Yunmin Chen
Xiaowu Tang
Liangtong Zhan
Editors

Advances in Environmental Geotechnics

Proceedings of the International Symposium on Geoenvironmental Engineering in Hangzhou, China, September 8-10, 2009

ZHEJIANG UNIVERSITY PRESS
浙江大学出版社

Springer

Yunmin Chen
Xiaowu Tang
Liangtong Zhan

Advances in Environmental Geotechnics

Proceedings of the International Symposium on Geoenvironmental Engineering in Hangzhou, China, September 8-10, 2009

With 1,091 figures

浙江大学出版社
Springer

Editors
Prof. Yunmin Chen
Department of Civil Engineering
Zhejiang University
388 Yuhangtang Road, Hangzhou 310058
China
E-mail: cheryunmin@zju.edu.cn

Prof. Xiaowu Tang
Department of Civil Engineering
Zhejiang University
388 Yuhangtang Road, Hangzhou 310058
China
E-mail: tangxiaowu@zju.edu.cn

Prof. Liangtong Zhan
Department of Civil Engineering
Zhejiang University
388 Yuhangtang Road, Hangzhou 310058
China
E-mail: zhanlt@zju.edu.cn

ISBN 978-7-308-06597-9
Zhejiang University Press, Hangzhou

ISBN 978-3-642-04459-5 e-ISBN 978-3-642-04460-1
Springer Heidelberg Dordrecht London New York

Library of Congress Control Number: 2009934114

Cover design: Frido Steinen-Broo, EStudio Calamar, Spain

Printed on acid-free paper

Springer is a part of Springer Science+Business Media (www.springer.com)

Preface

The International Symposium on Geoenvironmental Engineering (ISGE 2009) was held on September 8-10, 2009 in Hangzhou, China. ISGE 2009 was organized by MOE Key Laboratory of Soft Soils and Geoenvironmental Engineering, Zhejiang University, Chinese Institution of Soil Mechanics and Geotechnical Engineering (CISMGE), and Chinese Chapter of International Geosynthetics Society (CCIGS), under the auspices of ISSMGE TC5, sponsored by K. C. Wong Education Foundation, and National Natural Science Foundation of China, as well as Zhejiang University Zeng Guo-Xi Lecture Fund.

Issues associated with Environmental Geotechnics continue to be a major preoccupation for governments, public and private organizations and the general community worldwide. The Chinese Government has been putting great effort on environmental issues including sanitary disposal of solid waste, reuse of industrial wastes, remediation of contaminated land, prevention of groundwater contamination, environmental risk assessment, ecological techniques, etc. China also has much to share on the opportunities, challenges and responsibilities for environmental geotechnics with other countries, especially the developing countries.

Under the conference theme, "Reclamation of the Past and Toward a Sustainable Geoenvironment", 168 abstracts in total were received and 125 papers in total were reviewed and accepted for publication in this proceeding. This proceeding encloses 2 Zeng Guo-Xi Lectures, 26 Invited Lectures and 97 papers. The topics covered include basic and advanced theories for modeling of geoenvironmental phenomena, testing and monitoring for geoenvironmental engineering, municipal solid wastes and landfill engineering, sludge and dredged soils, geotechnical reuse of industrial wastes, contaminated land and remediation technology, applications of geosynthetics in geoenvironmental engineering, geoenvironmental risk assessment, management and sustainability, ecological techniques and case histories. This proceedings include papers authored by core members of ISSMGE TC5 (International Society of Soil Mechanics and Geotechnical Engineering - Environmental Geotechnics) and geoenvironmental researchers from more than 23 countries and regions (i.e., Albania, Austria, Bengalese, Brazil, Canada, China, France, German, Hong Kong, India, Iran, Indonesia, Japan, Korea, Macau, Malaysia, Portugal, Russia, Taiwan, UK, USA, Uzbekistan, Vietnam).

It is our desire that the proceedings of International Symposium on Geoenvironmental Engineering (ISGE2009) provide an opportunity for the exchange of views among academic researchers, practical engineers and administration officers. "Advances in Environmental Geotechnics" presents the latest development in this interdisciplinary field.

Prof. Yunmin CHEN
Chairman, Organizing Committee of ISGE 2009

Contents

The 2009 Zeng Guo-Xi Lecture

Invited Lectures

Basic and Advanced Theories for Modeling of Geoenvironmental Phenomena

Testing and Monitoring for Geoenvironmental Engineering

Municipal Solid Wastes and Landfill Engineering

Sludge and Dredging Soils

Geotechnical Reuse of Industrial Wastes

Contaminated Land and Remediation Technology

Applications of Geosynthetics in Geoenvironmental Engineering

Geoenvironmental Risk Assessment, Management and Sustainability

Ecological Techniques and Case Histories

APPLICATION OF GEOMEMBRANE AS CARBON CAPTURE AT PALM OIL MILL

Andryan SUHENDRA[1] and Amelia MAKMUR[2]

ABSTRACT: Global warming is the most important issue in last decade that causes a climate change. Global warming is triggered by greenhouse effect, whereas the process by absorption and emission of infrared radiation by atmospheric gases increases the temperature. Methane is one of the gases, which contribute to increase the greenhouse effect and predicted 20 times larger than Carbon Dioxide potential impact. However, methane can be used as alternative resources energy such as biogas. Methane is produced from organic waste like biomass, animal and human waste, also the palm oil mill's waste. In West Indonesia where the expansions of palm oil fields grow faster, the increasing methane gases become a serious matter. One of the alternative solutions to minimize that methane's impact is by using an aerobic bio-digestion process. HDPE geomembrane, one of the geosynthetics products can be used to captures the methane gases and led in them by using a pipeline to the biogas converter. The installation processes of geomembrane are including patterning, deploying, anchoring and seaming of HDPE geomembrane. As a carbon capture in Palm Oil mill, HDPE geomembrane contribute to reduce the greenhouse effect, provide an alternative energy and for the future hopefully will save our environment.

KEYWORDS: global warming, methane, carbon capture, HDPE geomembrane, biogas, anaerobic bio-digestion process

INTRODUCTION

The spectacular expansion of palm oil mill in Indonesia; especially in West Indonesia, not only generate income for inhabitant in that the region, but in the other hand it's also left a serious problem behind with the palm oil mill's waste. That waste potent to produce the methane gases (CH_4), which predict will be increasing the greenhouse gases effect 20 times larger than Carbon Dioxide. Contribution of several gases to increase the greenhouse effect is shown on the figure below.

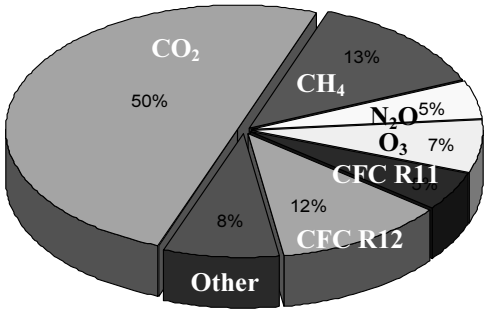

Fig. 1 Percentage contribution of several gases that increasing the greenhouse effect

Palm Oil Mill effluent as known as POME is a liquid waste of palm oil mill, which has 100 times potential as a pollutant waste than another municipal waste. That potential effect will increase the greenhouse effect, if there is no action to treat that entire palm oil mill's waste. The Biological Oxygen Demand of untreated POME average 25,000 mg/liter (Ojonoma & Nnennaya, 2007). Anaerobic biodigestion system can solve the problem of greenhouse gases effect of palm oil mill effluent and also give several benefits:

- Re-use the POME as an alternative source energy
- Create an electricity power
- Reduce the unpleasant odor
- Re-use the POME as a fertilizer
- Reduce the impact of greenhouse gases

Based on the research, 50 million tons of biomass has 1.4 trillion cubic meters potential of biogas or equivalent to 337 MW electrical power generations.

POME TREATMENT SYSTEM

The conventional treatment system of POME is use biological system, by utilizing the microbe to reduce BOD and neutralizing the acidity of POME.

[1] Lecturer of Bina Nusantara University, Jakarta. Member of Indonesian Society of Geotechnical Engineering (ISSMGE) and International Geosynthetic Society Indonesia Chapter (INA-IGS). Email:andryan@geosinindo.co.id
[2] Lecturer of Bina Nusantara University, Jakarta. Member of Indonesian Society of Geotechnical Engineering (ISSMGE) and International Geosynthetic Society Indonesia Chapter (INA-IGS). Email:amelia1935@binus.edu

This conventional system need open lagoon with size depend on the volume of POME will be treated. These are 3 phases of POME Treatment, such as:

Preliminary Treatment

This phase consist of de-oiling and acidifying pond.

At first phase, POME from fat-pit delivers to de-oiling pond, and then transferred to acidifying pond. The temperature and acid density at acidifying pond is kept constant in high condition to ensure the oil content at the POME surface still liquid.

The POME will be remained at acidifying pond during 4 to 5 days to increase the acid density for making easier the next process.

Anaerobic Biodigestion Treatment

The purpose of this treatment is to change the complex organic mass into the simple one.

There are 2 phases on an-aerobic biodigestion treatment i.e. primary and subsequent anaerobic alternation lagoon.

Primary alternation lagoon

In this pond, the complex organic mass will be changed to volatile acid by using an acid bacterial. BOD and COD will be decreased in neutral condition at lagoon during 40 days.

Fig. 2 Primary Lagoon

Subsequent anaerobic alternation lagoon

In this lagoon, the volatile acid changes into an acetate acid and then it will become the gases of CO, CH_4, H_2S, and H_2O.

Further Treatment

The further treatment of POME consists of 2 lagoons: facultative and aerobic lagoon.

Facultative lagoon

The aerobic oxidation occurs at the surface and in that time the an-aerobic fermentation of sedimentation is also occurred, as a consequence the value of BOD and COD will be decreased.

Aerobic lagoon

Bacterial need oxygen for proliferating, so in this place they will get it and all the process will decrease BOD and COD value.

Fig. 3 Subsequent Lagoon

BIOGAS

The biggest component of biogas, which produced from POME treatment, is methane gas; for 600 kg – 700 kg of POME can produce biogas approximately 20 m^3 (Goenadi, 2006).

The process of methane can be divided into 3 stages: hydrolysis, asetogenesis (dehydrogenesis) and metanogenesis (Sorensen, 2004).

At first phase (hydrolysis phase), the complex biomass is decomposited to a simple glucose by using microorganism enzyme as catalyst. The important thing in this process is the result of a simpler chemistry for the next phase.

The second phase will change glucose into an acetate acid and broken off the long acid chain become the short one finally it will produce an acetate acid as a final product.

The third phase is the changing process of biogas from acetate acid by using fermentation of metanogenic bacterial.

As an illustration, in case of palm oil mill process 100 ton of fresh fruit bunches (FFB) per hour, will produce 50 m^3/hour of POME (assumed 55% of FFB with unit weight 1.1g/cm^3, Kartiman, 2008). If the mill operates 10 hours/day, the volume of POME will be