# CHAPTER III
# EXPERIMENTAL

## 3.1 Materials and Equipment

Simapro 5.1 software, supplied by MTEC (National Metal and Materials Technology Center) was used in analyzing the environmental impacts of the different polyethylene shopping bag production studied. The methods called Eco-indicator 95 and 99 were used to assess the data.

## 3.2 Methodology

### 3.2.1 Goal and Scope Definition

*3.2.1.1 Objective and Purpose of the Research Work*

This research would collect data and provided database of biodegradable plastic production and conventional plastic production.

The environmental effects of biodegradable plastic production and conventional plastic production life cycle were evaluated using SimaPro 5.1 Software

*3.2.1.2 Functional Unit*

In this research, the functional unit was 1 kg of both type of conventional and degradable polyethylene shopping bag.

*3.2.1.3 Scope and System Boundary*

This research focused on life cycle study of biodegradable polymer and conventional polymer production associated with material acquisition through production, use and disposal, and compared between each step to determine step which generated the highest environmental effect.

*3.2.1.4 Limitation and Assumption*

Electricity production was derived from the Thai energy system. Polyethylene shopping bag manufacturing data were collected at the

following companies: Siam Midori, Thai Plastic Bag Industry (TPBI), Unity Thai, and NaraiPak.

3.2.2 Life Cycle Inventory

In this section, the principles of life cycle inventory analysis (LCI) were applied to any activities that involve the direct or indirect use of energy or materials. The inventory analysis and the tasks to be fulfilled were supported by a flow sheet for the considered product. This consists of data collection, refining system boundaries, calculation, validation of data, relating data to the specific system, and allocation.

*3.2.2.1 Data Collection*

The inventory analysis includes collection and treatment of data to be used in preparation of a material consumption, waste and emission profile for all the phases in the life cycle. These data can be quantitative or qualitative.

*3.2.2.2 Refining System Boundaries*

The system boundaries are defined as a part of the scope definition procedure. After the initial data collection, the system boundaries can be refined e.g. as a result of decisions of exclusion life stages or sub-systems, exclusion of material flows or inclusion of new unit processes shown to be significant according to the sensitivity analysis.

*3.2.2.3 Calculation*

It is the calculation of the performance characteristics of the overall system.

*3.2.2.4 Validation of Data*

The validation of data has to be conducted during the data collection process in order to improve the overall data quality. Systematic data validation may point out areas where data quality must be improved or data must be found in similar processes or unit processes.

*3.2.2.5 Relating Data to the Specific System*

The fundamental input and output data are often delivered from industry in arbitrary units e.g. energy consumption as MJ/machine/week or emissions to the sewage system as mg metals/liter wastewater. The specific machine

or wastewater stream is rarely connected to the production of the considered product alone but often to a number of similar products or perhaps to the whole production activity.

*3.2.2.6 Allocation*

When performing a life cycle assessment of a complex system, it may not be possible to handle all the impacts and outputs inside the system boundaries. This problem can be solved either by expanding the system boundaries to include all the inputs and outputs, or by allocating the relevant environmental impacts to the studied system. When avoiding allocation e.g. expanding the system boundaries there is a risk of making the system too complex. Allocation may be a better alternative, if an appropriate method can be found for solving the actual problem.

3.2.3 Life Cycle Impact Assessment

In this phase, Eco-Indicator 95 and 99 method in SimaPro 5.1 software were used for impact assessment. The Impact Assessment in LCA consists of the following three steps; classification-characterization; normalization; and evaluation.

*3.2.3.1 Classification and characterization*

Classification is the step in which the data from the inventory analysis are grouped together into a number of impact categories. This grouping is done in such a way that one entry from the inventory table may well be included in more than one category (e.g. NO*x* having both an acidifying and an eutrophication impact). The substances are aggregated within each category to produce an impact score. It is not sufficient just to add up the quantities of substances involved without applying weightings. Some substances may have a more intense impact than others. This problem is dealt with by applying weighting factors to the different substances. This step is referred to as the characterization step.

*3.2.3.2 Normalization*

A further development of the characterization step is to normalize the aggregated data per impact category in relation to the actual magnitude of the impacts within this category in some given area. The reason for doing this is to

increase the comparability of the data from the different impact categories and thus provide a basis for the next step, the evaluation. Therefore, each impact calculated for the life cycle of a product is benchmarked against the known total effect for this impact category.

*3.2.3.3 Evaluation*

The normalization reveals which effects are larger or smaller in relative terms. Evaluation is the step in which the contributions from the different specific impact categories are weighted so that they can be compared among themselves. The importance of the impact categories in relation to each other is a value-bound procedure based on assessment of the relative environmental harm. This assessment therefore reflects social values and preferences. In the evaluation phase the normalized impact scores are multiplied by a weighting factor representing the relative importance of the effect.

### 3.2.4 Life Cycle Interpretation

The interpretation phase was aimed at system improvements and innovation. In addition it also covers the following steps: identification of major burdens and impacts, identification of stages in the life cycle that contribute the most to these impacts (so-called 'hot spots'), evaluation of these findings, sensitivity analysis for data quality and gaps and final recommendations.

It is important to note that data quality is fundamental to LCA. Some of the data quality issues such as reliability and consistency can be overcome by using standardized databases, which are starting to emerge after years of data compilation and their incorporation into publicly and commercially available databases.