REMOVAL OF PHOSPHORUS BY MICROFLORA IN DRAIN

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I declare that this thesis entitled "Removal of Phosphorus by microflora in drain" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :..

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Date :

DEDICATION

In the Name of Allah, The Most Gracious and The Most Merciful

I humbly dedicated to…

my beloved mother and father

my family members

my friends

all people around me.

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ABSTRACT

One of the ways to reduce water pollution is to treat the wastewater from it source point. Wastewater biological treatment is one or the system that is used to treat wastewater before it can be discharged into the river. The aim of this study was to investigate the effect of micro flora in drain on the enhancement of biological phosphorus removal capability of a Sequencing Batch Reactor (SBR) inoculated initially with a mixed culture which was found in cafeteria drain. The experiment started with aerobic SBRs or known as treatment reactor 5l in volume, were filled with mixed cultures and different simulated wastewater concentration and organic loading rate (0.4, 1.3, 2.2, 3.1, and 4.0 mg/l day). All reactors were operated at constant hydraulic retention time (HRT) of 5 days. Along the experiment, three parameter were considered; Chemical Oxygen Demand (COD), Suspended Solid (SS) and Phosphorus concentration. The highest value of removal is 64% with 0.4 mg/l day operating loading rate. The amount of COD also reduces and showed that the micro flora used the oxygen to survive because COD indicates the mass of oxygen consumed per liter of solution. The highest COD removal is 92% with 1.3 mg/l day operating loading rate. From the analysis, SS also increase due to the growth of the micro flora.

ABSTRAK

Salah satu kaedah untuk mengawal pencemaran air adalah dengan merawat air sisa pada punca pencemaran yang dikenalpasti. Rawatan secara biologi adalah satu sistem rawatan air yang dibina bagi merawat air sebelum dilepaskan ke dalam sungai. Matlamat utama kajian ini adalah untuk mengkaji kesan mikroflora terhadap kebolehan memulihkan sisa air yang mengandungi fosforus dengan kaedah reaktor batch yg dicampur dengan mikroorganism yang diambil dari longkang kafeteria. Untuk kajian, aerobik reaktor atau lebih dikenali sebagai reaktor rawatan yang mengandungi kultur campuran dengan kepekatan sisa air buatan yang berbeza dan mengandungi kadar bebanan organik yang berlainan iaitu (0.4, 1.3, 2.2, 3.1, dan 4.0 mg/l hari) disediakan. Kesemua reaktor beroperasi pada kadar masa penahanan hidraulik masa yang tetap; 5 hari. Sepanjang eksperimen, tiga parameter diambilkira; Keperluan Oksigen Kimia, pepejal terampai dan kepekatan fosforus. Nilai peratus pengurangan kepekatan yang tertinggi adalah 64% dengan kadar bebanan organik 0.4 mg/l hari. Selepas eksperimen dijalankan, didapati kadar keperluan oksigen kimia berkurangan dan menunjukkan terdapat pertambahan mikroorganisma di dalam reaktor, memandangkan kandungan oksigen berkurangan. Nilai peratus pengurangan kadar keperluan oksigen kimia yang paling tinggi adalah sebanyak 92% dengan kadar bebanan operasi sebanyak 1.3 mg/l hari. Pertambahan mikroorganisma didalam reaktor menyumbang kepada pertambahan pepejal terampai.

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LIST OF SYMBOLS

L,l	-	Liter
mg	-	milligram
g	-	gram
kg	-	kilogram
t	-	time
hr	-	hour
^{o}C	-	degree Celsius

LIST OF ABBREVIATIONS

COD	Chemical Oxygen Demand
SS	Suspended Solid
TSS	Total Suspended Solid
EPBR	Enhanced Biological Phosphorus Removal
SBR	Sequence Batch Reactor
MBR	Membrane Batch Reactor
PAO	Polyphosphate Accumulation Organism
DNA	Deoxyribonucleic acid
RNA	Ribonucleic acids
OLR	Organic Loading Rate
P	Phosphorus

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CHAPTER ONE

INTRODUCTION

1.1 General

Water that is being used every day comes from multiple sources such as streams, rivers and lakes. This makes the rivers an increasingly scarce resource. Water scarcity is in fact a result of excessive exploitation of water bodies which in turns may result in depletion of those resources. Human tend to have clean water but at the same time contribute to the increased rate of pollution in water. Many lakes, river and stream are becoming increasingly polluted by industrial and agricultural activities, and most frequently by domestic wastes that are being discharged without proper treatment. The need of conducting a water quality treatment is significantly important for the evaluation of physical, chemical and biological nature of water of water in order to verify whether the observed water quality is suitable for the intended use. This would involve several physical, chemical and biological parameters to be taken into account as an indication of pollution level. When conducting such treatment program, it seems necessary that improvement measures should be taken upon polluted waters by controlling the rate of pollutants released into water bodies. The study emphasize on the significant of phosphorus removal using microflora as technologies to remove waste from water can be serves as an alternative for water quality improvement. This system stimulates the capability of indigenous microorganism for the degradation of wastes. This technology may improve the quality of environment by meant of practicing efficient and quality waste management system (Faradiella, 2005). The excess content of phosphorus in receiving waters leads to extensive algae growth (eutrophication). The phenomenon of eutrophication usually decreases the water quality and as a result it may increase significantly the cost of water treatment at treatment plants for surface water. The load of phosphorus discharged to receiving waters comes from various groups of sources of which the main sources are agricultural use of fertilizers, domestic and industrial wastewater, and atmospheric deposition (Stanisław Rybicki, 1997). The subject of this undergraduate research is the removal of phosphorus from wastewater by using microflora that can be found in drain.

1.2 Problem Statement

In a typical wastewater treatment process, optimum dosing of the appropriate chemicals, such as phosphorus is added into the water. When there is an insufficient dosing of phosphorus, may result in wastewater being untreated and at the same time, enhance pollution in water thus contribute to the poor surface water quality. This will affect the health of human and other living thing. One of the ways to reduce pollution in surface wastewater is to treat wastewater that contain phosphorus element at the sources point (Faradiella, 2005) This can be accomplished by using microflora at the sources point to treat water prior to discharge into the river. The microflora is breeding and will make reduce the phosphorus concentration in wastewater. The use of microflora enables this system to operate with the minimal maintenance due to its biological regeneration, thus this system is sustainable, effective and economical.

1.3 Objective of the study

The objectives of the study are:

(i) To study the degradation of ammonium-nitrogen by microflora in drain.

(ii) To study the effect of ammonium-nitrogen concentration in the growth of microflora.

(iii) To study the effect of different loading rate in ammonium-nitrogen removal.

At the end of the study, this objective will help in understanding the use of microflora in drain to treat phosphorus which is the main concern of this study.

1.4 Scope of Study

The scope of study includes the acclimatizing of microflora in drain to treat phosphorus in wastewater. The wastewater that contains PO^{3-}_4 was simulated with the appropriate nutrients for microflora. The initial simulated wastewater was analyzed. Then, experiments were conducted separately in treatment reactor with different operation loading rate (0.4, 1.3, 2.2, 3.1, and 4.0 mg/l day). The efficiency of treatment for different PO^{3-}_4 concentrations was evaluated in terms of water quality parameters (COD) and the changes in concentration. Besides that, the suspended solids parameter is used to measure the quality of the effluent.

CHAPTER TWO

LITERATURE REVIEW

2.1 Industrial Wastewater

Wastewater is described by its physical, chemical, and biological characteristics. The nature of the wastewater produced depends upon the processes that occur at each facility. Thus, treatment processes may be unique to each facility and the degree of treatment necessary is dependent upon the permit discharging requirements. Wastewater consists of organic and inorganic constituents. Some organic constituents include toxic chemicals, oils, grease, and volatile organic compounds. Inorganic constituents include trace heavy metals, chlorides, sulfur, pH, and nutrients, particularly ammonia nitrogen, nitrate, and phosphate. Additionally, wastewater may contain humid material, pathogens, toxins, and gases. Industrial wastewater treatment covers the mechanisms and processes used to treat waters that have been contaminated in some way by man's industrial or commercial activities prior to its release into the environment or its re-use (Belle, 2004). Most industries produce some wet waste although recent trends in the developed world have been to minimize such production or recycle such waste within the production process. However, many industries remain dependent on processes that produce water based waste stream. There are many sources of industrial wastewater such as agricultural wastewater, iron and steel industry, mines and quarries, food industries, complex organic chemicals industry, nuclear industry and water treatment (Tchobanoglous, 2003).

2.1.1 Sources of phosphorus in industrial wastewater

Industries produce waste that may be released directly to the atmosphere, land, surface waters or ground water or, in the case of solid or liquid waste, transferred off-site for land-based application, disposal in landfills or treatment in municipal wastewater plants. Most light industries discharge their wastewater into the municipal sewage system, their solid waste to municipal landfills, and their gaseous waste to the atmosphere. Industrial waste discharged to a licensed facility (a municipal wastewater treatment plant) is not typically regulated by the provincial or federal government with respect to the quantity or quality of their discharge. Some municipalities have sewer-use by laws regulating the strength of industrial discharges to sewer systems (Tchobanoglous, 2003). Wastewater biological treatment is designed to reduce bacterial contamination and biochemical oxygen demand, remove most Phosphorus (in the case of facilities with advanced Phosphorus removal) and, in some cases, convert ammonia to nitrate. There is little ability to do more than volatilize or dilute many industrial wastes. Large industries (pulp mills, mining operations, large manufacturing plants, etc.) that independently discharge their waste to air, water or land must obtain operating permits from the provincial government in which they are situated or, in the case of industries operating in the Territories, by the Federal Government (unless this responsibility has been devolved to the Territory). This permit may stipulate the quantity and/or quality of waste that can be disposed to land, air or water.

2.1.2 Disadvantages of Phosphorus

Phosphorus, in the forms to be found in waste water, is neither poisonous nor a health hazard. On the contrary, phosphorus is a component of many cell structures and the metabolism of animals and plants. Phosphorus occurs in sewage in its most highly oxidized forms and is therefore not an oxygen consuming substance. Nevertheless, phosphorus is a “problem” because in an aquatic environment, it is generally a limiting factor for the development of organisms. That means that the concentration of phosphates determines the extent to which e.g. algae (Phytoplankton) can develop or known as eutrophication (E. Kaschka, 1999). Eutrophication is frequently a result of nutrient pollution such as the release of sewage effluent and run-off from lawn fertilizers into natural waters (rivers or coasts) although it may also occur naturally in situations where nutrients accumulate (e.g. depositional environments) or where they flow into systems on an ephemeral basis (e.g. intermittent upwelling in coastal systems). Eutrophication generally promotes excessive plant growth and decay, favors certain weedy species over others, and is likely to cause severe reductions in water quality. In aquatic environments, enhanced growth of choking aquatic vegetation or phytoplankton (that is, an algal bloom) disrupts normal functioning of the ecosystem, causing a variety of problems such as a lack of oxygen in the water, needed for fish and shellfish to survive. The water then becomes cloudy, colored a shade of green, yellow, brown, or red. Human society is impacted as well: eutrophication decreases the resource value of rivers, lakes, and estuaries such that recreation, fishing, hunting, and aesthetic enjoyment are hindered. Health-related problems can occur where eutrophic conditions interfere with drinking water treatment. (Stanisław Rybicki, 1997)

2.1.3 Level Measurement to discharged Phosphorous

Surface waters contain certain level of phosphorus in various compounds, which is an important constituent of living organisms. In natural conditions the phosphorus concentration in water is balanced i.e. accessible mass of this constituent is close to the requirements of the ecological system. When the input of phosphorus to waters is higher than it can be assimilated by a population of living organisms the problem of excess phosphorus content occurs. Many countries set 1 mg/L and 2 mg/L as the limit for total phosphorus concentrations in discharges of wastewater treatment plants. One of the reasons for this low limit is that Phosphorus concentrations below 0.5 mg/l have been shown to be the limiting value for algal growth (Dryden, 1968), i.e., at Phosphorus concentrations below 0.5 mg/L algal growth in a natural, freshwater environment is essentially inhibited or blocked. This notwithstanding, requirements for wastewater treatment plants are being made ever more stringent, such that here in we consider a range of plant designs that would meet limits of between 0.05 and 2.00 mg/l of total phosphorus in their effluents. For Asian country such as Malaysia, the level measurement to discharge phosphorus is 0.2 mg/L; this is based from Department of Environment in national water quality standard in Malaysia.

2.2 Phosphorus Removal Method

There are many methods that can be used in order to treat phosphorus. The most common method used these three methods: Physical treatment, chemical treatment and biological treatment. All this method used different type of process and material. The development technology for each method also is increasing. Every method was highly developed to achieve a higher efficiency of Phosphorus removal.

2.2.1 Physical Treatment

Filtration for particulate P

Assuming that 2-3% of organic solids is Phosphorus, then effluent total suspended solids (TSS) of 20 mg/l represents 0.4-0.6 mg/l of effluent Phosphorus (Strom, 2006b). In plants with EBPR the Phosphorus content is even higher. Thus sand filtration or other method of Total Suspended Solid (TSS) removal (e.g., membrane, chemical precipitation) is likely necessary for plants with low effluent Total Phosphorus permits (Reardon, 2006).

Membrane technologies

Membrane technologies have been of growing interest for wastewater treatment in general, and most recently, for Phosphorus removal in particular. Membrane bioreactors (MBRs, which incorporate membrane technology in a suspended growth secondary treatment process), tertiary membrane filtration (after secondary treatment), and reverse osmosis (RO) systems have all been used in full-scale plants with good results. Reardon (2006) reported on several plants achieving <0.1 mg/l Total Phosphorus in their effluent, and suggested the current reliable limits of technology are 0.04 mg/l for MBRs and tertiary membrane filtration, and 0.008 mg/L for RO.

2.2.2 Chemical Treatment

Precipitation

Chemical precipitation has long been used for Phosphorus removal. The chemicals most often employed are compounds of calcium, aluminum, and iron (Tchobanoglous *et al.*, 2003). Chemical addition points include prior to primary settling, during secondary treatment, or as part of a tertiary treatment process (Neethling and Gu, 2006). Song *et al.* (2002), using thermodynamics, modeled the effects of Phosphorus and Calcium concentration, pH, temperature, and ionic strength on theoretical removal. Researchers (Hermanowicz, 2006) generally agree, however, that the process is more complex than predicted by laboratory pure chemical experiments, and that formation of and sorption to carbonates or hydroxides are important factors. A major concern with chemical precipitation for P removal continues to be the additional sludge that is produced. This can be dramatic, especially if the method selected is lime application during primary treatment (Tchobanoglous *et al.*, 2003). Use of alum after secondary treatment can be predicted to produce much less sludge, but the increase could still be problematic (Strom, 2006a).

2.2.3 Biological Treatment