ENHANCEMENT OF ANAEROBIC BIODEGRADABILITY IN MUNICIPAL WASTE ACTIVATED SLUDGE BY PHASE SEPARATED BIOLOGICAL DISINTEGRATION

A THESIS

Submitted by

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CERTIFICATE

This is to certify that all corrections and suggestions pointed out by the Indian /Foreign Examiner(s) are incorporated in the Thesis titled "ENHANCEMENT OF ANAEROBIC BIODEGRADABILITY IN MUNICIPAL WASTE ACTIVATED SLUDGE BY PHASE SEPARATED BIOLOGICAL DIINTEGRATION" submitted by Mr./Ms.KAVITHA.S

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Signature of the Supervisor

Place : Tirunelveli

Date : 20/07/2016

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Proceedings of the Ph.D. Viva-Voce Examination of Mr./Ms.KAVITHA.S held at 11:00 AM on 18.07.2016 in Conference Hall Anna University Regional Campus Tirunelveli 627007

The Ph.D. Viva-Voce Examination of ~~Mr.~~/Ms.KAVITHA.S (Reg. No. 1223789731) on ~~his~~/her Ph.D. Thesis Entitled " ENHANCEMENT OF ANAEROBIC BIODEGRADABILITY IN MUNICIPAL WASTE ACTIVATED SLUDGE BY PHASE SEPARATED BIOLOGICAL DIINTEGRATION " was conducted on **18.07.2016** at 11:00 AM in the Conference Hall Anna University Regional Campus Tirunelveli 627007.

The following Members of the Oral Examination Board were present:

1. Dr. K N Yogalakshmi,Assistant Professor,Centre for Environmental Science and Technology,Central University of Punjab Bathinda 151001,Punjab — Indian Examiner
2. Dr. G Kumaresan,Associate Professor,Department of Genetics,Centre for Excellence in Genomic Sciences School of Biological Sciences,Madurai Kamaraj University Madurai 625 021 — Subject Expert
3. Dr. Rajesh Banu.J,Assistant Professor, Department of Civil Engineering, Regional Centre of Anna university,Tirunelveli — Supervisor & Convenor

The research scholar, ~~Mr.~~/Ms. KAVITHA.S presented the salient features of ~~his~~/her Ph.D. work. This was followed by questions from the board members. The questions raised by the Foreign and Indian Examiners were also put to the scholar. The scholar answered the questions to the full satisfaction of the board members.

The corrections suggested by the Indian/Foreign examiner have been carried out and incorporated in the Thesis before the Oral examination.

Based on the scholars research work, ~~his~~/her presentation and also the clarifications and answers by the scholar to the questions, the board recommends that ~~Mr.~~/Ms.KAVITHA.S be awarded Ph.D. degree in the **Faculty of Science and Humanities**.

18/7/2016.
Indian Examiner

Subject Expert

18/7/16
Supervisor & Convenor

ANNA UNIVERSITY
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CERTIFICATE

The research work embodied in the present Thesis entitled "**ENHANCEMENT OF ANAEROBIC BIODEGRADABILITY IN MUNICIPAL WASTE ACTIVATED SLUDGE BY PHASE SEPARATED BIOLOGICAL DISINTEGRATION**" has been carried out in the Department of Civil Engineering, Regional Centre of Anna University, Tirunelveli. The work reported herein is original and does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion or to any other scholar.

I understand the University's policy on plagiarism and declare that the thesis and publications are my own work, except where specifically acknowledged and has not been copied from other sources or been previously submitted for award or assessment.

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ABSTRACT

In recent years, increased attention has been given to minimization of waste activated sludge in wastewater treatment process. Proper management of wastewater-sludge has become increasingly important due to environmental and economic concerns. This is because that the waste water treatment plant (WWTP) produce huge volume of sludge and the cost of disposal of sludge has been creating high economic burden to the management of wastewater treatment plants. Treatment and disposal costs of excess sludge account for approximately 40-60% of the entire operating cost of WWTPs.

Stabilization of sludge is an essential process since it reduces pathogen, control odour and removes organics. This is quite possible with anaerobic digestion (AD). AD has been used as an effective method of sludge stabilization, since it reduces nearly 40–50% of sludge along with the production of biogas, thus making the process profitable. The pre-treatment of sludge prior to anaerobic digestion is required because of low biodegradability of the cell walls and extracellular polymers in sludge. Many researchers have suggested that the Extracellular Polymeric Substance (EPS) plays a major in bioflocculation and in addition removal of EPS could enhance the rate and extent of solubilization. Therefore in the present study, it was planned to remove EPS (floc disruption) to increase the surface area for bacterial action and to improve the solubilization.

The present study provides the outcomes achieved from laboratory scale experiments of different phase separated disintegration methods – Ethylenediamine tetra acetic acid (EDTA), Sodium dodecyl sulphate (SDS),

Citric acid, Magnesium Chloride ($MgCl_2$) and Sodium Chloride (NaCl) mediated bacterial disintegration methods, assessment of anaerobic fermentation and methanogenesis of disintegrated sludges. The Waste activated sludge (WAS) was collected from municipal waste water treatment plant (MWWTP) at Karakonam, Kerala. Enzyme (Protease and Amylase) secreting bacterial consortium were isolated from WAS. The bacterial consortium (*Bacillus jerish -03 and Bacillus jerish 04*) was identified through 16s rRNA sequencing.

At first phase, 0.2 g/g SS of EDTA dosage was employed to disrupt the flocs. The results of pretreatment implied that EDTA mediated bacterial disintegration showed higher solubilization of about 17.33% comparatively higher than bacterially disintegrated sludge (11%) and control (6%). A maximal Volatile fatty acids (VFA) production of about 620 mg/L was achieved in floc disrupted sludge. The outcomes of Biochemical Methane Potential (BMP) assay reveal that EDTA mediated bacterial disintegration showed higher biogas production potential of about 0.106 L/(g VS) than the bacterially disintegrated 0.068 L/(g VS), respectively.

At second phase, 0.02 g/g SS of SDS dosage was employed to disrupt the flocs. The results of pretreatment implied that SDS mediated bacterial disintegration showed higher solubilization of about 19.79% comparatively higher than bacterially disintegrated sludge (11%) and control (6%). A maximal VFA production of about 700 mg/L was achieved in floc disrupted sludge. The outcomes of BMP assay reveal that SDS mediated bacterial disintegration showed higher biogas production potential of about 0.12 L/(gVS) than the bacterially disintegrated 0.068 L/(g VS), respectively.

At third phase, 0.05 g/g SS of Citric acid dosage was employed to disrupt the flocs. The results of pretreatment implied that Citric acid mediated bacterial disintegration showed higher solubilization of about 16.2%

comparatively higher than bacterially disintegrated sludge (11%) and control (6%). A maximal VFA production of about 580 mg/L was achieved in floc disrupted sludge. The outcomes of BMP assay reveal that Citric acid mediated bacterial disintegration showed higher biogas production potential of about 0.097L/(gVS) than the bacterially disintegrated 0.068 L/(gVS), respectively.

At fourth phase, 0.04 g/g SS of $MgCl_2$ dosage was employed to disrupt the flocs. The results of pretreatment implied that $MgCl_2$ mediated bacterial disintegration showed higher solubilization of about 21.4% comparatively higher than bacterially disintegrated sludge (11%) and control (6%). A maximal VFA production of about 640 mg/L was achieved in floc disrupted sludge. The outcomes of BMP assay reveal that $MgCl_2$ mediated bacterial disintegration showed higher biogas production potential of about 0.133 L/(g VS) than the bacterially disintegrated (0.068 L/(g VS)), respectively.

At fifth phase, 0.03 g/g SS of NaCl dosage was employed to disrupt the flocs. The results of pretreatment implied that NaCl mediated bacterial disintegration showed higher solubilization of about 23% comparatively higher than bacterially disintegrated sludge (11%) and control (6%). A maximal VFA production of about 710 mg/L was achieved in floc disrupted sludge. The outcomes of BMP assay reveal that NaCl mediated bacterial disintegration showed higher biogas production potential of about 0.138 L/(g VS) than the bacterially disintegrated 0.068 L/(g VS), respectively. On comparison, albeit all the pretreatment methods significantly enhances the biogas production potential and biodegrdability, the higher biogas production potential of about 0.138 L/g VS has been achieved for NaCl mediated bacterial disintegration which was observed to be relatively higher than that achieved in other pretreatment methods 0.106, 0.117,0.097,0.133 L/g VS (EDTA, SDS, Citric acid & $MgCl_2$).