CHAPTER 1

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1.1 General Introduction

The traditional wastewater management concept (urban wastewater collection system plus treatment of the wastewater in a central treatment plant) has been successfully applied over many decades in densely populated areas of industrialized countries. Whether this technology is of ultimate wisdom must be questioned, especially considering the urgent need for improved sanitary infrastructures in developing countries. The problem is that the costs for implementing a centralized system in mega-cities, particularly the investment costs for the sewer system, are exorbitant.

Decentralized wastewater management systems, with the wastewater treated close to where it is generated, are being considered by various researchers and institutions including the World Bank as an alternative to the traditional centralized system. When mass-produced, the costs for manufacturing such package plants can presumably be kept at a relatively low level. The plants should be delivered in a "user ready" state. The plant should produce an effluent, which is hygienically safe and can subsequently be utilized for toilet flushing, washing clothes, cleaning floors or watering lawns. In order to keep the plants operating properly, they should be controlled by remote sensing, and maintained by specialized service enterprises (Wilderer, 2000).

The increasing scarcity of clean water sets the need for appropriate management of available water resources. Regions suffering from lack of water urgently need integrated environmental protection and resource conservation (EP&RC) technologies in order to enable effective management of the available water resources. EP&RC-concepts focus on minimization of consumptive use of energy, chemicals, and water and a maximization of reuse of treated wastewater and of residues produced from the pollutants present in the wastewater. Consequently, by implementing these concepts, wastewater like sewage and industrial effluents become an important resource for water, fertilizers, and soil conditioners and to some extent also as an energy source (Van Lier, 1999).

The water resource is under increasing pressure, both from the increase in population and from the wish to improve the living standards of the individual. Water scarcity is defined as the situation where demand is greater than the resource. Water reuse becomes an option that has been considered exotic until recently. Water treatment has to be interpreted as the means by which to purify the water from any degree of impurity to any degree of purity that fits the desired use, including reuse. Water can be purified to any degree of purity - except zero. The challenge of future reuse will be to account for the attitudes related to trace chemicals in water (Harremoes, 2000).

The concepts of wastewater design and source control are introduced as contracts between wastewater handling agencies and consumers and consumers and industry respectively. Wastewater design serves to produce wastewater streams that are optimized in composition and time sequence for easy treatment. Source control makes services and installations available, which allows the consumer to adhere to the specifications of wastewater design. Increased delegation of responsibility to the consumer is expected to result in more flexible wastewater handling systems (Larsen, 2001).

New technologies are looking ways to prevent the pollution at source. Thus, end of pipe solution plays an important role especially in developing countries like Malaysia, in order to prevent pollutants from entering the ecological system. Designing a good wastewater treatment plant (WWTP) has been the example of end of pipe solution.

1.2 Water Pollution in Malaysia

On the whole, the environmental quality in 2001 showed an improvement compared to year 2000. In terms of water quality, the measurements indicated a reduction in the level of pollution in several rivers. The total number of clean river basins increased from 34 in 2000 to 60 in 2001. The estimated number of effluent related sources in 2001 was 13160 comprising mainly of agro-based industries, manufacturing industries, pig farms and sewage treatment plants (Figure 1.1) (DOE, 2001).

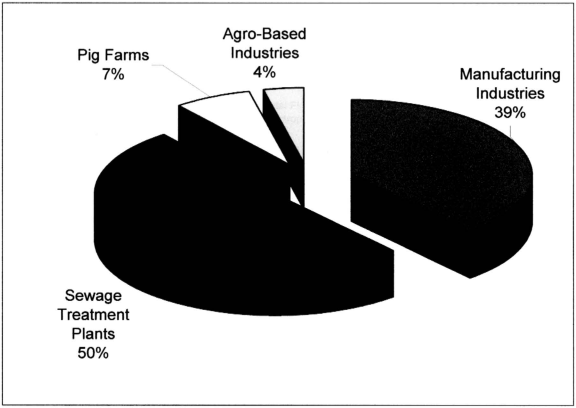

Figure 1.1

Water Pollution Sources by Sector for Year 2001

Based on Department of Environment (DOE) inventory compilation in 2001, a total of 5558 agro-based and manufacturing industries were identified and categorized into 16 types. The main sources in term of numbers were food and beverage industries, followed by chemical-based industries, paper products industries, rubber based industries, textile industries, electric and electronic industries, crude palm oil mills and raw natural rubber factories (Figure 1.2) (DOE, 2001).

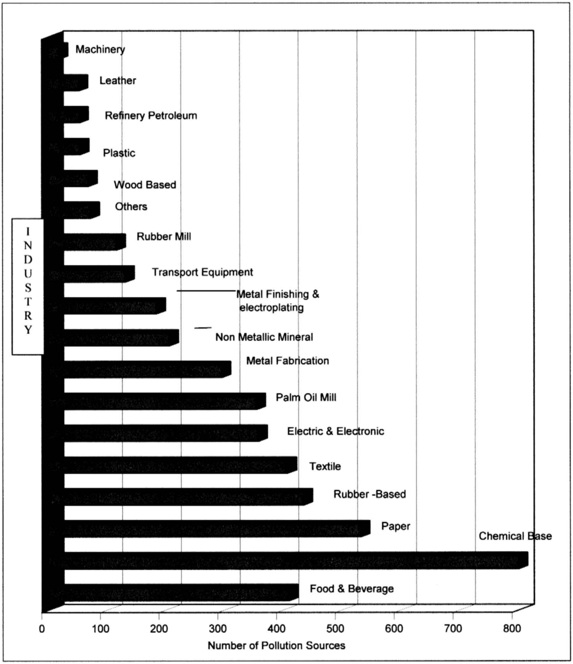

Figure 1.2

Industrial Water Pollution (Agro-based and Manufacturing Industries), 2001

Of the total number of identified sources in the agro-based and manufacturing sector, the highest numbers were in Johor, followed by Selangor, and Perak. Perlis had the least number (Figure 1.3) (DOE, 2001).

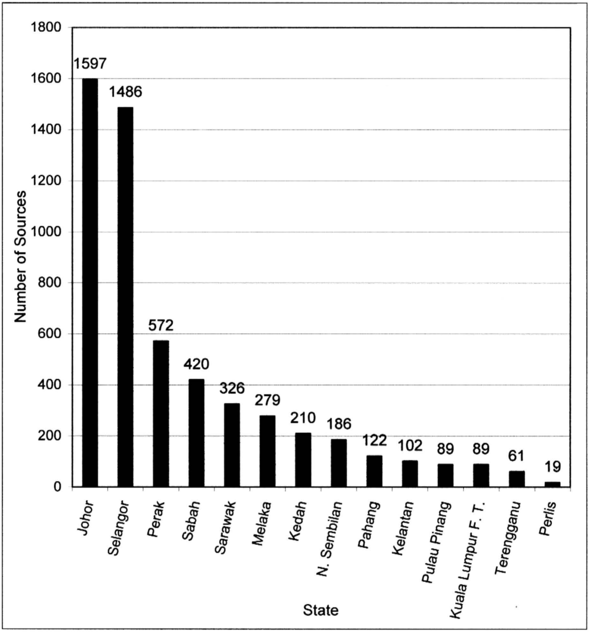

Figure 1.3

Industrial Water Pollution Sources (Agro-based and Manufacturing Industries) By State (2001).

1.3 Pollution Loading In Malaysia

Overall domestic sewage discharges remained the largest contributor of organic pollution load with an estimated Biochemical Oxygen Demand (BOD) load of 1101 tonnes/day. Out of this amount, 49.8% was contributed by IWK (Indah Water Konsortium) sewage treatment plants. Besides that, pig farming activities contributed 35 tonnes/day, manufacturing industries 23.6 tonnes/day and agro-based industries 22 tonnes/day (refer to Figure 1.4). In terms of organic pollution load by types of industry (refer to Figure 1.5), palm oil mills were the largest contributor of organic pollution load, followed by food & beverages, paper products, chemical-based industry and rubber mills (DOE, 2001).

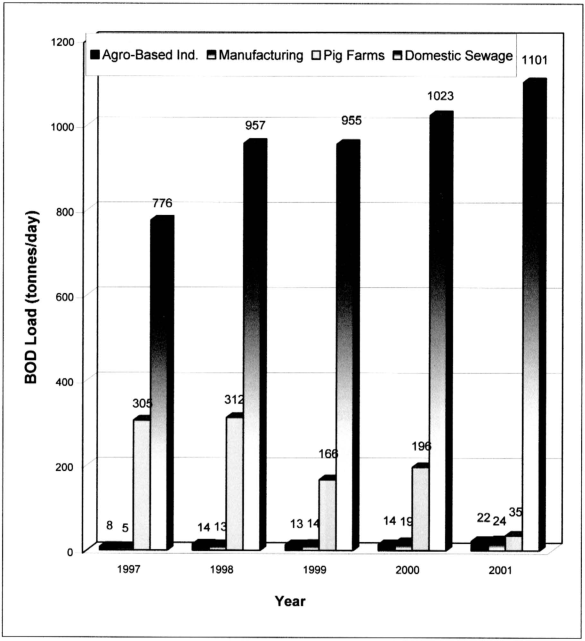

Figure 1.4

Estimated BOD Load By major Sectors,(1997 – 2001)

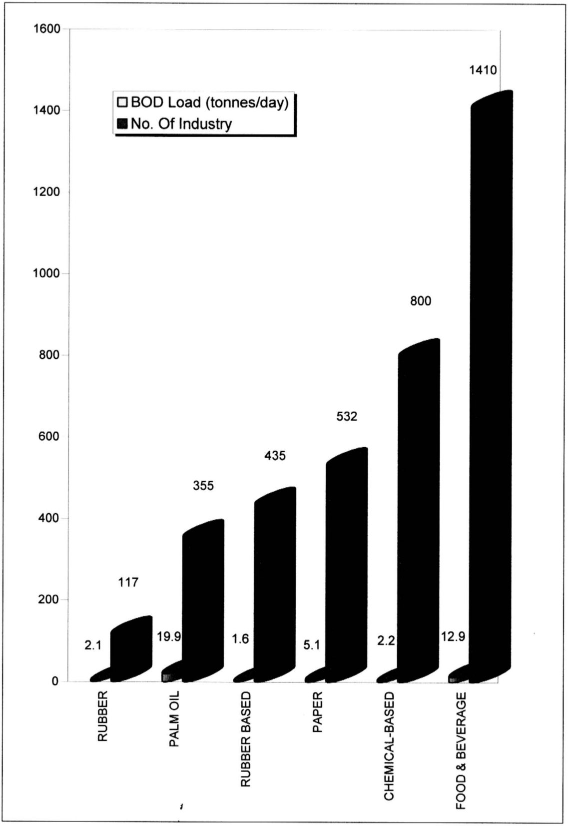

Figure 1.5

Estimated Organic Pollution Load (BOD) by Industrial Types,(2001)

1.4 Wastewater Treatment Plant

Building Wastewater Treatment Plant (WWTP) for each type of industry is quite a normal scene anywhere in the world. The WWTP is better controlled if the waste loading entering the plant is of one type of wastewater source only. But some industries have too little wastewater and do not have facilities in terms of space and finance to cater for building and controlling a WWTP. Therefore an integrated approach is more practical for these types of industries to co-operate and have only one treatment plant to cater to all type of wastes. An industry can build their WWTP and include other wastes from various industries in their area. By making these industries pay for the waste load entering the plant, the owner indirectly sustains his own running cost of the WWTP.

This thesis discusses the approach used to build such a type of plant in Malaysia. Initial investigations of the various characteristics of the wastes contributed by other industries within the vicinity were carefully carried out. It is essential that the main waste contributors be identified before the plant is designed.

An integrated WWTP has been set up to handle combined effluents from Central Utilities Facilities (CUF) and BP PETRONAS Acetyl Sdn Bhd (BPPA) for a 400,000 tonnes acetic acid plant (AAP) and its neighbouring plants. The stakeholders of AAP are British Petroleum (70%) and Petronas (30%). Enersave Engineering Systems Sdn. Bhd was awarded the contract to build the integrated plant. The combined wastewater is from CUF and its customers. The wastewater consists of discharge from water filters, water demineralisation packages, boilers, cooling towers, waste from Acetic Acid Plant (BPPA), Vinyl Chloride Monomer Plant (VCM), Ammonia Syngas Plant (ASGP). Wastewaters are also contributed from the CUF plant, which consists of plant run-off and storm water run-off.

The existence of many types of industries in the vicinity of the main plant (CUF) contributes a variety of wastes to the environment. Thus, the client decided, from an economical point of view, to build one WWTP that integrates all the wastes which would cut down on the cost of operating and building many WWTP. The CUF is a biological secondary treatment system and it uses the activated sludge process to treat the combined waste.

The main reason for the commissioning of the WWTP is to hand over the project to the client by the contractor. The contractor had managed the plant from the day the plant was built. To hand over the plant to the client, a 8 days commissioning period was required and at the end of the 8th day, the full DOE Standard B discharge limits must be complied to. The client and the contractor have agreed to this. During this period if the discharge limits do not comply with the full DOE Standard B requirements, the contractor needs to report the reasons for non-compliance and modify the operations of the plant untill another commissioning is carried out. During this period the contractor must also study the incoming wastes from the client and investigate if it meets or differs from the design specifications given by the client of each respective plants.

The treatment of multiple industrial wastewaters is always complicated and a problem often arises when the complexity increases. It is not only influenced by the actual incoming waste stream, but also the engineering of the plant, the skills and knowledge of the process manager and in particular the operator. These variables can all affect the final plant performance. At the time during the completion of this study, all units in the integrated plant have been operational except for the sludge treatment and sludge handling, as there was inadequate sludge produced to run the units.

1.5 Objectives

Discharge must satisfy effluent and water quality objectives or standards if they are to be discharged without creating a nuisance. Treatment facilities for accomplishing this may range from relatively simple land-based treatment systems to complex automated wastewater treatment plants. In some situations, several treatment methods may be equally suitable. And finally, the final choice of WWTP is based partly on engineering analysis, consultancy, and track record of the process.

The objectives to be achieved in this dissertation are as follows:-

- to characterize the various incoming wastewater types
- to study the integration of various wastewater into one treatment facility.
- to identify and remove all the pollutants and produce an effluent that meets the DOE full Standard B discharge level.
- To assess biological treatment as part of the overall performance assessment and identify the cause of fluctuations of the parameters in the treated effluent from this WWTP.

The main factors, which are taken into consideration, are physical, chemical and biological characteristics, as well as, the methods, design, management and monitoring of the WWTP.