MALAYSIAN PALM OIL BOARD

Summary Report

Malaysia

Verification Survey with the Private Sector for Disseminating Japanese Technologies for Improvement of Wastewater Treatment System and Recycling of Resources at Palm Oil Mills in Malaysia

August, 2017

Japan International Cooperation Agency

Hanshin Engineering Co., Ltd.

1. BACKGROUND

With the increase of palm oil consumption in the global market, the palm oil industry in Malaysia has been growing and has now become one of the country's key industries. There are more than 400 palm oil mills in Malaysia today.

The Department of Environment (DOE) under Ministry of Natural Resources and Environment of Malaysia, grants operating permits to palm oil mills according to the river effluent standard of 100mg/L BOD. In view of the industry growth and need for further environmental protection, DOE is now proposing tighter effluent regulations by applying a stricter standard of 20mg/L BOD nationwide. In the area near orangutan's habitat or drinking water source, like Sabah State or Ipoh in Perak State, the strict standard of 20mg/L BOD has already been introduced as prior efforts.

Malaysian Palm Oil Board (MPOB), the government agency whose mission is to supervise and monitor palm oil mills in Malaysia, is also in charge of finding and improving palm oil mill effluent (POME) treatment technology or system at palm oil mills.

2. OUTLINE OF THE PILOT SURVEY FOR DISSEMINATING SME'S TECHNOLOGIES

(1) Purpose

a. To introduce and verify the effectiveness of a POME (Palm Oil Mill Effluent) treatment system consisted of highly efficient submerged mechanical aerators, screen devices, dryer and carbonizer which contribute to achieving 20mg/L BOD at a competitive cost.

b. To disseminate this POME treatment system in the palm oil industry after it is proven effective.

c. To reduce waste from palm oil mills through recycling sludge or residue produced from wastewater treatment process or oil manufacturing process.

d. To enhance the technical level of POME treatment through technical training programs of activated sludge treatment system.

(2) Activities

1) Verification of "Activated Sludge Treatment System"

- Hanshin Engineering Co., Ltd. (Hanshin) installed the "Activated Sludge Treatment System" at Kilang Sawit Jengka 21 (Jengka 21), Felda Palm Industries Sdn. Bhd., and collected treated wastewater quality data to demonstrate the effect. The system consisted of aerators and screening devices.
- Prior to the actual installation of the system, a laboratory scale "Activated Sludge Treatment Pilot Plant" was installed to determine the operating condition.

2) Verification of "Sludge Carbonization System"

- Hanshin installed the “Sludge Carbonization System” at Jengka 21 in order to study the effective using sludge and other palm oil mill residue. The system consisted of a dryer and a carbonizer which are pilot scale equipment.
- The carbonized materials at several temperature zones were analyzed, and its market needs were explored while suggesting different usages (for example, fuel, compost, and adsorbent for wastewater treatment).

3) Technical training on “Activated Sludge Treatment System” in Malaysia

- Hanshin provided trainings on the activated sludge treatment system to technical staff of palm oil companies and engineering, procurement and construction (EPC) companies, using the lab-scale “Activated Sludge Treatment Pilot Plant”.
- Improvement of knowledge and skills about the system such as the method of understanding wastewater conditions and operating equipment in accordance with the wastewater conditions are important factors to maximize system capability.

<Training Course>

- 2 days training and 1 day training during the Verification Survey period
- The course consisted of two parts:
  - Lecture
    (Basics of activated sludge treatment, daily management methods, environmental management organizational development etc.)
  - Practice using the lab-scale “Activated Sludge Treatment Pilot Plant”
- Training text will be newly prepared by Hanshin.

- Trainings on operation and maintenance using the actual equipment also were provided.
- Technical seminars were held to introduce the system and technologies.
- In addition, half day seminar on carbonization was also conducted.

4) Technical Training Activities in Japan

- Hanshin invited several members from MPOB and other public agencies to Japan to visit similar facilities in operation and to observe industrial wastewater treatment administration in Japan.

<Training Course>

- 5 days training / once during the Verification Survey period
- The course included the followings;
  - Factory tour of Hanshin (demonstration of facility)
  - Site tour of wastewater treatment systems (sewage, industrial wastewater)

- Lecture & discussions (wastewater treatment technology, related laws) etc.

(3) Information of Product/ Technology to be Provided

Product	**Aerator® (Hanshin Engineering Co., Ltd.)**
Product specifications	"AQUARATOR®" (F-75AF, 75kW) with blowers
Quantity	3 sets (one for each treatment pond)
Sales performance	10,000 units sold at 1,000 sites in Japan (60% domestic market share) Rapidly expanding to Malaysia, Indonesia, Taiwan, China and Korea.
Advantage	• Energy cost saving • Easy and minimum maintenance • Innovative and outstanding design

Product	**Screening Device (Toyo Screen Kogyo Co., Ltd.)**
Product specifications	"ULTRA TN SCREEN" (N1500A1, 1500mm) with a pump
Quantity	2 sets (to be installed just before the 3 aeration ponds).
Sales performance	30,000 units sold in Japan Also sold in Thailand
Advantage	• Less likely to clog • Easy maintenance • Long-term durability (replacement required only once every few years because of stainless robust parts and a special screen shape)

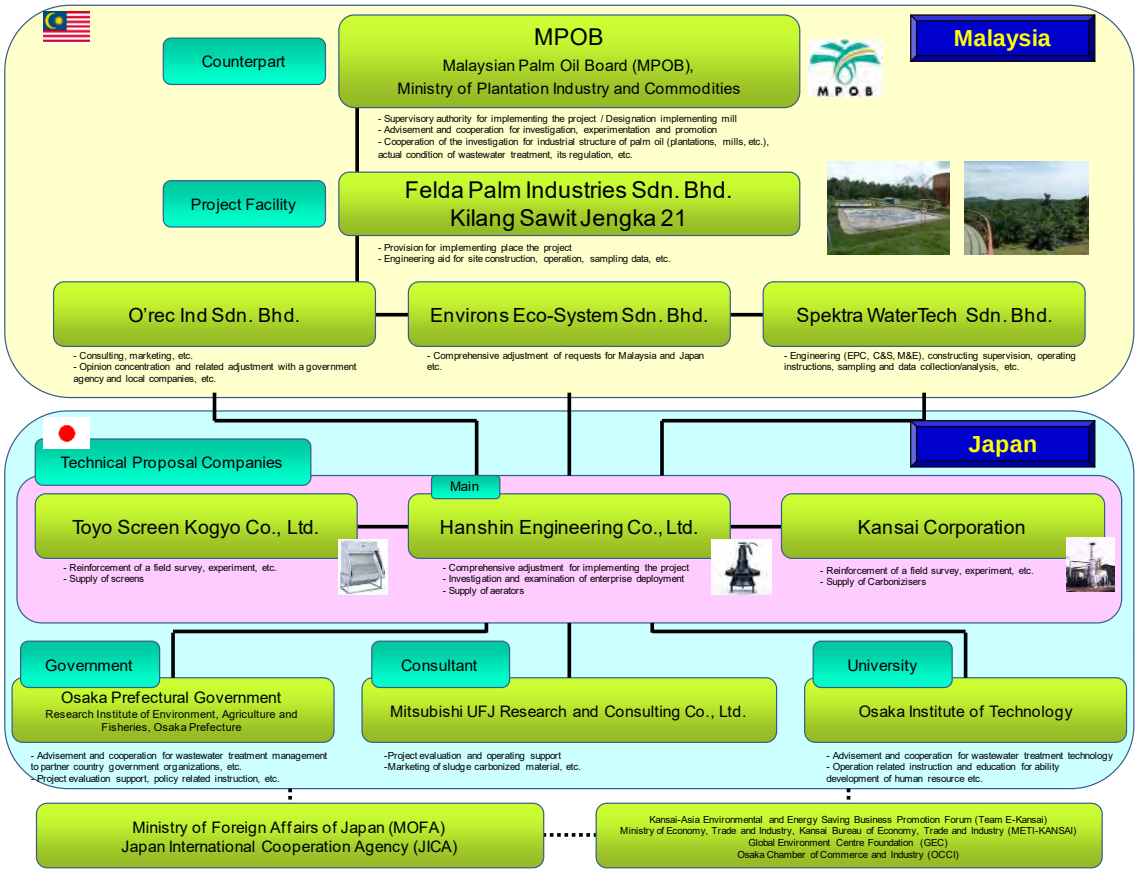
Product	**Sludge Carbonization Equipment (Kansai Corporation)**
Product specifications	Dryer (volume capacity: about 200L) Carbonizer (volume capacity: about 150L)
Quantity	1 set
Sales performance	Introduced in Philippines, Thailand etc. through projects of JICA, New Energy and Industrial Technology Development Organization (NEDO), the Ministry of Economy, Trade and Industry (METI) of Japan.
Advantage	• Possible use of waste

- In addition, one lab-scale "Activated Sludge Treatment Pilot Plant" and some equipment used for training and monitoring ware provided.

(4) Implementing Organization

- Malaysian Party: Malaysian Palm Oil Board (MPOB)

- Japanese Party: Hanshin Engineering Co., Ltd. (Hanshin)



(5) Target Area and Beneficiaries

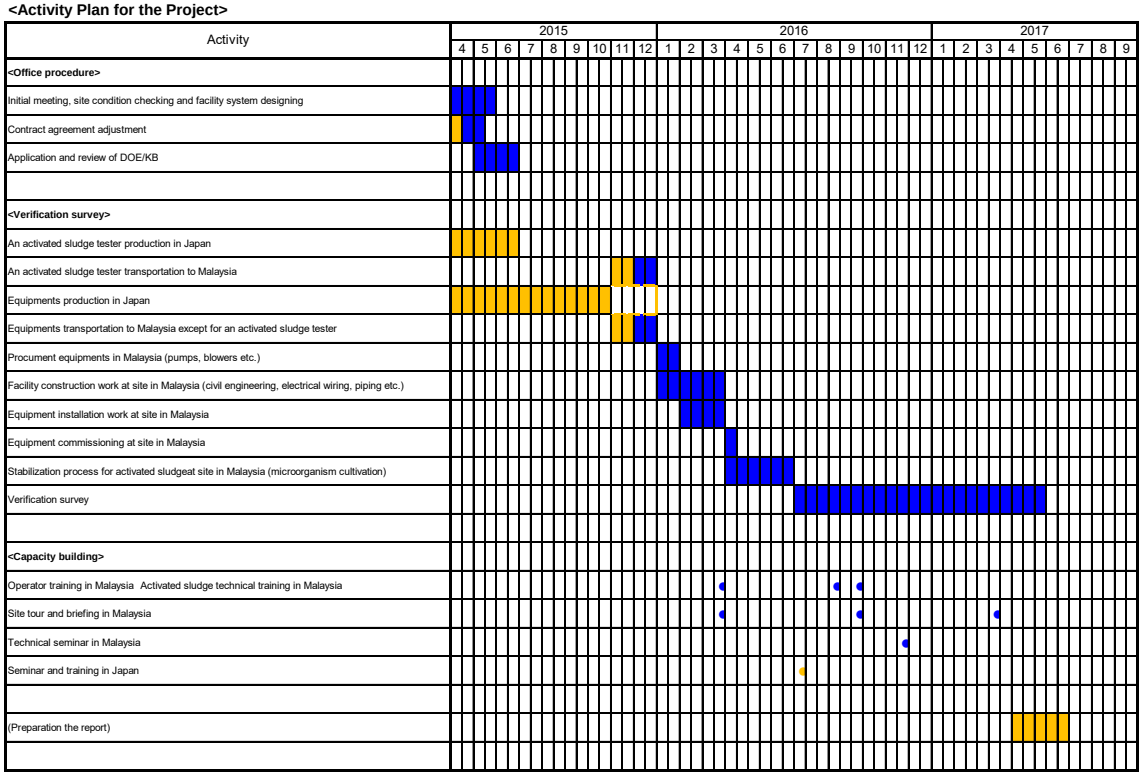
- Target Area: Kilang Sawit Jengka 21, Felda Palm Industries Sdn. Bhd.
- Beneficiaries:
  a. Palm oil mills (companies) with the wastewater treatment process
  b. Surrounding communities especially living near palm oil mills

(6) Duration

- From April 2015 to September 2017.

(7) Progress Schedule

<Activity Plan for the Project>



Blue part: The work in Malaysia
Bright orange part: The work in Japan

(8) Manning Schedule

(Please refer to the attached document.)

(9) Implementation System

- AQUARTOR is a submerged mechanical aerator/agitator utilizing in both aerobic tank and anaerobic tank. Miniaturized bubbles are generated and mixed with the liquid effectively to reach all areas of the aeration tank (Figure.1)
- Advantage
    1. The submerged mechanical aerator/agitator separates the power source for the 2 main functions for aeration which are the supplying of air and agitation/aeration.
    2. The submerged mechanical aerator/agitator is able to use flexibly as aerobic agitation or anaerobic agitation.
    3. The simple structure leads to no clogging.
    4. No scattering wastewater/sludge and no occurring noise/vibration.

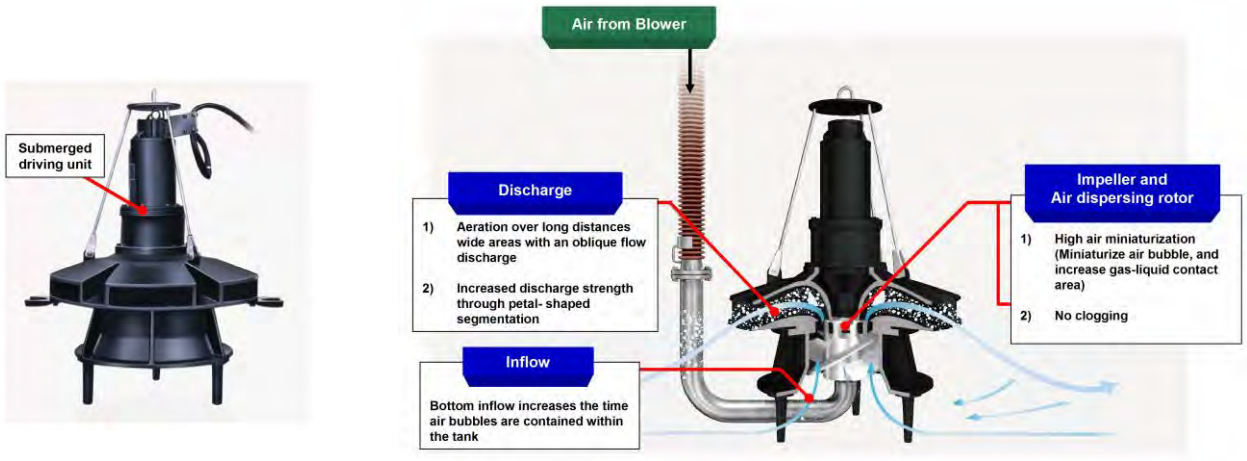


Figure 1. The Appearance and feature of AQUARTOR(Submerged mechanical aerator/agitator）

TABLE 1. DESIGN PARAMETER OF CASE STUDY FOR POLISHING PLANT

Parameter	Unit	Design value
Influent BOD	mg liter^{-1}	500
Effluent BOD	mg liter^{-1}	20
BOD removal rate	%	95
MLDO	mg liter^{-1}	2.0
MLSS	mg liter^{-1}	2500
Operating temperature of waste water	deg C	28
Aeration devise installation water depth (as water depth)	m	3.6

Note: Target tank specification is based on L1=18.5m W1=18.5m (L2=11.3m W2=11.3m) WD=3.6m for 1 tank,.
Number of aeration tanks: 3 tanks

3. ACHIEVEMENT OF THE SURVEY

(1) Outputs and Outcomes of the Survey

- We proposed the activated sludge treatment system with AQUARATORs and screen devices, and the carbonizer system for utilization of sludge from POME.
- We were able to demonstrate "it is the effective processing method contributing to the realization of stable BOD value of 20 mg/L at low cost", which is the object of this project.

TABLE 2. ACHIEVEMENT OF PURPOSE OF THIS PROJECT(1) AQUARATOR

Issues for Reducing BOD Value	Results of AQUARTOR introduction
Insufficient power to supply oxygen • Oxygen is not supplied to the activated sludge sufficiently by using the conventional method (like surface aerator or diffuser). This is a reason why the BOD value of the final discharged water is high.	**Improvement of oxygen supply amount** • By introducing AQUARATOR, the flow velocity was improved, and the stirring flow velocity from the top of the pound to the bottom was made uniform. • After introduction of the AQUARATOR, it was verified that the amount of dissolved oxygen increased to 6.0 - 8.0 mg / L (first phase). • In the conventional method, amount of dissolved oxygen was 1.0 mg / L or less.
The knowledge of the operator is insufficient • Operators cannot adequately manage activated sludge treatment due to lack of knowledge of technical principles. • The capability of activated sludge system is not performed.	**Implementing practical education for operators** • 38 engineers and operators have attended training program about activated sludge treatment operation which provided from Japanese side. • The program is easy to understand and practical. This can be implemented each mills, and ripple effects are expected. • Not only for senior engineers but also operators who work at the site.
For realization of final released water BOD 20 mg / L • In order to realize 20 mg / L at final discharge, it was expected introduction of technologies to achieve stable performance at low cost.	**Contribution to reduction of BOD value** • It has achieved removal of maximum 93.1% BOD loads by introducing AQUARATOR. • BOD value of final discharge water surely fell below the current regulation of 100 mg / L, indicating 20 to 60 mg / L. • It was estimated that BOD values could be improved at the final discharge by using a post-process of AQUARATOR treatment (like sand filtering device etc). It could be removing insoluble BOD component. Removal rate of BOD

	component could be improved from 76.1 - 81.1% (only aerobic treatment) to 86.3 - 92.8% (including post-process).

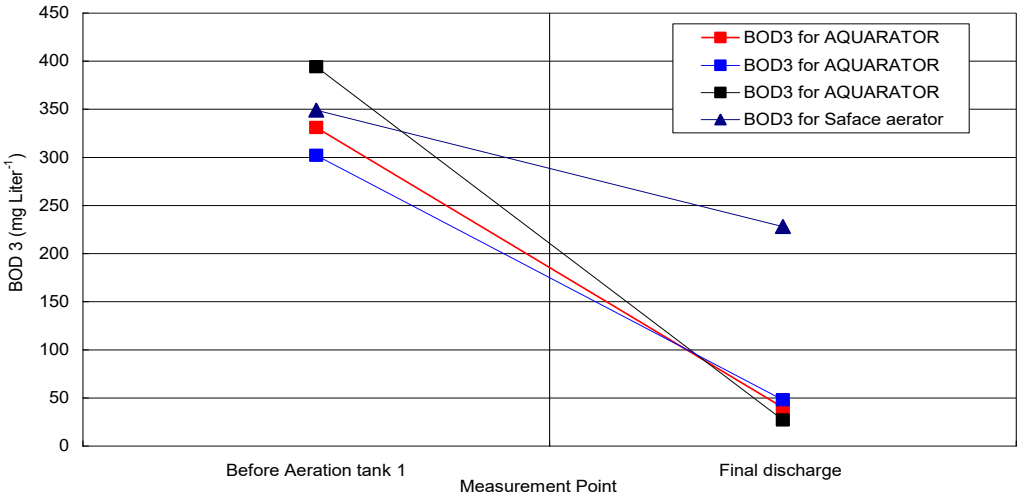


Figure2. Comparison of the variation of BOD concentration between surface aerator and AQUARATOR

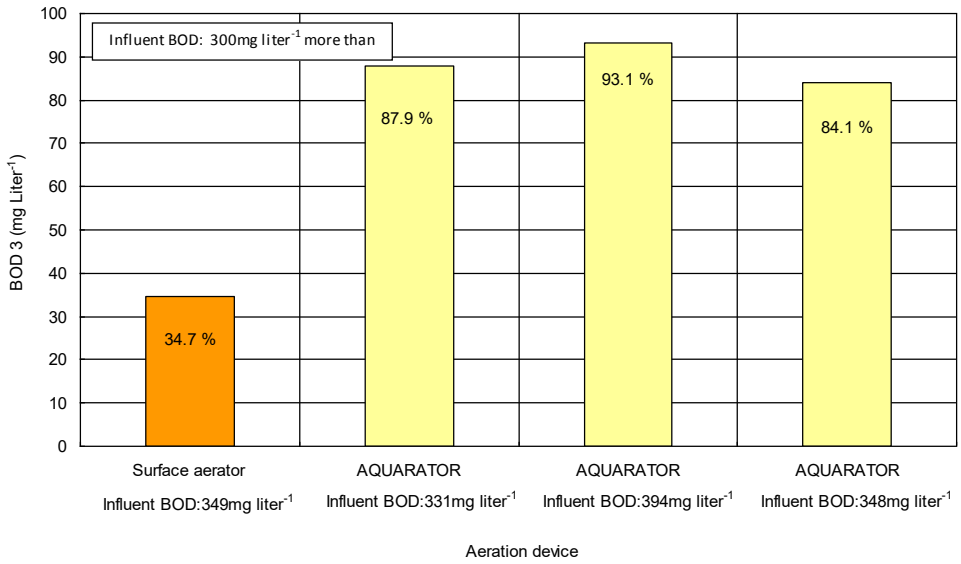


Figure3. Comparison of the removal rate of the BOD concentration between surface aerator and AQUARATOR

- As for the agitation performance, the analysis results of the Computational Fluid Dynamics (CFD) showed that the stirring flow velocity of 0.3 to 0.6 m sec-1 was observed entirely at the bottom of the tank. As a reference, it is thought that, from

the sedimentation velocity of activated sludge, constantly maintaining the flow velocity of about 0.1 m sec-1 or higher as an average flow velocity at bottom of the tank prevents sludge deposition.

- Since the flow velocity was observed from sections A and B in the entire tank, it was inferred that the state of complete mixing was realized. Because of the characteristics of the AQUARATOR, it creates a turbulent flow state in the tank, unlike the diffuser, and therefore the oxygen retention time is long, which allows maintaining the vapor-liquid transfer rate in sewage same as in clean water.
- Moreover, since the agitating function and the agitating diffusing function are separate, it is possible to maintain a constant MLDO state by changing the amount of air flow, even with a variating inflow load. From the examination results shown above, it was considered that in M5 using the surface aerator, the aeration and stirring states can be improved by replacing the surface aerator with the AQUARATOR, and that an aeration tank which allows an efficient BOD process can be realized (Figures 4 to 7).

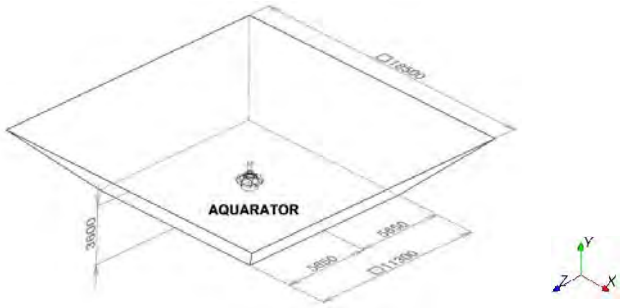


Figure 4. Three - dimensional model for aeration tank using

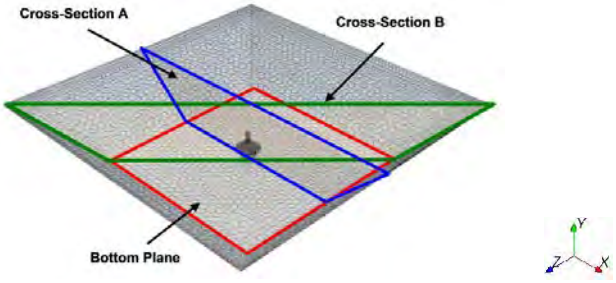


Figure 5. Mesh model for aeration tank using AQUARTOR

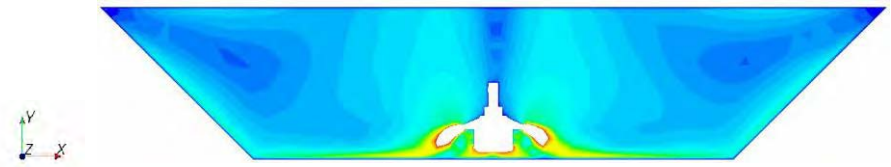


Figure 6. Cross flow speed at section "A"

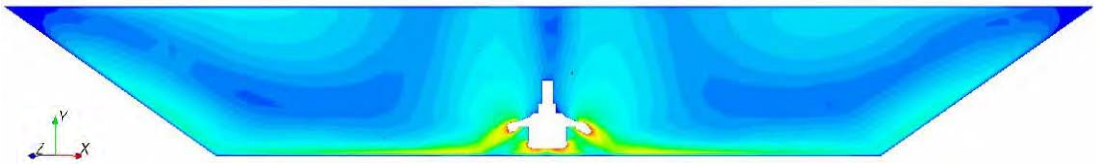


Figure 7. Cross flow speed at section "B"

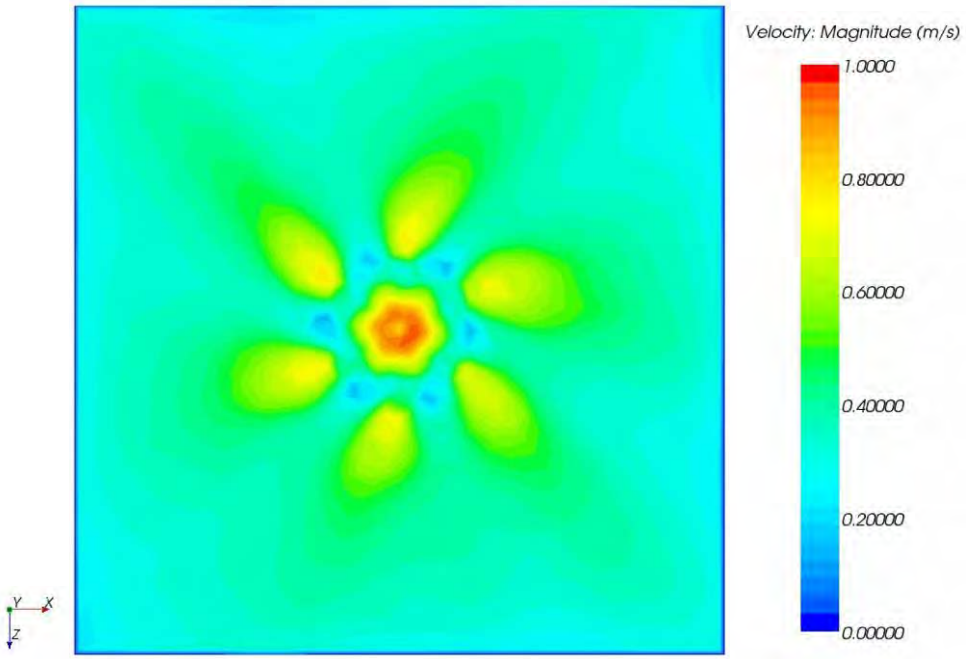


Figure 8. Cross flow speed at bottom plane

- In order to achieve stable improvement in water quality in an aeration tank by the ASM, especially to realize the BOD process, improvement in the aeration tanks was examined by replacing the surface aerator with the AQUARATOR which has the “agitation function” and “agitation diffusing function” separately, intended for use in aeration tank of polishing plant which adopts surface aerator. As a result of investigation of the MLSS and flow velocity by replacing the surface aerator with the AQUARATOR, the agitation state in the aeration tank had greatly improved, and the MLDO, various water quality criteria, especially the BOD process have improved from 34.7% to 93.1% at a maximum as a removal rate by adding the

"agitation diffusing function."

- Although the POME improvement was attempted targeting on the aeration tanks of ASM this time, the stable POME process would require controlling of the operation flow of the whole ASM including the aeration tank which serves as a core. It is considered that AQUARATOR which can control the "agitation function" and "agitation diffusing function" allows construction of stable ASM including variations in the inflow load change and seasonal variations, and that it can contribute to the POME process.

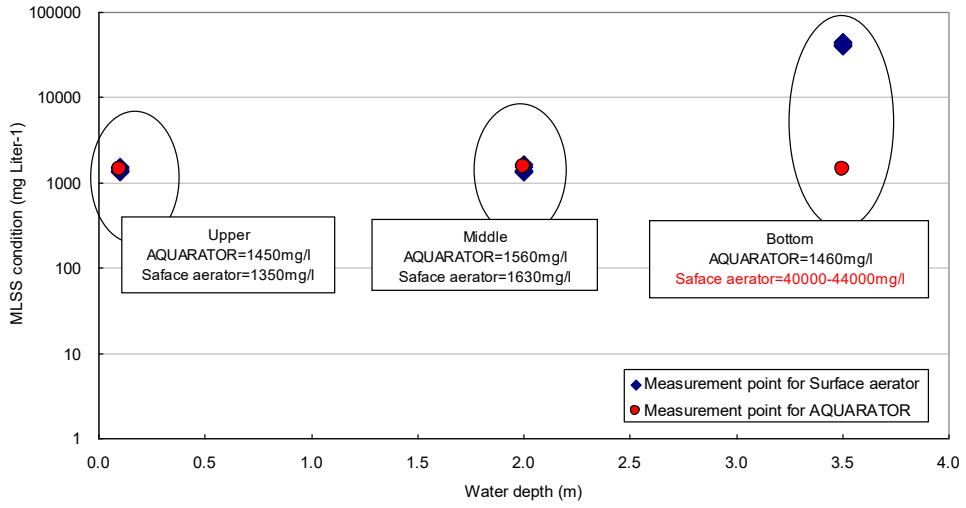


Figure 9. Comparison of MLSS condition in aeration tank

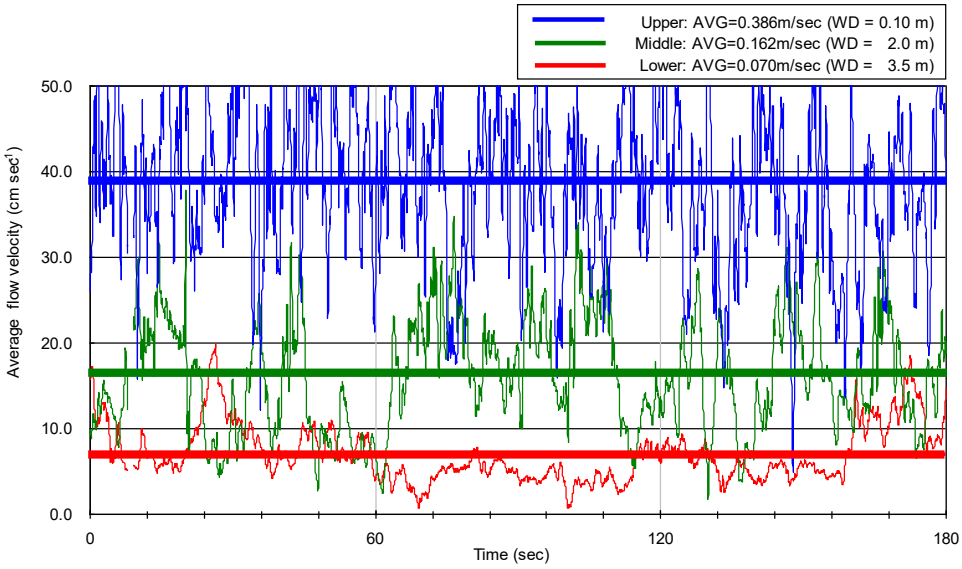


Figure 10. Flow velocity for surface aerator in aeration tank

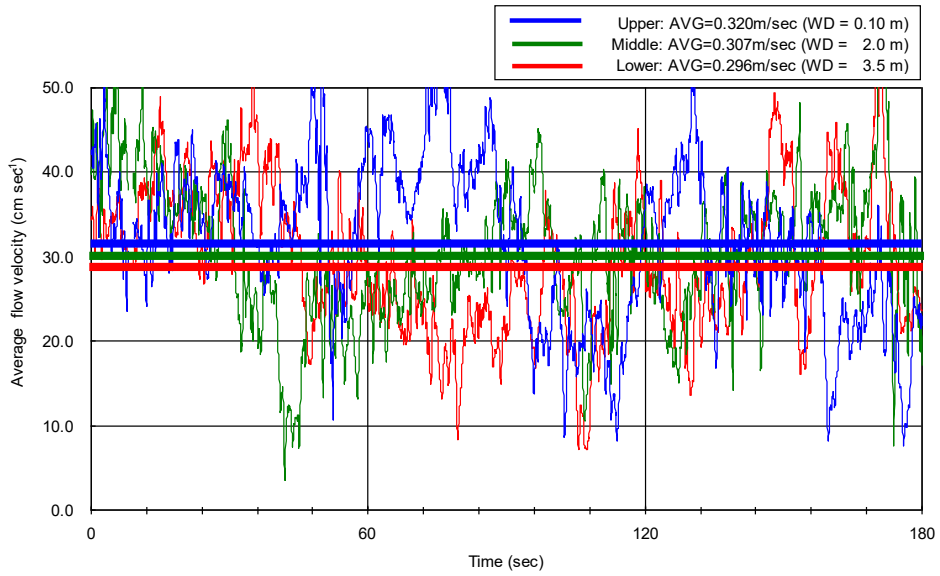


Figure 11. Flow velocity for AQUARATOR in aeration tank

TABLE 3. ACHIEVEMENT OF PURPOSE OF THIS PROJECT (2) Carbonizer

Use of sludge as valuable material	Result of carbonization demonstration
Using as Energy • To concentrate energy density as	• At this demonstration mill, due to anaerobic fermentation in the upstream process, there was not much volatile content left in the

good fuel	sludge. It was unsuitable for fuelization. • For EFB and PKS, energy density was improved by carbonization in the low temperature range. There is a possibility of carbonization fuel.
Using as Fertilizer / Soil conditioner • Carbonize the sludge into fertilizer	• It was confirmed that N: P: K ratio of coagulated sludge was about 2: 3: 1. • This result means that it was suitable for organic fertilizer as phosphorus fertilizer, and there is possibility of use as a fertilizer for fruits and flowers.
Using as POME treatment material • Using as adsorbent (especially color removal) for wastewater treatment	• In the high temperature carbonization, only PKS left the shape as semi-activated carbon. (Others could not remain the shape of semi-activated carbon) • As a result of the simple test, it was judged that PKS semi-activated carbon could not adsorb palm-derived carotene dye.

(2) Self-reliant and Continual Activities to be Conducted by Counterpart Organization

- After transferring ownership from JICA, MPOB will utilize some equipment in the organization for survey (Dryer, Carbonizer, and Activated Sludge Treatment Pilot Plant etc.) in research center. R & D is one of MPOB's major missions, and these devices are used for research and development.
- Some other equipment will used continuously in the Jengka 21 mill of FPISB as process devices and as demonstration devices after transferring ownership from MPOB (AQUARATOR, Screen etc.).

4. FUTURE PROSPECTS

(1) Impact and Effect on the Concerned Development Issues through Business Development of the Product/ Technology in the Surveyed Country

- Expectation of starting new regulation value
  - It will expect to start new POME effluent regulation in 2017.
  - At the seminar in 2016, it was introduced that the movement of regulation revision continues. On the other hands, it takes a lot of time to form agreement of stakeholders.
  - The activated sludge treatment system with AQUARATOR can contribute to realization of a BOD value of 20 mg / L. We hope that the existence of this

system will play a role in promoting the revision of regulations.

(2) Lessons Learned and Recommendation through the Survey

- Confirmation of daily treated water in each mill
  - DOE conducts inspection of final discharged water on a quarterly basis for each mill. Therefore, many palm oil mills do not have incentives to monitor daily water quality.
  - Through the providing operator training of activated sludge system, we propose daily management of water quality in each mill. For example, it is possible to develop easy daily management methods such as checking sludge ratio, sludge color, transparency of water, foaming condition without expensive equipment.
  - We believe that daily water management will stabilize the water quality of the final discharge and, as a result, create the environmentally friendly society.
  - Also, without this routine management, the performance expected of the AQUARATOR will not be fully demonstrated.
  - Continuing to promote education is desirable.

- Funding for regulatory compliance (especially for SMEs)
  - Malaysia's palm oil industry includes both large companies holding multiple mills and small companies operating only one mill.
  - Large companies have the high consciousness of compliance, and they also active in financing and technical acquisition for that purpose. It is assumed that major companies will take responsibility to respond to future enhancement of BOD regulation values at their own risk.
  - On the other hand, small and medium enterprises do not have adequate financial resources, and it is difficult to invest capital for compliance with regulations.
  - For these companies, it will be necessary to introduce "inexpensive technology" and "financial support" such as subsidies.
  - There are various menus in Japan, such as preferential tax treatment by early depreciation of capital investment, evaluation of CO2 emission reduction etc. The Malaysian governmental agency could refer to such fund support menus concerning environmental conservation.

ATTACHMENT: OUTLINE OF THE SURVEY

Malaysia

Verification Survey with the Private Sector for Disseminating Japanese technologies for Improvement of Wastewater Treatment System and Recycling of Resources at Palm Oil Mills in Malaysia

Hanshin Engineering Co., Ltd., Osaka, Japan

Concerned Development Issues in Malaysia

- It is now proposed tighter effluent regulations for palm oil mill by applying a stricter standard of 20mg/L BOD nationwide.
- Lack of appropriate water treatment technology that is stable processing at low cost

Implemented Activities in the Survey

- To introduce and verify the effectiveness of a wastewater treatment system consisted of highly efficient submerged mechanical aerators - Aquarator.
- To verify the effectiveness of a carbonizer as a recycling sludge system.
- To enhance the technical level of palm oil mill effluent treatment through training programs.

Proposed Products/Technologies

Hanshin AQUARATOR®
The Aquarator® can act as a submerged agitator for both aerobic and anaerobic agitation
- Realization of extremely high energy efficiency
- In the actual result, it is possible to eliminate pollution load amount of 90% or more

Survey Overview

Name of Counterpart:
Malaysian Palm Oil Board (MPOB)
Survey duration:
May 2015 - Sep 2017
Survey Area:
Jengka 21 of Felda Palm industries, Pahang state, Malaysia

Impact on the Concerned Development Issues in Malaysia

- To prove the effectiveness of the equipment which aims to achieve BOD of 20mg/L at a competitive cost
- To enhance technical level of POME treatment operation through technical training programs

Outputs and Outcomes of the Survey

- It is estimated that a proposed POME treatment system with Hanshin AQUARATOR® may remove 93.1% BOD load (Maximum).
- The carbonizer can contribute to build a sludge recycling if carbon content of sludge is high (difficult if carbon content is low)
- Around 60 person attended technical training program. - Activated sludge system (Mar.2016 and Sep.2016) and Carbonizer (Aug.2016)

ATTACHMENT: Manning Schedule

1. Works in Malaysia

№	Name	Part	Organization	2015 4	5	6	7	8	9	10	11	12	2016 1	2	3	4	5	6	7	8	9	10	11	12	2017 1	2	3	4	5	6	7	Total working days	Total working E
1	Hirotaka Kawashima	Project Leader	Hanshin Engineering		5/19-5/23 5days	6/15-6/20 5days		8/23-8/29 6days	9/12-19 8days	10/18, 25-11/1 9days	11/18-21 1days			2/21-27 7days	3/20-26 7days	4/5-10 6days		6/12-14 3days			9/4-9 6days	10/17-21 5days	11/27-30 4days	12/1-2 2days	1/9-1/14 6days		3/27-31 5days	4/1 1days		6/5-10 6days	7/23-28 6days	97days	3.23
2	Ikuma Sonda	Lead engineer of Aerator	Hanshin Engineering		5/19-5/23 5days			8/23-8/29 6days	9/12-19 8days	10/21, 24-31 9days	11/18-21 4days			2/17-26 10days	3/21-28 8days	4/6-8 3days		6/29, 30 2days	7/1-3, 19-22 7days	8/2-7 6days	9/4-9 6days	10/17-21 5days	11/28-30 3days	12/1-7 7days	1/9-1/14 6days		3/27-31 5days	4/1 1days		6/5-10 6days	7/23-31(-8/3) 9days	116days	3.87
3	Masanori Ishido	Negotiation	Hanshin Engineering		5/19-5/23 5days																											5days	0.17
replace	Manabu Yoshida	Negotiation	Hanshin Engineering																													0days	0.00
4	Norihiko Okamoto	Installation engineer	Hanshin Engineering								11/18-21 4days			2/17-26 10days						8/2-7 6days			11/28-30 3days	12/1-3 2days							7/23-28 6days	32days	1.07
add	Yoshinobu Tsuchida	Maintenance leader	Hanshin Engineering																				11/28-30 3days	12/1-2 2days								5days	0.17
5	Yuichi Yuniba	Chief adviser	Mitsubishi UFJ R & C		5/19-5/23 5days			8/23-8/28 6days		10/26-30 5days					3/21-25 5days					8/21-26 6days			11/28-30 3days	12/1-2 2days								32days	1.07
6	Takashi Nakamori	Market research (recycling resources)	Mitsubishi UFJ R & C					8/23-8/28 6days						2/21-25 5days							9/4-8 5days	10/17-20 4days										20days	0.67
7	Tomoaki Murakami	Administrative support	Mitsubishi UFJ R & C											2/21-25 5days	3/21-25 5days																	10days	0.33
8	Shoji Kita	Research (administrative systems, legal systems)	Mitsubishi UFJ R & C																													0days	0.00
9	Yasunori Kosaki	Capacity building, technical adviser	Osaka Institute of Technology					8/24-8/28 5days						2/21-25 5days	3/21-25 5days						9/4-9 6days											21days	0.70
10	Hiroyuki Monobe	Lead engineer of carbonization equipment	Individual participation		5/19-5/23 5days			8/23-8/28 6days		10/26-31 6days						4/4-6, 7-10 5days	4			8/21-27 7												20days	0.67
11	Koichi Hashimoto	Coordinator for activities in Japan	Osaka Prefectural Government		5/19-5/23 5days																											5days	0.17
replace	Hidefumi Minamiura	Coordinator for activities in Japan	Osaka Prefectural Government																				11/28-30 3days	12/1 1days								4days	0.13
12	Tetsuro Minami	Technical adviser	Research Institute of Osaka Prefecture																													0days	0.00
13	Tshuyosi Kubota	Technical adviser	Research Institute of Osaka Prefecture		5/19-5/23 5days																											5days	0.17

2. Works in Japan

1	Hirotaka Kawashima	Project Leader	Hanshin Engineering		5/13 1days	6/24 1days	7/2, 6, 16, 18, 20, 23 5days	8/4, 20 2days	9/11 1days	10/16 1days	11/6, 12, 16 3days	12/3 1days	1/28 1days	2/16, 17 2days		4/15 1days	5/13, 27 2days		7/26-31 6days	8/9			11/2, 7, 22 3days	12/13 1days		2/27 1days	3/1 1days	4/11 1days	5/25 1days	6/20 1days		36days	1.80
2	Ikuma Sonda	Lead engineer of Aerator	Hanshin Engineering				7/6, 9, 21 3days			10/14 1days													11/10, 14, 21 3days			2/24 1days		4/27 1days	5/30 1days	6/20 1days		11days	0.55
3	Masanori Ishido	Negotiation	Hanshin Engineering																													0days	0.00
replace	Manabu Yoshida	Negotiation	Hanshin Engineering																													0days	0.00
4	Norihiko Okamoto	Installation engineer	Hanshin Engineering																													0days	0.00
add	Yoshinobu Tsuchida	Maintenance leader	Hanshin Engineering																													0days	0.00
5	Yuichi Yuniba	Chief adviser	Mitsubishi UFJ R & C		5/13, 5/28 2days	6/4, 6/24 2days	7/24, 29 2days	8/4, 12 2days	9/10 1days	10/16, 19 2days	11/4, 13, 16 3days	12/10, 17 2days		2/23 1days	3/10, 11, 16, 17, 18 5days	4/12, 14, 15 3days	5/11, 27 2days	6/7, 16, 27, 29 2days	7/4, 11, 13, 21, 26-31 6, 6days	8/2, 17-18, 31 5	9/20, 26 2	10/4 1	11/4, 8, 24 3	12/26 1		2/17 1	3/1 1	4/26 1	5/30 1	6/20 1		35.6days	1.78
6	Takashi Nakamori	Market research (recycling resources)	Mitsubishi UFJ R & C				7/8, 9 2days		9/7, 11 2days	10/19 1	11/16 1days			2/16, 18, 26 3days	3/15 1days	4/14, 15 2days	5/27 1days	6/3, 8, 9, 28 4days	7/5, 12, 14, 20, 28, 30 6days	8/23, 31 2days	9/1-2, 12 2days	10/13-14, 21 1	11/4 1					5/30 1			26days	1.30
7	Tomoaki Murakami	Administrative support	Mitsubishi UFJ R & C			6/4 1days	7/21, 24, 27 3days	8/19 1days					1/12 1days	2/8, 16, 19, 22 4days	3/1, 8, 16, 18 4days																		14days	0.70
replace	Tsubasa Nakajima	Administrative support	Mitsubishi UFJ R & C																7/26, 27, 29 3days													3days	0.15
8	Shoji Kita	Research (administrative systems, legal systems)	Mitsubishi UFJ R & C																													0days	0.00
9	Yasunori Kosaki	Capacity building, technical adviser	Osaka Institute of Technology			6/4, 6/22 2days	7/13, 16 2days	8/18 1days		10/22 1days			1/12, 22 2days	2/18 1days	3/8, 11, 18 3days				7/18, 22, 28, 30 4	8/31 1													12days	0.60
10	Hiroyuki Monobe	Lead engineer of carbonization equipment	Individual participation	5/13 1days	6/22 1days	7/29 1days	8/19-20 2days	9/11 1days	10/20 1days	11/16 1days						4/13, 14 2days			7/13 1days	8/8 1days	9/28 1days	10/14, 17 2days										15days	0.75
11	Koichi Hashimoto	Coordinator for activities in Japan	Osaka Prefectural Government							10/19 1days					3/11 1days				7/21, 27 2days													4days	0.20
replace	Hidefumi Minamiura	Coordinator for activities in Japan	Osaka Prefectural Government																				11/24 1days									1days	0.05
12	Tetsuro Minami	Technical adviser	Research Institute of Osaka Prefecture														5/27 1days															1days	0.05
13	Tshuyosi Kubota	Technical adviser	Research Institute of Osaka Prefecture																													0days	0.00