CHAPTER 1.0 INTRODUCTION

1.1 SOLID WASTE GENERATION SCENARIO

The increase in population at 1.3 % per annum, from 5.9 billion in 1998 to about 6.0 billion in 2000 (Environmental Quality Report 1998) not only causes problems of food shortage, deterioration of the environment and limited spaces for settlement, but also leads to the acceleration of waste generation. The increase in the quantity of waste generated eventually will lead to a higher level of environmental pollution, as well as, creating health hazards to human beings in the long run, if not treated and disposed of appropriately.

An average person in a poor country generates below 0.5 kg of waste, meanwhile in developing countries and developed countries the generation of waste per person is 0.5 to 1.0 kg and >1.0 kg, respectively. The more developed the nation, the higher the rate of waste generation (Agamuthu, 2001).

In Malaysia, a rapidly developing country, the average rate of waste generation is 0.7 to 1.2 kg of waste daily (Ministry of Housing and Local Government, Malaysia, 1999). The waste produced consists of domestic waste and industrial waste, the latter generated in the process of producing industrial goods.

The type of waste generated can be classified into two major groups according to the ease of its disposal. The first group of waste is the non-hazardous waste which can be disposed of in a sanitary landfill without so much of highly technological treatment; and the second group of waste is the hazardous waste which not only requires special method of disposal but also its handling and storage demands special technique.

Agriculture-based industries are becoming more and more important. The increase in the number of agrobased industries not only affect the economy positively but also contributes towards pollution. According to The Malaysian Environmental Quality Report, 1998, the activity from agrobased industries together with domestic waste, manufacturing industry and livestock farming, have become the main source of pollution causing the deterioration of 69 % river quality; the parameters involved as the pollution indicators included biological oxygen demand (BOD), ammoniacal-nitrogen (NH_3 -N) and suspended solids (SS).

Department of Environment (DOE) of Malaysia reported that the amount of solid waste handled in 1996 had reached up to 331 000 tonnes (ENSEARCH, 1998). Agrobased industries contributed 3.5 % of the water pollution of the country (DOE, 1998). The specific water pollution sources are indicated in Table 1.1.

Table 1.1 Industrial Wastewater Pollution Sources by Type from Agrobased Industries and Manufacturing, 1998

Type of Industries	Number of Sources
Food and Beverage	1158
Chemical Based	638
Electrical and Electronics	452
Metal Finishing and Electroplating	433
Paper	409
Textile	387
Palm Oil Mill	326
Rubber Based	285
Non-metallic Mineral	267
Transport Based	222
Metal Fabrication	195
Wood Based	172
Rubber Mill	162
Machinery	143
Plastic	77
Others	75
Refinery/ Petroleum	70
Leather	59

(Source: Environmental Quality Report, 1998)

1.2 TREATMENT OF WASTE

Due to the high portion of wastes generated by agrobased industries, various types of waste treatment methods have been applied. The fact that the wastes generated by the agro-industry composed of very high proportion of organic matter with high BOD, COD and ammoniacal nitrogen, biological treatment methods have become the most promising option.

Besides biological treatment, physical and chemical treatments like separation by screens, acidification, neutralisation, solidification, coagulation, flocculation, and others are also used. Commonly, the selection of waste treatment method depends on the costs associated with the treatment.

In the case of waste from palm oil industry, treatment of palm oil mill effluent (POME) involves the combination of all three types of treatment. Biological, physical and chemical treatments are used due to the strong characteristics of POME (Ong *et al.,* 1986). However, palm oil industry has achieved zero-waste status due to the intensive research focussed on this area (Agamuthu, 1997). But oleochemical industry is relatively new and waste management in this industry is not efficient as palm oil plant. Hence, this research will concentrate on the downstream processing of palm oil and the wastes generated in these processes.

1.3 OLEOCHEMICAL INDUSTRY

1.3.1 A General Overview of Oleochemical Industry

The oleochemical industry produced chemicals from natural oils and fats. The popularity of the oleochemical products is increasing, particularly due to the fact that the raw material of this industry is from renewable sources such as castor oil, palm oil and tallow. The size of the global oleochemical industry can be indicated by the capacity of its production, which has exceeded 1.7 million tonnes per annum (tpa) (Speed, 1990). In Malaysia, oleochemical industry plays an important element within the Industrial Master Plan of Malaysia (IMP). Malaysia is one of the largest producers of oleochemicals and the country also has become a member of the ASEAN Oleochemical Manufacturers Group (AOMG). Other members of the AOMG are Thailand, Indonesia and Philippines. Among the four countries, Malaysia has the biggest number of oleochemical plants in the ASEAN region. The 16 established plants are owned and managed by locals and also foreign joint-venture companies. Among the established oleochemical companies in Malaysia are Acidchem International Sdn. Bhd., Akzo Nobel Oleochemical Sdn. Bhd., Fatty Chemical (Malaysia) Sdn. Bhd., FPG Oleochemical Sdn. Bhd., Cognis Oleochemical (M) Sdn. Bhd., Natural Oleochemical Sdn. Bhd., Palm Oleo Sdn. Bhd., Pan-Century Oleochemical Sdn. Bhd, Southern Acids (M) Sdn. Bhd., and Uniqema Malaysia Sdn. Bhd.

1.3.2 Cognis Oleochemical (M) Sdn. Bhd.

This research was carried out using waste from Cognis Oleochemical (M) Sdn. Bhd., which was previously known as Henkel Oleochemical (M) Sdn. Bhd. It is located in Teluk Panglima Garang, Selangor.

The company is one of the major manufacturers of basic oleochemical products which include caprylic-capric acids, fatty acid methylesters, distilled palm kernel fatty acid, fractionated fatty acid methylesters, fractionated fatty acids, saturated fatty alcohols and glycerine. The glycerine produced by Cognis Oleochemical (M) Sdn. Bhd is classified as P 11 EUR and has a purity between 99.5% and 99.8%.

The company's current export markets include Australia, Bangladesh, Belgium, Brazil, China, Egypt, Ethiopia, France, Germany, Hong Kong, India, Indonesia, Ivory Coast, Japan, Kenya, Kuwait, Lebanon, Malawi, Mexico, Nepal, New Zealand, Pakistan, Philippines, Saudi Arabia, Singapore, South Korea, Spain, Sri Lanka, Syria, Taiwan, Tanzania, Thailand, Tunisia, United States of America, United Arab Emirates, United Kingdom, Venezuela, Vietnam, and Zimbabwe.

Due to the rapid development in the industrial sector in Malaysia, the oleochemical industry faces problems of limited labour force and higher labour cost, and is also facing the problem of complying to the strict environmental protection regulations set by the DOE. Realising that the compliance of regulations is important to remain competitive in the oleochemical sector, many industries including Cognis Oleochemical (M) Sdn. Bhd. implemented Cleaner Technology in the production line and has been finding alternative solutions for waste treatment and disposal. Cognis Oleochemical's wastewater effluent is within the regulations stipulated by the Department of Environment (DOE), Schedule B. The company generates wastes, like wastewater sludge and glycerol residue, which are very high in organic compounds. As the company is under the process of adapting the ISO 14000, Environmental Management System (EMS) has been taken into consideration in the manufacturing process.

1.3.3 Waste Generated by Cognis Oleochemical (M) Sdn. Bhd.

The two major types of wastes generated by this company are the wastewater sludge and the glycerol residue. The wastewater sludge is generated from the wastewater treatment plant of the company. Water from various sources are combined and are allowed to enter the wastewater treatment plant where the wastewater undergoes physical, chemical and biological treatment as indicated in Figure 1.1

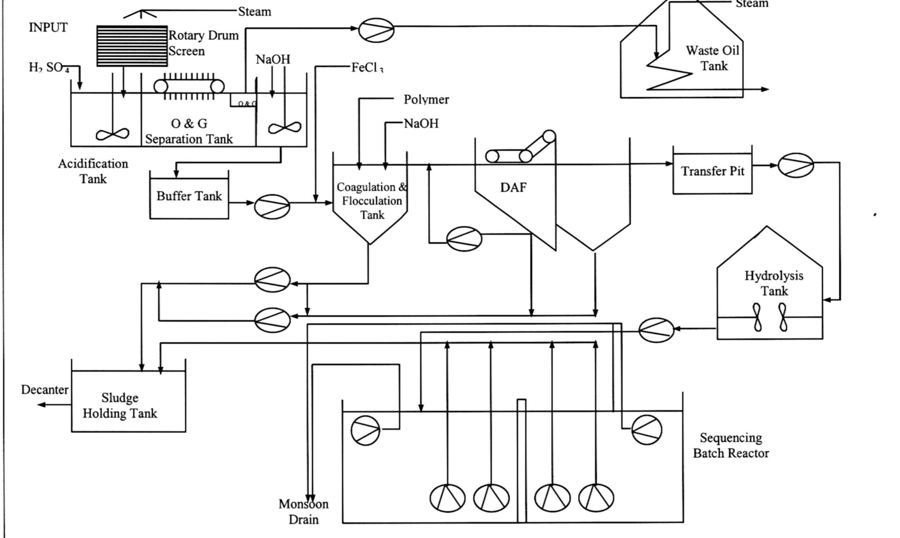

Figure 1.1: Detailed Diagram of The Production of Wastewater Sludge

About 800 to 900 m^3 of wastewater sludge are produced daily. The wastewater sludge generated by Cognis Oleochemical (M) Sdn. Bhd. can be disposed of in municipal solid waste landfill. This is so because the wastewater sludge contains no hazardous components. A simplified process flow of the wastewater is shown in Figure 1.2.

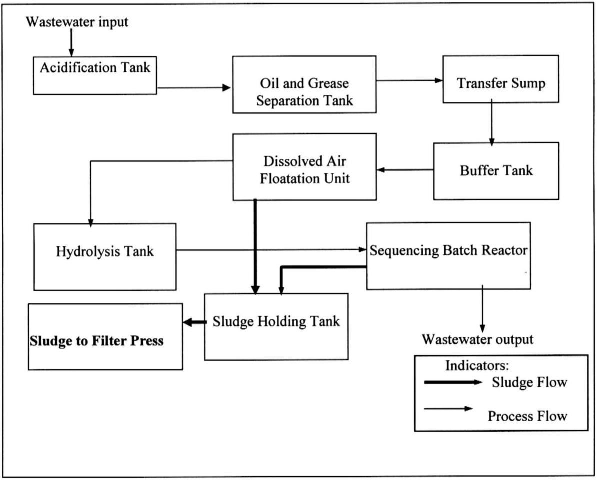

Figure 1.2: Simplified Process Flow of The Wastewater Treatment Plant Generating Sludge

The production of glycerol residue is much lesser compared to wastewater sludge as it is only produced from the transesterification process that is during the alcohol separation. The daily production of glycerol residue is less than one tonne and the production flow is shown in

Figure 1.3.

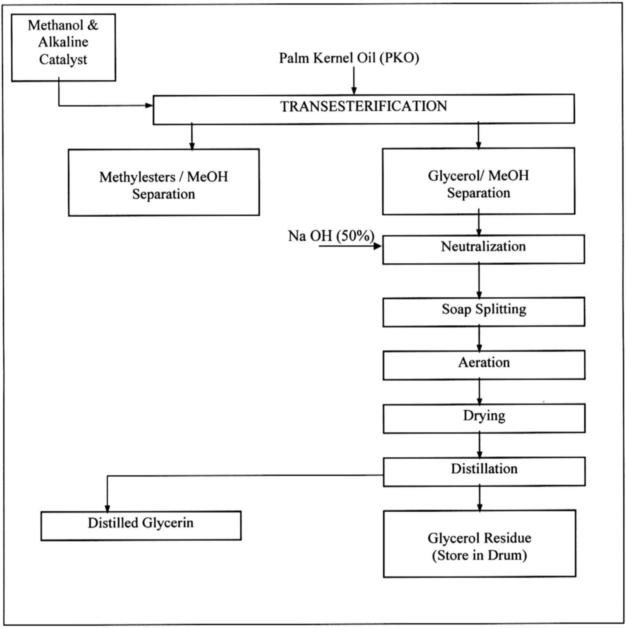

Figure 1.3: Flowchart of Glycerol Residue Production

The glycerol residue contains high concentrations of organic compounds and the major components are shown in Table 1.2. Due to the high alkalinity of nearly pH 10 to 12, the glycerol residue is classified as scheduled waste according to the Environmental Quality

(Scheduled Wastes) Regulations, 1989. Therefore, glycerol residue from this company requires special treatment and is disposed at The Integrated Scheduled Waste Treatment Centre at Bukit Nanas. Even though the only hazardous character of the waste is the high alkalinity and the high sodium content, the company has no option but to spend up to RM 700 per tonne for the disposal of glycerol residue.

Table 1.2: Typical Characteristics of Glycerol Residue

Content	Range	Mean
Glycerol (%)	15 – 35	23
Soap (%)	10 - 40	25
Sodium Chloride (%)	30 - 60	44
Free Fatty Matter (%)	0.5 - 8	3
Water (%)	1 - 10	6
pH	10 - 12	11.7
Appearance	Light to Dark Brown Powder or Paste	
Ash (%)	50 - 70	50

1.4 COMPOSTING AS AN ALTERNATIVE FOR WASTE MANAGEMENT

In order to prevent pollution and minimise waste generation, the option of treating waste into useful products is being seriously considered. Due to the presence of high organic content in the waste, particularly in wastewater sludge, biological treatment promises to be the best option.

The wastewater sludge produced is 100% organic meanwhile the glycerol residue contains nearly 87 % of organic components. Therefore, both waste have a higher possibility to be converted into compost. A research by Spellman (1997) showed that most wastewater biosolids or sludge could be used in the composting process to accelerate composting. However, the biological activities of microbes and the rate of composting depend on the nature of the material being composted (Singleton and Sainsbury, 1994).

A quality compost derived from biosolids can contain up to 2 % nitrogen, 2 % phosphorus, 1 % potassium and trace elements essential for plant growth (Spellman, 1997). However, the nutrient content of biosolids-derived compost is not its most valuable feature, instead, its moisture retaining and humus forming properties are more significant. Composting converts organic wastes into a stabilised form, reduces the volume of the waste material that must be handled, destroys pathogens, provides a means of recycling valuable plant nutrients, and the compost can be used as an effective soil conditioner for improving the growth of crops.

Composting of the waste not only allows the waste to be degraded biologically but also produces a commercial product with the production of good compost. The application of compost to agricultural soil is recognised as an effective method of improving productivity in agroecosystems.

1.5 PROJECT SUMMARY

The project was carried out in six stages as indicated in Figure 1.4. The first stage is the waste audit and investigation of reuse/ recycle possibility, which was conducted in the plant. The process was carried out for 4 weeks. The rest of the project was conducted in the laboratories in Institute of Postgraduate Studies and Research (IPSR), University of Malaya and Institute of Biological Sciences Research Farm, University of Malaya. The second stage involved the preliminary analysis while the third and fourth stages involved the preliminary and the actual composting trials. The fifth and the final stages involved planting trials using the compost prepared from the previous stages, and cost evaluation and comparison, respectively.

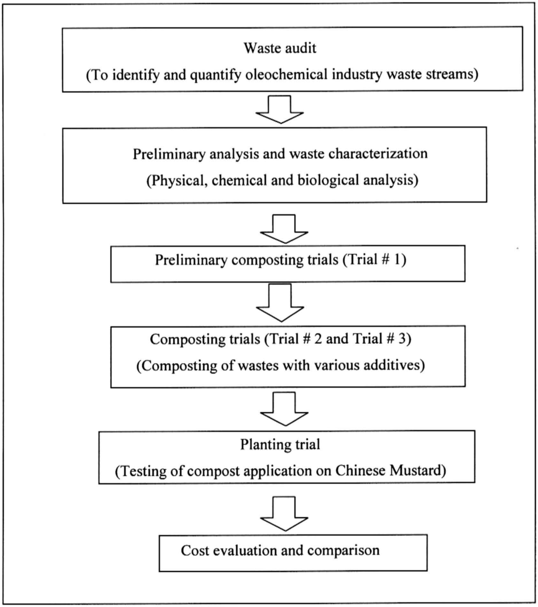

Figure 1.4: Simplified Flow Chart of Steps Involve in The Project

1.6 OBJECTIVES OF PROJECT

The objectives of the project are as follows:

1. to carry out waste auditing, to identify and quantify the unavoidable waste stream from the oleochemical industry processes.
2. to characterise the Cognis Oleochemical (M) Sdn. Bhd. industry waste and to investigate possibilities of reduction, recycling and reuse of waste materials.
3. to study composting of waste from Cognis Oleochemical (M) Sdn. Bhd. as an alternative treatment, disposal option to prevent environmental degradation, and to establish a cost estimate of the various waste treatment and disposal options.
4. to carry out field trials to determine the suitability of the application of the compost to plant, *Brassica* sp. (Chinese mustard) growth.