



# PROCEEDING

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## The 7<sup>th</sup> Asian-Pacific Landfill Symposium Sustainable Solid Waste Management for a Better Life

October 8<sup>th</sup> - 11<sup>th</sup>, 2012



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## **PREFACE**

Solid waste has become one of the most enormous environmental issues in the current modern cities. Improper solid waste handling also vividly contributes to the climate change and its deleterious impacts to the environment. A new paradigm, such as waste generation avoidance (reuse, reduce, and recycle/3Rs), has emerged at the top hierarchy and become the state-of-the-art in the solid waste management and technology.

Asian Pacific Landfill Symposium (APLAS) is a biennial international symposium which purpose is to manage the serious wastes issues/problems of the Asian-Pacific region. The previous APLAS meetings that have been held in Fukuoka, Japan (2000), Seoul, South Korea (2002), Kitakyushu, Japan (2004), Shanghai, People Republic of China (2006), Sapporo, Japan (2008), and Seoul, South Korea (2010), have provided various sharing of knowledge and network about landfill and solid waste-related system. The APLAS-Bali 2012 in Indonesia would be the next rendezvous for landfill and solid waste system experts to brainstorm new breakthroughs for solving the current challenges in this area of knowledge. The symposium will provide an opportunity for academia, researchers, engineers, governments, non-governmental organizations, private sectors, industries, consultants, contractors, and manufacturers, to meet and perform ideas-exchanging, to learn, share and exchange about the latest developments and researches in solid waste management.

The scope of the symposium is covering all aspects of solid and hazardous waste management, technology and engineering practices. The presentation of APLAS-Bali 2012 Symposium consists of several groups of session:

- Keynote Lecture;
- Oral Presentation;
- Poster Presentation;
- Country Report: Municipal Solid Waste Management and Technology in Asian Countries; and
- Special Lecture.

Finally, I wish to express my gratitude to all participants for their cooperation and contribution, and to the various sponsors for their support to this symposium.

**Enri Damanhuri**

Chairperson, APLAS-Bali 2012

Professor, Faculty of Civil and Environment Engineering, ITB, Indonesia



## **WELCOME ADDRESS**

The earth now faces a crisis that is unprecedented in the history of mankind, including natural disasters such as earthquake and Tsunami, increased temperatures, unusual weather conditions involving floods and droughts, desertification as a result of deforestation et al. The earth may not survive without solving these problems. In these circumstances, the disastrous earthquake and Tsunami in Japan on March 11, 2011 has occurred. It left innumerable disaster waste such as debris and rubble of the smashed houses, buildings and other concrete structures, and scrapped cars and ships. First of all, on behalf of Japanese people, I would like to express our sincere gratitude to many people in the world who helped us immediately. The total quantity of the disaster waste is estimated to amount 25 million tons.

The APLAS Symposium has become a major international meeting of the Asia-Pacific region for the discussion of overall waste issues at research level. This indicates the need to expand our view of global environmental issues in relation to waste management instead of focusing on landfill alone. At the same time, the issues related to final landfill sites, which were the original theme of the APLAS Symposium, are also a hot topic of discussion. With the transition of the concept of final landfill sites, there is now a particular need for transparency in waste treatment processes from generation to landfill in order to eliminate anxiety over the construction and maintenance of final landfill sites; this means in particular the disclosure of information based on quantitative evaluation of the process and risk assessment of hazardous substances. The transparency of final landfill sites as a technical dimension to control the waste management process (improving safety) and the information disclosure as a social dimension and community development involving local residents (developing a sense of reliability and reassurance) are simultaneously important key points. The difference that should be highlighted here now is that conventional discussions on treatment facilities have revolved around the facilities themselves, whereas the concepts of “material flow and conversion” and “social systems” toward a sound material-cycle society should be included in discussions from now on. To guide overall terminal waste management systems in the right direction, it is important to establish technologies and social institutions for treating the effects of hazardous waste and recycling useful waste, leading to the regeneration and the space recovery of final landfill sites for use over a longer time frame. This means that landfilling function should be considered as one of systems for proper waste management, namely as a final proper disposal system.

I would like to express my sincere congratulations to all involved in the significant holding of the Seventh Asian-Pacific Landfill Symposium in Bali, Indonesia, and to express my sincere gratitude to many people taking part in the event from Asian Pacific nations and many countries across the world. I am also pleased to share with all participants the pleasure of this opportunity for researchers, engineers, government officials and many other specialists involved in tackling waste problems faced by Asia-Pacific countries to assemble and exchange their latest research results and experiences. I strongly believe that the outcome will help to resolve the waste problems faced by many countries in the Asian-Pacific region and around the world, as well as providing insights toward the resolution of global environmental issues. Lastly, I hope for the success of this symposium with the cooperation of all participants, and for the continued development of the APLAS Symposium in the future.

**Toru Furuichi**

Chairperson, APLAS-Bali 2012

President, NPO•LSA

Professor, Hokkaido University, Japan



## **WELCOME ADDRESS**

In the first opportunity, I would like to convey my gratitude and welcome in the 7<sup>th</sup> Asian Pacific Landfill Symposium (APLAS) Bali 2012, which is held in Bali, on October 8<sup>th</sup>-11<sup>th</sup>, 2012. Other than Bali that has been well-recognized as one of the world class tourism destinations, Bali was chosen to host APLAS this year, due to its good performance to implement proper municipal solid waste management.

Locally, Indonesian Government puts high commitment to support a proper municipal solid waste system. Central Government has a role to regulate, monitor, and empower the capacity building of Local Governments, while Local Governments have a role to implement the municipal solid waste system in their provinces, districts, or cities. This is in line with the spirit of autonomy of Local Governments and decentralization. Thus, Central Government must stimulate the implementation and ensure the proper performance of Local Governments to achieve the determined goals in municipal solid waste sector.

In the international level, Indonesian Government has committed to reduce the greenhouse gas emission from municipal solid waste sector. This is achieved through the implementation of sanitary landfill or controlled landfill as the most common chosen technology to treat municipal solid waste in Indonesia. These technologies eliminate the uncontrolled of methane gas emission, which contributes to the global climate change. Furthermore, methane gas has calorific value that can be converted as the source of alternative and green energy.

In order to achieve proper dwellings and healthy environment in the local, regional, and global levels, Directorate General of Human Settlements Ministry of Public Works, has regulated the policy and strategy at the national level, for municipal solid waste system development. It has been legalized in the Ministry of Public Works Regulation number 21/PRT/M/2006. This policy and strategy regulates the waste minimization and reduction at the source of waste generation, thus it will further subdue the burden for storage, collection, transportation, and treatment subsystems. Other than technical and technological aspect, this legal document also states the need for organizational, regulation, community participation, and funding aspects in municipal solid waste sector.

APLAS Bali 2012 with the theme of “Sustainable Solid Waste Management for a Better Life” is expected to be an event for ideas, thought, and concept exchanging for researchers, engineers, Central/Local Governments, non governmental organizations, private companies, consultants, contractors, and manufacturers in municipal solid waste sector. It is expected that various topics are discussed in the symposium, not just landfilling technology, but also waste minimization technologies, alternative waste treatment technologies, hazardous waste treatments, waste/biomass to energy conversion technologies, municipal solid waste system in developing countries, and health impacts of waste to health and environment.

Lastly, I would like to wish you all to have a fruitful symposium. I hope that this symposium can give enormous outcomes for the development of science, technology, and sustainable development of municipal solid waste system in Indonesia.

**Budi Yuwono P.**

Steering Committee, APLAS Bali 2012

Head of Indonesian Society of Sanitary and Environmental Engineers

Director General of Human Settlements, Ministry of Public Works



## The 7<sup>th</sup> Asian-Pacific Landfill Symposium

October 8<sup>th</sup> - 11<sup>th</sup>, 2012, Bali, Indonesia

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The Role of Waste Processing at TPS on The Reducing of Carbon  
Footprint of Waste Management in Malang

**OSL - Sustainable Landfilling**

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|    | Solid Waste Management in Bangladesh : Implementation of Clean Dhaka Master Plan  |     |           |
| 3  | <b>Sour Sethy</b>   |     | MSWM 03-1 |
|    | Municipal Solid Waste Management in Cambodia  |     |           |
| 4  | <b>Kurian Joseph</b>  |     | MSWM 04-1 |
|    | Solid Waste Management in India Current Situation and Issues  |     |           |
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| 8  | <b>Ong Seng Eng</b>   |     | MSWM 08-1 |
|    | Solid Waste Management in Singapore   |     |           |
| 9  | <b>Orawan Siriratpiriya</b>   |     | MSWM 09-1 |
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| 11 | <b>Agamuthu Pariatamby</b>  |     | MSWM 11-1 |
|    | The 2012 Situation of MSW Management in Malaysia  |     |           |
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|             | Status and Future Directions on Solid Waste Management in Sri Lanka  |           |
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|             | Recent Trend in Municipal Solid Waste Management of Korea  |           |
| 15          | <b><i>Cynthia Hendrayani</i></b>   | MSWM 15-1 |
|             | Treatment of MSW at Bantargebang Landfill  |           |
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|             | Surabaya as Eco and Sustainable City in The Globalization World  |           |
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| 1           | <b><i>Yoichi Toyama</i></b>  | SL 01-1   |
|             | Waste Management Administration of Japan, History of Waste Management in Japan and Recent Activities on 3Rs Inside and Outside Japan |           |
| 2           | <b><i>David Kuper</i></b>  | SL 04-1   |
|             | Avoidance of Methane Production from MSW Decay Through Composting (CDM TPST Project) at Temesi (Gianyar), Bali                       |           |
| 3           | <b><i>Jan Theulen</i></b>  | SL 05-1   |
|             | Economical and Resource Efficient Recovery of MSW in Cement Kilns in Indonesia   |           |
| 4           | <b><i>Byung Chul Shin</i></b>  | SL 06-1   |
|             | Introduction to SLC and its Overseas Activities  |           |
| 5           | <b><i>Johannes Jager</i></b>   | SL 07-1   |
|             | Landfill Reconstruction for Sustainability   |           |
| 6           | <b><i>Budi S. Prasetyo</i></b>   | SL 09-1   |
|             | State of Art Geosynthetics Application in Landfill Engineering   |           |
| 7           | <b><i>Christopher Godlove</i></b>  | SL 10-1   |
|             | Global Methane Initiative : Targeting Solid Waste Management for Methane Emission Reductions   |           |
| <b>XIII</b> | <b>MAP AND LAYOUT VENUE</b>  |           |
| <b>XIV</b>  | <b>AKNOWLEDGEMENT</b>  |           |



# The 7<sup>th</sup> Asian-Pacific Landfill Symposium

October 8<sup>th</sup> - 11<sup>th</sup>, 2012, Bali, Indonesia

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## SYMPOSIUM AGENDA

| Time  | Monday,<br>8-Oct-12                  | Tuesday,<br>9-Oct-12                             |  | Wednesday,<br>10-Oct-12                          | Thursday,<br>10-Oct-12 |                                     |
|-------|--------------------------------------|--|--|--|------------------------|-------------------------------------|
| 8:00  |                                      | 08:00  |  | 08:00  | 08:00                  |                                     |
|       | Registration                         | Registration                                     |  | Registration                                     | Registration           |                                     |
| 9:00  |                                      | 09:00<br>Oral<br>Presentation<br>Session         | 09:00<br>MSWM<br>Session                 | 09:00<br>MSWM<br>Session                         | Site Visit             |                                     |
| 10:00 |                                      | 10:20<br>Coffee Break                            |  | 10:20<br>Coffee Break                            |                        |                                     |
| 11:00 |                                      | 10:40<br>Oral<br>Presentation<br>Session         | 10:40<br>MSWM<br>Session                 | 10:40<br>Special Lecture 1                       |                        |                                     |
| 12:00 |                                      | 12:00<br>Lunch, Exhibition and Poster<br>Session |  | 12:10<br>Lunch, Exhibition<br>and Poster Session |                        |                                     |
|       |                                      | 12:30<br>Opening Ceremony                        | 13:00<br>Oral<br>Presentation<br>Session | 13:00<br>MSWM<br>Session                         |                        | 13:10<br>Special Lecture 2          |
| 13:00 |                                      | 13:15<br>Opening of<br>Exhibition                |  |  |                        |                                     |
|       |                                      | 14:00<br>Plenary Lecture 1                       |  |  |                        |                                     |
| 14:00 |                                      | 14:30<br>Plenary Lecture 2                       |  |  |                        |                                     |
|       |                                      | 15:00<br>Plenary Lecture 3                       | 15:00<br>Oral<br>Presentation<br>Session | 15:00<br>MSWM<br>Session                         |                        | 18:30<br>Farewell Party<br>(Dinner) |
| 15:00 | 15:30<br>Coffee Break                |  |  |  |                        |                                     |
|       | 16:00<br>Plenary Lecture 4           |  |  |  |                        |                                     |
| 16:00 | 16:30<br>Plenary Lecture 5           |  |  |  |                        |                                     |
|       | 17:00<br>Plenary Lecture 6           |  |  |  |                        |                                     |
|       |                                      |  |  |  |                        |                                     |
| 18:00 |                                      |  |  |  |                        |                                     |
| 19:00 | 19:00<br>Welcoming Party<br>(Dinner) |  |  |  |                        |                                     |
| 20:00 |                                      |  |  |  |                        |                                     |

Room:

Wantilan Convention Center

Wantilan A, C1, C1, Jauk, Garuda

Wantilan B



**FIRST DAY(1<sup>st</sup> Day): Monday, October 8<sup>th</sup>, 2012**

***Plenary Session***

Room: Wantilan Convention Center

| Time          | Agenda   | Moderator                 |
|---------------|--|---------------------------|
| 08.30 - 12.30 | <b>Registration</b>  |                           |
| 12.30 - 13.15 | <b>Opening ceremony:</b> <ul style="list-style-type: none"> <li>- <b>Organizing Committee</b> (<i>Report of committee</i>)</li> <li>- <b>Chairperson of APLAS Bali 2012</b> (<i>Welcoming speech</i>)</li> <li>- <b>Governor of Bali, Indonesia</b> (<i>Welcoming speech</i>)</li> <li>- <b>Representative of Ministry of Environment, Japan</b> (<i>Welcoming speech</i>)</li> <li>- <b>Minister of Public Works, Indonesia</b> (<i>Opening remarks</i>)</li> </ul> | MC                        |
| 13.15 - 14.00 | <b>Opening of exhibition: Minister of Public Works, Indonesia</b>  |                           |
| 14.00 - 14.30 | <b>Plenary lecture 1: Mrs. Masnellyarti Hilman, Indonesia: Waste Management Policy in Indonesia</b>  | Prof. Enri Damanhuri      |
| 14.30 - 15.00 | <b>Plenary lecture 2: Dato' NadzriYahaya, PhD, Ministry of Housing and Local Government, Malaysia: Policy and Strategy of Solid Waste Management in Malaysia</b>   |                           |
| 15.00 - 15.30 | <b>Plenary lecture 3: Prof. ChettiyappanVisvanathan, AIT Thailand: 3R Pathway Towards Sustainable Landfill Management</b>  |                           |
| 15.30 - 16.00 | <b>Coffee break</b>  |                           |
| 16.00 - 16.30 | <b>Plenary lecture 4: Prof. Masaru Tanaka, TUES Japan: Promotion of 3Rs and Solid Waste Disposal</b>   | Prof. Agamuthu Pariatamby |
| 16.30 - 17.00 | <b>Plenary lecture 5: Prof. Kunio Yoshikawa, TIT Japan: Production of Useful Fuels and Electricity from Biomass and Waste Resources</b>  |                           |
| 17.00 - 17.30 | <b>Plenary lecture 6: Prof. Joni Hermana, ITS Indonesia: Landfill Leachate Handling and Treatment in Indonesia</b>   |                           |
| 19.00 - 21.00 | <b>Dinner, Welcoming party</b>   |                           |



**SECOND DAY(2<sup>nd</sup> Day): Tuesday, October 9<sup>th</sup>, 2012**

***Parallel Session***

**Session A – Waste Prevention Management (OWP)  
&Municipal Solid Waste in Developing Countries (OMS)  
Room : Wantilan A**

| No | Time        | ID no                                | Code   | Name                      | Country      | Title  | Moderator                        |
|----|-------------|--------------------------------------|--------|---------------------------|--------------|--|----------------------------------|
| 1  | 09.00-09.20 | 1                                    | OWP-1  | Ahmad Fariz Mohamed       | Malaysia     | Standard for Waste Recycling Industry in Malaysia: Towards Sustainability of Recycling Industry.   | Takeshi Fujiwara                 |
| 2  | 09.20-09.40 | 29                                   | OWP-8  | Sakaraia Serau            | Fiji Islands | Sharing the Experience of 3R Project in Fiji   |                                  |
| 3  | 09.40-10.00 | 75                                   | OWP-3  | Fauziah S.H.              | Malaysia     | Challenges of 3Rs Implementation: Public Participation towards Sustainable Waste Management in Malaysia  |                                  |
|    | 10.20-10.40 | Coffee Break                         |        |                           |              |  |                                  |
| 4  | 11.00-11.20 | 146                                  | OWP-9  | Tariq Bin Yousuf          | Bangladesh   | 3R Action Plan: A Targeted Waste Management Solution for Bangladesh  |                                  |
|    | 12.00-13.00 | Lunch, Exhibition and Poster Session |        |                           |              |  |                                  |
| 5  | 13.00-13.20 | 159                                  | OWP-5  | Hossein Ganjidoust        | Iran         | Municipal Solid Waste Minimization Programs in Alvand, Qazvin, I.R.Iran  | Agamuthu P. & Asep Sofyan        |
| 6  | 13.20-13.40 | 39                                   | OMS-9  | Siti Norbaizura Md. Rejab | Japan        | Low-Carbon City 2025; Sustainable Iskandar Malaysia - from the viewpoint of Solid Waste Management   |                                  |
| 7  | 13.40-14.00 | 58                                   | OMS-7  | Periyathamby Kuruparan    | Sri Lanka    | Development of Waste Segregation Scheme for Compost Processing in Ampara Urban Council in Ampara District Eastern Sri Lanka                                    |                                  |
| 8  | 14.00-14.20 | 59                                   | OMS-8  | Periyathamby Kuruparan    | Sri Lanka    | Learning Experience of Cluster Waste Management Facilities: Karaitivu Waste Transfer Station and Addalachenai Landfill under Ampara District Eastern Sri Lanka |                                  |
| 9  | 14.20-14.40 | 60                                   | OMS-5  | Irwan Ridwan Rahim        | Japan        | Economic Incentives in an Effort to Reduce Greenhouse Gas Emissions from Municipal Solid Waste Sector (Case study in Indonesians’ Major Cities)                |                                  |
|    | 14.40-15.00 | Coffee Break                         |        |                           |              |  |                                  |
| 10 | 15.00-15.20 | 79                                   | OMS-4  | Do Thi Thu Trang          | Japan        | Estimation of Commercial and Institutional Solid Waste Generation in Hue city, Vietnam   | Kurian Joseph & Dollaris Riauaty |
| 11 | 15.20-15.40 | 92                                   | OMS-10 | Yasuhiro Matsui           | Japan        | Comparison of Operational Efficiency Among Waste Collection Systems in Da Nang City, Vietnam   |                                  |
| 12 | 15.40-16.00 | 95                                   | OMS-6  | Naofumi Sato              | Japan        | Current Condition and Issues of Municipal Solid Waste Management in Sri Lanka  |                                  |
| 13 | 16.00-16.20 | 127                                  | OMS-1  | D.M.C.B. Wijerathna       | Sri Lanka    | Solid Waste Management Issues in Developing World – A case study from Sri Lanka  |                                  |
| 14 | 16.20-16.40 | 155                                  | OMS-3  | Dian Marya Novita         | Indonesia    | Heating Value Based on Composition and Characteristics of Municipal Solid Waste in Indonesia in Waste to Energy Concept  |                                  |



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**SECOND DAY(2<sup>nd</sup> Day): Tuesday, October 9<sup>th</sup>, 2012**

## *Parallel Session*

### **Session B – Waste Biomass Utilization (OWB) & Waste Processing and Treatment (OWT)**

Room : Wantilan C1

| No | Time        | ID                                   | Code   | Name                      | Country     | Title  | Moderator                          |
|----|-------------|--------------------------------------|--------|---------------------------|-------------|--|------------------------------------|
| 1  | 09.00-09.20 | 7                                    | OWB-8  | Sandhi Eko Bramono        | Indonesia   | Anaerobic Fermentation of Food Waste to Biosolvents by Clostridium species   | Suryaman Shakya                    |
| 2  | 09.20-09.40 | 22                                   | OWB-7  | Osamu Sawai               | Japan       | Supercritical Water Gasification of Sewage Sludge Using Bench-Scale Reactor: Study on the Behavior of Metals and Nutrients |                                    |
| 3  | 09.40-10.00 |                                      |        |                           |             |  |                                    |
|    | 10.20-10.40 | Coffee Break                         |        |                           |             |  |                                    |
| 4  | 10.40-11.00 | 46                                   | OWB-5  | Kyuyeon Kim               | Korea       | Waste Stream Analysis and Energy Recovery Plan on Organic Sewage Sludge in Korea   | Joni Hermana                       |
| 5  | 11.00-11.20 | 115                                  | OWB-10 | Wahyono Hadi              | Indonesia   | Solid Waste Biorafinery  |                                    |
| 6  | 11.20-11.40 | 157                                  | OWB-4  | Jae Sung Park             | Korea       | Biomass Contents and its Effect Factors of SRF in Korea  |                                    |
| 7  | 11.40-12.00 | 122                                  | OWB-2  | Emenda Sembiring          | Indonesia   | The Important of Germination Index for Compost Application to Enhance a Plant Growth                                       |                                    |
|    | 12.00-13.00 | Lunch, Exhibition and Poster Session |        |                           |             |  |                                    |
| 8  | 13.00-13.20 | 165                                  | OWB-9  | Seno Darmawan Panjaitan   | Indonesia   | Potency of Biogas from Municipal Solid Waste for Electricity Generation: Case Study of a Small Scale Landfill in Pontianak | Tariq Bin Yousuf & Alex Chalik     |
| 9  | 13.20-13.40 | 166                                  | OWB-6  | Ni Luh Putu Sari Udyani   | Indonesia   | C-Organic Degradation on Preliminary Study of Potential Composting of Sludge Produce Water from Oil and Gas Industry       |                                    |
| 10 | 13.40-14.00 | 23                                   | OWT-2  | Bijan Bina                | Iran        | Evaluation of Stability Parameters in In-Vessel Composting of Municipal Solid Waste  |                                    |
| 11 | 14.00-14.20 | 33                                   | OWT-6  | S.S.R.M.D.H.R. Wijesekara | Sri Lanka   | Application of Nano-Zero Valent Iron for Landfill Leachate Treatment in The Tropics  |                                    |
| 12 | 14.20-14.40 | 34                                   | OWT-7  | Sonia S.Mayakaduwa        | Sri Lanka   | Characterization of Leachate Draining From Gohagoda Landfill for Dissolved Organic Carbon, Nutrients and Heavy Metals      |                                    |
|    | 14.40-15.00 | Coffee Break                         |        |                           |             |  |                                    |
| 13 | 15.00-15.20 | 35                                   | OWT-1  | Ari Rahman                | Japan       | Thermodynamic Simulation of Textile Sewage Sludge Combustion   | Mitsuo Kawaguchi &Emenda Sembiring |
| 14 | 15.20-15.40 | 44                                   | OWT-4  | Mohajit                   | Indonesia   | Financial Prospect to The Application of Decanter System for The Treatment of Sludge Waste in Water Treatment Plant System |                                    |
| 15 | 15.40-16.00 | 135                                  | OWT-5  | Pham T.H.D.               | Vietnam     | Numerical Hydrodynamic of Liquid and Solid Phase in Moving Bed Biofilm Reactor to Removal Nitrogen                         |                                    |
| 16 | 16.00-16.20 | 161                                  | OWT-9  | Yong-Chil Seo             | South Korea | Application of Oxy-Combustion To Waste Sludge As A Carbon Capture and Storage Technology                                   |                                    |
| 17 | 16.20-16.40 | 28                                   | OWT-8  | Shunsuke Kashiwakura      | Japan       | Rapid Quantification of Manganese in Steel Scraps by Laser-Induced Plasma Spectroscopy under Atmospheric Pressure          |                                    |
| 18 | 16.40-17.00 | 164                                  | OWT-3  | Elisabeth Leonora         | Indonesia   | Study of Coagulation and Flocculation Process in Leachate Treatment  |                                    |





# The 7<sup>th</sup> Asian-Pacific Landfill Symposium

October 8<sup>th</sup> - 11<sup>th</sup>, 2012, Bali, Indonesia

ISBN 978-602-18925-0-3

**SECOND DAY(2<sup>nd</sup> Day): Tuesday, October 9<sup>th</sup>, 2012**

## *Parallel Session*

### **Session C – Integrated Solid Waste Management (OSM)**

Room : Wantilan C2

| No | Time         | ID                                   | Code   | Name                           | Country     | Title  | Moderator                  |
|----|--------------|--------------------------------------|--------|--------------------------------|-------------|--|----------------------------|
| 1  | 09.00 -09.20 | 27                                   | OSM-11 | Yoshinori Ito                  | Japan       | Empirical Study About The Waste Environmental Measure and Corporate Value in Japanese Companies  | Kati Andraini              |
| 2  | 09.20-09.40  | 53                                   | OSM-3  | Dennis Victor                  | Malaysia    | Strategic Environmental Assessment Policy Intervention Scenario For Solid Waste Management In Malaysia   |                            |
| 3  | 09.40-10.00  | 87                                   | OSM-10 | Yong-Chul Jang                 | South Korea | Current Practices and Challenges of Municipal Solid Waste Management toward a Sustainable Society in Korea   |                            |
| 4  | 10.00-10.20  | 88                                   | OSM-9  | Sithamparanathan Sivakumaran   | Sri Lanka   | Integrated Solid Waste Management System Implementation In Ampara District, Sri Lanka  |                            |
|    | 10.20-10.40  | Coffee Break                         |        |                                |             |  |                            |
| 5  | 10.40-11.00  | 119                                  | OSM-12 | Yu-Chi Weng                    | Japan       | Proposal of Estimation Model for the Destruction Quantity of the Building Stock Considering the Regional Characteristics and its Application to the Regional Rehabilitation Plan-Learned from the Lesson of the Great East Japan Earthquake            | Mohammad Helmy             |
| 6  | 11.00-11.20  | 120                                  | OSM-13 | Yu-Chi Weng                    | Japan       | Study of Reduction of Final Disposal Amount and GHG Emission by Waste Management Strategy for the Municipalities without Incinerators - Effectiveness of Recycling by Improved Separation of Kitchen Waste, Papers, and Plastics in Kitahiroshima City |                            |
| 7  | 11.20-11.40  | 133                                  | OSM-5  | Kazuei Ishii                   | Japan       | A New Concept of Final Disposal Systems for MSW Management Considering Storage of Recyclable Materials and Disaster Waste  |                            |
| 8  | 11.40-12.00  | 141                                  | OSM-2  | Dena Sismaraini                | Indonesia   | Waste Characteristic Suitability in Bogor Regency as Alternative Fuels and Raw Materials in Cement Industry  |                            |
|    | 12.00-13.00  | Lunch, Exhibition and Poster Session |        |                                |             |  |                            |
| 9  | 13.00-13.20  | 81                                   | OSM-7  | Margareththa Christine Siregar | Indonesia   | Bank Sampah Wahana Bersama: Understanding Community's Attitude towards The Role of The Informal Sector in Solid Waste Management in Pontianak.   | Ben Basnayake & Djoko Heru |
| 10 | 13.20-13.40  | 100                                  | OSM-8  | Mochammad Chaerul              | Indonesia   | Evaluation and Improvement of Solid Waste Management at Traditional Market (Case Study: Ujung Berung Traditional Market in Bandung City)   |                            |
| 11 | 13.40-14.00  | 125                                  | OSM -1 | Asep Sofyan                    | Indonesia   | Greenhouse Gas Mitigation Scenario for Solid Waste in Indonesia  |                            |
| 12 | 14.20-14.40  | 73                                   | OSM-4  | Haryo Tomo                     | Austria     | Combinatorial and Pinch Analysis for Minimizing Generated-Air Pollution from Solid-waste Treatment Area  |                            |
|    | 14.40-15.00  | Coffee Break                         |        |                                |             |  |                            |



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**SECOND DAY(2<sup>nd</sup> Day): Tuesday, October 9<sup>th</sup>, 2012**

## *Parallel Session*

### **Session D – Hazardous Waste Management (OHW) &Health and Environment Aspect of Solid Waste Handling (OHE) Room : Jauk Room**

| No | Time         | ID                                   | Code   | Name                         | Country     | Title   | Moderator                           |
|----|--------------|--------------------------------------|--------|------------------------------|-------------|---|-------------------------------------|
| 1  | 09.00 -09.20 | 43                                   | OHW-2  | Sithamparanathan Sivakumaran | Sri Lanka   | Evaluation of Clinical Waste Disposal Practices of Hospitals In Ampara District   | Orawan Siriratpiriya                |
| 2  | 09.20-09.40  | 89                                   | OHW-3  | Widi Astuti                  | Indonesia   | Public Perception Study and Influential Factors of Electronic Waste (E Waste) in Semarang City  |                                     |
| 3  | 09.40-10.00  | 130                                  | OHW-6  | Zeneth Ayesha Thobarony      | Indonesia   | Characteristic and Potential of Toxic Waste From Assembly Process in Automobile Industry (Case Study: Industry X)                           |                                     |
|    | 10.20-10.40  | Coffee Break                         |        |                              |             |   |                                     |
| 4  | 10.40-11.0   | 163                                  | OHW-1  | Asri Cipta Indah Oktaviana   | Indonesia   | Identification of Informal Integrated Circuit Recycler and Collector as a Basis for Material Flow Analysis of Integrated Circuit in Bandung | Yong-Chil Seo                       |
| 5  | 11.00-11.20  | 86                                   | OHW-4  | Yong-Chul Jang               | South Korea | A Roadmap of Waste Electrical and Electronic Equipment(WEEE) Recycling Technology Development in Korea                                      |                                     |
| 6  | 11.20-11.40  | 42                                   | OHE- 6 | Sunarto                      | Indonesia   | The Role of Waste Processing at TPS on The Reducing of Carbon Footprint of Waste Management in Malang                                       |                                     |
| 7  | 11.40-12.00  | 118                                  | OHE- 2 | Kyeong-ho Lee                | Korea       | An Assessment Study on The Potential Application of Solidified Sludge As Landfill Cover by Using of Odor Index Species                      |                                     |
|    | 12.00-13.00  | Lunch, Exhibition and Poster Session |        |                              |             |   |                                     |
| 8  | 13.00-13.20  | 121                                  | OHE -1 | Emenike C.U.                 | Malaysia    | Leachate Risk: Bioaccumulation of Heavy Metals in Fish  | Made Sudiana Mahendra &Jaehyuk Hyun |
| 9  | 13.20-13.40  | 70                                   | OHE -3 | Nguyen Phuc Than             | Japan       | Potential on GHG Mitigation of Municipal Solid Waste Treatment Alternatives in Vietnam  |                                     |
| 10 | 13.40-14.00  | 124                                  | OHE -4 | Ramrav Hem                   | Japan       | Three-Dimensional Analysis of Groundwater Contaminated by 1,4-Dioxane at An Illegal Dumping Site with Complex Hydrogeological Features      |                                     |
| 11 | 14.00-14.20  | 158                                  | OHE-5  | Samaneh Pasha Zanousi        | Iran        | Evaluation of Sludge Reduction in WWTPs by Aquatic Tubifex  |                                     |
|    | 14.40-15.00  | Coffee Break                         |        |                              |             |   |                                     |



**SECOND DAY(2<sup>nd</sup> Day): Tuesday, October 9<sup>th</sup>, 2012**

***Parallel Session***

**Session E – Sustainable Landfilling Sitting Process (OSL)**

Room : Garuda Room

| No | Time         | ID                                   | Code   | Name                 | Country     | Title  | Moderator                         |
|----|--------------|--------------------------------------|--------|----------------------|-------------|--|-----------------------------------|
| 1  | 09.00 -09.20 | 5                                    | OSL-6  | Kent P. von Maubeuge | Germany     | Advantages of Geosynthetics over Natural Materials in Composite Liner Systems  | Benno Rahardya                    |
| 2  | 09.20-09.40  | 9                                    | OSL-5  | Kasam                | Indonesia   | Effect of Age of Municipal Solid Waste on Quantity And Quality of leachate Landfill Generation By Column-Experiment                        |                                   |
| 3  | 09.40-10.00  | 6                                    | OSL-7  | Kent P. von Maubeuge | Germany     | The New Generation of Geosynthetic Clay Liners   |                                   |
| 4  | 10.00-10.20  | 18                                   | OSL-2  | Dongbei Yue          | China       | Effectiveness of Aerobic Pretreatment of Municipal Solid Waste for Reduction of Non-methane Organic Compounds during Simulated Landfilling |                                   |
|    | 10.20-10.40  | Coffee Break                         |        |                      |             |  |                                   |
| 5  | 10.40-11.00  | 25                                   | OSL-11 | Pham T.H.D.          | Belgium     | N removal Modelisation in a Moving Bed Bio-film Reactor (MBBR) with a Modified ASM3 Model  | Haryo Satryo Tomo                 |
| 6  | 11.00-11.20  | 30                                   | OSL-1  | Alice Leney          | New Zealand | Landfill Construction and Leachate Management for Low-lying Coral Atolls   |                                   |
| 7  | 11.20-11.40  | 38                                   | OSL-16 | Takashi Miyagawa     | Japan       | Improvement of An Existing Open Dumping Site by Fukuoka Method through JICA Training Follow-up Program                                     |                                   |
| 8  | 11.40-12.00  | 142                                  | OSL-17 | Tri Padmi/Sandia     | Indonesia   | Identification of Bacteria Communities That Play Role on Methane Oxidation In Landfill Cover Material                                      |                                   |
|    | 12.00-13.00  | Lunch, Exhibition and Poster Session |        |                      |             |  |                                   |
| 9  | 13.00-13.20  | 52                                   | OSL-12 | R.T.K. Ariyawansa    | Sri Lanka   | Inferences Drawn from Converting a Dumpsite Quarry to a Sustainable Landfill in the East Coast of Sri Lanka                                | Chettiyappan Visvanathan          |
| 10 | 13.20-13.40  | 65                                   | OSL-18 | Tri Budi Prayogo     | Japan       | The Effect of Water Content of Waste Material on Gas Generation  |                                   |
| 11 | 13.40-14.00  | 94                                   | OSL-3  | Gemunu Herath        | Srilanka    | Characterizing Solid Waste at Dumps in Different Geographical Settings of Sri Lanka for Potential Energy Generation                        |                                   |
|    | 14.40-15.00  | Coffee Break                         |        |                      |             |  |                                   |
| 14 | 15.00-15.20  | 156                                  | OSL-19 | Widodo Brontowiyono  | Indonesia   | The Role of Community Solid Waste Management towards Sustainable Final Disposal Site (TPA) Piyungan, Yogyakarta                            | Ariani Dwi Astuti and Asep Sofyan |
| 15 | 15.20-15.40  | 143                                  | OSL-8  | M. Saravanan         | Malaysia    | Landfill Liner Interface Parameters And Member Selection With Stability Assessment, And Factor Of Safety Predictions With Seismic Loading  |                                   |
| 16 | 15.40-16.00  | 162                                  | OSL-15 | Sri Darwati          | Indonesia   | Developing A Block Landfill Concept for Sustainable Solid Waste Management at Final Processing Site  |                                   |
| 17 | 16.00-16.20  | 149                                  | OSL-10 | Opy Kurniasari       | Indonesia   | Performance Methan Oxidation in Lisimeter Using Compost Landfill Mining As Biocover to Reduce Methane Gas Emissions from Landfills         |                                   |
| 18 | 16.20-16.40  | 3                                    | OSL-13 | Ruslan Ramang        | Indonesia   | Effects of Problems and Waste Handling on The Community Participation in Waste Management (a Case Study in The Urban Cimahi)               |                                   |
| 19 | 16.40-17.00  | 129                                  | OSL-14 | Samin                | Indonesia   | The Determination of Leachate Generation Using a modified Thornthwaite method  |                                   |



**SECOND DAY(2<sup>nd</sup> Day): Tuesday, October 9<sup>th</sup>, 2012**

***MSWM Session***

***Municipal Solid Waste Management and Technology in Asian Country***

***Country Report and Best Practices***

Room: Wantilan B

| Time          | Agenda  | Moderator  |
|---------------|---|--|
| 08.00 - 09.00 | Registration  |  |
| 09.00 - 10.20 | - Indonesia: M. SjukrulAmien<br>- Bangladesh: Tariq Bin Yousuf<br>- Cambodia: Sour Sethi                                      | Masaru Tanaka                                    |
| 10.20 - 10.40 | Coffee break  |  |
| 10.40 - 12.00 | - India: Kurian Joseph<br>- Japan: Takeshi Fujiwara<br>- Indonesia: Anita Firmanti Eko Susetyowati                            | Chettiyappan<br>Visvanathan                      |
| 12.00 - 13.00 | Lunch, Exhibition and Poster Session  |  |
| 13.00 - 14.40 | - Nepal: Suryaman Shakya<br>- Singapore: OngSengEng<br>- Thailand: Orawan Siriratpiriya<br>- Indonesia: H. Rendra Kresna      | Kunio Yoshikawa<br>& Aboejoewono<br>Aboeprayitno |
| 14.40 - 15.00 | Coffee break  |  |
| 15.00 - 16.40 | - Malaysia: Agamutu Pariatamby<br>- Srilanka: Ben Basnayake<br>- South Korea: Jaehyuk Hyun<br>- Cynthia Hendrayani (PT. NOEI) | Joni Hermana &<br>Mohammad<br>Helmy              |



**THIRD DAY(3<sup>rd</sup> Day): Wednesday, October 10<sup>th</sup>, 2012**

***MSWM and Special Lecture Sessions***  
***Municipal Solid Waste Management and Technology in Asian Country***  
***Country Report and Best Practices***  
Room: Wantilan Convention Center

| <b>MSWM Session</b>            |  |                                 |
|--------------------------------|--|---------------------------------|
| <b>Time</b>                    | <b>Agenda</b>  | <b>Moderator</b>                |
| <b>08.00 - 09.00</b>           | <b>Registration</b>  |                                 |
| <b>09.00 - 10.20</b>           | <ul style="list-style-type: none"> <li>- <b>China: Kaimin Shih</b></li> <li>- <b>Indonesia: Tri Rismaharini</b></li> <li>- <b>Vietnam: Ngo Kim Chi</b></li> <li>- <b>Indonesia: Jos Rizal</b></li> </ul>   | Kati Andraini                   |
| <b>10.20 - 10.40</b>           | <b>Coffee break</b>  |                                 |
| <b>Special Lecture Session</b> |  |                                 |
| <b>10.40 - 12.10</b>           | <b>Special Lecture 1:</b> <ul style="list-style-type: none"> <li>- <b>Yoichi Toyama (MoE Japan):</b> <i>Waste Management Administration in Japan, History of Waste Management in Japan and Recent Activities on 3Rs Inside and Outside Japan</i></li> <li>- <b>Mitsuo Kawaguchi (LSA, Japan):</b> <i>History and Regulation of Waste Landfilling in Japan</i></li> <li>- <b>SugiantoTandio (PT. Tirta Marta):</b> <i>Are you a ZEROnaut? (Plastic's Problems, Trends, Myths &amp; the ZEROnaut Solution)</i></li> </ul>  | Ben Basnayake                   |
| <b>12.10 - 13.10</b>           | <b>Lunch, Exhibition, and Poster Session</b>   |                                 |
| <b>13.10 - 14.30</b>           | <b>Special Lecture 2:</b> <ul style="list-style-type: none"> <li>- <b>David Kuper (Temesi Recycling Facility, Indonesia):</b> <i>Avoidance of Methane Production from MSW Decay through Composting (CDM TPST project) at Temesi (Gianyar), Bali</i></li> <li>- <b>Jan Theulen (Heidelberg Cement, Germany):</b> <i>Economical and Resource Efficient Recovery of MSW in Cement Kilns</i></li> <li>- <b>ByungChul Shin (SLC, Korea):</b> <i>Introduction to SLC and its Overseas Activities</i></li> </ul>  | Susmono                         |
| <b>14.30 - 14.50</b>           | <b>Coffee Break</b>  |                                 |
| <b>14.50 - 16.50</b>           | <b>Special Lecture 3:</b> <ul style="list-style-type: none"> <li>- <b>JohanesJager (TU Darmstadt, Germany):</b> <i>Landfill Reconstruction for Sustainability</i></li> <li>- <b>Tariq Bin Yousuf (Dhaka North City Corporation, Bangladesh):</b> <i>Semi-aerobic Landfill at Dhaka Final Disposal</i></li> <li>- <b>Budi S. Prasetyo (PT. Karya PrimaAnugerahMandiri, Indonesia):</b> <i>State of the Art Geosynthetic for Landfill Engineering Application</i></li> <li>- <b>Christopher Godlove (Global Methane Initiative, US-EPA):</b> <i>Global Methane Initiative in Asia</i></li> </ul> | Nugroho Tri Utomo & Alex Chalik |
| <b>18.30 - 20.30</b>           | <b>Dinner and Farewell Party</b>   |                                 |



**FOURTH DAY(4<sup>th</sup> Day): Thursday, October 11<sup>th</sup>, 2012**

**Site Visit Agenda**

| <b>Time</b>          | <b>Agenda</b>                                    |
|----------------------|--|
| <b>08.00 – 08.30</b> | Registration                                     |
| <b>08.30 – 08.45</b> | Trip to TPA (Landfill) Suwung (Denpasar City)    |
| <b>08.45 – 10.30</b> | Field Visit at TPA (Landfill) Suwung             |
| <b>10.30 – 12.00</b> | Trip to Bebek Bengil                             |
| <b>12.00 – 13.00</b> | Lunch  |
| <b>13.00 – 13.45</b> | Trip to TPA (Landfill) Temesi (Gianyar District) |
| <b>13.45 – 15.30</b> | Field Visit at TPA (Landfill) Temesi             |
| <b>15.30 – 17.00</b> | Trip to Garuda Wisnu Kencana                     |
| <b>17.00 – 18.30</b> | Tour Visit at Garuda Wisnu Kencana               |
| <b>18.30 – 19.00</b> | Trip to Jimbaran                                 |
| <b>19.00 – 20.00</b> | Dinner   |
| <b>20.00 – 20.45</b> | Back to Aerowisata Sanur Beach Hotel             |



**Identification of Bacteria Communities that Play Role of Methane Oxidation  
inside Potential Landfill Cover Material (Biocover)**

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**ABSTRACT**

Landfill plays a role as important source of methane as green house gas. Several researches were conducted to reduce methane emission from landfill; one of them was a low cost approach which used cover layer material from composting called biocover. Microbial activity was designed inside column reactor as its natural habits in landfill. Characterization of isolated indigenous bacteria was needed to enhance its potential inside biocover. Three different bacteria were isolated and identified using the sequencing of 16S rRNA genes. A phylogenetic tree of the 16S rRNA was built to compare with methylotrophic (bacteria that utilize methane and/or methanol as carbon source) using neighbor-joining and bootstrapping method. The first isolate (SP1) has 99.68% similarity with *Methyloversatilis universalis* and 99.58% similarity with uncultured bacterium clone EDW07B001. Isolate SP1 could reduce methanol up to 1.0% (v/v), reduced nitrate as nitrogen source, reached highest growth rate ( $\mu$ ) of 0.0681 day<sup>-1</sup>, reduced methanol up to 68.57%, VSS of 1620 mg/L, and yield coefficient (Y) of 0.945. The second isolate (SP2) has 95.82% similarity with *Hyphomicrobium vulgare*. Isolate SP2 could reduce methanol up to 1.0% (v/v), reduced nitrate, reached highest growth rate ( $\mu$ ) of 0.0551 day<sup>-1</sup>, reduced methanol up to 51.43%, VSS of 1240 mg/L, and yield coefficient (Y) of 0.964. The third isolate (SP3) has 99.32% similarity with uncultured bacterium clone NCD938F06C1 and 99.24% similarity with *Methylobacterium lusitanum*. Isolate SP3 could reduce methanol up to 1.0% (v/v), reduced ammonium and nitrate, reached highest growth rate ( $\mu$ ) of 0.0798 day<sup>-1</sup>, reduced methanol up to 51.43%, VSS of 1150 mg/L, and yield coefficient (Y) of 0.894.

**Keywords:** biocover, compost, landfill, methane, methanol, methylotrophic bacteria.

**1. INTRODUCTION**

Nowadays, at landfill sites, waste containing organic matters is dumped, and landfill gas (LFG) such as methane (CH<sub>4</sub>) and CO<sub>2</sub>, are emitted by microbial degradation of organic matters. CH<sub>4</sub> as the second most important green house gases after CO<sub>2</sub>, is 23 times more effective at trapping heat than CO<sub>2</sub> (IPCC, 2001). The atmospheric CH<sub>4</sub> concentration has increased by 143% over the last 250 years, largely due to increasing emissions from anthropogenic sources (US EPA, 2006). Landfills are the largest single anthropogenic source of US CH<sub>4</sub> emissions (US EPA, 2007).

The production of LFG will continue until the majority of the organic material in the waste has been degraded, which can take several decades. Both CH<sub>4</sub> and CO<sub>2</sub> are classified as greenhouse gases (i.e. gases that have a high capacity of absorbing infrared radiation reflected from the earth's surface).

LFG such as CH<sub>4</sub>, which is a greenhouse effect gas and a toxicant, is preferably removed from the gas before released to the air. To study the clean-up LFG, this research is developed by using biologically active top cover to oxidize CH<sub>4</sub> components to CO<sub>2</sub> gas in landfill lysimeter. Compost from landfill disposal is used as cover material in lysimeter.

Landfill biocover such as compost is known contain microorganisms of bacteria methanotrophic, the bacteria that use methane gas for a living. Many methods of identification are now made to isolate bacteria that oxidize methane gas potential. Stresse and Stegmann (2003, in Mor *et al.*, 2006) explained that the use of compost as biofilter material for microorganisms can enhance the degradation of methane gas. From a variety of existing research, proving the presence or absence of methanotrophic of bacteria in the soil cover was not easy.

The presence of some methylotrophic bacteria inside landfill covers material from solid waste dumped site showed high potency for finding new microorganisms from this compost sample. However, current screening isolation method using synthetic media was difficult to confirm methylotrophic and methanotrophic microbial diversity inside soil sample because methanotrophic bacteria were difficult to grow in synthetic media (Murell *et al.*, 1998). Therefore, molecular biological techniques application was suitable for understanding the communities and their interaction in methane oxidation process. The methylotrophic and/or methanotrophic bacteria which played role in methane oxidation pathway through methanol utilization were studied.

## 2. MATERIALS AND METHODS

### Materials

Soil sample from Jelekong Landfill that was mined under 1 m, called as compost landfill mining, was adapted inside continuous flow reactor (Kurniasari *et al.*, 2011).

AMS (Ammonium Mineral Salt) and NMS (Nitrate Mineral Salt) was used as media specific for this research (Atlas, 1993 and Whittenbury *et al.*, 1970). 0.5% (v/v) of methane or methanol was used for carbon source (Whittenbury *et al.*, 1970).

### Sample Characterization

Sample compost landfill mining was characterized before it was adapted for 3 months inside methane-reactor continuous flow as could be seen in Figure 1 (Kurniasari *et al.*, 2011). The highest bacterial point sampling was taken for physic and chemical characterization.

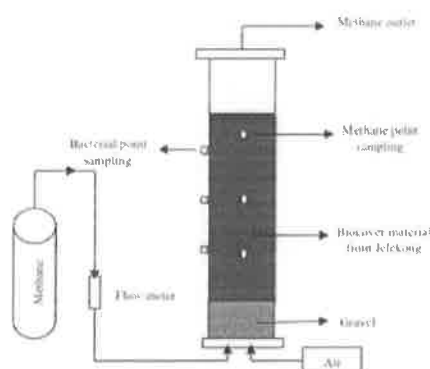
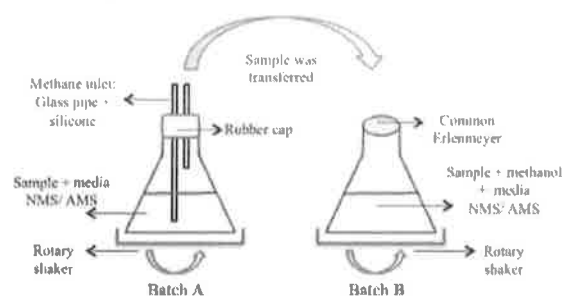


Figure 1 Reactor continuous flow (Kurniasari *et al.*, 2011)

### Screening Isolation of Methanotrophic/ Methylotrophic

One gram sample was inoculated inside media AMS and NMS with methane as carbon source with several volume levels. After it was incubated for 1 week, sample was transferred to media AMS and NMS with several volume levels of methanol; as seen on Figure 2. Subculture was conducted for several times until obtained pure isolation.



**Figure 2** Batch reactors for bacterial isolation

#### Identification of Methanotrophic/Methylophilic Bacteria

In this step, DNA genome from pure bacterial colony in the previous steps was isolated with Ultra Clean™ Soil DNA Isolation Kit. Subsequently, 16S rRNA gene was amplified with Polymerase Chain Reaction thermal cycler using a bacterium specific forward primer (B27f, 5'-AGAGTTTGATCCTGGCTCAG-3') and a universal reverse primer (U1492r, 5'-GGTACCTTGTTACGACTT-3') (Lane, 1991). The PCR product was then purified, sequenced, and analyzed for constructing phylogenetic tree by using sequences of the reference organisms from NCBI (National Centre for Biotechnology Information) and programme MEGA 4.0 (Molecular Evolutionary Genetic Analysis). Certain species would be obtained according to similarity percentage from phylogenetic tree.

#### Bacterial Screening: Methanol and Nitrogen Source Utilization

All of isolated bacteria from previous step were inoculated inside media AMS and NMS with several levels methanol concentration (0.5%, 0.75%, and 1.0% (v/v)). Bacteria were also tested in several selective media to see their ability as bacteria which was played role in nitrogen cycle. The nitrogen is ammonium, nitrite, and nitrate.

#### Measurement Bacterial Growth Rate and Substrate Utilization

All of screened bacteria inoculated 10% (v/v) into media AMS or NMS, as it specific previous isolation media, with methanol as carbon source (25°C, 120 rpm). For every 2-3 days, sample was taken for counting bacteria cell and methanol reduction. The bacterial growth curve, methanol utilizing curve, and bacteria yield was measured.

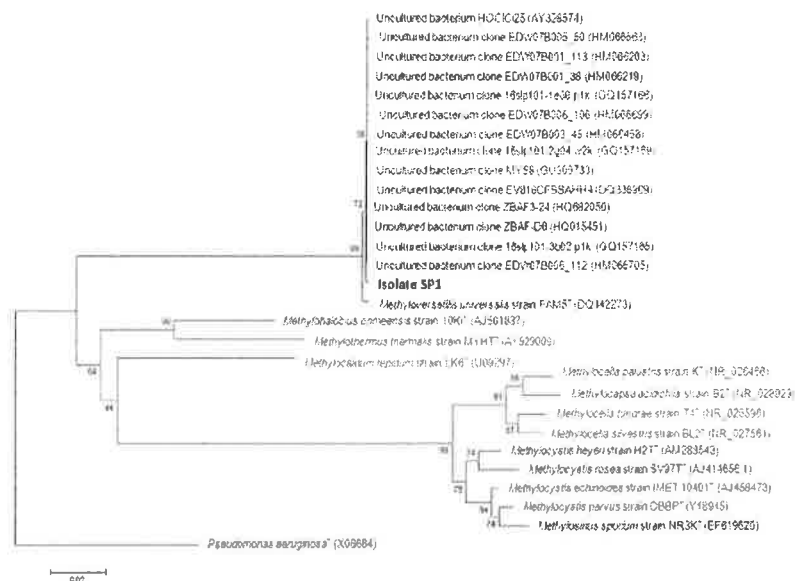
### 3. RESULTS AND DISCUSSION

#### Sample Characterization

Soil sample contained 55.77% of sand, 32.38% of silt, and 3.02% of clay. This sandy loam sample, has adequate porosity ( $n=0.67$ ) for methane, oxygen, and water exchange. It also has pH balance and adequate organic composition that for supporting microbial activity and methane oxidation.

#### Identification of Isolate SP1

Figure 3 showed that SP1 had 99.68% similarity with *Methyloversatilis universalis*. *M. universalis* was methylophilic bacteria that used methanol (Kalyuzhnaya *et al.*, 2006). Isolate SP1 was not closely affiliated with reference methanotrophic species genetically. It also could observe that Isolate SP1 had close relationship with uncultured bacteria such as uncultured bacterium clone EDW07B001 with 99.58% similarity.



Isolate SPI had ability to reduce nitrate. However, the closest reference of Isolate SPI c.q. *M. universalis* could not reduce nitrate (Kalyuzhnaya *et al.*, 2006). Therefore, further analysis on genotype and fenotype data should be accomplished. Besides Isolate SPI also had high similarity with uncultured bacteria that couldn't cultivate from synthetic media.

Besides, we also have identified another isolate named Isolate SP2. As shown in Figure 4, Isolate SP2 had 95.82% similarity with *Hyphomicrobium vulgare*. This bacteria group was methylotrophic and nitrate utilizing-bacteria. Moreover, these bacteria also had slow growth rate and ability to survive in limited nutrition condition (Attwood and Harder, 1972). It could be analyzed that these bacteria could perform optimally in the end of methane oxidation pathway if there is only small amount of methanol.

Figure 5 shows affiliation of another isolated bacteria c.q. Isolate SP3 to the closest references. Isolate SP3 had 99.32% similarity with uncultured bacterium clone NCD938F06C1 and 99.24% similarity with *Methylobacterium lusitanum*. Methylobacter group has limited ability in utilizing carbon source and energy, both methanol and/or methane (Aken *et al.*, 2004). Its close similarity with uncultured bacteria in synthetic media showed there was a certain amount of methylotrophic and methanotrophic microbes inside biocover that was difficult to be cultivated. Another molecular method was indeed required to understand these communities.

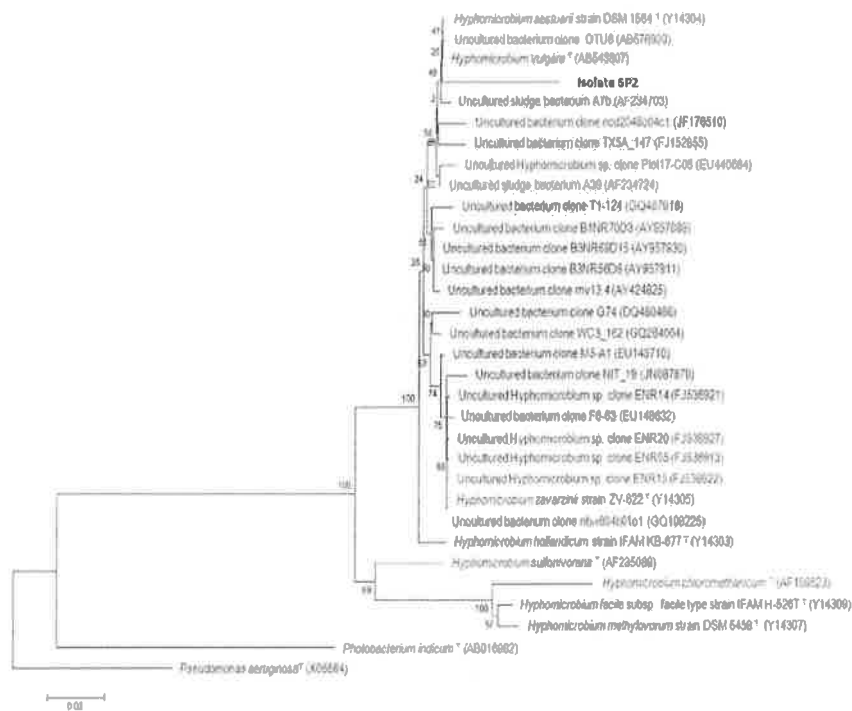


Figure 4 Phylogenetic tree of isolate SP2

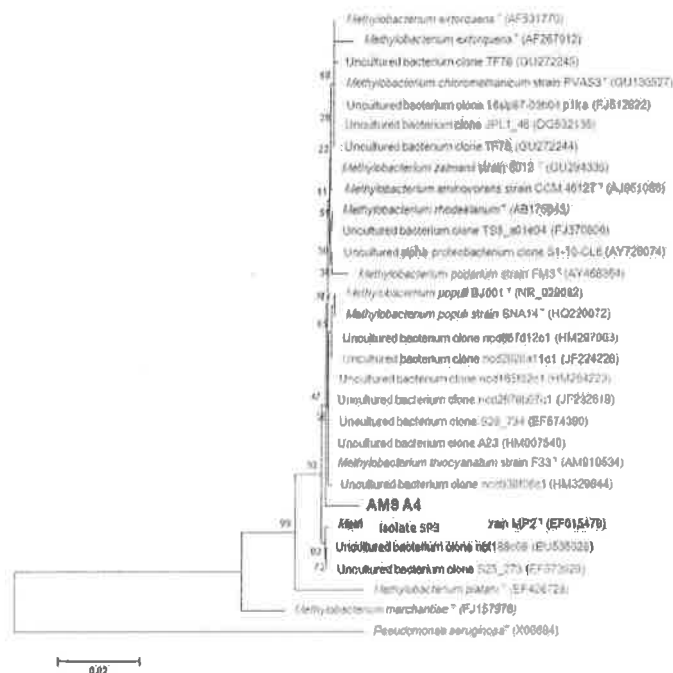


Figure 5 Phylogenetic tree of isolate SP3

### Growth Curve and Substrate Utilizing of Isolate SP1, SP2, and SP3

Isolate SP1 was reached the highest growth rate ( $\mu$ ) of 0.0681/day and reduced methanol (as COD) up to 68.57% from 2,500 mg O<sub>2</sub>/L until 785.71 mg O<sub>2</sub>/L (Figure 6). Based on VSS measurement from 1,620 mg/L of Isolate SP1, it resulted on yield coefficient (Y) of 0.945. Isolate SP1 could reduce methanol up to 1.0% (v/v) and reduced nitrate as nitrogen source better than any nitrogen source, even it isolated from AMS media.

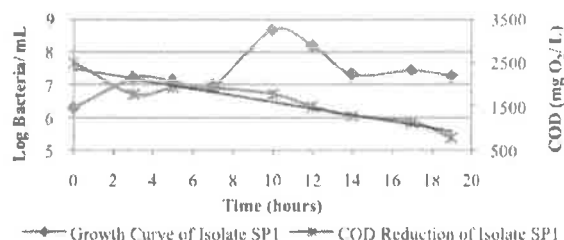


Figure 6 Growth curve and COD reduction of isolate SP1 inside AMS

Besides, Isolate SP2 was reached the highest growth rate ( $\mu$ ) of 0.0551/day and reduced methanol (as COD) up to 51.43% from 2,500 mg O<sub>2</sub>/L until 1,214.29 mg O<sub>2</sub>/L (Figure 7). It also had 1,240 mg/L of VSS and 0.964 of yield coefficient (Y). It could reduce methanol up to 1.0% (v/v) and reduced nitrate well.

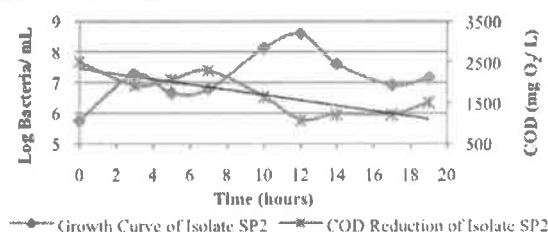


Figure 7 Growth curve and COD reduction of isolate SP2 inside NMS

Furthermore, Isolate SP3 (Figure 8) was reached the highest growth rate ( $\mu$ ) of 0.0798/day and reduced methanol up to 51.43% from 2,500 mg O<sub>2</sub>/L until 1,214.29 mg O<sub>2</sub>/L in COD basis. It also had 1,150 mg/L of VSS and 0.894 of yield coefficient (Y). This culture could reduce methanol up to 1.0% (v/v) and had ability to reduce ammonium and nitrate.

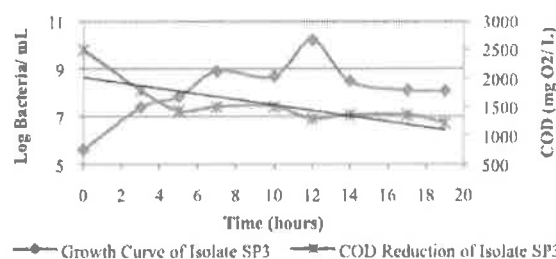


Figure 8 Growth curve and COD reduction of isolate SP3 inside AMS

### 4. CONCLUSION

Based on this research, we have successfully identified three methylotrophic and/or methanotrophic bacteria which played role in methane oxidation pathway through methanol

utilization. These were Isolate SP1 which had 99.68% similarity with *Methyloversatilis universalis* and 99.58% similarity with uncultured bacterium clone EDW07B001; Isolate SP2 which had 95.82% similarity with *Hyphomicrobium vulgare*; and Isolate SP3 which had 99.32% similarity with uncultured bacterium clone NCD938F06C1 and 99.24% similarity with *Methylobacterium lusitanum*.

## 5. ACKNOWLEDGMENTS

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