PRE-TREATMENT OF WASTEWATER AT WET MARKET USING EFFECTIVE MICROORGANISM (EM) TECHNOLOGY

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ABSTRACT

Wastewater quality was very important because it surround us almost everywhere. Aquatic life can be destroyed and health problems also can occur and affect human being. The quality of wastewater coming from wet market was known to be a public problem before it being treated. Pre-treatment process by using environment friendly method, Effective Microorganism (EM) Technology was proposed to be a solution way to reduce pollution problem with the wastewater. The objectives of the research were to determine the level of parameters of wastewater coming from the wet market and to see how effectiveness of using EM technology as the pre-treatment of the wastewater from the wet market. Sample taken from Pasar Borong Kemunting, Pahang and be analyzed in UMP laboratory. The experimental was carried out once a week and continues for 12 weeks period. The 7 parameters were analyzed which include pH, Turbidity, Total Dissolve Solid (TDS), Ammonia Nitrogen, Total Suspended Solid (TSS), Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD). The 7 parameters will be referred to Standard Examination of Water and Wastewater by American Public Health Associate (APHA, 2002). In this research, wastewater sample collected from the wet market being added by two types of EM which were Effective Cultura (EC) and J-M21 (JM). The results obtained then being compared to the Interim National Water Quality Standard (INWQS) for Malaysia to see the differences. Statistical analysis of the data to evaluate performance differences among two type of EM was done by using Independent Sample T-test in Social Scientific Statistical Software (SPSS). Based on the finding result, it was found that most of the parameter improved in water quality after EM was added like turbidity, AN, TSS, COD and BOD. The most positively improvement from the results was turbidity parameter, which changes from Class II to nearly Class I after pre-treatment were made. Turbidity percentages of changing were determined as 73% for EC and 74.7% for JM. However, more time was needed to see the optimum reaction of the EM. From the study, it hopes to provide solutions to the pollution. EM technology was easy to use and cost effective because it does not requires changes to the existing treatment and collection system and application equipment is relatively inexpensive.

ABSTRAK

Kualiti Air Sisa adalah sangat penting kerana ia berada hampir di mana-mana. Ia boleh mengakibatkan hidupan air musnahkan dan masalah kesihatan berlaku terhadap manusia. Sebelum air sisa dirawat, kualiti air sisa dari pasar basah telah dikesan menjadi salah satu masalah umum. Proses pra-rawatan dengan menggunakan kaedah yang mesra alam iaitu Teknologi Mikroorganisma Efektif (EM) dicadangkan menjadi penyelesaian bagi mengurangkan masalah pencemaran air sisa. Tujuan kajian ini adalah untuk menentukan tahap parameter air sisa yang berasal dari pasar basah dan untuk melihat bagaimana keberkesanan penggunaan teknologi EM sebagai proses pra-rawatan air sisa dari pasar basah. Sampel diambil daripada Pasar Borong Kemunting, Pahang dan dianalisa di lab UMP. Data eksperimen diambil pada setiap minggu dan dijalankan selama 12 minggu. Tujuh parameter dianalisis yang meliputi pH, Kekeruhan, Jumlah Pepejal Terlarut (TDS), Ammonia Nitrogen (AN), Jumlah Pepejal Terampai (TSS), Keperluan Oksigen Kimia (COD) dan Keperluan Oksigen Biokimia (BOD). Tujuh parameter tersebut dirujuk kepada Standard Pemeriksaan Air dan Air Sisa oleh 'American Public Health Association (APHA, 2002). Dalam kajian ini, sampel air sisa dikumpul dari pasar basah dan ditambah dengan dua jenis EM iaitu 'Effective Cultura' (EC) dan J-M21 (JM). Keputusan yang diperolehi kemudian dibandingkan dengan Interim National Water Quality Standard (INWQS) untuk Malaysia. Keputusan ini juga dianalisis secara statistik untuk melihat perbezaan dengan menggunakan 'Independent Sample T-test' di dalam 'Social Scientific Statistical Software' (SPSS). Berdasarkan hasil kajian, didapati bahawa sebahagian besar parameter mengalami peningkatan kualiti air selepas EM ditambah seperti kekeruhan, AN, TSS, COD dan BOD. Keputusan yang paling efektif adalah kekeruhan dimana keputusan dari parameter kekeruhan berubah daripada Kelas II ke Kelas I selepas pra-rawatan dibuat. Peratusan perubahan bagi setiap jenis EM adalah 73% untuk EC dan 74.7% untuk JM. Namun, lebih banyak masa diperlukan untuk melihat reaksi optimum EM. Dari kajian ini, ia harap dapat memberikan penyelesaian untuk pencemaran. Teknologi EM adalah mudah digunakan dan kos efektif kerana tidak memerlukan perubahan untuk rawatan yang sedia ada dan sistem pengumpulan dan peralatan aplikasi yang relatif murah.

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LIST OF ABBREVIATIONS

EM	-	Effective Microorganism
BOD	-	Biochemical Oxygen Demand
TDS	-	Total Dissolved Solids
COD	-	Chemical Oxygen Demand
TSS	-	Total Suspended Solids
AN	-	Ammonia Nitrogen
DOE	-	Department of Environment
IWK	-	Indah Water Konsortium Sdn. Bhd.
STP	-	Sewerage Treatment Plant
PE	-	Population Equivalent
NPS	-	Non-point source
FOG	-	Fats Oils and Grease
CWA	-	Clean Water Act
NFR	-	Non-filterable residue
INWQS	-	INTERIM National Water Quality Standard
SPSS	-	Social Scientific Statistical Software
APHA	-	American Public Health Association
EC	-	Effective Cultura
JM	-	J-M21

LIST OF SYMBOLS

%	-	Percent
kg	-	Kilogram
m^3	-	Cubic meter
ppm	-	Parts per million
mg/L	-	Milligrams per liter
^oC	-	Degree Celsius
:	-	Ratio
^oF	-	Degree Fahrenheit
mL	-	Mililiter

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Water quality is a term to express the suitability of water to sustain various uses or processes. Wastewater is any water that has been adversely affected in quality by anthropogenic influence. It needs to be treated to minimize the effect on human's health and environment.

Although there are many methods used, there are numerous concerns raised regarding the presence of constituents including heavy metals, pathogens and other toxic substances. This requires the selection of the correct disposal method focusing on efficient and environmentally safe disposal. New technologies are being produced to assist in the treatment and disposal of sewage sludge, conforming to strict environmental regulations. One of these new technologies being proposed is the use of Effective Microorganisms (Szymanski and Patterson, 2003).

The technology of Effective Microorganisms (EM) was developed during the 1970's at the University of Ryukyus, Okinawa, Japan (Sangakkara, 2002). Studies have suggested that EM may have a number of applications, including agriculture, livestock, gardening and landscaping, composting, bioremediation, cleaning septic tanks, algal control and household uses (EM Technology, 1998).

Effective Microorganisms or EM was first introduced 25 years ago by Dr. Teruo Higa, a professor of Horticulture from Japan. EM and useful microorganism is produced from ingredients which are used in the food industry through the fermentation process. EM is highly effective for the degradation of organic ingredients which has been used from more than 150 countries. The principles of EM usage are to improve human health standards, provide economical benefits, ease of use, environment friendly and quality productivity. EM is a mixture of groups of organisms that are coexisting anaerobic and aerobic beneficial microorganisms for humans, animals and the natural environment. The main species involved in EM are: Lactic acid bacteria, Photosynthetic bacteria, yeasts, Actinomycetes and fermenting fungi (Szymanski and Patterson, 2003).

The basic purpose of EM is the restoration of healthy ecosystem in both soil and water by using mixed cultures of beneficial and naturally-occurring microorganism. Therefore, the EM has great potential in creating an environment most suitable for the existence, propagation, and prosperity of life (Higa & Parr, 1994).

The EM technology has a great potential for restoring water quality by increasing freshwater supply to meet the demand of various sectors. However, the sustainability of the freshwater supply for domestic, agriculture and industrial use need to be analyzed as it would be a critical aspect of sustainable water management.

1.2 Problem Statement

The river systems in Malaysia are an integral part of the water resources system. There are more than 100 river systems in Malaysia, contributing more than 90 per cent of the raw water supply. Decades of rapid modernization and industrialization have inevitably led to the severe deterioration of the river water quality. Recently EM has become a successful weapon in the cleaning of water in nature, especially in regions of Asia. It is through the activity of these EM that the river pollutants in Malaysia are also starting to be broken down and cleaned. The EM technology has and is being applied in different domains nationwide beginning 2008 (Zakaria *et. al.*, 2010)

In 2008, the number of river basins monitored remained at 143 and the number of monitoring stations was 1,063. Out of these, 612 (58%) were found to be clean, 412 (38%) slightly polluted and 39 (4%) polluted. There was a significantly reduction in the number of clean river basins in 2008 compared with 2007. There were 76 (53%) clean river basins in 2008 as compared with 91 in 2007. However, the number of polluted river basins remained at 7. The decrease in the number of clean river basins was attributed to two factors. Firstly, an increase in the number of polluting sources such as sewage treatment plants, agro-based factories and pig farms which contributed to an increased in the pollutant load. Secondly, a decrease in the amount of rainfall in the states of Pahang and Sarawak deteriorated from clean to slightly polluted (DOE, 2008).

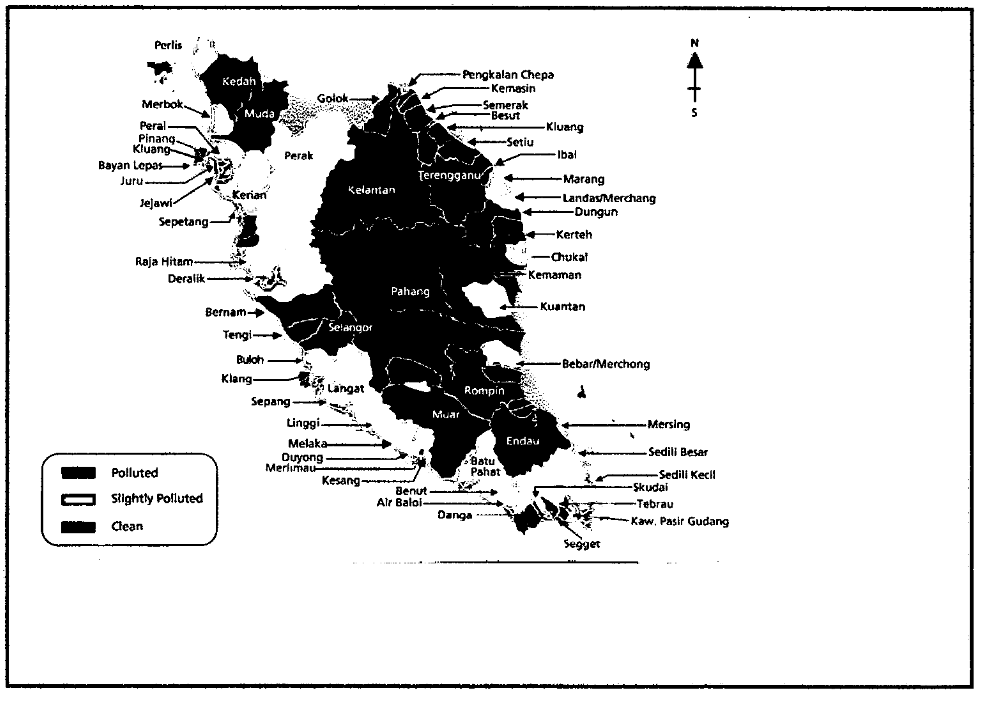

Figure 1.1: Water Quality Status for River Basins of Peninsular Malaysia (DOE, 2008)

The scenery of wet market in Malaysia which synonyms with unpleasant odor, dirty environment, and pathogen development. It can cause pathogenic organisms transmit disease to humans and cause water pollution. Wastewater produce by the wet market can causing pollution if not being treated at the early stage. Problems that have to be study is due to the wastewater from composing vegetables, fruits, meats and fish at the main Kuantan's wet market that are doubted in their quality.

This research will propose economically and easy-to-use method that can be used by the hawkers to improve their working environment at the wet market. The method suggested was an environment friendly method to solve the problems.

1.3 Objectives of Study

The objectives of this research are:

a) To determine the parameters level of wastewater at the wet market.
b) To determine the effectiveness of using EM technology as the pre-treatment of the wastewater from wet market.

1.4 Scope of Study

The scope of this study is to determine the wastewater profile of Kuantan's wet market (Pasar Borong Kemunting) after being treated by Effective Microorganism (EM) technology. Study will also show the effectiveness of this method in order to improving wet market environment and decreasing the number of water pollution.

Area of research is in Kuantan's main wet market where the sample of wastewater from fresh composing materials flow in drain will be taken and experimental in UMP's environment laboratory. Sampling of the study will be taken in several locations at the wet market to see the accuracy of the result.

For laboratory testing, samples will be added with several dosage of EM. The laboratory and on-site testing which will be conduct are Biochemical Oxygen Demand (BOD), Total Dissolved Solids (TDS), Chemical Oxygen Demand (COD), pH, and Total Suspended Solids (TSS), Ammonia Nitrogen (AN) and Turbidity. The quality parameters of wastewater also will be obtained from the laboratory testing.

1.5 Significant of study

From the study, it hope to improve the wet market environment to be more comfortable and clean, so that it will help the trades in their economic which have been problems due to competition from the hypermarkets.

We can know how EM will affect with the problem occur in wet market which will increase the wastewater quality. It later will act as the lowest impact and environment friendly method can be used by the communities in order to minimize the environment water pollution.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Water pollution is the contamination of water bodies like lakes, rivers, oceans, groundwater. Water pollution affects plants and organisms living in these bodies of water and in almost all cases the effect is damaging either to individual species and populations, but also to the natural biological communities.

In nature, the nutrition and environmental load of a water system will depend on the ecology in that particular area and the water quality will be sustained by the functioning of a self-cleansing process. This ecology stands on an ecological pyramid with the microflora as the base, and the water is purified through the food chain of plankton, small animals, and fish that are sustained by the microflora. However in polluted water systems, where pollution has built up and foul odors are produced, the amount of beneficial microorganisms will be reduced and putrefactive microorganisms will become dominant. Because of this, the purifying ability of the ecology will decrease, and a vicious circle will occur in which, as the nutrition and oxygen needed to sustain the ecology decrease, the ecology will be damaged even further (EM Research Organization, 2008).

2.2 Water Pollution

Water pollution is a major problem in the global context. It has been suggested that it is the leading worldwide cause of deaths and diseases, and that it accounts for the deaths of more than 14,000 people daily. An estimated 700 million Indians have no access to a proper toilet, and 1,000 Indian children die of diarrhea sickness every day. Some 90% of China's cities suffer from some degree of water pollution, and nearly 500 million people lack access to safe drinking water. In addition to the acute problems of water pollution in developing countries, industrialized countries continue to struggle with pollution problems as well. In the most recent national report on water quality in the United States, 45 percent of assessed stream miles, 47 percent of assessed lake acres, and 32% of assessed bay and estuarine square miles were classified as polluted (Wikipedia, 2010).

2.2.1 Water Pollution Problem in Malaysia

The Department of Environment (DOE) maintains mainly records of point sources. In 2008, 17,633 water pollution point sources were recorded. These comprise of sewage treatment plants (9,524: 54.01% inclusive of 668 Network Pump Stations), manufacturing industries (6,830: 38.73%), animal farm (788: 4.48%) and agro-based industries (491: 2.78%) as shown in Figure 2.1.

The number of sewage treatment plants under the management of Indah Water Konsortium Sdn. Bhd. (IWK) had increased from 9,337 plants in 2007 to 9,524 plants in 2008. Selangor had the largest number of sewage treatment plants (2,715: 28.5%), followed by Perak (1,422: 14.9%), Johor (1,061: 11.1%) and Negeri Sembilan (945: 9.9%)

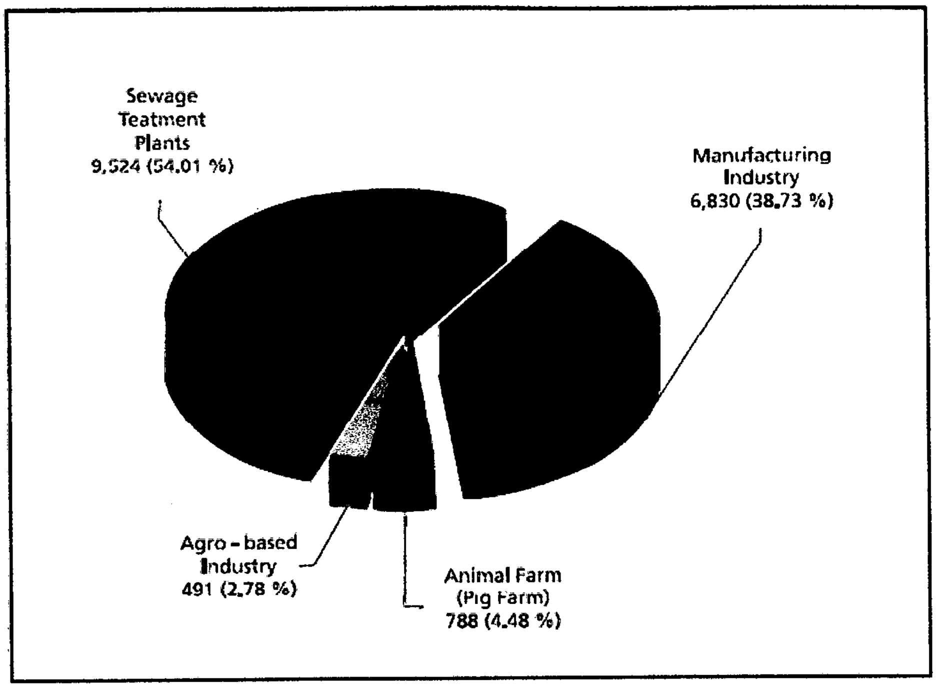

Figure 2.1: Composition of Water Pollution Sources by Sector (DOE Malaysia, 2008).

Domestic sewage discharge, in the form of treated sewage and partially treated sewage, remained the largest contributor of organic pollution load with an estimated biochemical oxygen demand (BOD) load of 944,533.80 kg/day. The estimated BOD loading contributed by other major sectors were agro-based and manufacturing industries (76,186.36 kg/day) and pig farming (226,929.17 kg/day). Table 2.1 indicates the total BOD load in kg/day discharged from sewage treatment plants throughout Malaysia in the states managed by IWK in 2008 (DOE Malaysia, 2008).

Table 2.1: Total BOD Load (kg/day) from Sewage Treatment Plants (IWK, 2008).

State	No. of STP	Total PE	Flow (m^3/day)	BOD Load (kg/day)
Selangor	2,715	6,579,871	1,480,471	370,117.74
Perak	1,422	1,300,646	292,645	73,161.34
Johor	1,061	1,370,605	308,386	77,096.53
Negeri Sembilan	945	996,659	224,248	56,062.07
Kedah	806	626,258	140,908	35,227.01
Melaka	770	623,622	140,315	35,078.74
Pulau Pinang	662	1,554,709	349,810	87,452.38
Pahang	521	332,668	74,850	18,712.58
WP Kuala Lumpur	307	3,195,659	719,023	179,755.82
Terengganu	231	69,165	15,562	3,890.53
Perlis	43	21,839	4,914	1,228.44
WP Labuan	32	42,309	9,520	2,379.88
WP Putrajaya	9	77,702	17,483	4,370.74
Total	**9,524**	**16,791,712**	**3,778,135**	**944,533.80**
Note: STP = Sewage Treatment Plant, PE = Population Equivalent				

2.2.2 Point Source Pollution

Point source pollution refers to contaminants that enter a waterway through a discrete conveyance, such as a pipe or ditch. Examples of sources in this category include discharges from a sewage treatment plant, a factory, or a city storm drain. The U.S. Clean Water Act (CWA) defines point source for regulatory enforcement purposes. The CWA definition of point source was amended in 1987 as in Figure 2.2, to include municipal storm sewer systems, as well as industrial stormwater (U.S EPA, 2003).

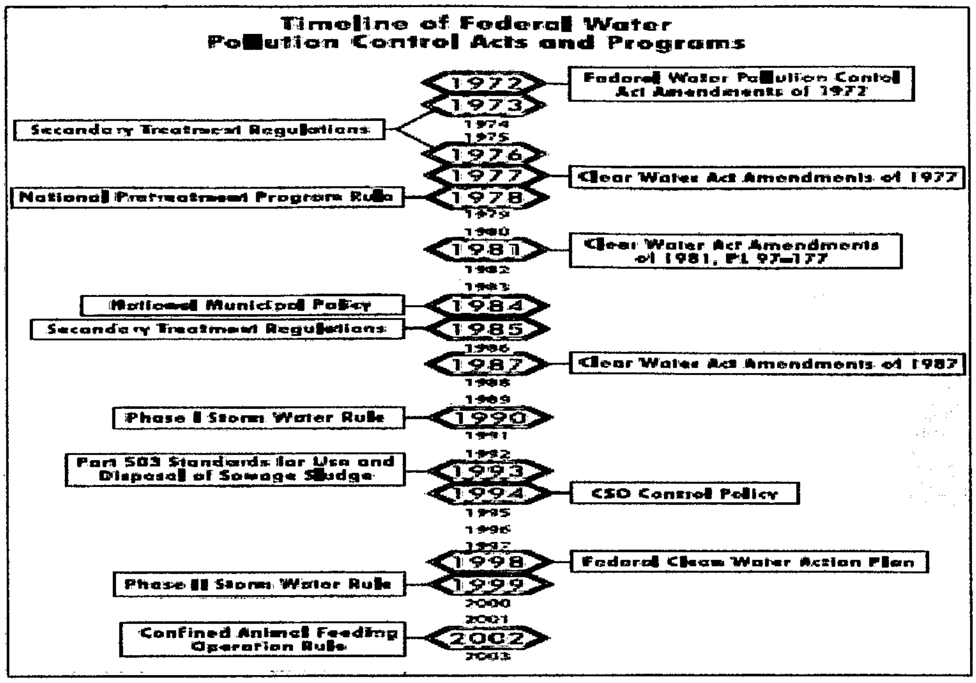

Figure 2.2: Timeline of Federal Water Pollution Control Acts and Programs (U.S EPA, 2003).

2.2.3 Non-point Source Pollution

Non-point source (NPS) pollution refers to diffuse contamination that does not originate from a single discrete source. NPS pollution is often accumulative effect of small amounts of contaminants gathered from a large area. The leaching out of nitrogen compounds from agricultural land which has been fertilized is a typical example.

2.3 Water and Disease

2.3.1 Microorganisms and Disease

Many aspects of daily life are dependent upon the activities of the smallest of organisms (microorganisms): from the preparation of food (e.g. yoghurt, bread, cheese) and drink (e.g. wine and beer), the production of antibiotics (e.g. penicillin), the natural breakdown of decaying material (composting), sewage treatment (activated sludge, filtration beds) - the list is endless. Equally, they can also be a nuisance to mankind causing, for instance, the corrosion of concrete pipes, spoilage of food and, of course, disease. Indeed, the history of mankind is inextricably dominated by a close interaction with the microbial world. However, the most effective manifestation of the activities of microorganisms is the range of diseases which they may give rise to in susceptible hosts (EM Trading, 2000).

Raw domestic wastewaters normally carry the full spectrum of pathogenic microorganisms - the causative agents of bacterial, virus and protozoan diseases endemic in the community and excreted by diseased and infected individuals. While recycling and reuse of wastewater for agriculture, industry and non-potable urban purposes can be a highly effective strategy for developing a sustainable water resource in water short areas, nutrient conservation and environmental protection, it is essential to understand the health risks involved and to develop appropriate strategies for the control of those risks (EM Trading, 2000).

2.4 Wastewater

2.4.1 Definition of Wastewater

Wastewater is any water that has been adversely affected in quality by antrophogenic influence. It comprises liquid waste discharge by domestic residences, commercial properties, industries, or agriculture and can encompass a wide range of potential contaminant and concentration. In the most comman usage, it refers to the municipal wastewater that contains a broad spectrum of contaminant resulting from the mixing of wastewater from different sources (Salt, 2001).

Generally waste water is synonymously with sewage even though sewage is a more general term that refers to any polluted water including wastewater, which may contain organic and inorganic substance, industrial waste, groundwater that happens to infiltration and to mix with contaminated water, storm, runoff, and other similar liquids (Miretzky *et al.* 2004).

2.4.2 Characteristic of Wastewater

In general, wastewater is water that has been generated from domestic and industrial sources where throughout the world by dumping 10,000 new organic compounds each year. These compound needs to be properly handled and removed if they cause health problem. There are many industrial plants that have required pre-treating their wastewater before dumping in the wastewater system (Chandra and Kulshrenta, 2004).

2.5 Wastewater Treatment

Wastewater collection systems like sewer networks and centralized and decentralized treatment systems are designed and managed primarily to protect human and environmental health. Though their benefits are widely recognized, there are other aspects of this infrastructure and associated technologies that are not so obvious and hence less acknowledged, yet they impact communities and the surrounding environment. For example a positive aspect of the sewer network is the collection and transport of wastewater to appropriate treatment facilities, whereby pathogens and chemical constituents such as oxygen-depleting organic matter and phosphorus are removed before the treated water is returned to the environment. A negative aspect of such a network is that it can create an imbalance in water and nutrient fluxes and therefore distort natural hydrological and ecological regimes. For instance the discharge of large volumes of treated wastewater that contains low concentrations of chemical constituents may still lead to an excessive input of nutrients in a receiving water body, thus, leading to a water quality problem (Muga and Mihelcic, 2008).