Experimental Comparison between Conventional Activated Sludge System, Moving Bed Biofilm Reactor, and Integrated Fixed Film Activated Sludge System for Municipal Wastewater Treatment

By

Radwa Hanafy Bahr Awad Allah

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Civil Engineering – Public Works

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Title of Thesis:

EXPERIMENTAL COMPARISON BETWEEN CONVENTIONAL ACTIVATED SLUDGE SYSTEM, MOVING BED BIOFILM REACTOR, AND INTEGRATED FIXED FILM ACTIVATED SLUDGE SYSTEM FOR MUNICIPAL WASTEWATER TREATMENT

Key Words:
Activates Sludge; MBBR; IFAS; Wastewater; Carriers

summary:

This thesis presents a comparison between suspended growth processes, attached growth processes, and hybrid growth processes. The main aim of this study is to compare between conventional activated sludge process (AS), moving bed biofilm reactor (MBBR), and integrated fixed film activated sludge system (IFAS). A pilot system was established at Zenein wastewater treatment plant, to simulate AS, MBBR, and IFAS systems. Various parameters, included hydraulic retention time (HRT), different amounts of returned sludge, and concentrations of dissolved oxygen (DO), were studied in order to show their effect on removal efficiencies of chemical oxygen demand (COD), biochemical oxygen demand (BOD_5), total suspended solids (TSS), volatile suspended solids (VSS), and ammonium nitrogen (NH_4-N). The maximum removal efficiencies of COD, BOD_5, and NH_4-N were 64.8%, 80%, and 99.3% respectively in MBBR system and occurred at DO = 5.4 mg/l. The maximum removal efficiencies of TSS and VSS were 86.17% and 86.7% respectively in IFAS system and occurred at DO = 5.4 mg/l.

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Dedication

To my Mother & father's soul,
The reason of what I become today,
Thank you for your love, support and care.

To my sister,
I am really grateful to you,
you have been my inspiration and my soul mate.

To my family,
All the love and respect to you for your support

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Abstract

This thesis presents a comparison between suspended growth processes, attached growth processes, and hybrid growth processes. The main aim of this study is to compare between activated sludge process (AS), moving bed biofilm reactor (MBBR), and integrated fixed film activated sludge system (IFAS).

A pilot system was established at Zenein wastewater treatment plant, to simulate AS, MBBR, and IFAS systems. The experimental work was batch experiment.

The main objective was to investigate the performance of suspended growth systems, attached growth systems, and hybrid growth systems in biological treatment of municipal wastewater. This had been done through performing a comparison between conventional Activated sludge system, Moving bed biofilm reactor, and Integrated fixed film activated sludge.

Various parameters, included hydraulic retention time (HRT), different amounts of returned sludge, and concentrations of dissolved oxygen (DO), were studied in order to show their effect on removal efficiencies of chemical oxygen demand (COD), biochemical oxygen demand (BOD_5), total suspended solids (TSS), volatile suspended solids (VSS), and ammonia nitrogen (NH_4-N).

The maximum removal efficiencies of COD, BOD_5, and NH_4-N were 64.8%, 80%, and 99.3% respectively in MBBR system and occurred at DO = 5.4 mg/l. The maximum removal efficiencies of TSS and VSS were 86.17% and 86.7% respectively in IFAS system and occurred at DO = 5.4 mg/l.

Chapter1: Introduction

1.1- General

Municipal wastewater in general is comprised of water (99.9%) together with relatively small concentrations of suspended and dissolved organic and inorganic solids. The cloudiness of sewage is caused by suspended particles which in untreated sewage ranges from 100 to 350 mg/l. This small percentage of organic matter is the cause of the spread of diseases and epidemics; therefore, it must be eliminated. Sewage treatment consists of three main stages: preliminary treatment, primary treatment, and secondary treatment (biological treatment). In primary treatment, the flow enters a settling tank for a period of two to three hours to remove suspended particles, and that after the passage of wastewater through screens and grit removal chambers which represent the preliminary treatment. In these two stages, around 40% of the dissolved organic matter and 60% of the suspended solids are eliminated. The role of biological treatment comes after that, where about 90% of the dissolved organic matter and the suspended solids are eliminated in it. This stage depends on the presence of microorganisms that consume organic matter in the presence of oxygen. There are several methods used around the world for biological treatment, some use suspended growth systems (e.g., the activated sludge system), some use attached growth systems (e.g., the moving bed biofilm reactor), and recently, the two systems have been combined (e.g., Integrated Fixed Film Activated Sludge system (IFAS)). Finally, the wastewater which almost treated is passed through another tank for settlement. After that, the water becomes free from chemicals and harmful substances. The effluent that come out from the final sedimentation tank is disinfected by chlorine (the most common method). This is done by sending water through a series of basins for a sufficient time, and that for killing microorganisms that were not removed during previous treatment processes. Now the effluent has been treated and can be reused for several purposes. It can be discharged into the groundwater, also it can be used for non-edible crop irrigation and landscape irrigation. It can also be used for construction activities and dust control. But it is not allowed to be used for drinking.

1.2- Objectives of the thesis

The main objective is to investigate the performance of suspended growth systems, attached growth systems, and hybrid growth systems in biological treatment of municipal wastewater. This will be done through performing a comparison between conventional Activated sludge system, Moving bed biofilm reactor, and Integrated fixed film activated sludge. The specific objectives are:

1. Investigate the performance of Conventional activated sludge system with different amount of return sludge in removal of Chemical oxygen demand (COD), Five-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), volatile suspended solids (VSS), and ammonium-nitrogen (NH_4-N).
2. Investigate the performance of Moving bed biofilm reactor system in removal of Chemical oxygen demand (COD), Five-day biochemical oxygen demand