TREATMENT OF TAPIOCA STARCH-PROCESSING WASTEWATER IN SEQUENCING BATCH REACTOR

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To my beloved parents

Hj. Hamzah bin Mohamad

Hjh. Rusenaini Binti Ibrahim

May Allah bless you

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ABSTRACT

Starch processing industries have increased their production recently due to high demand in various food products. As a result, water consumption was increased and discharged without proper treatment which may cause pollution. Major problems caused by tapioca starch wastewater is water pollution due to high biological oxygen demand (BOD), chemical oxygen demand (COD) and suspended solids (SS) concentrations causing low water quality. Untreated starch wastewater contained high BOD_3, COD and SS concentrations at 2,532 mg/L, 14,966 mg/L and 4,869 mg/L with pH 6.33 and high colour range at 1770 ADMI, respectively. High water consumed had increased the production cost for treatment of starch processing wastewater. Sequencing batch reactor (SBR) is a simple, compact and save spacing technology to treat wastewater due to simultaneous operation in one tank. SBR also had great potential to remove organic matter as desired with variables cycle time and operation. In this study, starch wastewater was treated at organic loading rate of 1.5 kg COD/m^3d. SBR was operated at 24h cycle for 60 days. The treatment was conducted in two columns namely R1; operated without granules and R2; operated with granules in activated sludge, respectively. The efficiencies of BOD_3, COD and colour removals were observed to monitor the SBR performance while mixed liquor suspended solid (MLSS) and mixed liquor volatile suspended solid (MLVSS) were the parameters that used to monitor the activated sludge performance in SBR. After 60 days of operation, R1 showed BOD_3, COD and colour removal achieved at an average of 97%, 70% to 96% and 50% to 89% while R2 showed higher removal at an average of 98%, 85% to 94% and 76% to 95% removals respectively.

ABSTRAK

Industri kanji telah berkembang dengan pesatnya sejak akhir-akhir ini kerana mendapat permintaan yang tinggi daripada pelbagai cabang produk makanan. Akibatnya, penggunaan air telah meningkat dan pelepasan air sisa tanpa rawatan boleh menyebabkan pencemaran. Masalah punca utama oleh yang dihasilkan oleh air sisa berkanji adalah pencemaran air kerana kandungan *biological oxygen demand* (BOD), *chemical oxygen demand* (COD) dan *suspended solids* (SS) boleh menjejaskan kualiti air. Hasil dari pemerhatian, air sisa berkanji yang tidak dirawat mengandungi kepekatan BOD_3, COD dan SS yang tinggi iaitu 2,532 mg/L, 14,966 mg/L dan 4,869 mg/L dengan pH 6.33 dan warna pada kadar 1770 ADMI. Peningkatan air yang digunakan telah meningkatkan kos pengeluaran untuk merawat air sisa berkanji. *Sequencing batch reactor* (SBR) adalah teknologi yang mudah, padat dan menjimatkan ruang untuk merawat air sisa kerana semua fasa rawatan beroperasi di dalam satu tangki. SBR juga mempunyai potensi yang besar untuk menyingkirkan bahan organik seperti yang dikehendaki dengan mengubah kitaran masa dan operasi. Dalam kajian ini, air sisa berkanji dirawat pada kadar muatan organik 1.5 kg COD/m^3d. SBR telah dikendalikan dengan kitaran 24h selama 60 hari. Rawatan ini telah dijalankan dalam dua kolum dimana R1; tanpa granul dan R2; dengan granul di dalam enapcemar yang diaktifkan. Kecekapan SBR telah di perhatikan melalui keupayaan menyingkirkan BOD_3, COD dan warna, manakala *mixed liquor suspended solid* (MLSS) dan *mixed liquor volatile suspended solid* (MLVSS) adalah parameter yang diukur bagi mengawal enapcemar diaktifkan di dalam SBR. Selepas beroperasi selama 60 hari, R1 telah menunjukkan kecekapan pengurangan kandungan BOD_3, COD dan warna pada 97%, 70%-96% dan 50%-89% manakala R2 menunjukkan kadar penyingkiran lebih baik dengan mencapai 98% BOD_3, 85%-94% COD dan 76%-95% penyingkiran warna.

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COD	-	Chemical oxygen demand
BOD	-	Biological oxygen demand
BOD_5	-	Five-days biological oxygen demand
BOD_3	-	Three-days biological oxygen demand
SS	-	Suspended solid
MLSS	-	Mixed liquor suspended solids
MLVSS	-	Mixed liquor volatile suspended solids
TSS	-	Total suspended solids
TS	-	Total solid
VSS	-	Volatile suspended solids
VS	-	Volatile solid
DO	-	Dissolved oxygen
DS	-	Dissolved solids
NH_4-N	-	ammonium
NO_3-N	-	Nitrate
PO_4-P	-	Phosphate
TKN	-	Total kjehdahl nitrogen
VFA	-	Volatile fatty acid
TP	-	Total phosphorus
TN	-	Total nitrogen
TC	-	Total carbon
TIC	-	Total inorganic carbon
TOC	-	Total organic carbon
CODF	-	Chemical oxygen demand of filtrate
SVI	-	Sludge volume index

SSE	-	Sedimentable solids
sCOD	-	Soluble Chemical oxygen demand
PHA	-	Polyhydroxyalkanoates

CHAPTER 1

INTRODUCTION

1.1 Background

Food industrial wastewater contains high biological oxygen demand (BOD), chemical oxygen demand (COD) and suspended solid (SS) concentration that may deteriorates water quality when discharged without treatment into receiving water courses due to industrial bad practice (Ibrahim *et al*., 2013). Corn, potato, wheat, tapioca and rice are among the examples of starch-rich produces that generate starch-containing wastewater during its production. In China for example, starch processing wastewater was commonly discharged into rivers and reservoirs due to the rapid growth of potato processing industries (Yang and Zhao, 2009).

Starch processing wastewater contains high concentration of COD, BOD and SS concentrations due to the high level of several organic compounds such as carbohydrates, starches, protein, sugar, and other soluble substances (Kobya *et al.,* 2006; Zhong, Zhuo *et al*., 2006; Wang *et al*., 2009). Starch processing wastewater was produced from the series of processing steps including storing, cleaning, shelling, choosing and cutting, slicing, washing, frying, salting, picking and coating and packing step-by-step of starch product (Ibrahim *et al*., 2013; Kobya *et al*., 2006).

The wastewater will be discharged according to their pollutant load levels (low, medium and high cotamination) depending on to the collection or treatment site i.e: on-site installation and in the municipal sewage treatment plant (Kobya *et al*., 2006; Mavrov and Bélières 2000). Most of the starch processing industry applies conventional biological method to treat the effluents. According to Ahn *et al*. (2001), potato is regarded as the main source of starch in which the wastewater contains massive dissolve organic pollutant which is aerosol exhibiting colloidal state.

In this study, a sequencing batch reactor (SBR) with suspended biomass configuration was used to treat starch-processing wastewater. An SBR operates under a series of cyclic periods constituting a fill and draw version of the conventional activated sludge process. The cycles consisted of five stages including fill, react, settle, decant and idle process (Singh and Srivastava, 2011).

1.2 Problem Statement

Large production of starch products will increase the water consumption which will end as wastewater. Untreated starch wastewater may pollute the environment due to bad industrial practice as this may pollute receiving water courses due to high BOD, COD and SS concentration. High BOD concentrations may can cause rapid depletion of oxygen content in the receiving water body. This may promote the growth of nuisance organism. The conventional methods commonly used such as using ponding system may become complex due to decreasing land availability which will increase the production cost due to large area requirement. Moreover, several methods have been used to treat starch wastewater, however, organic removal was found to be inefficient between 20% to 40 % only. Hence, this study aims to investigate the possibility of treating starch-containing wastewater using SBR.

1.3 Objective of The Study

The objectives of this study are outlined as follow:

1. To characterize tapioca starch-containing wastewater sourced from a local tapioca starch-processing industry.

2. To investigate the treatment of tapioca starch-processing wastewater in a sequencing batch reactor (SBR) based on COD, BOD and colour removal effluent.

3. To investigate microbial characteristics of sludge in SBR treating tapioca starch containing wastewater based on size and morphology characterizations.

1.4 Scope of Study

This study focused on the treatment of starch-containing wastewater using a laboratory scale SBR. Raw tapioca starch-containing wastewater was characterized by using parameters including BOD_3, COD, TSS, VSS, colour and pH. The SBR performance was observed by measuring chemical oxygen demand (COD), three-days biological oxygen demand (BOD_3), mixed liquor suspended solids (MLSS), mixed liquor volatile suspended solid (MLVSS) and pH. Microscopic examinations were carried out to observe possible flocs formation. However this study does not investigate the formation of aerobic granular sludge.

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