

PALM OIL MILL EFFLUENT TREATMENT SYSTEM

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Malaysian Palm Oil Board



M P O B



PRESENTATION OUTLINE



BACKGROUND



PROCESS MONITORING



TERTIARY/POLISHING TREATMENT SYSTEM



SURVEY FINDINGS ON BOD 20 PPM TECHNOLOGIES



ISSUES AND CHALLENGES



MPOB EFFORT ON BOD 20 ISSUES

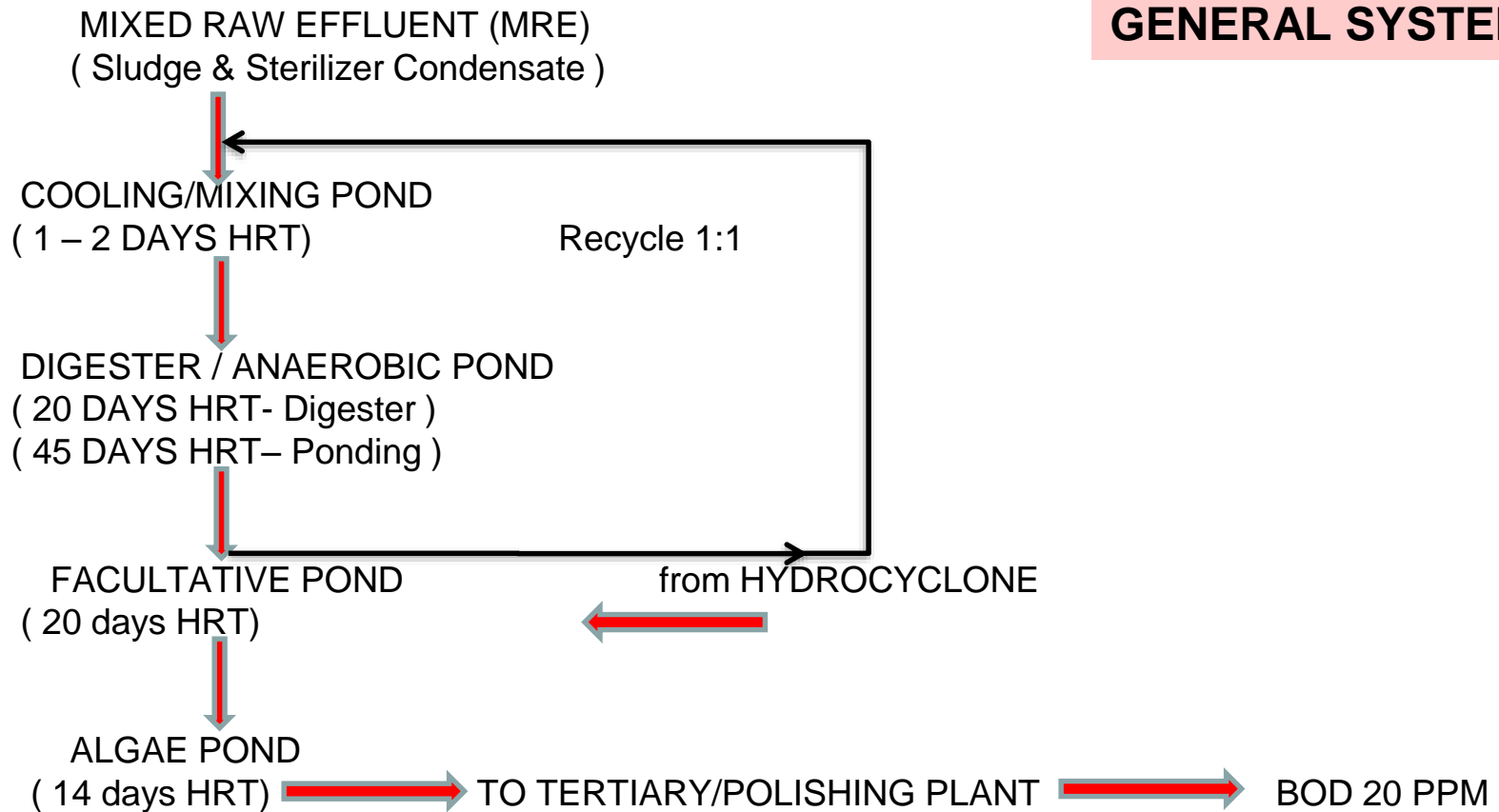


WAY FORWARD

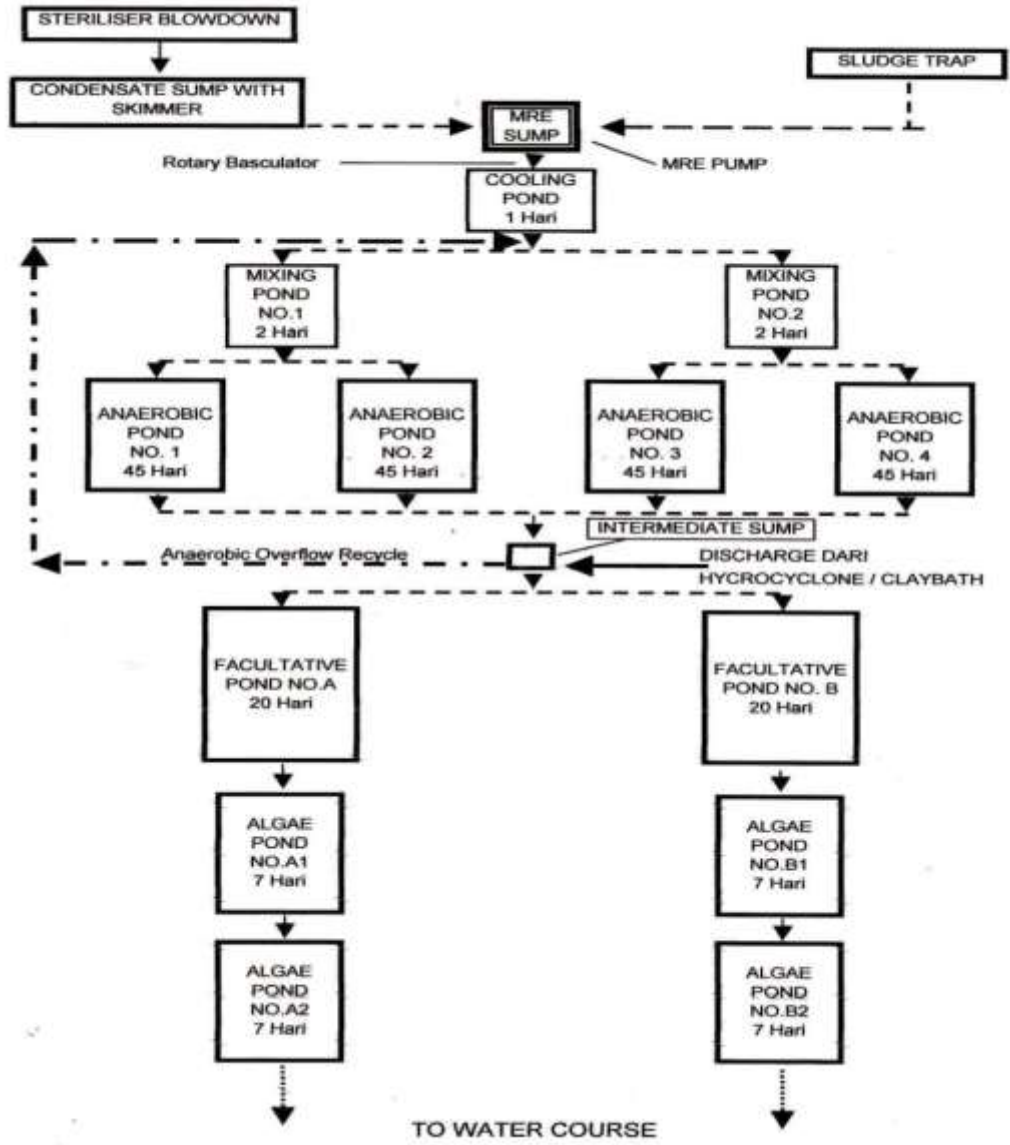


BACKGROUND

GENERAL SYSTEM



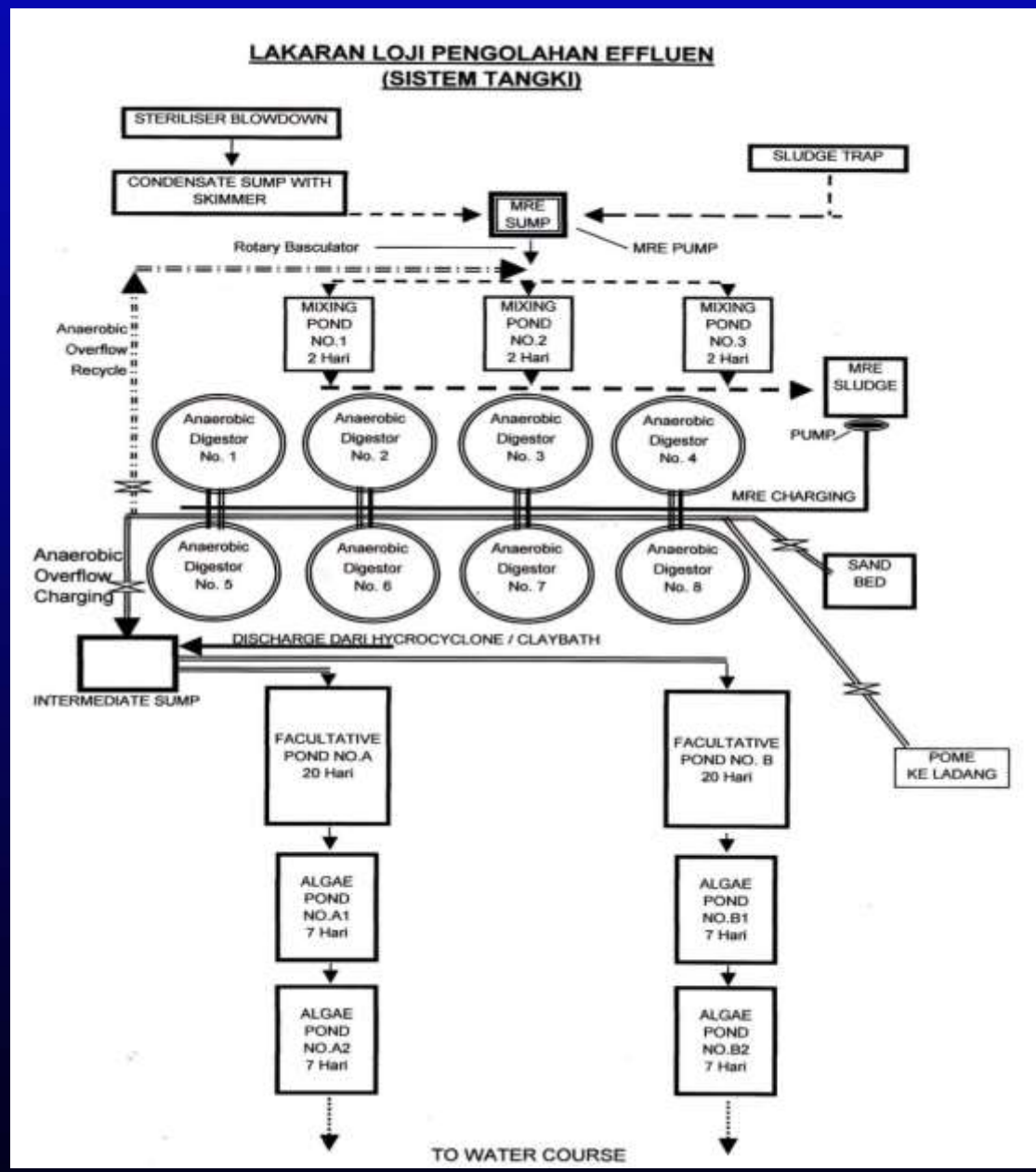
**LAKARAN LOJI PENGOLAHAN EFFLUEN
(SISTEM KOLAM)**



PONDING SYSTEM



DIGESTER TANK SYSTEM



SECONDARY TREATMENT SYSTEM

Mixing Pond



Anaerobic pond



Facultative pond



Aerobic/Algae pond



BACKGROUND

3 STEPS OF TREATMENT

- ❑ Primary – Less POME production / involve chemical treatment either in the secondary or tertiary treatment.
- ❑ Secondary – Biological process involve reduction in BOD through anaerobic and aerobic process
- ❑ Tertiary/polishing – Biological aerobic process use extended aeration and followed by mechanical/ ultrafiltration / macrofiltration / activated carbon filter



BACKGROUND

TYPES OF PROCESS	PROCESSES
BIOLOGY	PONDING /ACTIVATED SLUDGE
CHEMICAL	COAGULATION / NEUTRALIZATION
PHYSICAL	SETTLING / FILTRATION(MEMBRANE / SAND FILTER)
HYBRID	COMPOST PLANT / MEMBRANE BIO-REACTOR / COMBINE AERATED LAGOON & ULTRAFILTRATION



BACKGROUND

BOD TARGET

POME TREATMENT	BOD (ppm)
RAW EFFLUENT	25,000 – 35,000
ANAEROBIC POND/STAGE	< 2000
FACULTATIVE POND	< 500
ALGAE/AEROBIC TERTIARY TREATMENT SYSTEM	< 100 < 20

- ANAEROBIC PROCESS GIVES VERY SIGNIFICANT BOD REDUCTION (> 90%)
- IMPORTANT STAGE IN POME TREATMENT SYSTEM



PROCESS MONITORING



CONDITIONS OF ANAEROBIC DIGESTER

- ❖ Daily inspection on anaerobic liquor in digester
 1. $\text{pH} = 6.8 - 7.2$
 2. $\text{TA} = 2000 - 5000 \text{ ppm as Ca CO}_3$
 3. $\text{TVA} \leq 600 \text{ ppm as Ca CO}_3$
 4. $\text{TVA/TA} \leq 0.3$, optimum value = 0.2
 5. Optimum temp. = $30^\circ \text{C} - 45^\circ \text{C}$
- ❖ if $\text{pH} < 5.5$, pH has to be pushed to 7.0 using soda ash
- ❖ Frequent desludging activity



CONDITIONS OF AEROBIC SYSTEM

- **pH** – 6.5 to 7.5
- **Temperature** – psychrophilic (12 -18°C / mesophilic m/o (25 - 40°C)
- **Nutrients**
- **Oxygen** – dissolved O₂
- **Proper mixing**



❑ CONDITIONS OF TERTIARY TREATMENT SYSTEM MONITORING

- ❑ Influent (flowrate m^3/hr)
- ❑ pH
- ❑ Dissolved oxygen (DO)(mg/L)
- ❑ Sludge removal/desludging
- ❑ SV30 (ml/L)
- ❑ Sludge volume index (SVI)
- ❑ Mixed liquor suspended solid (MLSS)(mg/L)
- ❑ Mixed liquor volatile suspended solid (MLVSS)(mg/L)
- ❑ Food to microorganism (F/M) ratio
- ❑ Solid built up (m)(clarifier) , RAS (m^3/hr) & WAS(m^3/hr)
- ❑ Treated effluent to watercourse/land irrigation (m^3/hr)



TERTIARY / POLISHING TREATMENT SYSTEM



❑ PONDING SYSTEM

Aeration/high rate aeration / extended aeration

❑ SUSPENDED GROWTH OR ACTIVATED SLUDGE

Suspended growth system, the m/o responsible for waste breakdown are maintained in suspension with the mainstream.

❑ ATTACHED GROWTH/ FIXED FILM

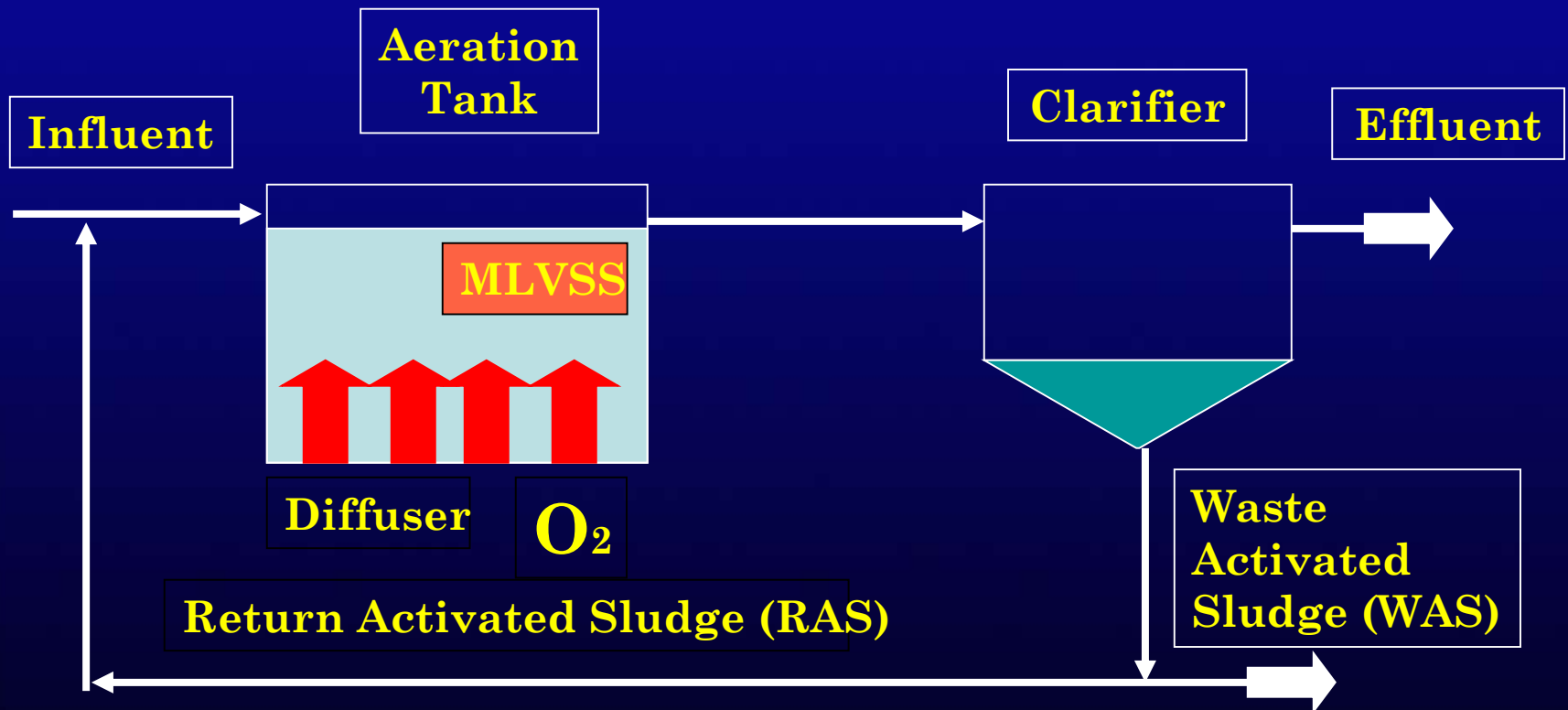
In fixed film systems, m/o attach to an inert medium

E.g.:

- Aerated sludge process
- Step aeration
- Contact stabilization
- Sequential batch reactor (SBR)
- Aerated lagoon
- Extended aeration



GENERAL CONCEPT OF ACTIVATED SLUDGE



Extended Aeration + Activated Sludge Plant



White and fine
bubble



Aeration Tank Reactor & Clarifier



Clarifier

Reactor tank 2
With cover

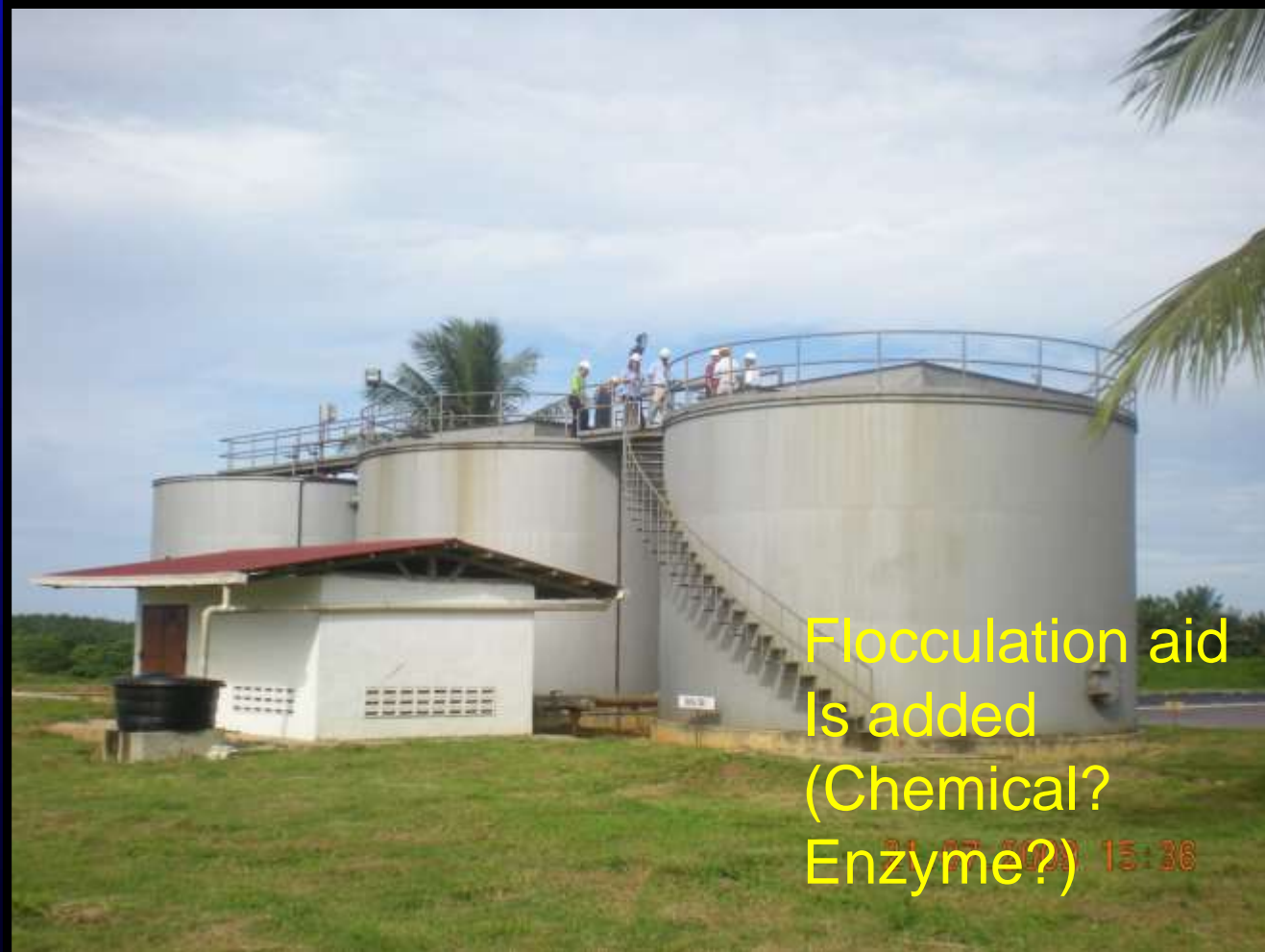
Reactor tank 1
With cover

Blower house

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Two Aerobic Reactors And a Clarifier



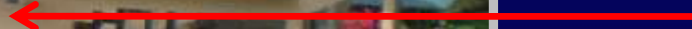
Extended Aeration-Activated Sludge Plant



Clarifier



Attached growth reactor



In-house bacteria
Is added to the
reactor



Extended Aeration Plant



Extended
Aeration pond



High Rate Aeration



High Rate Aeration



SURVEY ON BOD 20 PPM



▪ **STUDY CONDUCTED (Phase 1 – 4)**

- **Phase 1** : The survey was conducted by MPOB to study the performance of tertiary system by reviewing mill records and through site visits. 18 mills were involved in this survey (2010).
- **Phase 2** : Joint-sampling by MPOB and DOE at 14 mills (3 mills in Sabah and 11 mills in Sarawak) that were listed by DOE as consistently complying with BOD₃ 20 ppm (ponding and tertiary system) (2010/2011).
- **Phase 3**: Based on phase 1 and 2, six (6) mills (2 in Sabah, 4 in Sarawak) having tertiary systems which complied with BOD less than 20 mg/L were selected for further study. 1 grab sample of influent (final discharge from ponding system) and effluent (final discharge from tertiary system) were collected daily for 5 days (2011/2012).
- **Phase 4**: Long monitoring (April – December 2012), purposely to focus on 4 mills (2 mills in Sarawak) that are equipped with most potential technology that was capable to achieve BOD 20 mg/l consistently over a long period.

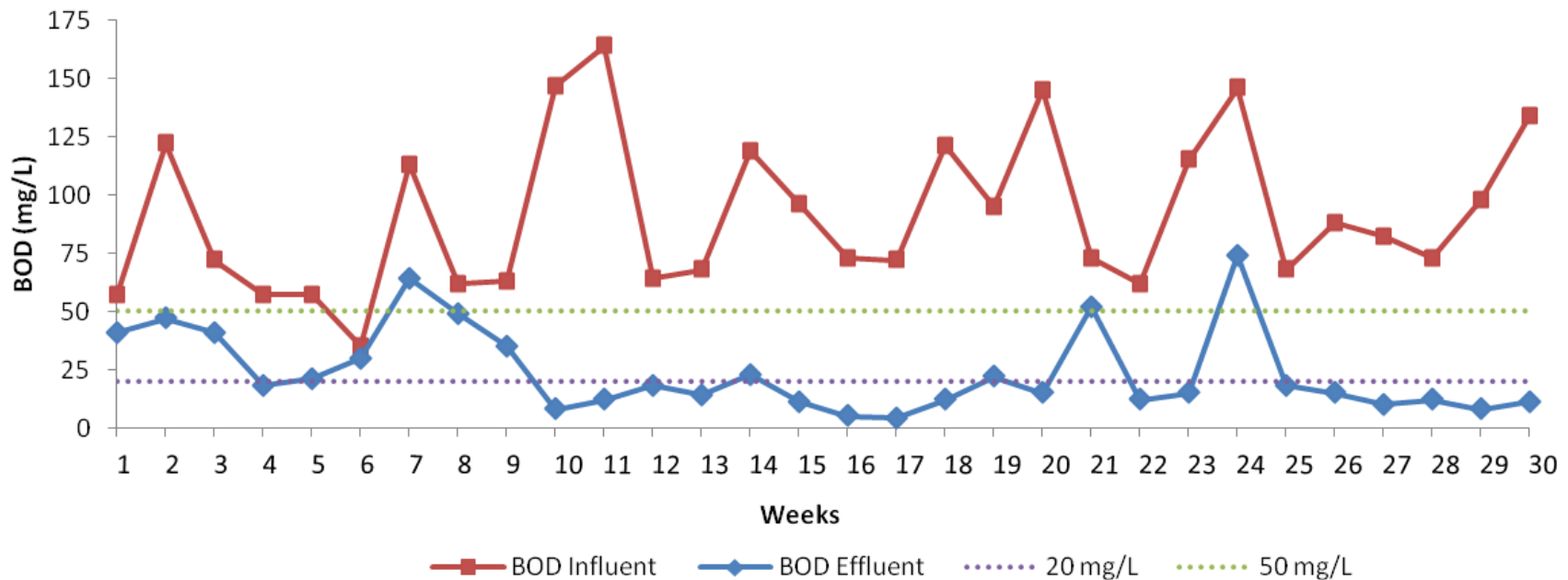


MILL A

- Year Commissioned (Mill): 1995
- Capacity of mill: 60 MT/hr
- Actual throughput: 24.2 – 58.9 MT/hr
- Type of tertiary system:
AS Plant Bioflow 500 m³ x 2 + clarifier
- Influent flowrate: 30 – 35 m³/hr

- HRT of ponding system : 138 days
- Designed BOD inlet : 250 mg/L
- Actual BOD inlet : 57-164 mg/L
- Cost of the Plant : ± RM 2 Million
- Year Commissioned (Tertiary): 2008
- Compliance <20 ppm : 60%
- Compliance <50 ppm : 90%

BOD of Final Discharge at Mill A



MILL A- Activated Sludge + clarifier



Clarifier

Reactor tank 2

Reactor tank 1
With cover

Blower house

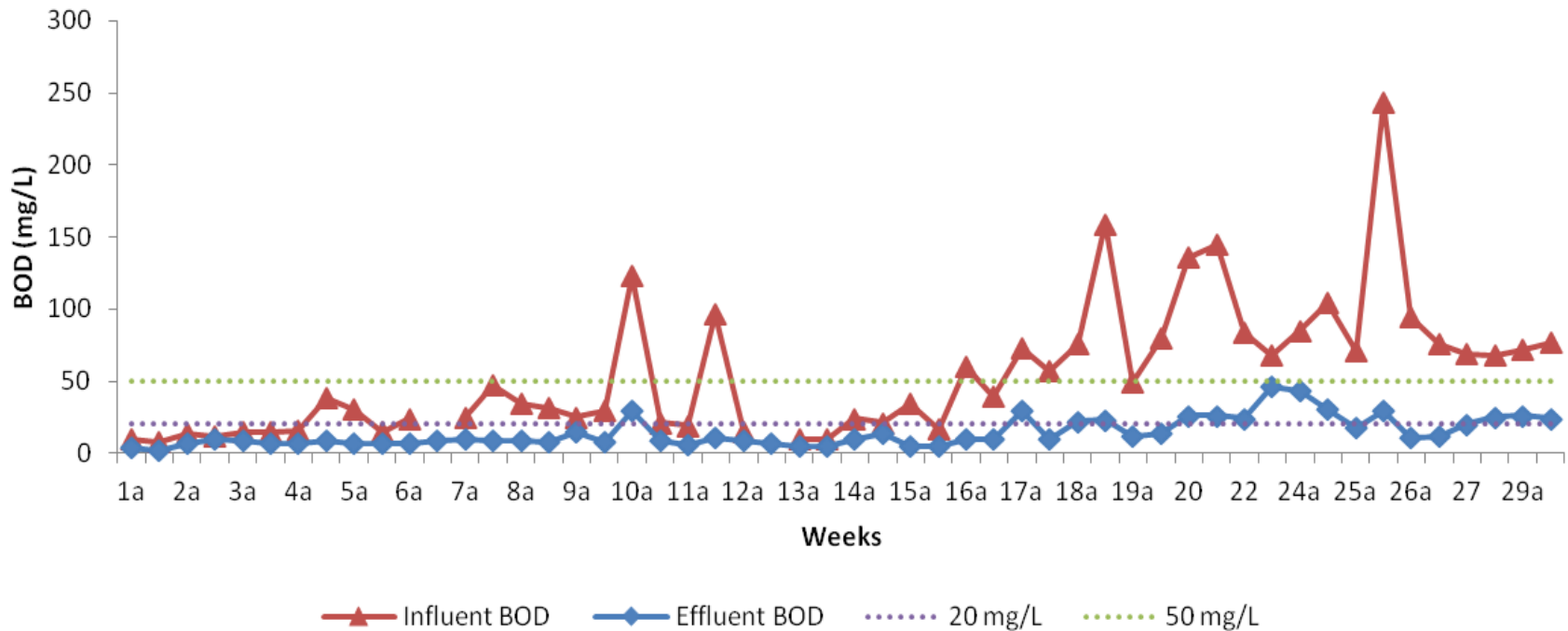


MILL C

- Year Commissioned (Mill): 2005
- Capacity of mill: 45 MT/hr
- Actual throughput: 40 – 46 MT/hr
- Type of tertiary system: Extended aeration + Sand Filtration
- Influent flowrate: 34.55 m³/hr

- HRT of ponding system : 122 days
- Designed BOD inlet : 300 mg/L
- Actual BOD inlet : 8-243 mg/L
- Cost of the Plant : RM 2 Million
- Year Commissioned (Tertiary) : 2006
- Compliance <20 ppm : 73%
- Compliance <50 ppm : 100%

BOD of Final Discharge at Mill C



MILL C: Extended Aeration + Clarifier (biofloc)+ Sand Filtration



Polishing Plant



Filtration System



Aeration Tank

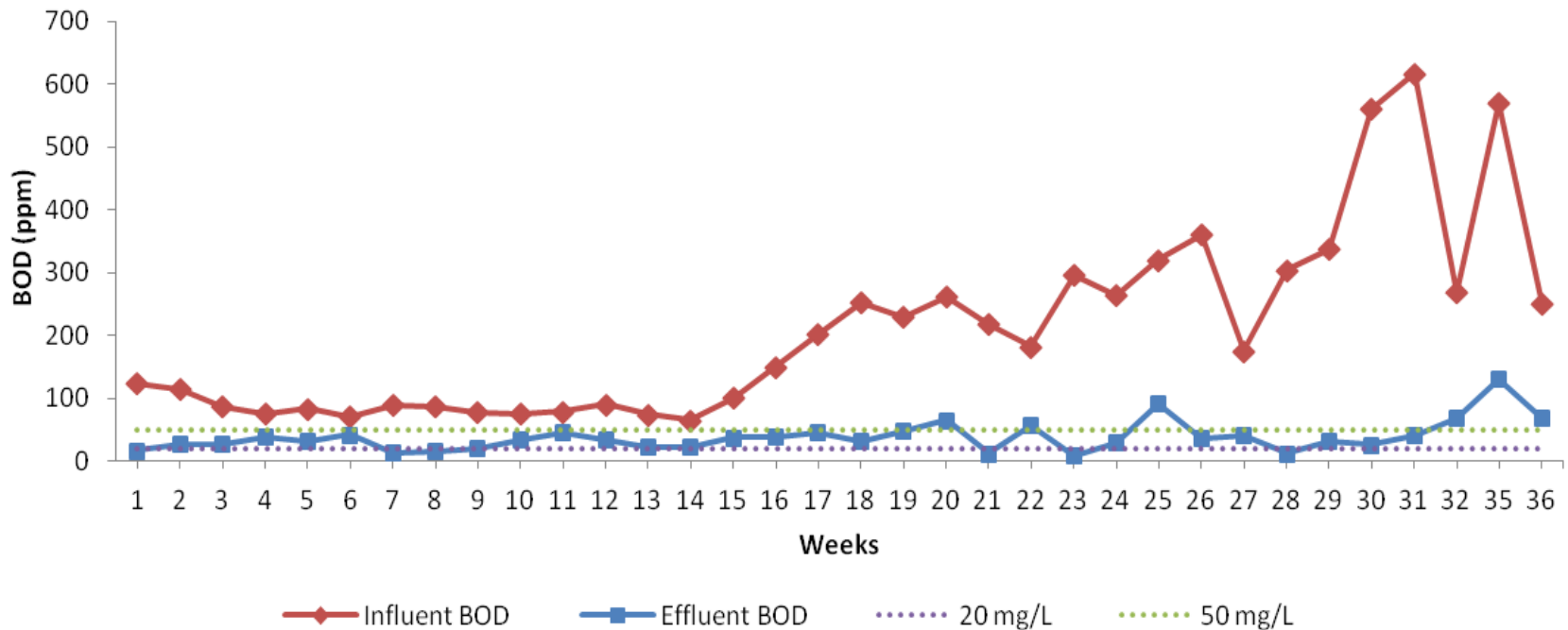


MILL E

- Year Commissioned (Mill): 2004
- Capacity of mill: 60 MT/hr
- Actual throughput: 46.5 - 56 MT/hr
- Type of tertiary system:
Extended aeration + ultrafiltration
- Influent flowrate: 28.69 – 31.83 m³/hr

- HRT of ponding system : 71 days
- Designed BOD inlet : 200 mg/L
- Actual BOD inlet : 65-617 mg/L
- Cost of the Plant : ± RM 1.4 Million
- Year Commissioned : 2010
- Compliance <20 ppm : 21%
- Compliance <50 ppm : 82%

BOD of Final Discharge Mill E



* The tertiary treatment plant stopped the operation on week 33 & 34



MILL E: Extended Aeration + Clarifier + Ultrafiltration



Aeration pond



Clarifier



Submerged
UF

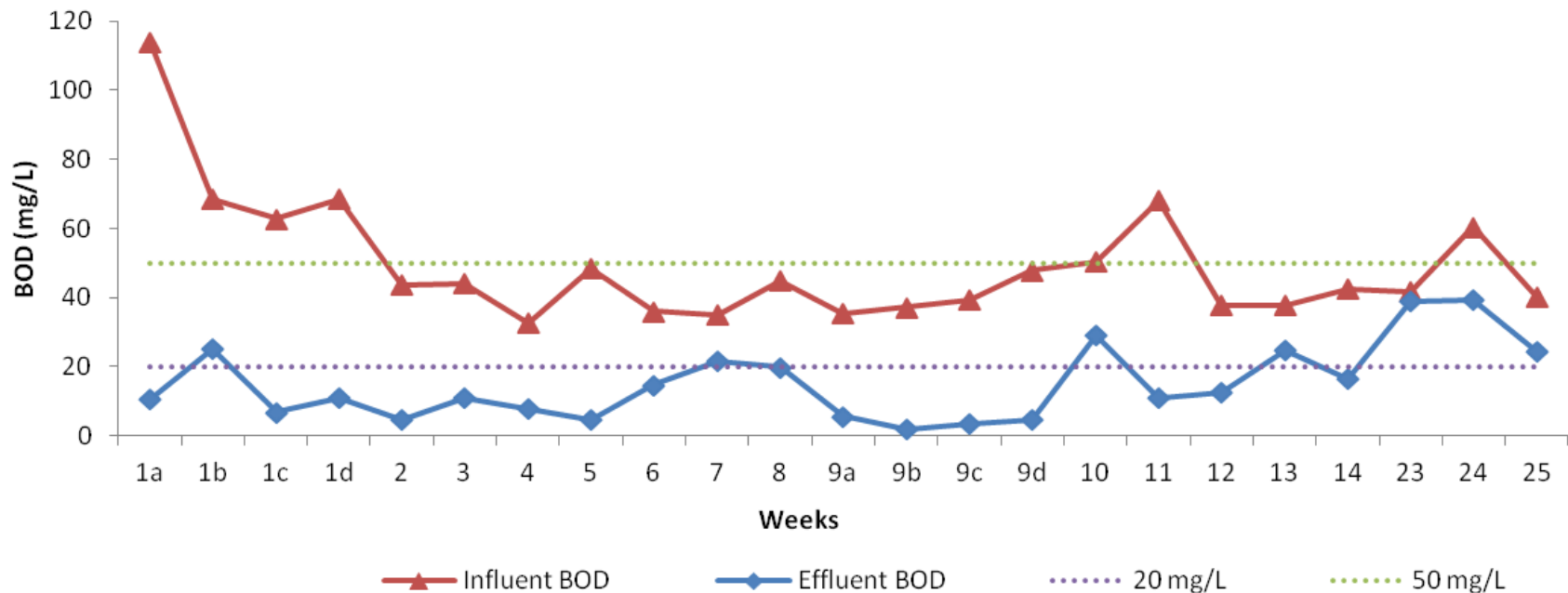


MILL F

- Year Commission (Mill): 1995
- Capacity of mill : 45 MT/hr
- Actual throughput: 29.5 – 41.2 MT/hr
- Type of tertiary plant :
Extended aeration (attached growth)
+ Stone Filtration
- Influent flowrate: 0.5 – 6.63 m³/hr

- HRT of ponding system : 176 days
- Designed BOD inlet : 250 mg/L
- Actual BOD inlet : 32.5 – 114 mg/L
- Cost of plant = RM 1.9 Million
- Year of commission (Tertiary) : 2005
- Compliance <20 ppm : 70%
- Compliance <50 ppm : 100%

BOD of Final Discharge at Mill F



*Plant monitoring was started from May 2012

**The plant was under maintenance from October to November 2012 (Week 15 to 22)



MILL F: Extended aeration + Clarifier(biofloc) + Stone filter



Aeration Tank

Contact Aeration Reactor (CAR)



ECOBED



ISSUES AND CHALLENGES

- The discrepancy of BOD analysis were affected by several factors which led to its variation of result such as sampling procedure, sample preservation, traveling distance of samples and microbiological activities in the samples.
- Limited land area for additional ponding before going to tertiary treatment system.
- Dealing with high strength of wastewater (BOD/solid).
- BOD overload at tertiary system. It normally happen during peak crop season (July – October).
- The effluent load from the mill is varies from time to time. Its depend on the mill's throughput and processing hours.
- Majority of the tertiary treatment system does not equipped with own gen-set and most of the time rely from the mill.



ISSUES AND CHALLENGES

- Design problem
- Inconsistent Input
- Operational Issues
- Performance monitoring issues



1. DESIGN PROBLEM

- Design – understanding activated sludge design and operation requirements
 - Organic loading load, kg BOD/m³.day
 - F/M ratio (BOD/MLSS or BOD/MLVSS)
 - Recycle ratio
 - Clarifier design – further polishing by carbon filter, membrane, continuous backwash sand filter
 - Diffuser type (coarse, fine bubble, oxygen transfer improvement using bio-surfactant etc)
 - Media type for attached growth process



2. INCONSISTENT INPUT

- ❖ Consistency input to Tertiary Treatment Plant is important to make sure the **STABILITY** of the biological process.

- ❖ Parameter that should be control :-
 - BOD
 - Suspended Solid
 - Flow rate
 - Nutrient

- ❖ Feeding to tertiary plant are not consistent due to :-
 - Pond Siltation at the upstream process unit (mixing, anaerobic, facultative)
 - Pond cleaning – increasing in SS and lower feeding
 - High suspended solid – will lower the D.O level, Increase loading then affect the performance – **CRITICAL ISSUE**
 - Action to be taken - no feeding to plant during mill inspection/major breakdown/pond desludging.



3. OPERATIONAL ISSUE

Plant operation

- Insufficient aeration at aerobic and bioreactor tanks
 - Blower should be operated continuously (24 hours)
 - (Turn to anaerobic – blower not running more than **3 hours**) – detected from smell of RAS.
 - Feeding should be controlled between limit
 - BOD/Suspended Solid – control between limit

- RAS (recycled activated sludge) from clarifier
 - Pump to be operated smoothly / provide standby unit.

- WAS (Wasted activated sludge) from clarifier
 - Indicator parameter when the sludge should be wasted **must be clarified** to the operator.

- Consistent Feeding (Flow rate, BOD, SS)
 - To ensure feeding to polishing plant consistent depend on the process capacity.



MAINTENANCE

- Poor maintenance reduce the efficiency of plant.
- Scaling in the pipeline.
- Poor workmanship especially in the blower-diffuser installation – cause failure at pipeline & diffuser.
- Total preventive maintenance not in place. (e.g : Blower, pump)



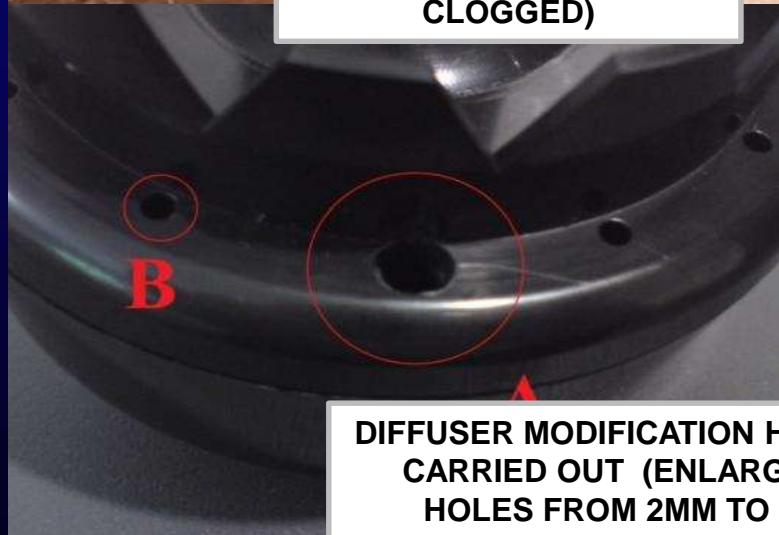
OPERATIONAL ISSUE (CLOGGING OF DIFFUSER)



DIFFUSER CONDITION IN THE AERATION TANK (80% CLOGGED)



MANUALLY CLEANING THE DIFFUSER



DIFFUSER MODIFICATION HAS BEEN CARRIED OUT (ENLARGE THE HOLES FROM 2MM TO 5MM)



MPOB EFFORTS TO TACKLE POME & BOD 20 PPM ISSUES



1. MPOB TOT NO. 537 - 2013

ZERO WASTE TECHNOLOGY FOR PALM OIL MILLS (POMEDfree)

ZULKIFLI AB RAHMAN; NU'MAN ABDUL HADI; YAHAYA HAWARI;
ZULKIFLI HASHIM and DANNY TAN



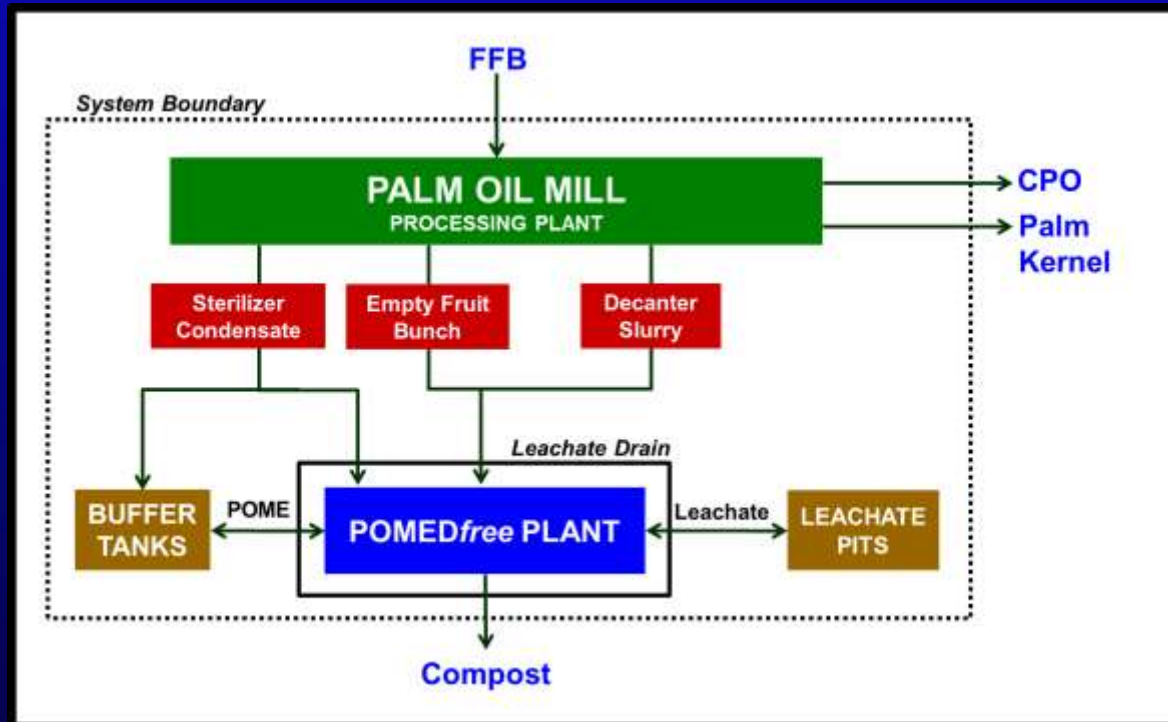
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MPOB TT No. 537

BEST OPTION IN DEALING WITH HIGH POLLUTANT-LADEN
WASTEWATER FROM PALM OIL MILLS IN ORDER TO
PRESERVE OUR ENVIRONMENT AND PROMOTE
SUSTAINABILITY OF PALM OIL



Zero Waste Technology through 100% Fertilizer Composting



BENEFITS

✓ ZERO POME DISCHARGE / ZERO POLLUTION

- No more worries for biological oxygen demand (BOD) compliance
- Eliminate desludging of ponds
- Allow palm oil mills to be built at sensitive areas such as peat soils, overloaded rivers, aquaculture and proximity to villagers

✓ SUBSTITUTION OF INORGANIC FERTILIZER BY 30%

- 100% nutrients recovery from all wastes - high nutrients value
- 4 - 6 years payback period

✓ CORPORATE SOCIAL RESPONSIBILITY

- Reduction of greenhouse gases
- Zero Pollution to Rivers



2. MPOB TOT NO. 574 - 2015

INTEGRATED MICRO-SCREEN AND ULTRA-FILTRATION SYSTEM FOR PALM OIL MILL EFFLUENT (POME) POLISHING TREATMENT

NOR FAIZAH JALANI; NOORSHAMSIANA ABDUL WAHAB; ASTIMAR ABDUL
AZIZ and ROPANDI MAMAT



703

MPOB INFORMATION SERIES • ISSN 1511-7871 • JUNE 2015

MPOB TT No. 574

Extended aeration system



Coagulation – flocculation
treatment



Micro-screen filtration system



Membrane ultra-filtration
system



Extended aeration system



Chemical and polymer mixing tank



Ultra-filtration system



3. LOJI RINTIS RAWATAN POME DI POMTEC, LABU



1) Loji rintis pengurusan sisa enapcemar – Filter Press



2) Loji rintis penapisan mikro (Micro-screen)



3) Loji rintis penapisan ultra (Membrane Ultra-filtration)



4) Loji rintis DAF dan kitar semula air (DAF and water recycling system)

4. AquaEco-SRORS Filtration & Evaporation system



- ✓ Recover residue oil
~0.5% OER to FFB
- ✓ Remove suspended solids
- ✓ Reduce COD/BOD
~70%
 - *thus reduce ~70% GHG*
- ✓ Revenue of RM10-13/mt FFB



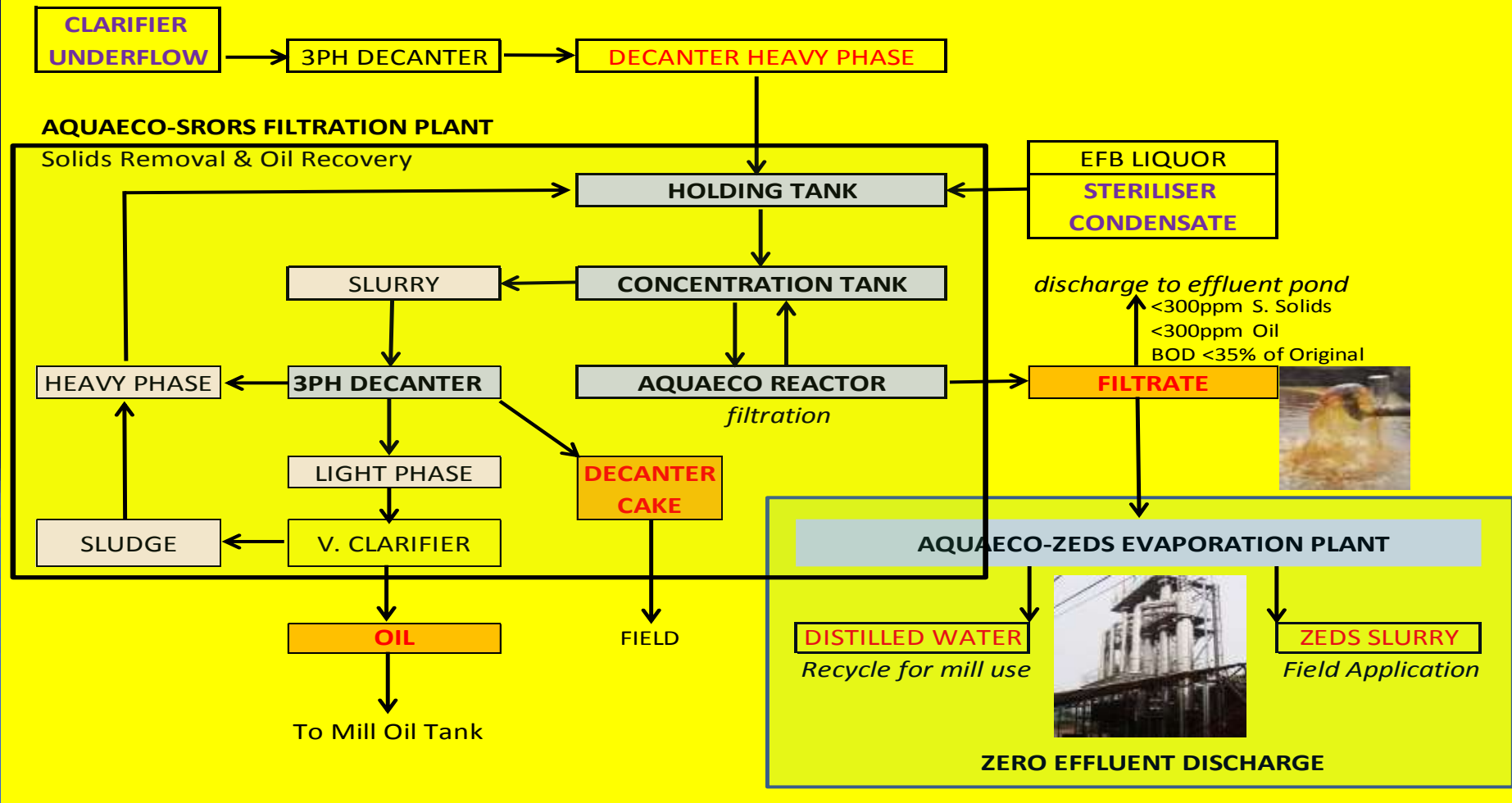


Evaporation System (pilot scale test)

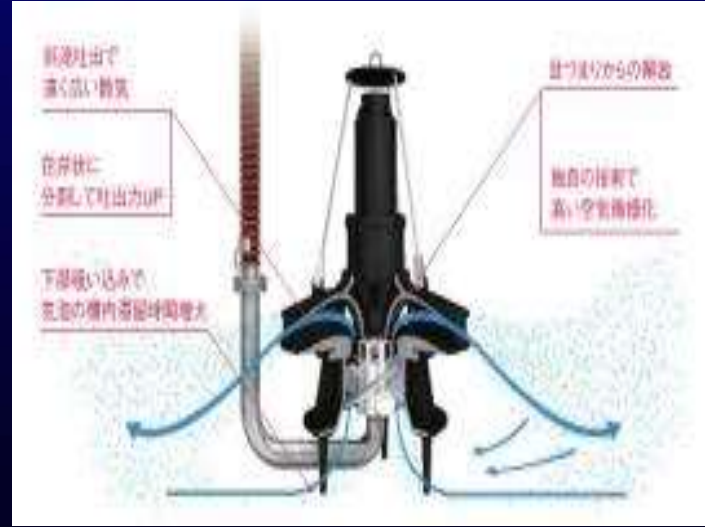
- ✓ Evaporate filtrate
- ✓ Zero discharge
- ✓ Biogas Avoidance Facility
- ✓ Zero Biogas, CO₂
- ✓ Recycle clean water
- ✓ Reduce water footprint
~70%



FLOW PROCESS OF AQUAECO PLANT - A BIOGAS AVOIDANCE & ZERO DISCHARGE SYSTEM FOR PALM OIL MILL



5. MPOB/JICA PROJECT- BOD 20 PPM (Performance of Aquarator & sludge removal system)



SCREENING DEVICE

Aquarator system



MINUTES OF MEETING
BETWEEN
MALAYSIAN PALM OIL BOARD
AND
THE JAPAN INTERNATIONAL COOPERATION
AGENCY
CONCERNING
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

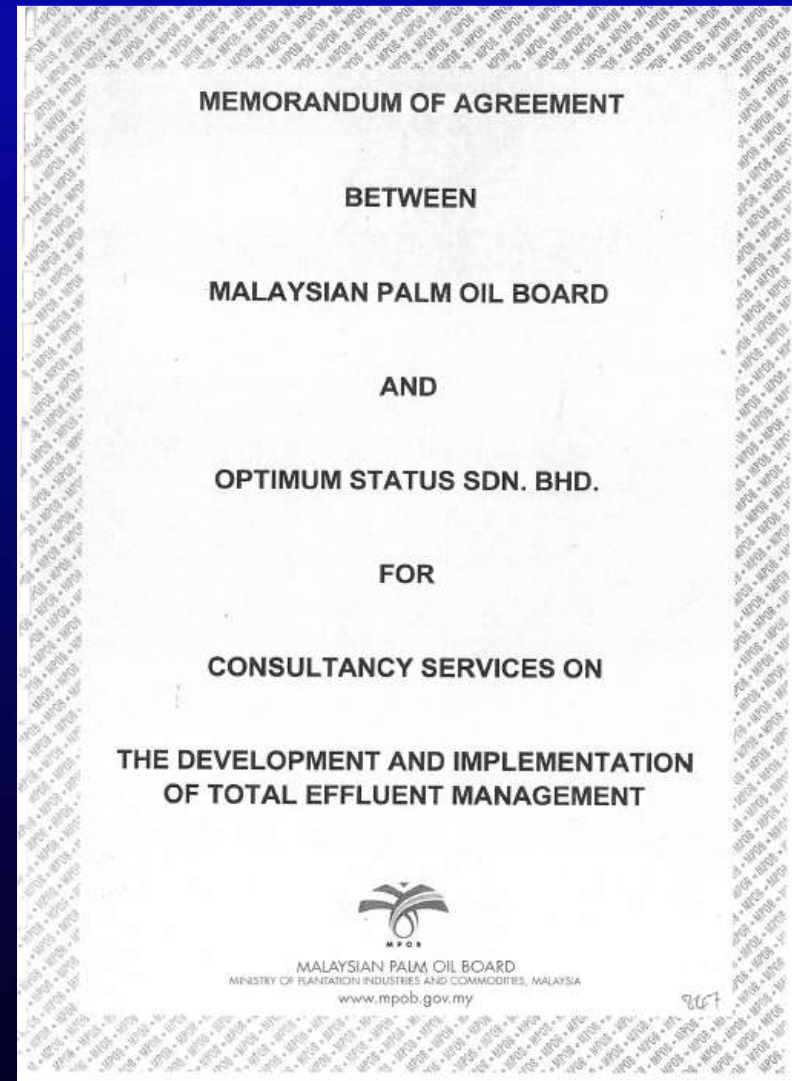


MALAYSIAN PALM OIL BOARD
MINISTRY OF PLANTATION INDUSTRIES AND COMMODITIES, MALAYSIA
www.mppob.gov.my

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6. CONSULTANCY SERVICES



MPOB EFFORTS

- **Ministry level** – Addressing Minister of MPIC on findings of the survey as well as challenges faced by the palm oil mills in achieving effluent BOD of 20ppm.
- **Presenting the finding** to MPOA TRC meeting, MPOB industry forum
- **Presentation to regulatory bodies** – Presented findings and proposing BOD limit of 50ppm to DOE Headquarters, DOE Sabah & Sarawak, EPD Sabah & Sarawak State.



MPOB EFFORTS

- Seminars & Conferences – Organized a series of seminars and effluent treatment courses for operators as well as for mill management.
 - National Seminar on Palm Oil Milling, Refining, Environment and Quality (POMREQ) - [2010, 2012, 2014, 2016 (29 – 30 November)]
 - Seminar / Workshop on Palm Oil Mill Effluent Treatment (POMET3) – [2010]
 - *Kursus Asas Rawatan Sekunder dan Tertiri Efluen Sawit* – [Since 2011- 2016]
 - *Presented at Seminar Pematuhan KKS kepada EQA 1974 (Penyerahan lesen sesi 2013/2014)* – [Sabah, 2013]
 - Survey study – Continue monitoring of 40 mills located at Kinabatangan, Segaliud and Muanad river basins.



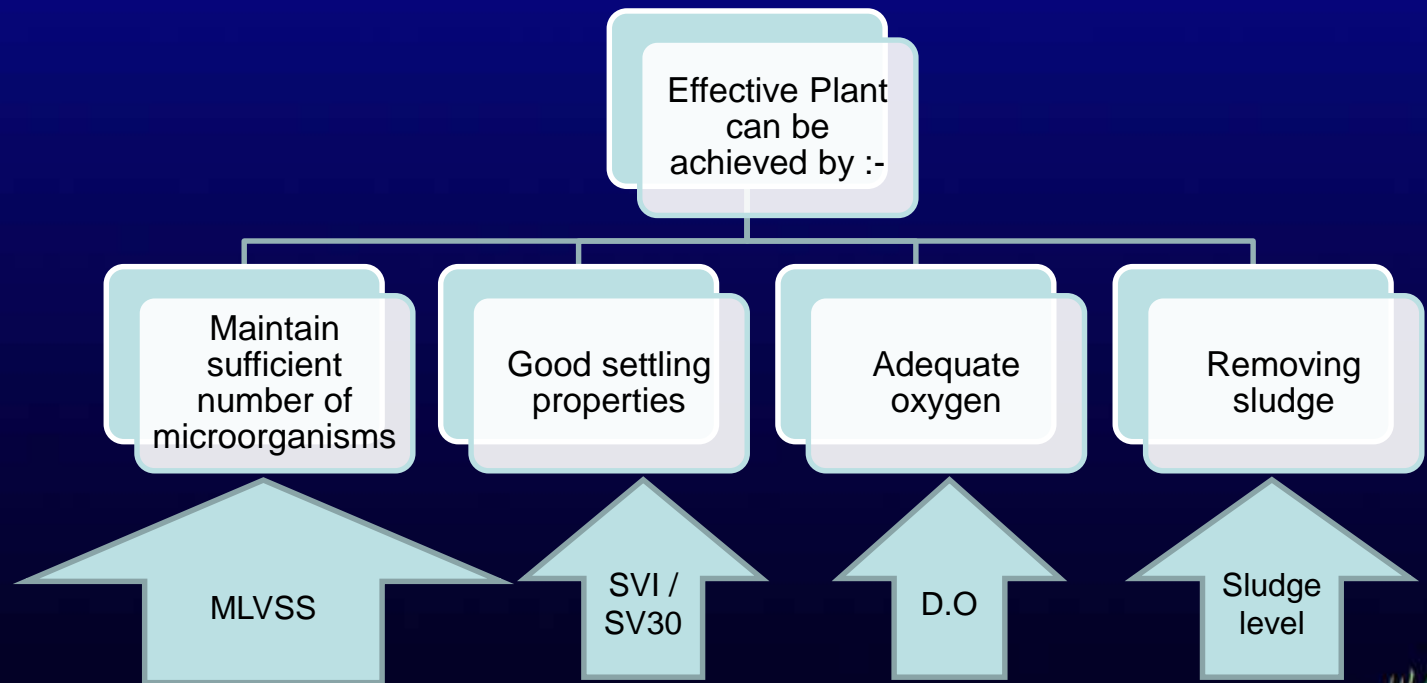
WAY FORWARD

- ❖ **UPGRADE** effluent treatment plant to cater for peak crop situation
- ❖ **OPTIMAL** operational parameters being **MAINTAINED** at the operational stage
- ❖ **MANDATORY** scheduled maintenance of effluent treatment system
- ❖ New power source to make sure plant operated 24hr (TNB / GENSET)
- ❖ Installation new sludge pump for Return Activated Sludge (RAS) purpose (not adequate)
- ❖ Installation flocculants dosing system (to insist healthy floc produced at the final clarifier)
- ❖ Consider zero discharge technology – filtration + evaporation
- ❖ POMEDfree zero waste technology through innovative composting technology (100% POME + 100 EFB + decanter cake + boiler ash)



❖ The success of operation of an activated sludge process is dependent upon 2 FACTORS

1. The **ADEQUACY** of the design
2. **OPTIMAL** operational parameters being **MAINTAINED** at the operational stage.



❖ Primarily - 5 different ways To Control

Constant Solids Methods

Basically refer **MLVSS**

(Range : Trial & Error – varies between mill)

Guideline : Typical MLVSS for activated sludge process :

1000 – 2000 mg/l

F/M ratio

BOD : Range : 0.05 – 0.1 kg/kg MLVSS under aeration

COD : Range : 0.2 kg/kg MLVSS under aeration

Sludge Age

Range : 5 to 15 days (typical)

SVI – Range : 50 – 100 (the lower / the better)

Specific Oxygen Uptake Rate (SOUR)

Range : 8 to 20 mg of O₂ per hr per g of MLVSS



❖ Sludge Volume Index Method

SVI – Range : 50 – 100 (the lower / the better)

SV₃₀ – Range : 15-35% (Depend on mills)

Control Method	Information & Data Required	Details of operator's task for controlling the activated sludge process using the chosen control method
Sludge Volume Index (SVI)	<p>Determined the optimum SVI which gives the required effluent quality.</p> <p><i>Information required:</i> settled sludge volume, mL/L x 100</p> <hr/> <p>MLSS Concentration, mg/L</p>	<ul style="list-style-type: none"> • If SVI is increasing, increase the solid level and sludge age by lowering the sludge wasting rate. • If SVI is decreasing decrease the sludge age by wasting more.



Thank you

See You at: POMREQ 2016
29 -30 November 2016
The Royale Chulan Hotel
Kuala Lumpur

&

See You At:



Mark this date!

14-16 November 2017

Kuala Lumpur Convention Centre,
Kuala Lumpur, Malaysia

For more information, please contact:

pipoc2017@mpob.gov.my

or visit MPOB website at

www.mpob.gov.my



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