CHAPTER III

EXPERIMENTAL

3.1 Materials and Equipment

3.1.1 Equipment:

3.1.1.1 Desktop computer (Pentium IV, RAM 1 GB, Window XP and Microsoft Office 2007)

3.1.2 Software:

3.1.2.1 PRO/II version 8.2

3.1.2.2 SimaPro version 7.0

3.1.2.3 SustainPro

3.1.2.4 ICAS version 12.0

3.1.2.5 GAMS version 2.0

3.2 Experimental Procedures

3.2.1 Preparation

Study and review the background of bioethanol production including their environmental impact through LCA technique, contract Thai Roong Ruang Energy Co.,Ltd (TRE) and gathering all of the data available.

3.2.2 Modeling

Simulate the process of base case design based on TRE process and literatures as shown in Table 3.1, by using PRO/II 8.2 simulation program as simulator.

Table 3.1 Source of data of base case simulation

Stage Data Item	Source of data	
	TRE	Literatures
Pretreatment	*	*
Neutralization	*	*
Fermentation		*
Recovery	*	*

3.2.3 Sustainability Analysis

Perform sustainability analysis of base case design using SustainPro. This analysis is divided in to five steps as follow:

3.2.3.1 Collection of Steady-state Data

3.2.3.2 Flowsheet Decomposition

3.2.3.3 Calculation of Indicators, Sustainability Metrics and Safety Indic es

3.2.3.4 Indicator sensitivity analysis

3.2.3.5 Operational sensitivity analysis

3.2.4 Life Cycle Assessment

The assessment is carried out in four phases consisting of:

3.2.4.1 Defining

- Identify functional unit of bioethanol production: In this research, two functional units are used in this study: 1 kilogram of bioethanol 99.5 wt% purity and 1 megajoule of bioethanol 99.5 wt% purity.
- Determine system boundaries of bioethanol production (what is and is not included in this research) and make assumptions based on the goal definition. In this research, system boundary of bioethanol production process is shown in Figure 3.1.

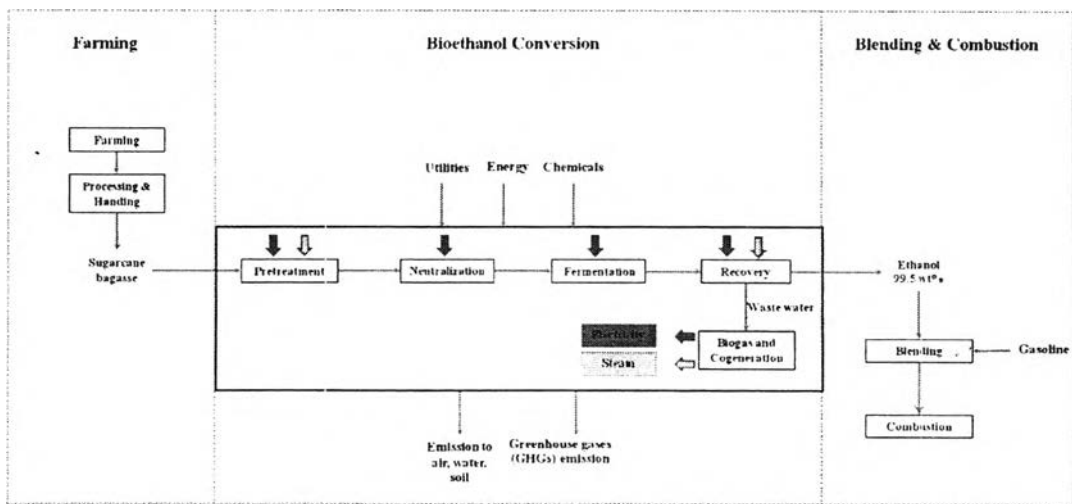

Figure 3.1 System boundary for bioethanol conversion process.

3.2.4.2 Inventory Analysis

- Collect data related to environment and technical quantities for all relevant and within the boundaries unit processes, for example;
  - Raw materials, utilities, and energy consumptions
  - Air and water emissions
  - Waste generations

The source of inventory data of bioethanol conversion process is shown in Table 3.2.

Table 3.2 Sources of inventory data of bioethanol conversion process

Step	Type of data	Data source
Sugarcane farming and processing	2nd Data	MTEC Research
Ethanol conversion	2nd Data	Process Simulation
Waste water treatment	2nd Data	TRE CDM project

- Quantify how much energy and raw materials are used, and how much solid, liquid and gaseous waste is generated, at each stage of the product's life.

3.2.4.3 Impact Assessment

- Calculate impact potentials based on the LCI results by using software named—SimaPro version 7.0—with Eco-indicator 95 and CML 2 baseline 2000 methods.
- Analyze and compare the impacts on human health and the environment burdens associated with raw material and energy inputs and environmental releases quantified by the inventory, for example;
  - Acidification
  - Global warming
  - Eutrophication
  - Energy Resources

3.2.4.4 Interpretation

- Evaluate the net energy gain, net energy ratio and GHG emission per one kilogram ethanol the design of bioethanol conversion process.
- Evaluate opportunities to reduce energy, material inputs, or environmental impacts at each stage of the product life-cycle.
- Analyze an improvement, in which recommendations are made based on the results of the inventory and impact stages.

3.2.5 Re-modeling

3.2.5.1 Generate new design alternative using PRO/II and consider the results from sustainability analysis.

3.2.5.2 Perform sustainability analysis of new design to calculate indicators. sustainability metrics, and safety indices. The example of indicators are;

- Material-value added (MVA)
- Energy and waste cost (EWC)
- Total value added (TVA)

3.2.5.3 Perform life cycle assessment of new design to evaluate environmental impact. The examples of impacts are;

- Acidification
- Global warming
- Eutrophication
- Energy resources

3.2.6 Comparing

Compare the results between base case and alternatives to confirm that how much the new design is improved. The results are included;

3.2.6.1 Indicators

3.2.6.2 Sustainability Metrics

3.2.6.3 WAR Algorithm

3.2.6.4 Safety Indices

3.2.6.5 Life Cycle Assessment