CHAPTER III
PROCEDURE

In chapter I, there are three subtopics to minimize energy consumption in gas separation plant. Thus, this chapter can be divided into three procedures following the objective of the research. PROII simulation is used as a tool to find thermodynamic properties and other information. Table 3.1 shows the constrained parameters to assure the reliability of process data representation.

Table 3.1 Accuracy parameter of process simulation

Parameters	Error	Unit
Flow rate	± 10	%
Temperature	± 5	^{0}C
Pressure	± 0	Bar
Composition	± 0.05	-
UA of heat exchanger	± 10	%

3.1 Retrofit of Gas Separation Unit (Design and Actual Case)

Gas separation unit of PTT is chosen as case study to retrofit in this research. This unit is the process for separating the natural gas undergo into many kinds of products, like NGL (natural gasoline), ethane, and LPG (Liquefied Petroleum Gas). The procedures of retrofit plant are divided into three steps.

3.1.1 <u>Data Extraction and Plant Simulation</u>

The information of gas separation unit was collected on 1 July 2004 which consists of designed and actual data. The simulator, PROII provision, is used to simulate this unit by using the designed data at first.

After that the actual data is applied by substituting specified parameter in the simulator. There are four products produced from the unit; sales gas (methane), ethane, LPG and natural gasoline (NGL). The purity of these products is very concerned and careful to simulate. Table 3.2 shows the specification of products in the unit.

Table 3.2 Product quality specification of gas separation unit

Product	Quality
Ethane	C3 $\leq$ 1.5%
LPG	$C5^+ \leq$ 1.5%
NGL	RVP $\leq$ 13.5 bar
Sales Gas	N/A

3.1.2 Calculation and Designing with Pinch Analysis

After simulating the gas separation unit with PROII, the necessary data and information are mass heat flow capacity, temperature inlet and temperature outlet for heat exchanger networks. In this research, there are two methods, pinch analysis for heat exchanger network and distillation column targeting

3.1.2.1 Pinch Analysis for Heat Exchanger Networks (HENs)

There are three procedures for calculating and designing heat exchanger networks (HENs). First step is using data from the first step to calculate allowable minimum temperature approach (ΔT_{min}). To find the minimum temperature approach (ΔT_{min}) of existing process, the stepwise of pinch analysis for heat exchanger network that is described in chapter II is used. By this method, utility requirements can be obtained for various ΔT_{min} and a trial–and-error procedure to ascertain ΔT_{min} for the existing utility level. After knowing ΔT_{min}, the next step is finding energy usage and recovery in heat exchanger network. The non optimum energy conservation is observed by three "rule of thumb" such as heat transfer across pinch. Modifying new heat exchanger networks for optimum energy conservation as shown in Figure 3.1 is the last step.

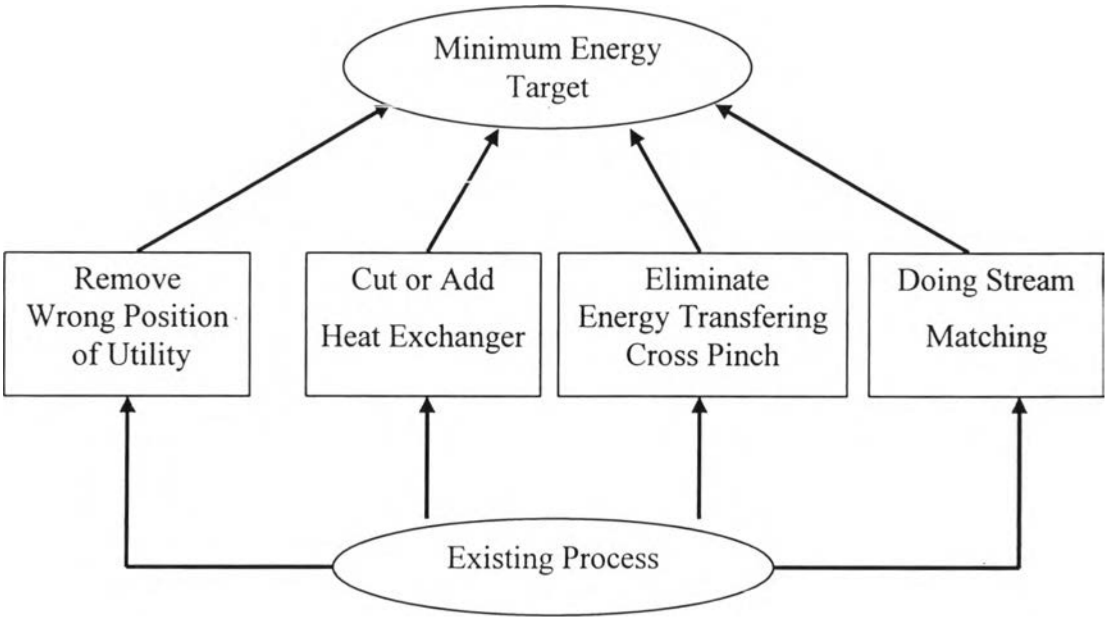

Figure 3.1 Modification of heat exchanger networks.

3.1.2.2 Pinch Analysis for Distillation Column

The first step is using data to generate column grand composite curve (CGCC). The second step is modifying these below parameters to investigate energy consumption in column

- Reflux ratio
- Feed Location
- Feed condition (Heating or Cooling)
- Side condensing and reboiling

3.1.3 Energy Integration

By the result of HENs and distillation column targeting, the energy integration between GCC and CGCC is observed to find the energy minimization opportunity.

3.2 New Design of Stabilizer Unit

Stabilizer unit planned to be constructed in the future is used to separate the heavy hydrocarbons before sending to gas separation unit. The procedure of this case is to check energy efficiency of the design of stabilizer unit.

3.2.1 Data Extraction and Plant Simulation

Because of the new design case, the data and information of this stabilizer come from the simulator directly. There are two main products, overhead gas to gas separation unit and natural gasoline product. There is only one known specification of product in the unit, the reid vapor pressure of natural gasoline of less than 12.8 Psig. To follow these constraints, 12.5 Psig of reid vapor pressure (ASTM D323) is specified in the simulation.

3.2.2 Calculation and Designing with Pinch Analysis

Similarly, in case of stabilizer unit, there are two applications of pinch analysis, HENs design and distillation column targeting.

3.2.2.1 Pinch Analysis for Heat Exchanger Networks (HENs)

The first step is using simulation and choosing the minimum temperature approach (ΔT_{min}) of the process. The second step is finding pinch point and minimum utilities (hot and cold) of process by the method that described in chapter II. The last step is using the matching rule to design the networks based on pinch analysis

- Pinch problem, using PDM method.
- Unpinch problem, using Fast matching algorithm. (Ponton and Donalson, 1974)

3.2.2.2 Pinch Analysis for Distillation Column Targeting

The first step is using data from the first step to calculate and plot column grand composite curve (CGCC). Follow by modifying these parameters to investigate energy consumption in column

- Reflux ratio
- Feed Location
- Feed condition (Heating or Cooling)
- Side condensing and reboiling

3.2.3 Energy Integration

By the result of HENs and distillation column targeting, the energy integration between GCC and CGCC is observed to find the scope of energy savings.

3.3 Sensitivity Analysis of Propane and LPG Production

At present, Gas separation plant of PTT produces sales gas (methane), ethane and LPG as products. The depropanizer column in the unit is now used to produce only LPG. Because of reason for economic, propane will be planned to produce in the near future by using depropanizer column and LPG is produced by side tray drawn from the column. The objective of this topic is to find the optimum condition to operate and produce both propane and LPG by minimum reboiler and condenser duties. The important parameters are

- Composition of feed stream
- Side tray for maximum LPG production (tray number = 80)
- Pressure of column (limitation of column pressure = 19 psig)

Product quality is used as the same constraint as other cases. The purity of products from this unit is shown in Table 3.3.

Table 3.3 Product quality specification in case of propane production

Product	Quality
Ethane	C3 $\leq$ 1.5%
Propane	$C4^{+} \leq 0.01\%$
LPG	$C5^{+} \leq 1.5\%$
NGL	RVP $\leq$ 13.5 bar
Sales Gas	N/A

Moreover, propane and LPG flow rate, which are produced, are not more than 100 kgmol/hr.