CHAPTER III
METHODOLOGY

3.1 Materials and Equipment

3.1.1 Equipment

- Laptop (ASUS, RAM 4 GB, Window 8 and Microsoft Office 2010)

3.1.2 Software

- Commercial process simulation software SimaPro version 7.1

3.2 Experimental Procedures

3.2.1 Preparation

The literature and background of the life cycle of microemulsion biofuel production process from different oil sources from different formulations were reviewed and their environmental impacts were evaluated through LCA approach.

3.2.2 Goal, Scope, Functional Unit, and System Boundary

3.2.2.1 Goal and Scope of the Study

The goal of this study was to assess the environmental impacts of the microemulsion biofuel production from different formulations. The process of biofuel production is divided into four stages: cultivation, oil extraction, refining and microemulsion production. In microemulsion biofuel production stage, it differs into different production processes. Moreover, the environmental impacts from production of microemulsion biofuel from different materials will be compared. The scenarios investigated under this study are shown in Table 3.1. The methodology used in this study was based on ISO14040 series. The life cycle inventory data were collected from secondary data sources (National Thai LCI database, previous works on LCA of palm oil based microemulsion biofuel, and selected references). Commercial LCA software, SimaPro 7.1, with CML 2 baseline 2000 methods and Eco-indicator 99(H) were applied to evaluate the eleven potential environmental impact categories such as acidification, eutrophication, abiotic depletion, greenhouse

gas (GHG) emission, ozone layer depletion (ODP), human toxicity, fresh water aquatic ecotoxicity, marine aquatic ecotoxicity, terrestrial ecotoxicity, land use and photochemical oxidation. Production of capital goods, risk, facilities, construction and human labor are excluded in the system boundary of this study.

Table 3.1 Different scenarios of microemulsion biofuel production

Different scenarios of microemulsion biofuel production			
Scenario I (Base case)	Scenario II	Scenario III	Scenario IV
Palm olein	Palm olein	Palm olein	RDBPO
Ethanol	Bioethanol	Ethanol Butanol (blend)	Ethanol
Methyl Oleate*	Biodiesel (FAME)	Methyl Oleate*	Methyl Oleate*
1-octanol**	1-octanol**	1-octanol**	1-octanol**
Diesel	Diesel	Diesel	Diesel
Electricity	Electricity	Electricity	Electricity

FAME : Fatty Acid Methyl Ester

RDBPO : Refined Deodorized Bleached Palm Oil

*Ethoxylated alcohol is substituted as inventory data in LCA program

** 1- butanol is substituted as inventory data in LCA program

3.2.2.2 Functional Unit of the Assessment

In this research, functional unit which provides a reference in which the inputs and outputs are related is set to be one ton of microemulsion biofuel production.

3.2.2.3 System Boundary of the Study

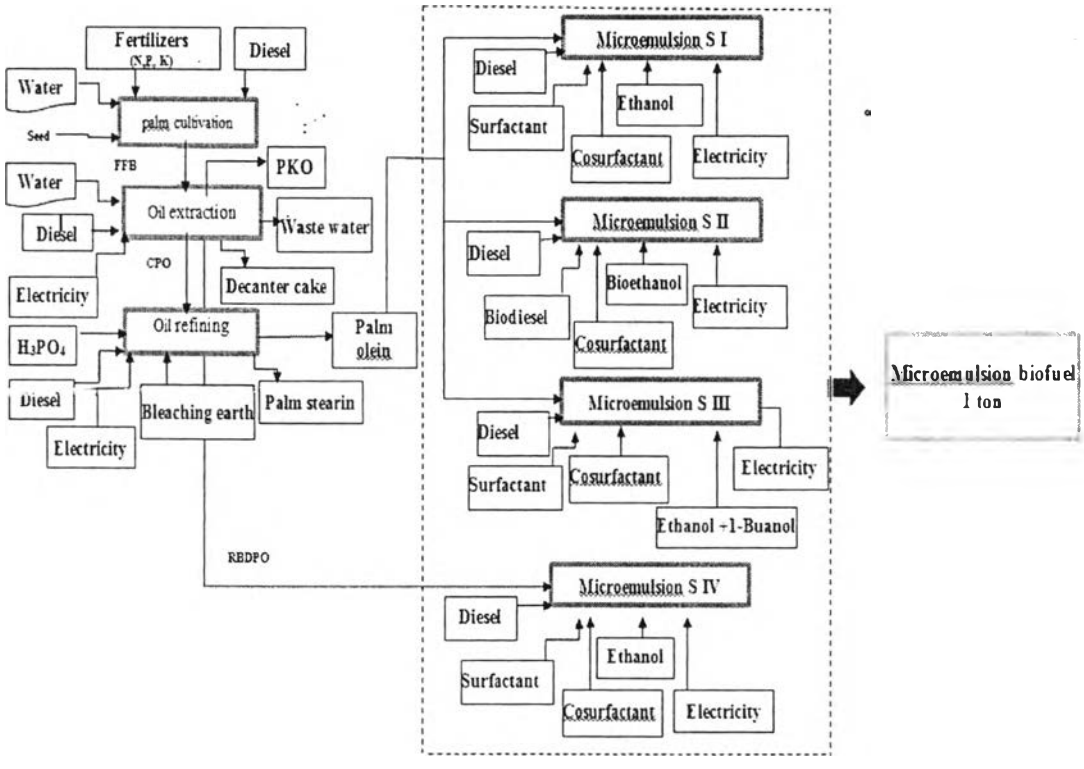

Figure 3.1 The system boundary of microemulsion biofuel production from palm oil.

The system boundary which covers cultivation, oil extraction, refining and microemulsion production was illustrated in Fig. 3.1. The capacity of microemulsion biofuel production is 1 ton/day.

3.2.3 Inventory Analysis

Both numerical and qualitative data for all activities are collected from available Thailand database based on the system boundary. They are as follows;

- Raw material consumption
- Water consumption
- Utility consumption
- Waste generation

3.2.4 Impact Assessment

Commercial software, SimaPro version 7.1, with CML 2 baseline 2000 method and Eco-indicator 99(H) were used to calculate impact potentials based on the LCI results.

The impacts on human health and the environmental burdens associated with raw material inputs quantified by the inventory are analyzed and compared. Potential impact categories included in this study are as follows;

- Acidificatin
- Fresh water aquatic ecotoxicity
- Human toxicity
- Terrestrial ecotoxicity
- Marine aquatic ecotoxicity
- Ozone layer depletion
- Eutrophication
- Abiotic depletion
- Photochemical oxidation
- Global warming potential
- Land use

3.2.5 Interpretation

This step is the combination of the results of the inventory and impact assessments to provide conclusions and recommendations relevant to the goal and scope of the study.