# PROOF OF CONCEPT ON REMEDIATION OF SEWAGE TREATMENT PLANT WASTEWATER USING COMBINED MICROBE & ENVIRONMENTAL BALANCE DEVICE (EBD) AT IWK, PTG 117 USJ 12, SUBANG JAYA

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# 1 INTRODUCTION

The IWK is the consortium company that manages wastewater in Malaysia and it has allowed RDV and its business partner IASB Sdn. Bhd. to conduct Proof of Concept (POC) on Improving Consistency of Effluent Quality, Reducing Sludge, Eliminating Odor and Reducing Power Consumption at the Indah Water Consortium (IWK), Sewage Treatment Plant (STP). The selected STP is PTG 117 USJ 12, SUBANG JAYA.

The POC is based on energy saving and optimization technology. EBD units and lab grown microbes will be introduced to the existing treatment plant and the effluent water quality will be monitored. Energy audits will be conducted at the selected oxidation pond, before and during the POC period to check and monitor energy consumption when the aeration time is gradually reduced from 100 % down to 50%. The objective is to reduce the electric energy bill when EBD is installed to affect the remediation of the STP. Initial treatment of bio-catalyst containing microbe is done to accelerate the function of EBD. Envaiopro Biocatalyst activity will rejuvenate and strengthen the bacteria as well reduce the sludge hence improving final effluent quality

## 1.1 OBJECTIVE

i. To enhance the sewage water treatment process and improve final effluent quality by using a combination of Envaiopro biocatalyst and Environmental Balance Device (EBD).

ii. To minimize the overall power usage at STP. The energy consumption of the mechanical & equipment at each plant will be reduced by decreasing the operating time of aeration.

iii. To reduce to production of sludge.

## 1.2 SCOPE OF WORK

i. To conduct a load breakdown for the STP – power logger, energy consumption, power factor and power quality by pre-power audit on key system and equipment.

ii. To apply Envaiopro biocatalyst and install Environmental Balance Device (EBD).

iii. To do reduce aeration time and evaluate energy saving and power optimization.

iv. To conduct water quality analysis and compare with existing data.

v. To conduct a post power audit and evaluate on the cost savings and power optimization.

vi. To conduct data analysis and prepare a report.

## 1.3 POC SITE

Table 1: Selected Site

| No. | Location | Asset No. | Type | CPE |
|---|---|---|---|---|
| 1 | USJ 12, SUBANG JAYA | PTG 117 | OD | 37,385 |
| | 6 months/26 weeks (1/10/20 – 31/3/21) | | | |

Detailed information of the asset, condition, functionality, electricity bill, sewage total flow rate, and water quality report was identified and recorded.

## 1.4 WORK PROGRAM

The weekly activities and treatment schedule is summarized in Table 2 below: -

Table 2: Activities and Treatment for PTG 117

| No | Activities | Description |
|---|---|---|
| 1 | Site Assessment | • Site visit<br>• Planning<br>• Detail information gathering<br>• |
| 2 | Power Audit | • Analyze total power usage<br>• Analyze pump efficiency<br>• Analyze |
| 3 | Sampling | • Effluent water sampling and lab analysis<br>• Sewage water monitoring<br>• Settled sludge volume test<br>• Sludge monitoring<br>• Sludge sample analysis at the end of the POC |
| 4 | Envaiopro Dosing | • Dosing of cultured Envaiopro biocatalyst<br>• Dipping of Envaiopro biocatalyst |
| 5 | EBD | • Installation of EBD units at site |

The work treatment schedule for six (6) months: -

Table 3: Proposed Work Pogram Timeline

| ACTIVITY | PERIODS (WEEKS) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PLAN START | PLAN DURATION | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| **Timeline** | 1 | 26 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Site Assessment** | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Power audit 1** | 2 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Sampling 1** | 2 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Envaiopro Dosing** | 3 | 12 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **EBD Installation** | 3 | 24 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Power Audit 2** | 5 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Sampling 2** | 5 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Power Audit 3** | 9 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Sampling 3** | 9 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Power Audit 4** | 14 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Sampling 4** | 14 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Power Audit 5** | 22 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Sampling 5** | 22 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Site Assessment** | 23 | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | |

Based on Table 3 above, the total timeline for the Proof of concept (POC) periods is planned to be for over 26 weeks (about 6 months). The site assessment will be done twice that is before and after the POC period. Power audit and sampling will be done about 5 times from the beginning until the end of the treatment periods. Envaiopro dosing and EBD installation will be done on the 3$^{rd}$ week. Envaiopro dosing will be stopped at the end of the 14th week and treatment on STP shall continue with EBD treatment only until the end of the POC timeline.

## 2 METHODOLOGY

### 2.1 POWER AUDIT

i. Bill utilities minimum of 24 months for elected site location.

ii. Study of single line electrical design at site.

iii. Install power logger at MSB with time sampling every 10 minutes for 3 days. Data collection such as to Voltage, Amps, Frequency, Power Factor, kW, kVA, kVAR, kWh, KVARh Voltage unbalance and Current unbalance. THD Voltage harmonics and Current Harmonics.

iv. Install power logger over individual incoming motor to measure Voltage, Amps, Frequency, Power Factor, kW, kVA, kVAR, kWh, Voltage unbalance and current.

v. Use torque meter to find the mechanical power based on the motor speed and load.

vi. Used thermal imager to snapshot every:

- MSB board (equipment, cable, MCCB, protection relay and others).
- Motor, DB and protection relay
- Coupling
- Bearing

vii. To measure efficiency of motor.

- Result outcomes
- Bill utilities
- Efficiency of motor performance
- Maintenance conditioning (data report)

### 2.2 ENVAIOPRO BIOCATALYST

It is a novel super biocatalyst that enhances the rate of biochemical reactions. It is a revolutionary combination of human and environmentally friendly active micro-organisms creating a powerful cocktail of beneficial enzymes, super catalyzing enzymes and co-factors with remarkable ability to fully digest a wide range of compounds and sanitize the environment.

#### 2.2.1 INSTALLATION OF MANUAL DOSING TANK

Installation of manual dosing tank will be done after treatment plant sizing and planning. Dosing tanks are usually located at the inlet sump. The dosing tanks used are usually 150 liters HDPE drums or $1m^3$ plastic tanks (TOTE Tank). The manual dosing operations (which do not

require any electricity) will be done weekly by the treatment operator (minimum 1 person) to dose and refill water (from the nearby existing water tap in the STP) for the treatment solutions.

Fig. 1: Dosing tanks at the inlet of the STP

2.2.2 DOSING RATE

The initial Bio-catalyst dosing rate will be fine-tuned between 5-30 ppm of the estimated water volume. Initially, the dosing process will be done twice on a weekly basis for the first month, once on weekly basis for the second month and subsequently will be adjusted depending on the treatment process conditions.

2.2.3 DOSING CULTURED BIOCATALYST

The Biocatalyst solution must be cultured by mixing with water for 24 hours in the dosing tanks before use. Manually open the control outlet valve of the dosing drum and drip the solution into the inlet sump where the biocatalyst solution will mix with the incoming sewage water. The dripping process will be completed until all the solution in the drum has discharged into the inlet sump.

2.3 ENVIRONMENTAL BALANCE DEVICE (EBD)

2.3.1 Environmental Balance Device (EBD) installations in Sewage Treatment Plant (STP).

The "EBD Sewage Packs" will be placed on the corners of the oxidation ditch tank system and at the inlet screening chamber. Please refer to Picture 2. This technology will permanently increase treatment efficiency without having to add expensive new infrastructure. It is an affordable solution to upgrade existing or new STP facilities.


Fig. 2: EBD & Dosing Tank Installation Location at STP

Picture 2 above shows the location of the dosing tank and the EBD units. The dosing tank is located at the inlet sump of the STP. A total of 8 EBD Packs (4 Sewage Packs & 4 Soil Packs) was be installed at the STP. 2 EBD units will be installed after the screening chamber, 3 EBD units at the left side of oxidation tank 2 and another 3 EBD units at right side of oxidation tank.

## 3 MONITORING OF WORK PROGRESS

### 3.1 BIOLOGICAL PROCESS MONITORING

The following visual monitoring of the performance of the process will be carried out on a weekly basis: - the process water quality, clarified water quality and the discharge effluent quality.

### 3.2 EFFLUENT SAMPLING FOR LAB ANALYSIS

Water quality analysis was carried out by an accredited laboratory appointed or approved by the client before treatment and on a predetermined schedule at the final effluent of the treatment plant pre and post treatment.

The sampling was carried out by qualified personnel or personnel who have obtained certification for sampling under APHA Standards approved by the Department of Environment (DOE). The effluent discharge standard limit applicable for IWK PTG 117 is category (iii) which depends on the year that each STP was approved in the Second Schedule (Regulation 7) of Environment Quality (Sewage) Regulations, 2009 regulated by the DOE as shown in Table 4 below: -

Table 4: Category (iii) Existing Sewage Treatment System (Approved after January 1999)

| Parameter | | Unit | Standard | |
|---|---|---|---|---|
| | | | A | B |
| (a) | BOD5 at 20°C | mg/L | 20 | 50 |
| (b) | COD | mg/L | 120 | 200 |
| (c) | Suspended Solids | mg/L | 50 | 100 |
| (d) | Ammoniacal Nitrogen | mg/L | 50 | 50 |
| (e) | Oil and Grease | mg/L | 20 | 20 |

The effluent sampling for treatment performance was monitored:-

i. Before treatment,
ii. Progress treatment, and
iii. After treatment

3.3 WORK SCHEDULE

Table 5: POC Timeline

| Activities | Frequency | No. | Date |
|---|---|---|---|
| FE Sampling | 8 | 1 | 1/10/20 |
| | | 2 | 28/10/20 |
| | | 3 | 2/12/20 |
| | | 4 | 11/1/21 |
| | | 5 | 19/1/21 |
| | | 6 | 11/2/21 |
| | | 7 | 4/3/21 |
| | | 8 | 26/3/21 |
| | | 9 | 15/4/21 |
| Sludge Sampling | 1 | 1 | 1/10/20 |
| Activated Sludge Sampling | 1 | 1 | 15/4/21 |
| Dosing | 31 | 31 | Weekly |
| EBD Installation | 2 | 1 | 20/10/20 |
| | | 2 | 5/1/20 |
| Power Audit | 4 | 0 | 13-17/2/20 |
| | | 1 | 28/9 – 5/10/20 |
| | | 2 | 12-15/1/21 |
| | | 3 | 2-5/2/21 |
| | | 4 | 11-16/3/21 |


Fig. 3: Dosing of Bio-catalyst & EBD System installation at STP

The analysis was conducted individually by IASB/RDV and IWK, the STP owner. The data corresponding to September 29, 2020 and October 1, 2020 is read at the pre-POC trial. There is no clear trend on the water quality, however, the data is very much the same prior to pre-trial and well below the stipulated requirement by the DOE Malaysia. It can seen that there are some spikes on the parameters observed. This is mostly due to more inflow of sewarage water as the usage increases during weekends, public holidays and Covid-19 movement control order (MCO). These spikes again does not exceed the mandatory discharge limit.

Reduction of aeration time was done according to Table 7 below. As it can seen from the water quality analysis above, the values of BOD, COD and other parameters remain about the same value before reduction of aeration time by up to 50%. These indicate the successful outcome of POC trail.

3.4 Results & Outcome of POC

**Table 6: Water quality analysis**

| PARAMETER | UNIT | DOE Para I (B) | DOE Para iii (B) | 1/10/20 | 29/9/20 | 27/10/20 | | 2/12/20 | | 11/1/21 | | 19/1/21 | 18/1/21 | 11/2/21 | | 18/2/21 | 26/2/21 | 4/3/21 | | 25/3/21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | IASB | IWK | IASB | IWK | IASB | IWK | IASB | IWK | IASB | IWK | IASB | IWKC | IWKC | IWKC | IASB | IWKC | IASB |
| pH | - | 6-9 | - | 6.8 | 7.2 | 7.1 | 7.2 | 6.4 | 7.4 | 6.7 | 7.3 | 6.3 | 7.2 | 6.9 | 7.5 | 7.3 | 7.1 | 7.8 | 7.3 | 7.0 |
| $BOD_5$ | mg/L | 50 | 50 | 3 | 3 | 6 | 4 | 5 | 2 | 4 | 2 | 5 | 4 | 3 | 8 | 22 | 5 | 5 | 16 | 5 |
| COD | mg/l | 200 | 200 | 14 | 24 | 19 | 20 | 19 | 20 | 17 | 18 | 24 | 21 | 15 | 38 | 83 | 23 | 22 | 57 | 21 |
| TSS | mg/L | 100 | 100 | 7 | 3 | 5 | 2 | 4 | 5 | 9 | 2 | 4 | 2 | 8 | 9.4 | 12 | 12 | 7 | 4 | 4 |
| $NH_3N$ | mg/L | 20 | 50 | ND | 2 | ND | 4 | ND | 6 | 1.2 | 3 | 0.9 | 8 | 7.76 | 9.4 | 9.9 | 17.9 | 10.29 | 9.1 | 13.2 |
| Oil & Grease | mg/L | 10 | 20 | ND | 3 | ND | 2 | ND | 3 | ND | 3 | ND | 2 | ND | ND | 0.6 | 0.6 | ND | 3.2 | ND |
| NO3N | mg/L | 50 | - | 25.8 | 6.5 | 21.3 | 1.2 | 23.2 | <1 | 2.6 | 3.8 | 1.2 | 1 | 2.7 | 4.57 | 19.9 | 2.88 | 2.5 | 8.95 | 2.1 |

Table 7 : Energy Saving Activities

| No. | Item | Date | Description | Percentage |
|---|---|---|---|---|
| 1 | First time aeration reduction | 12 January 2021 | 12hrs to 10hrs | 16% |
| 2 | Second time aeration Reduction | 1 February 2021 | 10hrs to 8 hours | 33% |
| 3 | Third time aeration reduction | 1 March 2021 | 8 hours to 6 hours | 50% |

Most critical POC evaluation is the stress test conducted starting March 17, 2021, in which case, the STP remediation is done entirely from the function of EBD installed at 37% aeration time reduction. The aeration will be further reduced to 50% in the final month of POC. The water quality analysed is shown in Table 8 below.

As the Table shows, the water quality measurement suggests that EBD starts functioning after 6 months of installation. Results seem to suggest that on the 2$^{nd}$ week of stress test, the water quality parameters analysed is slightly better than during the 1$^{st}$ week of stress test especially on the COD and Ammoniacal Nitrogen results. The EBD is expected to maintain the same quality or improve further toward the final months of the POC evaluation. The clarity of the discharge water is shown in the Fig. 5. below.

Table 8: Comparison of Water Effluent Quality at Stress Test

| Description | Unit | | Water Quality Measurement Date | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sep. 29 2020 | March 4 2021 | March 9 2021 | March 16 2021 | March 25 2021 (Stress test) | March 31 2021 (Stress Test) | 22 Apr 2021 (Stress Test) | 26 Apr 2021 (Stress Test) | 17 May | 28 May |
| Biological Oxygen Demand ($BOD_5$) | mg/l | 3 | 16 | 4 | 8 | 6 | 2 | 2 | 11 | 3 | 2 |
| Chemical Oxygen Demand (COD) | mg/l | 24 | 57 | 21 | 82 | 33 | 14 | 16 | 32 | 16 | 28 |
| Ammoniacal Nitrogen | mg/l | 6.5 | 9.1 | 19 | 15 | 13 | 8 | 8 | 16 | 7 | 7 |
| Nitrate Nitrogen | mg/l | 2 | 8.95 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| pH for Sewage Sample | number | 7.2 | 7.3 | 7.3 | 7.5 | 7.2 | 7.3 | 7.2 | 7.4 | 7.1 | 7.2 |
| Oil And Grease | mg/l | 3 | 3.2 | 2 | 4 | 3 | 2 | 6 | 2 | 2 | 3 |
| Suspended Solids | mg/l | 3 | 4 | 4 | 28 | 13 | 2 | 2 | 8 | 3 | 3 |
| | | Before POC | | | | Stress starts March 17, 2021 | | | | | |

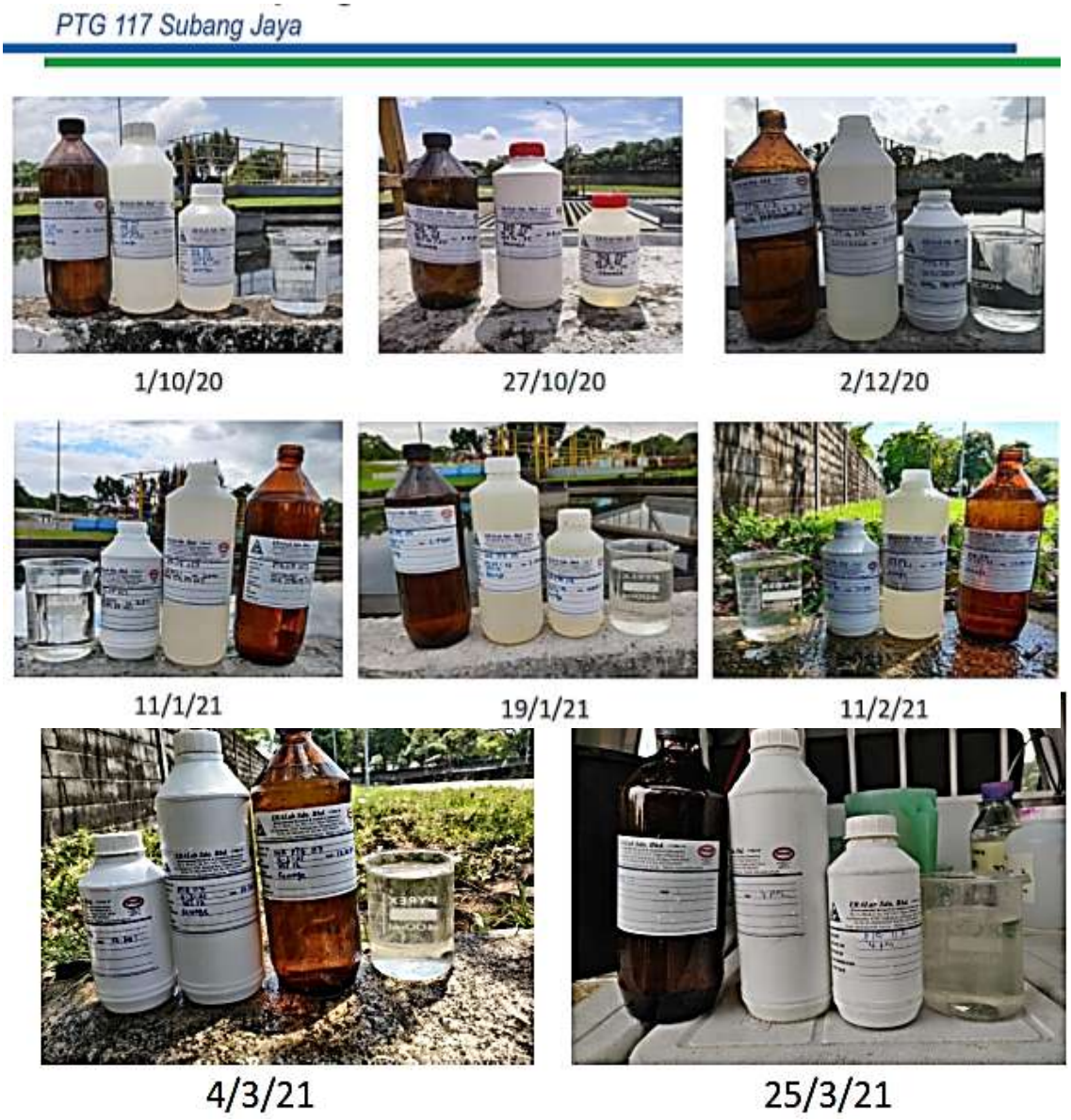


Fig 5: Water Sampling and Clarity of Treated Effluent

### 3.5 Energy Saving Outcome

In order to evaluate how the installation of EBD and biocatalyst treatment can contribute to energy saving to STP, a reduction of aeration pump time was carried out. The reduction time is shown in Table 7 above.

An energy audit was done at aeration reduction period. The energy saving result is Tabulated in Table 9. The energy savings are then calculated into the savings in the electricity bill. Table 10 shows that about 35% of electric bill savings has been achieved. This achievement is attained without compromising the discharge water quality.

Table 9: Energy usage percentage detail

| Energy Audit | kWh | kWh (Saving) | Percentage (%) |
|---|---|---|---|
| Phase 1 (2/20-4/10/2020) | 1705.3 | 0 | 0 |
| Phase 2 (13/1-15/1/2021) | 1271.8 | 433.5 | 25.4 |
| Phase 3 (2/2-5/2/2021) | 1262.4 | 442.9 | 25.9 |
| Phase 4 (12/3-16/3/2021) | 1062.16 | 643.16 | 37.7 |

Table 10: Monthly Electricity (TNB) Usage

| **Benchmark** | | | | | **Reduction on billings** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Month** | **Sept 20** | **Oct 20** | **Nov 20** | **Dec 20** | **Jan 21** | **Feb 21** | **March 21** | **Apr 21** | **May 21** |
| kWh | 46,103 | 44,748 | 47,692 | 50,494 | 43,438 | 30,251 | 31,209 | 28,770 | 35,443 |
| TNB Bills (RM) | 18,412.55 | 18,361.85 | 19,072.45 | 20,243.45 | 16,254.45 | 12,223.60 | 12,364.99 | 11,712.55 | 13,646.11 |
| Reduction % | Average bill RM 19,022.58 | | | | 14.55 | 35.74 | 34.99 | 38.43 | 28.26 |
| Remarks | | | | | Normal operations | Normal operations | Additional 3 tanks dewatering | | |

## 4 CONCLUSION

It can be concluded that the water quality has been maintained as per IWK effluent standard, without aeration but using a combined treatment of bio-catalyst and installation of EBD at the perimeter of oxidation pond. With the installation of EBD, the operation of aeration can be reduced by 35% during the 6 month long POC evaluation. At the conclusion of POC trail, as much as 28% of energy bill has been reduced. This reduction of aeration time is expected to be further reduced after the POC period when the EBD system is fully remediating the wastewater. Thus will result in a very significant reduction of energy bill to the STP operator.

Stress test i.e. POC evaluation on EBD installed alone has shown the effluent quality remains the same without dosing of bio-catalyst after 4 months of POC trial. This further confirms that EBD can help remediate the wastewater from STP. Dosing of bio-catalyst at early POC is only to help accelerate the function of EBD.

It is further concluded that the EBD is very effective for long term solution for sewage wastewater treatment. Besides remediating the effluent quality, its installation can help reduce the energy bill for the STP operator subsequently.