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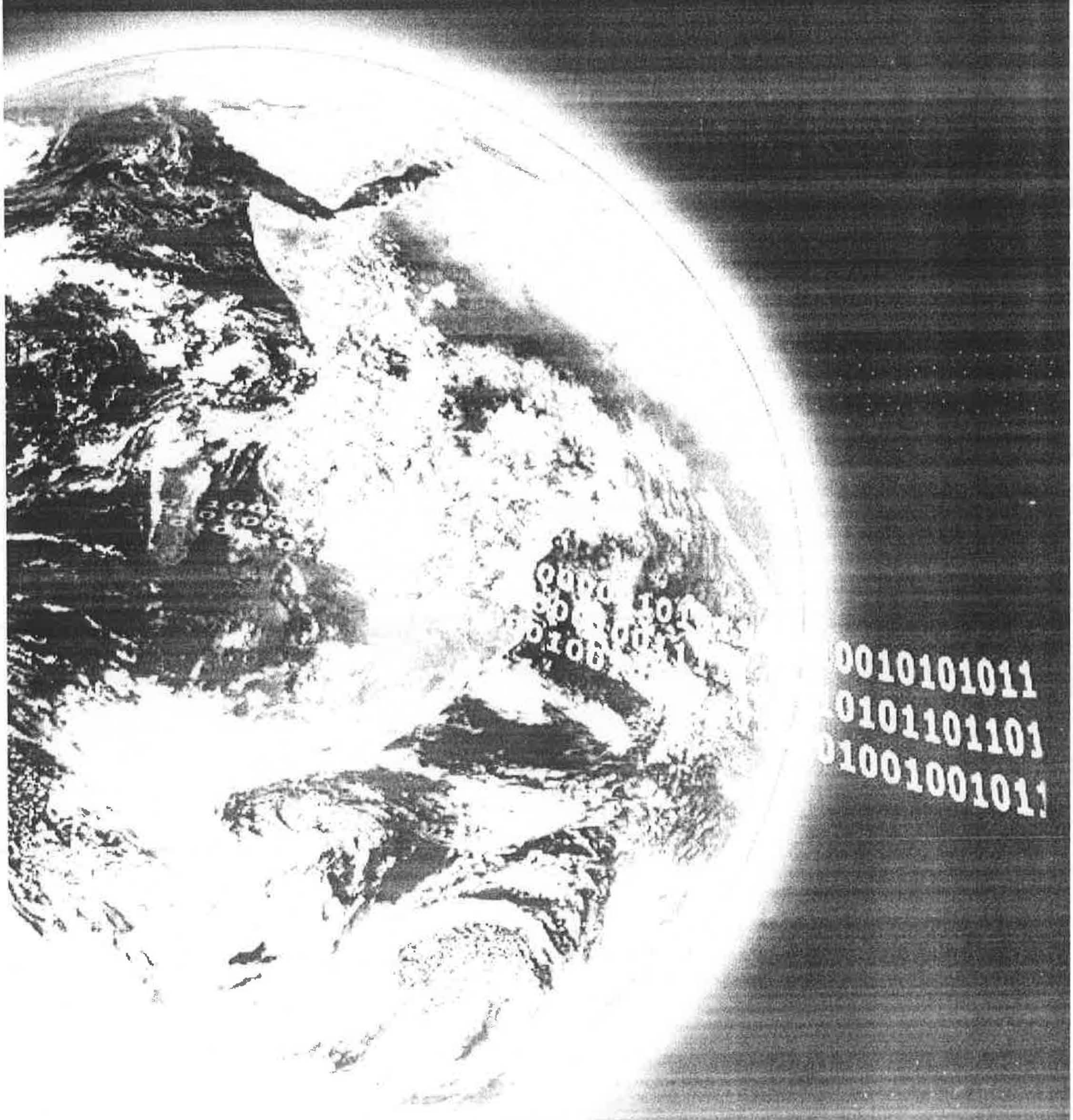
The 4th South East Asian Technical University Consortium (SEATUC) Symposium



HYBRID TWINNING PROGRAM 2009

PREFACE

Since establishment in 2006, SEATUC (South East Technical University Consortium) has created valuable and attractive opportunities for member institutions by offering chances for faculty members to get PhD degrees at SIT, and organizing scientific symposium, attracting participation of increasing number of lecturers and students year by year. The symposium this time is the 4th symposium, held on 25th -26th February 2010, and at Shibaura Institute of Technology (SIT), Japan.

Prof. Dr. Ha Duyen Tu
SEATUC President
4th SEATUC Symposium
Vice- President of HUT

Symposium 2010 continues to focus on 6 main fields including energy and environment, information technology, architecture-urban planning-design, bioscience and engineering, robotics and mechanism, and materials science. The total number of papers printed is 101, which over exceed those of the 3rd symposium and nearly triple those of the 2nd symposium. The increasing number of papers submitted over the 4 symposiums is an absolute evident for the popularity of the proceeding among professors and students of the member institutions and within regional and international scientific community as well. It is also an eloquent proof for the continuous success of symposiums over the years.

The symposium this time is strongly believed to continue promoting exchange of advanced scientific and technological information among speakers and participants beyond the research topics and strengthen the successful collaboration in education and research among member institutions.

Finally, on behalf of Organizing Committee, I would like to express high appreciation to Shibaura Institute of Technology for facilitating the organizing task and providing symposium venue, and Hanoi University of Technology for their great effort with organization duties. My appreciation is also to scientists, researchers, and students who have submitted papers and actively participated in the symposium, contributing to the success of the symposium 2010.

Time Table of 4th SEATUC Symposium, Japan Feb. 25-26, 2010

Date	Time (Room 301)	Session / Field (Room 301)	Presenter (Room 301)	Time (Room 302)	Session / Field (Room 302)	Presenter (Room 302)
Feb. 25	9:45 12:30	**Opening Session of SEATUC Symposium & Intensive Workshop Program "Engineering education to foster human resources for innovation"** 9:45- Opening Address 10:00- Keynote Lecture & Panel Discussion				
		Afternoon session				
	13:00 15:40	**Session A-1** **Architecture,Urban Planning and Design** (Chairpersons: SIT, UTM)	A-01 (KMUTT) Prasitchai Promliphonkul A-02 (SIT) Takashi Ishidou A-03 (SIT) Akbar Adhuitama A-04 (SIT) Aswin Indraprastha A-05 (SIT) Nafisa Binti Hosni A-06 (SIT) Makoto Itoh A-07 (UTM) Kei Saito A-08 (UTM) Norliza bt. Mohd Isa	13:00 15:40	**Session B-1** **Bioscience and Engineering** (Chairpersons: SIT,KMUTT)	B-09 (KMUTT) Pravate Tuitemwong B-10 (KMUTT) Kornkanok Aryusuk B-11 (KMUTT) Panthip Boonsong B-12 (SIT) Akira IZUMIYA B-13 (SIT) Heizo KAJIWARA B-14 (SIT) Azham Zulkharnain B-15 (SIT) Tomohisa Kato B-16 (SIT) Yoshihiko Ito
		Break				
	16:00 18:00	**Session A-2** **Architecture,Urban Planning and Design** (Chairpersons: SIT, UTM)	A-09 (UTM) Ismail Bin Said A-10 (UTM) Mohd. Hamdan Bin Ahmed A-11 (UTM) Ismail Bin Said A-12 (UTM) Sumaiyah binti Othman A-13 (UTM) Sapura Mohamad A-14 (UTM) Ismail Bin Said	16:00 18:00	**Session B-2** **Bioscience and Engineering** (Chairpersons: SIT,KMUTT)	B-17 (SIT) Nobutaka MAEZAKI B-18 (SIT) Nobuo Watanabe B-19 (UTM) Eraricar Salleh B-20 (UTM) Fong Wan Heng B-21 (UTM) Roshafima Rasit Ali B-22 (UTM) Siti Hamidah Mohd-Setapar
	18:40	**Closing for Day 1**				
	19:00	**Reception Party**				
Feb. 26	9:00	Morning Session				
	9:00 10:00	**Session A-3** **Architecture,Urban Planning and Design** (Chairpersons: SIT, UTM)	A-15 (UTM) Hamidah Ahmad A-16 (UTM) Mohd Hisyam Rasidi A-17 (KMUTT) Viroat Srisurapanon	9:00 11:00	**Session R-1** **Robotics** (Chairpersons: SIT, HUT)	R-09 (SIT) Makoto Mizukawa R-02 (SIT) Kanlaya Rattanyu R-03 (SIT) Ngo Trung Lam R-04 (SIT) Masaru Ide R-05 (SIT) Weerachai Skulkittiyut R-06 (SIT) Kazuo Naito
		Break				
	10:20 13:00	**Session M-1** Materials Science (Chairpersons: SIT, KMUTT)	M-01 (KMUTT) Weerasuk Surareungchai M-02 (SIT) Nor Akmal Fadil M-03 (SIT) Tetsuya Okuyama M-04 (SIT) Takeshi Saito M-05 (SIT) Tatsuhiko Aizawa M-07 (UTM) Mohd Nasir Tamin M-08 (SIT) Keiichi Hagiwara M-09 (SIT) Akito Takasaki		**Break**	
				11:20 13:20	**Session R-2** **Robotics** (Chairpersons: SIT, UTM)	R-07 (SIT) Katsuhiro MAYAMA R-08 (SIT) Motoki TAKAGI R-10 (SIT) Akira Shimaba R-11 (SIT) Kazuhisa Ito R-12 (SIT) Yoshiyuki SHIBATA R-13 (UTM) Marzuki Khalid
	13:30	**Symposium Closing : HUT & next host univ**				

*. The first alphabet of each field is used to mark different session (Architechture, Bioscience, Energy, Information, Materials, Robotics)

Time Table of 4th SEATUC Symposium, Japan Feb. 25-26, 2010

Date	Time	Room 303 Session / Field	Room 303 Presenter	Room 307 Time	Room 307 Session / Field	Room 307 Presenter
Feb. 25	9:45 12:30	**Opening Session of SEATUC Symposium & Intensive Workshop Program "Engineering education to foster human resources for innovation"** 9:45- Opening Address 10:00- Keynote Lecture & Panel Discussion				
		Afternoon session				
	13:00 15:40	**Session E-1** **Energy and Environment** (Chairpersons: SIT, HUT)	E-01 (ITB) Edwan Kardena E-02 (KMUTT) Nitus Tipsotnaiyana E-03 (KMUTT) Suchapa Netpradit E-04 (KMUTT) Krittika Tanprasert E-05 (KMUTT) Nucharin Luangsa-ard E-06 (SIT) Nguyen Duc Tuyen E-07 (SIT) Arwindra Rizqiawan E-08 (SIT) Nafisah ABDUL RAHIMAN	13:00 15:40	**Session I-1** **Information Technology** (Chairpersons: SIT, UTM)	I-01 (SIT) Khrisna Ariyanto I-15 (SIT) Shigeki Nakamura I-03 (SIT) Phat Nguyen Huu I-04 (SIT) Keita Nabeta I-06 (SIT) Yuuki Kuribara I-07 (SIT) Shunsuke Kobayashi I-08 (SIT) Satoshi Aoki I-05 (SIT) Sittapong Settapat
		Break				
	16:00 18:40	**Session E-2** **Energy and Environment** (Chairpersons: SIT, ITB)	E-09 (SIT) Nobuaki Nishimura E-10 (SIT)Goro Fujita E-11 (SIT) Satoshi Matsumoto E-12 (SIT) Suharyanto E-13 (UTM) Rubita Sudirman E-14 (UTM) Lee Yoke Lai E-15 (UTM) Makbul Anwari E-16 (UTM) Ho Chin Siong	16:00 18:00	**Session I-2** **Information Technology** (Chairpersons: SIT, UTM))	I-09 (SIT) Hiroyuki Kawamura I-10 (SIT) Shin Hasegawa I-11 (SIT) Hung Yu Shih I-16 (SIT) Keizaburo Nishina I-13 (SIT) Kaoru Koshimizu I-14 (SIT) Tomoki Takemura
	18:40	**Closing for Day 1**				
	19:00	**Reception Party**				
Feb. 26	9:00	**Morning Session**				
				9:00 10:40	**Session I-3** **Information Technology** (Chairpersons: SIT, UTM))	I-02 (SIT) Tran Minh Quang I-12 (SIT) Nurzal Effiyana binti Ghazali I-17 (SIT) Hiroki Murata I-18 (SIT) Akira Aiba I-19 (SIT) Eiji Kamioka
					Break	
				11:00 12:40	**Session I-4** **Information Technology** (Chairpersons: SIT, UTM))	I-20 (SIT) Michiko Ohkura I-21 (SIT) Masaomi Kimura I-22 (SIT) Takumi Miyoshi I-23 (UTM) Abu Sahmah Mohd Supaat I-24 (UTM) Khairul Anuar Abdullah
	13:30	**Symposium Closing : HUT & next host univ**				

*. The first alphabet of each field is used to mark different session (Architechture, Bioscience, Energy, Information, Materials, Robotics)

Time Table of Intensive Workshop, Japan Feb. 25, 2010

Date	Time	Room 306
Feb. 25	9:45 12:30	**Opening Session of SEATUC Symposium & Intensive Workshop Program "Engineering education to foster human resources for innovation"** 9:45- Opening Address 10:00- Keynote Lecture & Panel Discussion
		Afternoon session
	14:00 14:20	**Introduction to the Workshop**
	14:20 16:50	**Presentation for 6 persons** The talk is 15 minutes for the presentation and 10 minutes for the Q&A.
	16:50 17:30	**Discussion**

Timetable of Intensive Workshop

■ *Date* *February 25th (Thursday) 14:00 —17:15*

■ *Venue* *Room 5, Shibaura Campus, Shibaura Institute of Technology*

*) The talk is 15 minutes for the presentation and 10 minutes for the Q&A.

14:00-14:20 Introduction to the Workshop

14:20-14:45

"Mobile Context-Wareness for Traffic Estimation"

Tran Minh Quang and Eiji Kamioka, Shibaura Institute of Technology

14:45-15:10

"Radical Oxygen Species Change Cancer Treatment —Synthesis of New Type of Anticancer Drug —"

Kohei Imai[1], Asao Nakamura[1], Haruhiro Okuda[2] and Kiyoshi Fukuhara[2],

[1] Shibaura Institute of Technology, [2]National Institute of Health Sciences.

15:10-15:35

"User-Centric Soft Handovers between UMTS-WIMAX for Voice Service Using SCTP with Two Thresholds"

Nurzal Effiyana binti Ghazail[1], Eiji Kamioka[1], Abu Sahmah Mohd, Supa' at[2] and Sharifah Hafizah Syed Ariffin[2]

[1]Shibaura Institute of Technology, [2]Universiti Teknologi Malaysia.

15:35-16:00

"A Progressive Developing of Torque Transferring Mechanism for Superconducting Mixer"

Atikorn Wongsatanawarid, Yotaro Shimpo, S. Kobayashi, Hironori Seki

Shibaura Institute of Technology.

16:00-16:25

"Demands of Medical Robotics Field and Relevance to Our Researches"

Masaru Ide[1], Makoto Mohri[2], Pierluigi Beomonte Zobel[3], Hiroyuki Koyama[1], Shin-ichiro Yamamoto[1] and Takashi Komeda[1]

[1]Shibaura Institute of Technology, [2]Mohri Hospital, [3]University of L'Aquila

16:25-16:50

"Protein Movement Visualization Advantages in Medical Science and Biotechnology"

Naoto Kawasaki, Shibaura Institute of Technology.

16:50-17:15 Discussion.

Architecture, Urban Planning and Design

Bioscience and Engineering

Energy and Environment

Information Technology

Materials Science

Robotics and Mechanical Engineering

Biosurfactant Produced from *Azotobacter vinelandii* and its application for Enhanced Oil Sludge Biodegradation Process

Qomarudin Helmy[1], Syarif Hidayat[1], Wisjnuprapto[1] and Edwan Kardena[1]
Water and Wastewater Engineering Research Group, Faculty of Civil and Environmental Engineering,
Institute Technology of Bandung-Indonesia. Ganesha 10 Bandung-West Java Indonesia.

ABSTRACT
The problem of petroleum waste management is giving a due consideration of the national level. Large quantity of dehydrated oil sludge, generated in the disposal process of oil-containing sewage in Indonesia that needs to be rendered harmless to human and to the environment. Microbial degradation has been accepted as an important method for the treatment of oil sludge by employing indigenous or extraneous microbial flora. The purpose of this study was to investigate the performance of biosurfactant in its attempt in enhanced biodegradation of oil sludge process. Measurement of biosurfactant production indicated that the maximum production occurred at the end of exponential growth phase (48 h). In the oil sludge biodegradation assay, it was found that addition of petrofilic consortia increased the removal efficiency up to 55%, while addition of biosurfactant in this reactor increased the total efficiency of 70% after 70 days of incubation. These results suggest that both petrofilic consortia and biosurfactant addition stimulate the biodegradation and overcome the limitation of petroleum hydrocarbon degradation process.

Keywords: A.vinelandii, biosurfactants, biodegradation, oil sludge

1. INTRODUCTION

Contamination of soils, groundwater, sediments, surface water, and air with hazardous and toxic chemicals is one of the major problems facing the oil and gas industry in Indonesia. Recent accidents attribute to oil spillages in Tarakan (East Kalimantan), Sorong (Papua), Indramayu (West Java) and Bojonegoro (East Java) should giving a due consideration of the national level. Petroleum hydrocarbon continues to be used as the principle source of energy and hence a large global environmental pollutant. Apart from accidental contamination of ecosystem, one of the most encountered pollutants in petroleum production companies is the formation of oil sludge that is entrapped with the effluents during treatment and conditioning of the wells produced crude oil through treatment process facilities.

Biodegradation is a treatment technology used to remediate a variety of contaminants, including soils contaminated with petroleum hydrocarbons. Bioremediation is an engineered process where the natural biodegradation of petroleum hydrocarbons by indigenous soil bacteria, fungi, and protozoa is accelerated. Since the vast majority of hydrocarbons in crude oils and refined products are biodegradable, and hydrocarbon-degrading microbes are ubiquitous, biodegradation can be an environmentally acceptable way of eliminating oil sludge (Helmy et al., 2008). So far, biodegradation suggests an effective method (Boopathy, 2000). During biodegradation, hydrocarbon containing in oil sludge is used as an organic carbon source by a microbial process, resulting in the breakdown of oil sludge components to low molecular weight compounds. However, the bioavailability of weakly soluble hydrophobic compounds for microbial conversion is usually low and thus limits their degradation rate in aqueous medium (Genouw et al., 1994; Vasudevan and Rajaram. 2001). The use of surfactants has been found to enhance degradation of crude oil (Abalos et al., 2004; Urum and Pekdemir, 2004) or other hydrocarbons (Olivera et al., 2000). In this paper, we investigated the performance of petrofilic consortia in degrading oil sludge and surfactant addition to enhance biodegradation process.

In this paper, we report the possible application of biosurfactant produced from *A. vinelandii* in the oil industry, enhancing the oil sludge biodegradation process.

MATERIAL AND METHODS

Reagents.

All chemicals were of reagent grade, purchased from Merck, J.T. Baker and Sigma Chem Co. Growth media were purchased from Oxoid ltd. Crude oil and oil sludge samples was obtained from Duri Oil Field Pekanbaru and Balongan Oil Field Indramayu Indonesia, respectively

Bacterial strain and Culture Conditions.

Azotobacter vinelandii AV01 was used in producing biosurfactant, while the petrofilic consortia containing *Bacillus cereus* BL01, *Pseudomonas stuzeri* BL02, *Acinetobacter* sp. BL03 and *Bacillus* sp BL04 were used in the biodegradation assay of oil sludge. All bacteria were obtained from the Culture Collection of Environmental Biotechnology Laboratory-Environmental Engineering Department, Institute Technology of Bandung, Indonesia. *A. vinelandii* was maintained at 4°C on mannitol enrichment agar slants containing (l^{-1}): 20 g mannitol, 20 g yeast extract, 20 g tryptone, and 15 g of agar.. While each petrofilic bacteria was maintained at 4°C on Nutrient Agar covering with 1 drop of crude oil. Sub-cultures were made to fresh agar slants every 1 month to maintain viability.

Biosurfactant Production.

Cultures of *A. vinelandii* were grown on a minimal basal medium (MB) which composed the following components (l^{-1}) of distilled water: 1.5 g of K_2HPO_4; 0.5 g of KH_2PO_4; 0.2 g of $MgSO_4$; 0.25 g of $(NH_4)_2$ SO_4; and 20 g glucose as substrate. 10 ml Trace Element solution was added per liter of MB medium. The compositions of this trace element (l^{-1}) are 12 g of $Na_2EDTA_2.H_2O$; 1 g of $CaCl_2$; 0.4 g of $ZnSO_4.7H_2O$; 10 g of $NaSO_4$; 0.4 g of $MnSO_4.4H_2O$; 0.1 g of $CuSO_4.5H_2O$; 0.5 g of $Na_2MoO_4.2H_2O$. The medium was sterilized by autoclaving at 121°C for 15 min. The inoculums of *A. vinelandii* was prepared by transferring cells grown on a slant to 250 ml Erlenmeyer flasks containing 50 ml of MB broth. Culture was incubated in an orbital shaker at room temperature, 110 rpm for 2 days. The MB containing 10^6 cells/ml was used to initiate growth using 2% (v/v) inoculums. Biosurfactant production was carried out in 2.000 ml Erlenmeyer flasks containing 800 ml MB at room temperature (27°C) with shaking at 110 rpm for 2 days in an orbital shaker.

Crude Biosurfactant Isolation

The fermentation broth was centrifuged at 13.000 rpm for 30 minute to obtain a cell free broth. After centrifugation, the supernatant was then dissolved in a 4 N hydrochloric solution and allowed to stand overnight at 4°C, followed by the biosurfactant extraction step with a chloroform solvent at room temperature (Makkar and Cameotra, 1998). The organic layer was transferred to a round-bottom flask and the aqueous layer was re-extracted two times for complete recovery of biosurfactant. The organic phases were combined yielding a viscous brown-colored crude biosurfactant product and then evaporated to remove the solvent; the residue was collected and weighted. Vermani et al. (1995) method was used to determine the exopolysaccharide fraction of biosurfactant. A mixture of 1:2 (v/v) biosurfactant and chilled acetone were agitated and stand overnight to precipitate. Formed precipitate were filtered and gravimetrically analyzed.

Emulsification Index (E24).

To determine the emulsification index, Batista et al., (2006) method was applied. Centrifugation at 13,000 rpm to separate biosurfactant from microorganism cells yielding a *cell free broth*. A mixture of 1:1 between biosurfactant and crude oil is agitated for about 2 minute then stabilized for 24 hour. Emulsification index (%) determined by measuring the column height of emulsified oil against its total height multiplied by 100 times.

Total Petroleum Hydrocarbon (TPH) Measurements.

Measurement of TPH was conducted with gravimetric method as described by Mishra et al. (2001). Sample was extracted with *n*-hexane, the organic layer were pooled and dried by evaporation of solvents. After evaporation, the amount of residual TPH recovered was weighted.

Biodegradation Assay

To determine the performance of petrofilic bacteria in degrading oil sludge, a preliminary biodegradation assay developed and set up as follows:

- Control-1: without addition of both petrofilic inoculums/P and biosurfactant/B.
- Control-2: without P; add 2% (v/v) B.
- Reactor-1: add 2% (v/v) P; without B.
- Reactor-2: add 2 % (v/v) each of P and B.
- Oil sludge initial concentration was 10% TPH and incubation time for biodegradation assay was 70 days.

Total petroleum hydrocarbon (TPH) concentration and growth of petrofilic bacteria were observed on certain time.

RESULT AND DISCUSSIONS

Biosurfactant Production

Growth and biosurfactant production from *A. vinelandii* with 2% glucose as sole carbon source was described in the **Figure 1**.

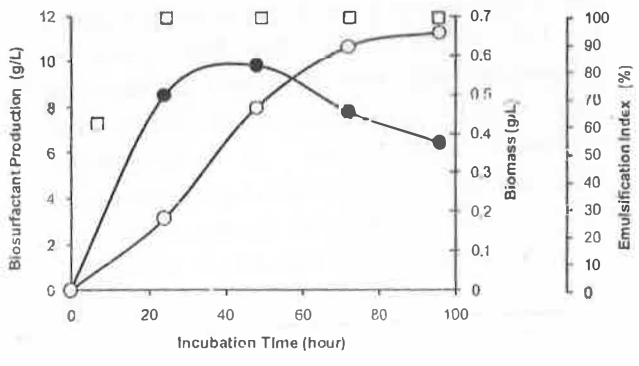


Figure 1. Growth (open circle symbol), biosurfactant production (solid circle symbol) and emulsification activity (open square symbol) profiles of *A. vinelandii* grown in minimal basal medium with 2% (v/v) glucose as a carbon source at 27°C.

The biosurfactant production started to increase during the exponential phase, reaching its maximum after about 48 h (9.81 g/l). These results indicate that the maximum of biosurfactant biosynthesis from glucose occurred predominantly at the end of the exponential growth phase. The emulsification activity of the cell free broth increased up to 90% in the first 24 hour of incubation, whereas surfactant accumulation increased during this period and start to decrease after reaching its maximum synthesis. This might be due to biosurfactant were used as carbon source by *A. vinelandii*. Similar result reported by Sarubbo et al. (2007), that grown *C.lipolytica* with 10% canola oil and 10% glucose. Biosurfactant concentration reaching its maximum production after 48h at the end of exponential phase and start to decrease in a longer incubation time.

Biosurfactant Enhanced Biodegradation

Biosurfactant is a well known surface active agent that generally used in improving the viability of contaminant to the microbial attack. The biosurfactant affect the biodegradation process by increasing the solubility and dispersion of the compound (Desai and Banat, 1997). There are two ways in which biosurfactant affect which is increasing the surface area of hydrophobic water insoluble substrate. Secondly is increasing the bioavailability of hydrophobic water-insoluble substances. A laboratory scale of biosurfactant enhanced biodegradation of oil sludge was conducted. Effects of addition of biosurfactant from *A. vinelandii* in the biodegradation process were shown in **Table 1**. We used crude biosurfactant in the form of cell free broth directly without purifying the biosurfactant first for the simplicity reason of the experiments.

Table 1. TPH removal efficiency of oil sludge biodegradation in batch reactor. C1/Control 1 without addition both Petrofilic inoculums/P and Biosurfactant/B; C2/Control 2 (–P, +B); R1/Reactor 1 (+P, –B); R2/Reactor 2 (+P, +B).

Biodegradation system	TPH Removal Efficiency (%)[1]	Increased Removal Efficiency (%)
C1	12.4	6.4 (C1-C2)
C2	18.8	55.6 (C1-R1)
R1	68.0	20.9 (R1-R2)
R2	88.9	70.1 (C2-R2)

[1] means values from triplicate measurement.

The low water-solubility of many hydrocarbons reduces their availability to microorganisms and limits the biodegradation process. It has been assumed that biosurfactant can be used to enhance the bioavailability of hydrophobic compounds. On the other hand this low water-solubility increases sorption of compound to surface and limits their availability to biodegrading microorganisms (Abalos et al., 2004). Once again, biosurfactant can enhance growth on bound substrates by desorbing them from surfaces or by increasing their apparent water solubility. **Figure 2** showed the microbial growth and TPH profile of control reactor. It was noticed that changes in oil sludge environmental condition from its originally slurry phase into more aqueous phase in the reactor, triggering the indigenous bacteria in it to grow. For the total plate count measurement, the CFU values increased from $10^{3.2}$ (CFU/ml) at day 0 and reach its maximum to $10^{5.4}$ (CFU/ml) in the first week of incubation. Similar pattern occurred in the control reactor-2 (without addition of petrofilic inoculants, added by 2% v/v of biosurfactant only). Biosurfactant addition make the oil sludge become more soluble in the reactor, this shown by increase in the microbial growth from $10^{3.2}$ (CFU/ml) at day 0 and reach its maximum to 10^{6} (CFU/ml) in the first week of incubation. However, the degradation process of oil sludge by mean of indigenous bacteria predicted small enough/neglect able throughout the experiment. TPH losses in control reactors mainly due to weathering/physical influences (Eweis et al., 1998; Venosa and Zhu. 2003) such as temperature shift, shaking condition, and volatilization of low molecular weight of hydrocarbon.

Figure 3 shows that after 70 days of incubation, a significant reduction of TPH (68%) occurred in the biodegradation system supplemented with petrofilic consortia/R-1. This positive result suggests that bio-augmented bacteria could degrade TPH significantly.

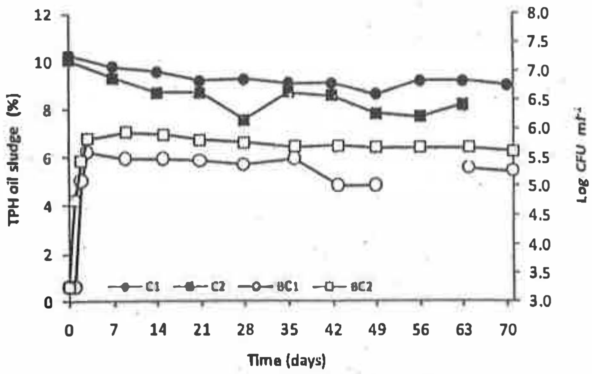


Figure 2. The indigenous microbial growth (open symbol) and TPH degradation (solid symbol) profiles in batch control reactor system with 0 (circle/C-1) and 2(square/C-2) % v/v of biosurfactant addition at 27°C.

Bioaugmentation also can be used to increase the biodegradative capabilities of the indigenous microbial population. Compared with control reactor/C1, addition of petrofilic consortia increased the removal efficiency up to 55%. Non biological degradation (physical transformation) also occurred in the process; however the biological transformation dominated the process based on the growth of bacteria observed during the process. For the total plate count measurement, the CFU values increased from 10^{6} (CFU/ml) at day 0 to $10^{7.5}$ and $10^{6.7}$ (CFU/ml) in the first week and day 70 respectively. The presence of biosurfactant in biodegradation system (R-2) increased the removal efficiency up to 20% compared to those without addition of biosurfactant/R-1. The present of biosurfactant also increased the microbial growth from $10^{6.5}$ (CFU/ml) at day 0 to $10^{8.8}$ (CFU/ml) in the first week of incubation and $10^{8.1}$ (CFU/ml) at day 70. Similar result by Whang et al. (2007), that examined the effect of rhamnolipid biosurfactant to diesel/water degradation from 0 to 80 mg/l significantly increases biomass growth and diesel biodegradation percentage from 1000 to 2500 mg VSS/l and 40-100%, respectively.

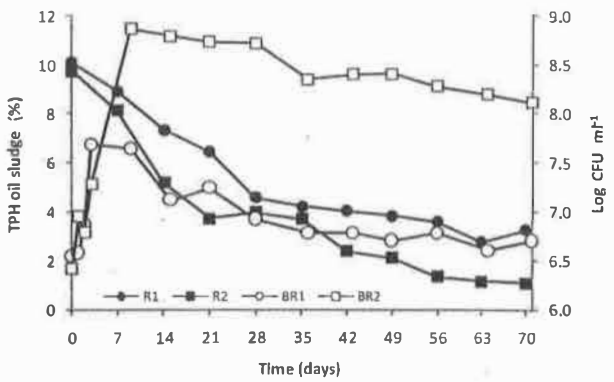


Figure 3. The petrofilic consortia growth (open symbol) and TPH degradation (solid symbol) profiles in batch reactor system with 0 (circle/R-1) and 2 (square/R-2) % v/v of biosurfactant addition at 27°C.

Our findings show that the addition of both petrofilic consortia and biosurfactant favors the biodegradation of the oil sludge. The limiting condition in the degradation of hydrocarbon and other PAH is their insolubility, thus decreasing the efficiency and rate of degradation. This limitation can be overcome either by addition of surface-active compounds surfactant to the growing culture, thus making hydrocarbons more water-soluble and available for the cell to degrade, or by production of its own surfactant by the augmented organisms to facilitate uptake. The presence of biosurfactant also stimulate the catabolism of hydrocarbon by mean of co-metabolism process since biosurfactant are organic compound and readily degradable to microorganism.

ACKNOWLEDGEMENT

This research was supported and financed by ITB Research Grant and Directorate General of Higher Education (DIKTI), Government of Indonesia. QH thank J.F. Nadapdap for contributing in part of the research.

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