MODIFICATION OF ACTIVATED SLUDGE SYSTEM FOR OPTIMUM REMOVAL OF NUTRIENTS

A Thesis
Submitted to the Faculty of Engineering
Ain Shams University for the Fulfillment
of the Requirement of Ph. Degree
in Civil Engineering

Prepared by

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M.Sc. of Civil Engineering, May 2008
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DEDICATION

I wish to dedicate this work to who suffered to educate, prepare, build capacity and help myself to be as I am,

TO MY MOTHER AND MY FATHER

Also thanks

TO MY WIFE
for her encouragement and support to complete this work

STATEMENT

This dissertation is submitted to Ain Shams University, Faculty of Engineering for the degree of Ph.D in Civil Engineering.

The work included in this thesis was carried out by the author in the department of Public Works, Faculty of Engineering, Ain Shams University, from September 2008 to January 2014.

No part of the thesis has been submitted for a degree or a qualification at any other University or Institution.

The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others

Date: - ---/-- /2014

Signature: - ----------

Name: - ***MOSTAFA MOAWED MOSTAFA GAD***

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ABSTRACT

NAME :- MOSTAFA MOAWED MOSTAFA

Title : - "MODIFICATION OF ACTIVATED SLUDGE SYSTEM FOR OPTIMUM REMOVAL OF NUTRIENTS".

Faculty : Faculty of Engineering, Ain Shams University
Specialty : Civil Eng., Public Works, Sanitary Engineering

Summary :

The experiment has been performed in order to investigate the effect of using contact stabilization activated sludge as an application of Enhancing Biological Phosphorous Removal (EBPR) by using contact tank as a phosphorus uptake zone and using thickening tank as a phosphorus release zone.

The study involved the construction of pilot plant which setup in Quhafa Wastewater Treatment Plant (WWTP) included contact, final sedimentation, stabilization and thickening tanks respectively with two returns sludge in this system one of them to contact tank and another to stabilization tank. Results showed the removal efficiencies of COD, BOD_5 and TP for this pilot plant with the range of 91%, 92 % and 85 % respectively during the first stage by effecting of 3mg/l influent TP, but during the second stage were with the range of 91%, 93% and 83% respectively by effecting of 5mg/l influent TP and 91%,92% and 83% for COD,BOD_5 and TP respectively under the effect of 8mg/l influent TP during the third stage.

Finally the mechanism of this pilot plant depends on the Removal of the phosphorus from the domestic wastewater as a concentrated TP solution form supernatant above the thickening zone not through waste sludge like traditional systems.

Keywords: Enhancement Biological Phosphorus Removal (EBPR); contact stabilization; activated sludge; phosphorus Accumulating Organisms (PAO), poly-β-hydroxyalkanoates (PHA) and total phosphorus (TP).

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INTRODUCTION

1.1 General

Biological phosphorus removal from wastewater is based on the enrichment of activated sludge with phosphate-accumulating organisms (PAOs). To achieve a phosphorus-removing bacterial population in an activated sludge system, exposure of sludge to alternating anaerobic and aerobic (or anoxic) conditions is necessary. Under anaerobic conditions, P removing bacteria convert volatile fatty acids (VFAs) synthesized in the zone by fermenters to polyhydroxybutyrate (PHB) which is stored intracellularly. Under aerobic conditions, stored PHB is used to generate cell growth, poly-P synthesis and glycogen formation and maintenance, resulting in the uptake of phosphate.

The dominant bacteria in the activated sludge system are aerobic heterotrophs that degrade and eventually mineralize organic compounds present in wastewater to carbon dioxide and water. It is the small size of bacteria and their resultant large surface area to volume ratio which makes them efficient in terms of nutrient and catabolic exchange. Heterotrophic bacterial populations remain relatively stable throughout the plant with various environments in the three zones allowing different bacteria to dominate in terms of metabolic activity.

Several early studies have shown that the removal and release of phosphorus within sludge are the results of the dominance of a single genus of bacteria known as *Acinetobacter* spp. and more specifically a single species, *Acinetobacter calcoaceticus*. *Acinetobacter* spp are able to accumulate more phosphate than is required for cell synthesis; the so-called **luxury phosphate uptake**.

Acinetobacter spp. are normally present in activated sludge, but in the minority due to the low growth rate. *Acinetobacter* organisms prefer VFAs, especially acetate, as a growth substrate which are present or can be produced from wastewaters in an activated sludge system. This is achieved by incorporating an anaerobic zone, mostly