6149	287.2511677	0.1718
184.1919	0.4995	0.5064	184.2950	0.0560	283.8494873	0.4239	0.4341	284.0306497	0.0638
183.6427	0.4627	0.4509	183.4663	0.0960	284.8620911	0.4808	0.5002	285.2080625	0.1215
183.2816	0.4385	0.4183	182.9795	0.1648	282.9677124	0.3744	0.3702	282.8924245	0.0266
182.4337	0.3817	0.3403	181.8149	0.3392	282.2169189	0.3323	0.3381	282.3206401	0.0368
182.4110	0.3802	0.3468	181.9119	0.2736	281.3424072	0.2832	0.2793	281.2732592	0.0246
182.4401	0.3822	0.3662	182.2016	0.1307	281.5220642	0.2933	0.2814	281.3106656	0.0751

182.6053	0.3932	0.3724	182.2942	0.1704	282.1550598	0.3288	0.3003	281.6473238	0.1799
180.8516	0.2758	0.2298	180.1650	0.3797	280.3232117	0.2260	0.2169	280.1617529	0.0576
181.3085	0.3064	0.2790	180.8996	0.2256	281.0824585	0.2686	0.2306	280.4057856	0.2407
182.5061	0.3866	0.4030	182.7511	0.1342	283.3691406	0.3970	0.3752	282.9814875	0.1368
183.3707	0.4445	0.4925	184.0875	0.3909	282.1765747	0.3300	0.2916	281.4923542	0.2425
183.3999	0.4465	0.4998	184.1965	0.4343	281.9978638	0.3200	0.2928	281.5137293	0.1717
182.8303	0.4083	0.4613	183.6216	0.4328	282.5718689	0.3522	0.3278	282.1371703	0.1538
184.2556	0.5038	0.5886	185.5224	0.6875	284.596405	0.4659	0.4248	283.8649925	0.2570
182.6861	0.3986	0.4443	183.3678	0.3732	283.7802734	0.4200	0.4146	283.683304	0.0342
182.4196	0.3808	0.3930	182.6018	0.0998	280.0960388	0.2132	0.225	280.306035	0.0750
182.6150	0.3939	0.4197	183.0005	0.2111	280.696991	0.2469	0.2195	280.2080657	0.1742
182.4789	0.3848	0.4043	182.7705	0.1598	280.3017273	0.2248	0.2222	280.2561597	0.0163
182.2066	0.3665	0.3785	182.3853	0.0981	279.8068237	0.1970	0.1888	279.6612189	0.0520
182.4311	0.3816	0.3776	182.3718	0.0325	279.5237427	0.1811	0.1957	279.7841258	0.0932
182.7234	0.4011	0.4362	183.2468	0.2865	281.1178284	0.2706	0.2866	281.4032912	0.1015
182.9235	0.4145	0.4197	183.0005	0.0421	280.3164368	0.2256	0.2806	281.2964156	0.3496
182.9523	0.4165	0.4225	183.0423	0.0492	281.1292419	0.2712	0.3178	281.9590443	0.2952
182.9280	0.4148	0.4353	183.2334	0.1669	280.5166931	0.2368	0.2692	281.0933519	0.2056
182.7277	0.4014	0.4140	182.9153	0.1027	280.239624	0.2213	0.2725	281.1521335	0.3256
183.3816	0.4452	0.4450	183.3782	0.0018	282.6355591	0.3558	0.3781	283.0331441	0.1407
182.3783	0.3780	0.3973	182.6660	0.1578	279.316925	0.1695	0.2132	280.0958463	0.2789
182.0681	0.3573	0.3847	182.4778	0.2250	281.728241	0.3048	0.3449	282.4417657	0.2533
182.0154	0.3537	0.3827	182.4480	0.2376	281.5811157	0.2966	0.3187	281.9750756	0.1399
182.2878	0.3720	0.3842	182.4704	0.1001	281.3312378	0.2826	0.2941	281.5368857	0.0731
182.0772	0.3579	0.3726	182.2972	0.1208	279.9243774	0.2036	0.2069	279.9836269	0.0212
181.9939	0.3523	0.3715	182.2808	0.1576	281.6988525	0.3032	0.2829	281.3373845	0.1283
182.0009	0.3528	0.3538	182.0165	0.0086	282.6329956	0.3556	0.3535	282.5949541	0.0135
181.7078	0.3331	0.3090	181.3475	0.1983	284.0133667	0.4331	0.4288	283.9362429	0.0272
181.0396	0.2884	0.2884	181.0399	0.0002	283.9932861	0.4320	0.4516	284.3423702	0.1229
181.5365	0.3217	0.3166	181.4610	0.0416	284.5533142	0.4634	0.4522	284.3530577	0.0704
181.1235	0.2940	0.2814	180.9354	0.1038	283.3556519	0.3962	0.3751	282.9797063	0.1327
181.0351	0.2881	0.2733	180.8145	0.1219	283.4374695	0.4008	0.3947	283.3288332	0.0383
179.6146	0.1929	0.1941	179.6319	0.0096	281.0512085	0.2668	0.2466	280.6907872	0.1282
181.1588	0.2964	0.3016	181.2370	0.0432	284.0961609	0.4378	0.4036	283.4873654	0.2143
180.8508	0.2757	0.2966	181.1624	0.1723	284.3575134	0.4525	0.418	283.7438668	0.2158
181.1921	0.2986	0.2776	180.8787	0.1730	281.7120361	0.3039	0.2776	281.2429778	0.1665
180.9940	0.2853	0.2755	180.8473	0.0811	281.5289307	0.2937	0.2739	281.1770711	0.1250

180.4348	0.2479	0.2368	180.2695	0.0916	282.1641541	0.3293	0.2859	281.3908223	0.2741
177.1940	0.0308	0.1018	178.2537	0.5981	279.4415588	0.1765	0.2102	280.0424085	0.2150
178.5190	0.1196	0.1521	179.0048	0.2721	283.0288086	0.3779	0.3924	283.2878642	0.0915