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Palm Oil Mills Odour Emission Survey based on Different POME Treatment System

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ABSTRACT

Odorous gaseous such as ammonia and hydrogen sulphide produced by anaerobic bacteria are emitted when palm oil mill effluent (POME) is treated via anaerobic digestion. The Department of Environment (DOE) under the jurisdiction of the Air Division has proposed an odour emission limit of 12,000OUm^{-3} at source sample for Malaysian palm oil mills recently. The objective of this paper is to investigate the odour concentration at effluent treatment area within palm oil mills which practise different types of common POME treatment systems such as Open Ponds Treatment, Covered Lagoon and Digester Tank. The odour source grabbed samples from the respective treatment plants were assessed according to MS 1963:2007 Air Quality – determination of odour concentration by dynamic olfactometry. In addition in-situ odour concentration surrounding the respective project sites have been measured based on enhanced procedures adapted from VDI3940 Grid Method. The survey results showed that odour emitted from Open Ponds Treatment was having highest concentration while Digester Tank was having the lowest concentration due to quarantine factor. None of the observations comply the DOE proposal. Thus, alternative approaches need to be counter proposed in the legislation drafting so that the millers compliance could be ensured while avoid the public sensory annoyance complaints.

Keywords: Odour; palm oil mill; anaerobic pond; POME

INTRODUCTION

Palm oil mills generate about 3.5 tonnes of palm oil mill effluent (POME) in order to produce one tonne of crude palm oil (CPO) or about 0.6 tonne of POME for every tonne of fresh fruit bunches (FFB) processed. This acidic effluent contains water, oil, protein and trace of minerals (Gurmit Singh et al. 1999). Table 1 shows the typical dried POME powder composition (Fatah et al. 2012).

The average biochemical oxygen demand (BOD) of POME is about 25,000ppm and needs to be treated in order to reduce its BOD below 20ppm before being discharged into water course. Open effluent pond digestion treatment is the most common treatment system practiced by Malaysian mills due to the low capital expenditure (CAPEX) and operation expenditure (OPEX) where the POME is digested by a consortium of the micro-organisms commonly found in soil and air (Ma, 2000). Due to the recent biogas capture policy to further address sustainability issues, various treatment systems have been installed in palm oil mills such as covered lagoon and digester tank systems. Practical data show that 1m^3 of POME could generate 25m^3 of biogas with average calorific value of 22,000 kJm^{-3} containing 62.5 % methane, 37 % carbon dioxide and traces of hydrogen sulphide and ammonia. Figure 1 shows the common POME treatment in palm oil mills (Loh et al. 2017).

ANAEROBIC POND

Anaerobic digestion is a complex biochemical process as shown in Figure 2 that a consortium of micro-organisms converts organic compounds in the absence of oxygen into methane and carbon dioxide in four stages, which are hydrolysis, acidogenesis, acetogenesis and methanogenesis (Dinopolou et al. 1987).

Anaerobic POME treatment releases odorous gases such as ammonia and hydrogen sulphide (Thauer 1998) that are known as a particular kind of air pollutants which have become a serious environmental concern for many years (Hassan et al. 2015). Environmental factors such as wind speed and direction, topography, atmospheric stability and pollutant concentration need to be considered during odour assessment.

ODOUR AND ENVIRONMENTAL ISSUE

Smell sense accomplishes with two main nerves. Chemicals perception is processed by the olfactometry nerve whereas chemicals irritation or pungency is processed by the trigeminal nerve.

All olfactory signals meet in the olfactory bulb where the information is distributed to two different parts of the brain.

Limbic system pathway processes emotion and memory response of the body. The other information pathway is to the frontal cortex. From nostril to the brain signal, the process takes only about 500 milliseconds (Mauskar 2008).

Odour intensity is the perceived odour sensation strength which is related to the odorant concentration as shown in the equation (1) below, known as Stevens' law or the power law.

$$I = k(C)^n \quad (1)$$

where I is the intensity, k is a constant C is the concentration, n is exponent ranges from about 0.2 to 0.8 depending on the odorant. The odour concentrations mentioned as odour units per cubic meter is based on a correlation between a physiological response when the nose detect odour, and exposure concentration of a particular sample.

Odour unit is that amount of odorant(s) when evaporated into 1 cubic meter of neutral gas at standard conditions, elicits a physiological response equivalent to that elicited by one European Reference Odour Mass (EROM) which is equivalent to 123 µg *n*-butanol evaporated in one cubic meter of neutral gas at standard conditions (DEFRA 2010).

1 EROM ~ 123 MG *N*-BUTANOL ~ 1 OU_E FOR THE MIXTURE OF ODORANTS ($OU\ M^{-3}$)

The results of odour assessment are expressed in terms of a single number. A defined measurement standard for the odour unit is prescribed in a standard method set out in the MS 1963:2007 olfactometry standard. The odour panel members are evaluated and selected based on the sensitivity to *n*-butanol. The specific odour emission rate (OU_E/m^2s) was calculated as

$$\text{Odour emission rate} = O_C[F_A / H_A]$$

where O_C is odour concentration [OUm^{-3}], F_A is flush air flow rate [m^3s^{-1}] and H_A is flux hood area [m^2] (Malaysian Standard 2015).

Figure 3 shows the odour wheel for general composting processes. Theoretically the anaerobic palm oil mill effluent treatment emits odour similar to the sulfur composting group in the odour wheel below. Preliminary investigation in odour nuisance and emission rate from a palm oil mill located at Nibong Tebal, Penang recently showed that anaerobic pond is having the highest odour emission (Nurashikin et al. 2015).

The Department of Environment proposed an odour emission limit recently covering various industries and facilities including palm oil mills with proposed odour limits of 12000 OU/m^3. More reliable palm oil mill odour emission data derived from a representative sample size consisting of different effluent treatment systems is crucial to establish whether the palm oil mills are able to meet this odour limit and to identify appropriate odour control techniques for the odorous areas within a palm oil mill.

OBJECTIVE

The work in this paper is to investigate the odour concentration at effluent treatment areas within palm oil mills that use different types of POME treatment systems in order to recommend a fair and reasonable universal odour limit value for environmental regulation.

RESEARCH HYPOTHESISES

The experiments were designed based on hypothesises below.

1. Anaerobic pond is the main irritating odour source in palm oil mill.
2. Biogas capture practice will reduce odour emission.
3. Odour emission varies from day to night and also from high to low crop seasons.
4. Geographical factor within Malaysia is negligible in the odour emission level variation.
5. Portable Scentroid SM100 in-field olfactometer complete with dilution devices.
6. Olfactometry laboratory complete with SS400 Scentroid dynamic olfactometer.
7. Flux chamber and 10-liter nalophan bags for air sample collection.
8. *n*-Butanol for periodic olfactometer calibration and the traceable reference uses.
9. Six (6) panel members screened with 123 µg *n*-butanol.
10. Three (3) palm oil mills with different types of POME treatment (Open lagoon, covered lagoon and digester tank).

METHODS

The *in-situ* odour assessment method is based on Balch` et al. (2015) and Bakhtari and Medina (2016) which were enhanced procedures adapted from the Germany VDI3940 Grid Method. The assessment involved the determination of odour intensity, odour concentration and odour characters (descriptors).

Odour intensity was recorded every 10 seconds for 10 minutes to a scale of 0 to 6 following UK Environment Agency guideline (2007) as shown in the Table 2.

Odour concentration was determined using an in-field olfactometer (SM 100 Scentroid Olfactometer, Canada), with detection limit of 3.5 – 16,667 OUm^{-3} as calibrated. At least three (3) odour concentration readings were recorded within 10 minutes period and reported as OUm^{-3} as shown in Figure 4. Odour concentration was only recorded at locations with an odour intensity scale of 2 and above.

Predominant odour characters and source of emission were also noted for each location when odour intensity of 2 (weak) and above was observed. The odour descriptor of UK Environment Agency shown in Appendix 1 was used as a guide.

TABLE 1. Typical dried pome powder composition

Element	Composition [%w/w]	Element	Composition [%w/w]
Moisture	4.500	Nitrogen, N	1.850
Ash	14.000	Phosphorus, P_2O_5	0.620
Protein	12.000	Manganese, Mn	0.010
Oil	13.000	Copper, Cu	0.010
Calcium oxide, CaO	1.250	Zinc, Zn	0.010
Potassium oxide, K_2O	3.550	Molybdenum, Mo	0.002
Magnesium oxide, MgO	1.170	Selenium, Se	0.003

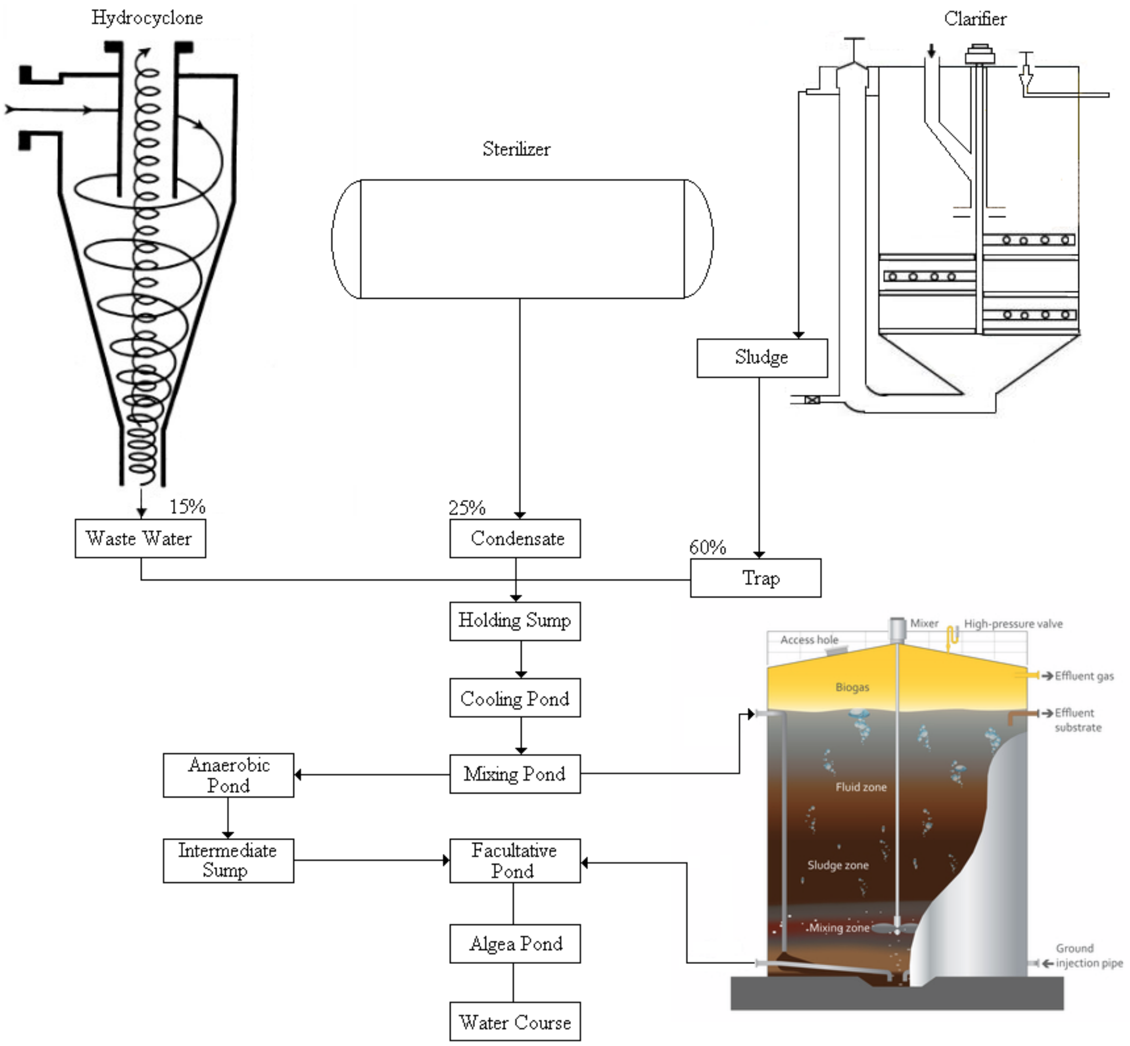


FIGURE 1. Palm oil mill effluent treatment schematic diagram

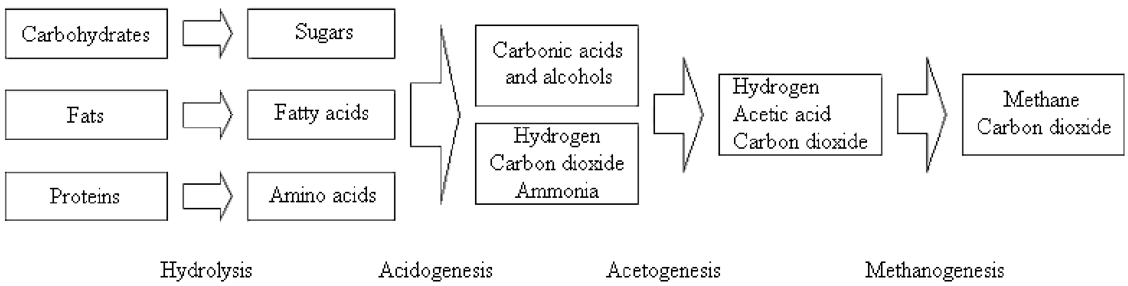


FIGURE 2. Anaerobic digestion stages

Odour source sampling and assessment was performed according to MS 1963:2007 Air Quality – determination of odour concentration by dynamic olfactometry. Flux hood and vacuum chamber have been used for odour sampling at the acidification pond. Samples were collected into 10 L Nalophan bag and sent to the odour laboratory at USM Engineering Campus for dynamic olfactometry analysis as shown in Figure 5.

METHODOLOGY

MATERIAL

Three (3) project sites with different types of POME treatment system which are, Open Ponds Treatment, Covered Lagoon and Digester Tank have been duly selected. Odour assessment was performed *in-situ*, using the Scentroid SM100 In-field olfactometer in conjunction with odour intensity and descriptor for a total of 12 samples at nearby anaerobic ponds, covered lagoons or digester tanks area respectively. In addition, 12 odour samples were collected from a single acidification pond and analysed in the USM Odour Laboratory the following day. Each project site will be evaluated twice at different crop season in order to investigate the effect as mentioned in the hypothesis. The Geometric Mean as shown in Equation (2) is used to compare and analyse the data properties.

$$\Delta z_i = \frac{a_i}{GM} \text{ if } a_i \geq GM \; ; \Delta z_i = \frac{GM}{a_i} \text{ if } a_i < GM \; ; 1 \leq \Delta z_i \leq 1.5 \quad (2)$$

RESULTS

The open pond treatment project site has been evaluated on 15-17 August, 2016 for peak crop season and 28-30 March, 2017 for general average operation. The odour assessment results are shown in Figure 6 and Figure 7. The *in-situ* odour is pungent like urine and rotten egg with odour intensity level 3 to 4 as described in UK Environment Agency Guideline.

The Covered Lagoon project site has been evaluated on 26-28 September, 2016 for peak crop season and 7-9 February, 2017 for general average operation. The odour assessment results are shown in Figure 8 and Figure 9. The *in-situ* odour is pungent like urine and rotten egg with odour intensity level 3 to 4 as described in UK Environment Agency Guideline.

The Digester Tank project site has been evaluated on 24-26 October, 2016 for peak crop season and 21-23 February, 2017 for general average operation. The odour assessment results are shown in Figure 10 and Figure 11. The *in-situ* odour is like fecal or manure with odour intensity level 1 to 2 as described in UK Environment Agency Guideline.

Correlation studies between source against in-situ odour measurements, odour measurements against BOD analysis and odour measurements against COD analysis are shown in Figure 12, Figure 13 and Figure 14 respectively.

DISCUSSION

Malaysia has tropical monsoon climate which is hot with normal ambient temperature ranging from 25°C to 35°C, humidity up to 85% and rain throughout the year. The highest ambient temperature is usually recorded from 12:00 to 15:00 and the sun heating effect is negligible during 19:00 to 07:00. Thus the micro-organisms' activities within the POME treatment ponds vary from day to night but remain in similar trend throughout the year.

Anaerobic digestion wastewater treatment releases odorous gaseous such as ammonia (NH_3) and hydrogen sulphide (H_2S) produced by the biochemical reduction of organic nitrogen compounds and sulphate reducing bacteria oxidising organic materials using sulphate (SO_4^{2-}) or sulphide (SO_3^{2-}) as electron acceptor respectively. The mechanisms are shown in the reactions below (Startsev, 2017).

$$C_5H_7O_2N + 3H_2O \rightarrow 2.5CH_3COOH + NH_3$$

$$CH_3COOH + H_2SO_4 \rightarrow 2H_2CO_3 + H_2S$$

Temperature is the most important factor that affects the rate of anaerobic digestion because most of the anaerobic bacteria thrive best at temperature of about 36.7°C. In addition, according to Gay Lussac's Law, the pressure of the gases, P will increase with the increasing in temperature, T which is also complying with the ideal gas equation below.

$$PV = mRT \; ; R = 8.3144598 \text{ J mol}^{-1} \text{ K}^{-1} \quad (3)$$

Thus, higher temperature in day time increased the odour gas molecules during sampling hence increasing the odour concentration. Although the temperature difference between day time and night time is about 10ºC, the high water specific heat capacity [C_p = 4.187 kJ(kgK)$^{-1}$] reduces the water temperature variation near the pond bed throughout the days and enabled the anaerobic digestion to remain active. Thus, odorous gas production may not reduce across the night as shown in the field survey.

The amount of influent nutrient flows into the treatment pond, F is determined as equation (4).

$$F = \text{Flow } [m^3s^{-1}] \text{ X Nutrient Concentration } [kgm^{-3}] \quad (4)$$

The nutrient available for anaerobic digestion vary from high crop season to low crop season because the influent flow rate depends on the amount of fresh fruit bunches processed in the mill. Thus the odour emission levels vary with crop season.

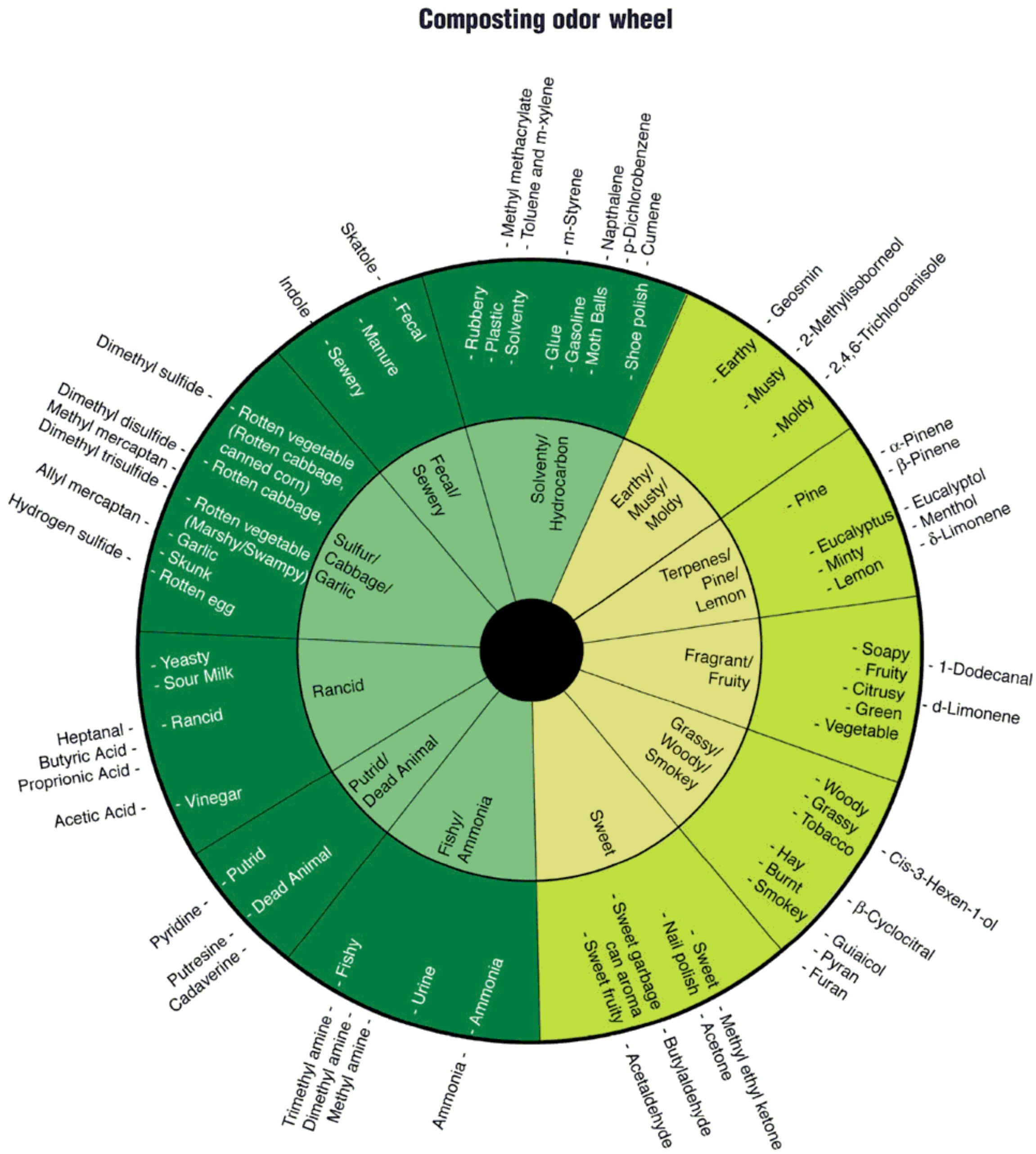


FIGURE 3. General composting odour wheel

Theoretically the in-situ odour measurements should proportionate to the source odour measurements. The low correlation between the source and in-situ odour measurements as shown in Figure 12 is due to various factors such as wind blow and the POME treatment plant design.

Experimental results show that the odorous gases were produced during acidogenesis and acetogenesis stages before methane gas is produced in the methanogenesis stage. The low in-situ odour level at the Digester Tank area which is about 80 m away from the acidification pond with high in-field odour level shows that those odorous gases are heavy and unable to travel far in the air. Thus the high in-situ odour level at the Covered Lagoon project site may be due to the distance where the covered lagoons are located side by side with the acidification pond. Figure 15 shows the Covered Lagoon project sites and Figure 16 shows the Digester Tank project sites.

Field survey results show that COD > BOD as predicted theoretically but the correlation between BOD and odour emission level is much better than the correlation between COD and odour emission level as shown in Figure 13 and Figure 14. This is because the odorous gases are produced from biological fermentation processes rather than chemical oxidation processes. Beside odorous gases such as ammonia and hydrogen sulphide, microbial anaerobic fermentation also produces other non-odorous gases such as carbon

TABLE 2. UK Environment agency guideline

Intensity level	Odour strength	Description
0	No odour	No odor
1	Very weak	There is probably some doubt as to whether the odour is actually present
2	Weak	The odour is present but cannot be described using precise words or terms
3	Distinct	The odour character is barely recognizable
4	Strong	The odour character is easily recognizable
5	Very strong	The odour is offensive. Exposure to this level would be considered undesirable
6	Extremely strong	The odour is offensive. An instinctive reaction would be to mitigate against further exposure

FIGURE 4. *In-situ* odour assessment using SM 100 Scentroid olfactometer

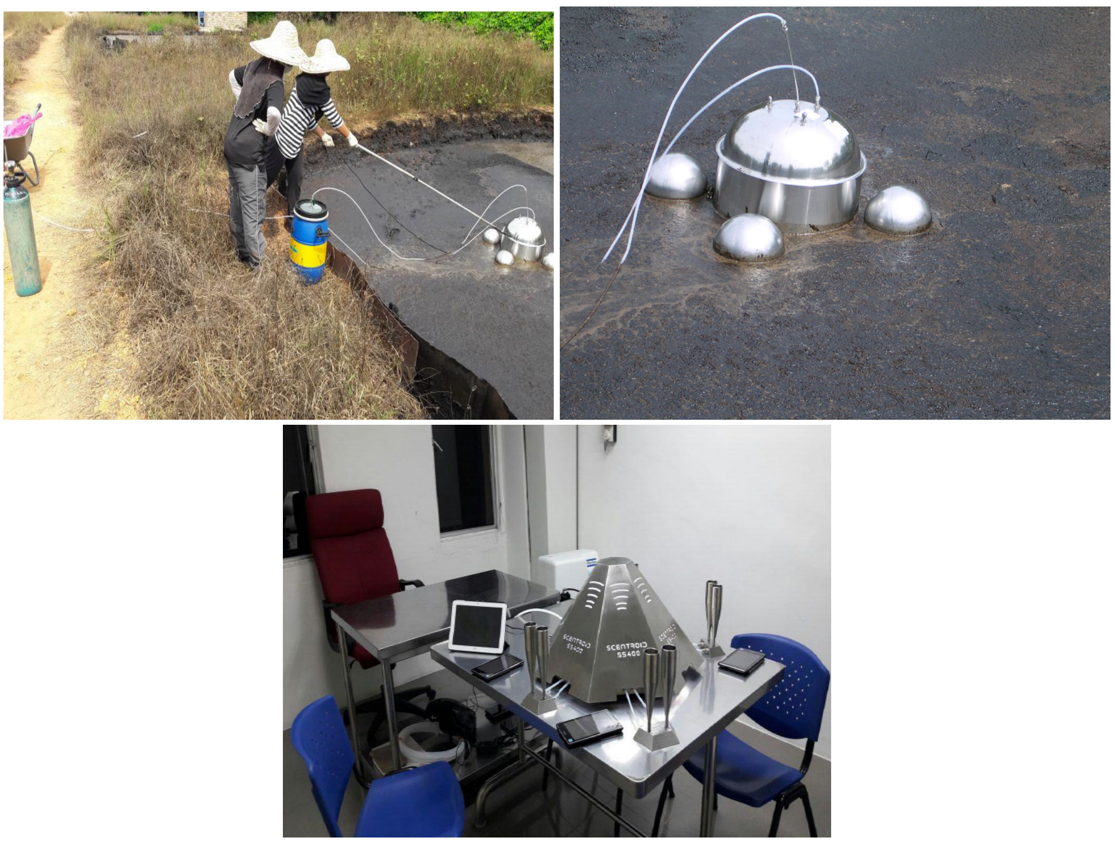


FIGURE 5. Site odour sampling and SS400 Scentroid dynamic olfactometer

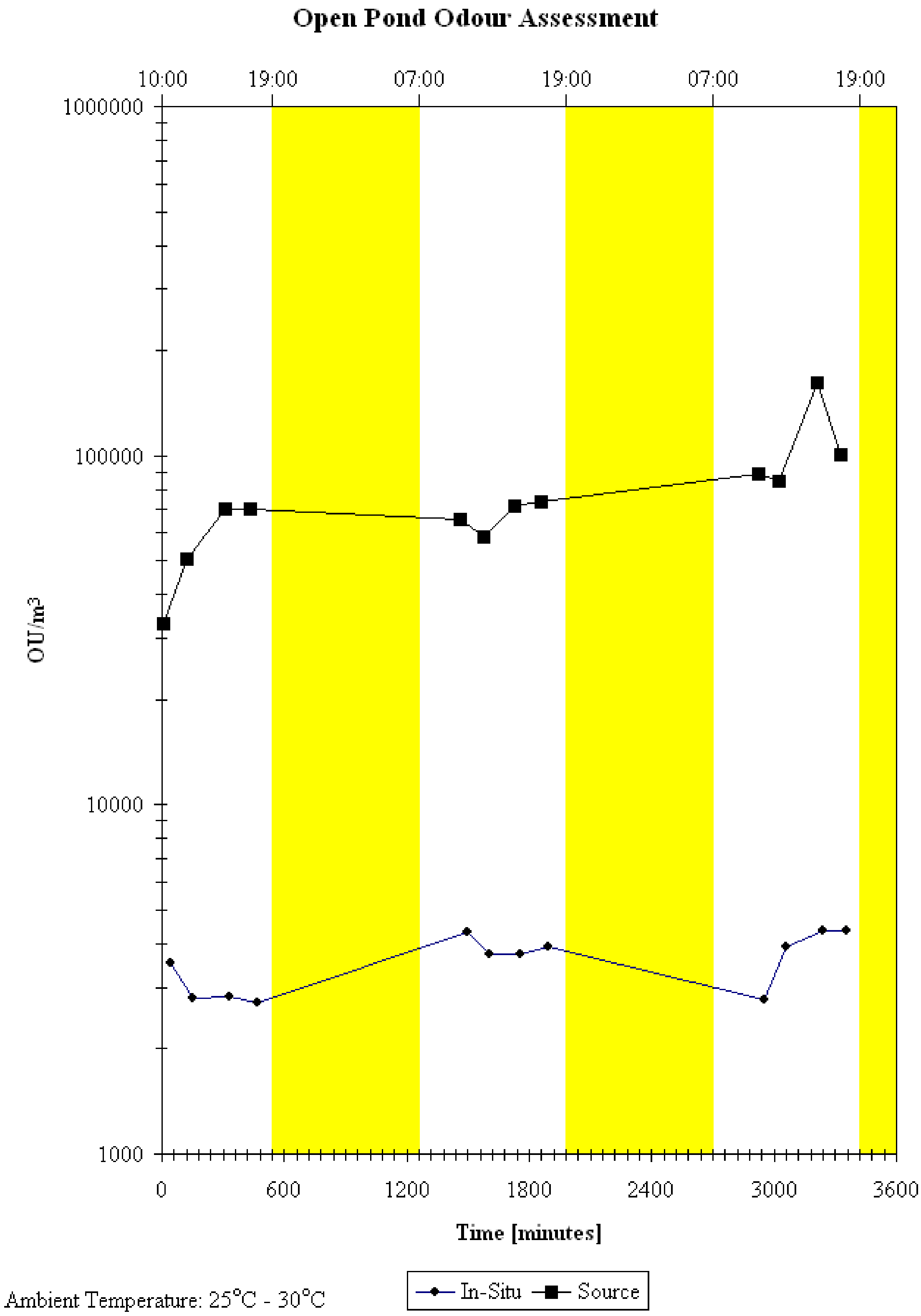
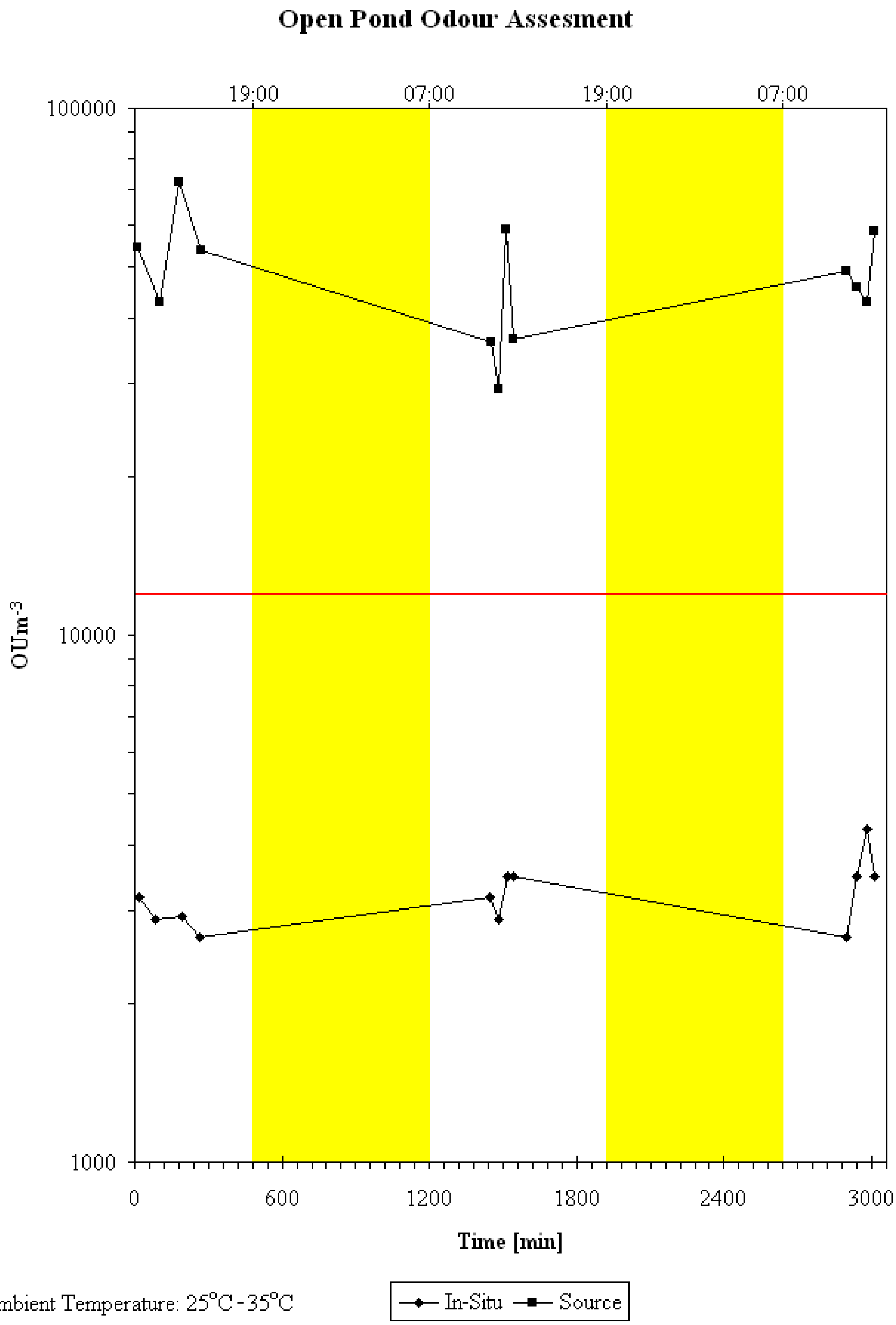
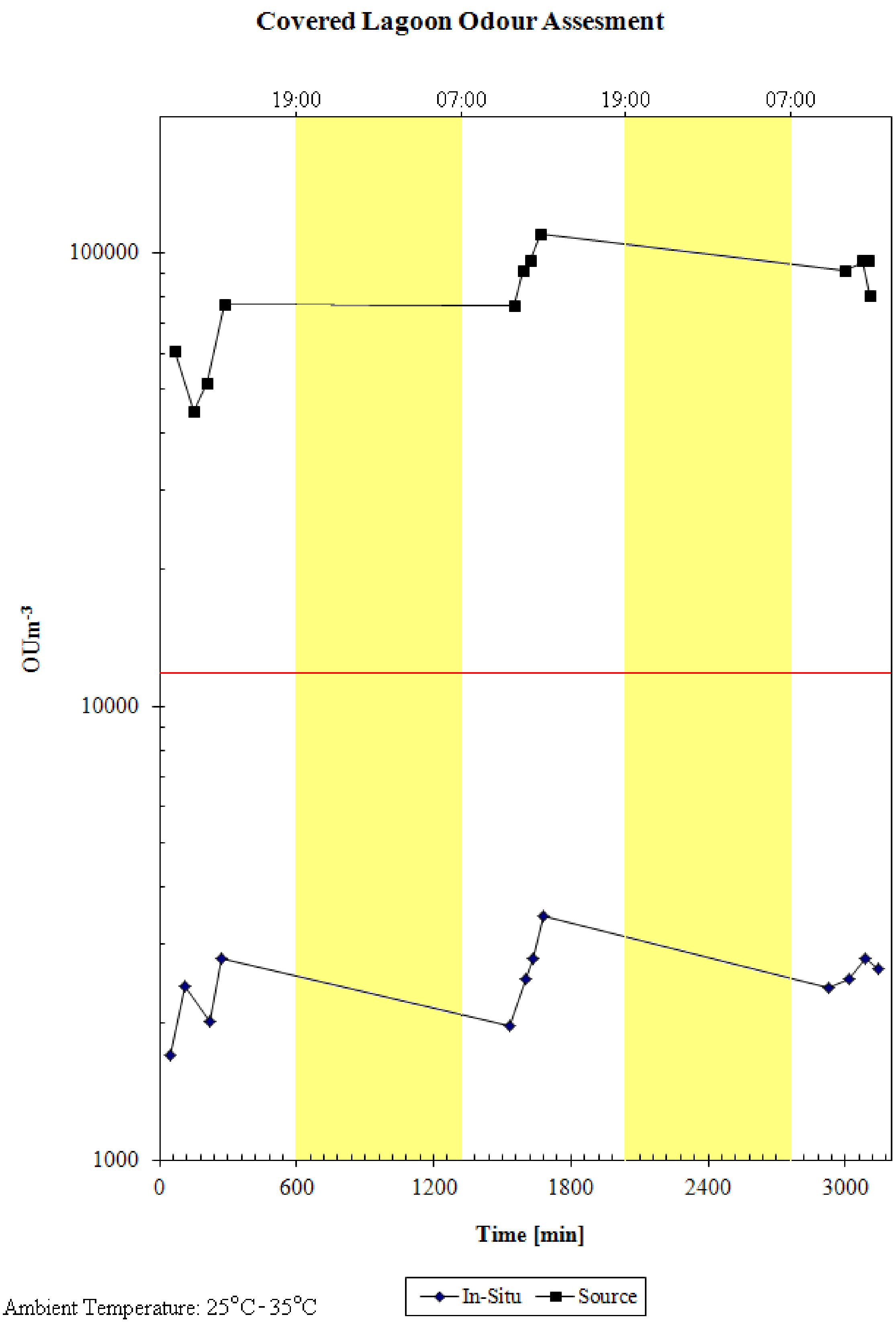


FIGURE 6. Open pond odour assessment result for peak crop season.



Ambient Temperature: 25°C - 35°C

FIGURE 7. Open pond odour assessment result for general average operation.



Ambient Temperature: 25°C - 35°C

FIGURE 8. Covered lagoon odour assessment result for peak crop season

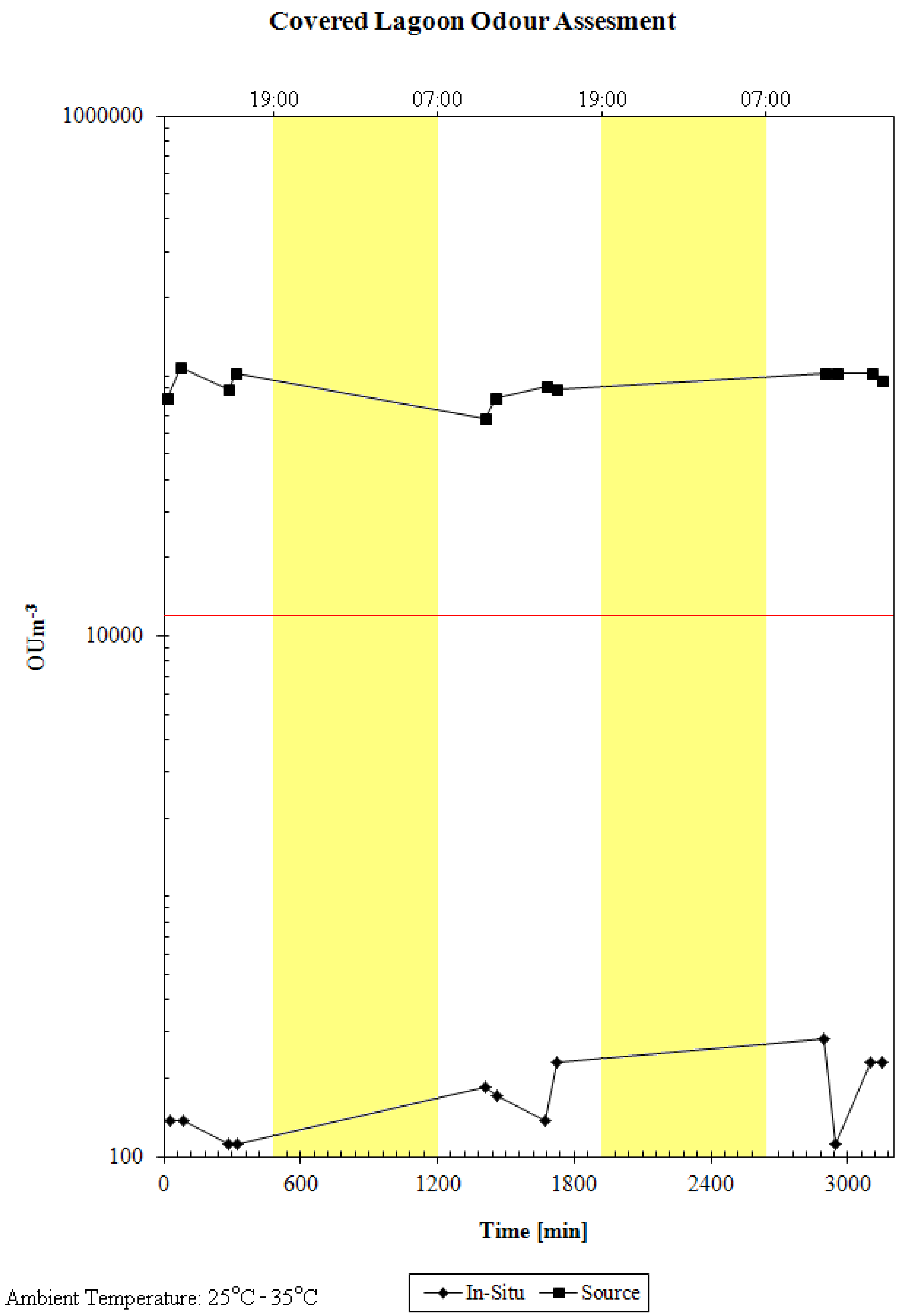


FIGURE 9. Covered lagoon odour assessment result for general average operation

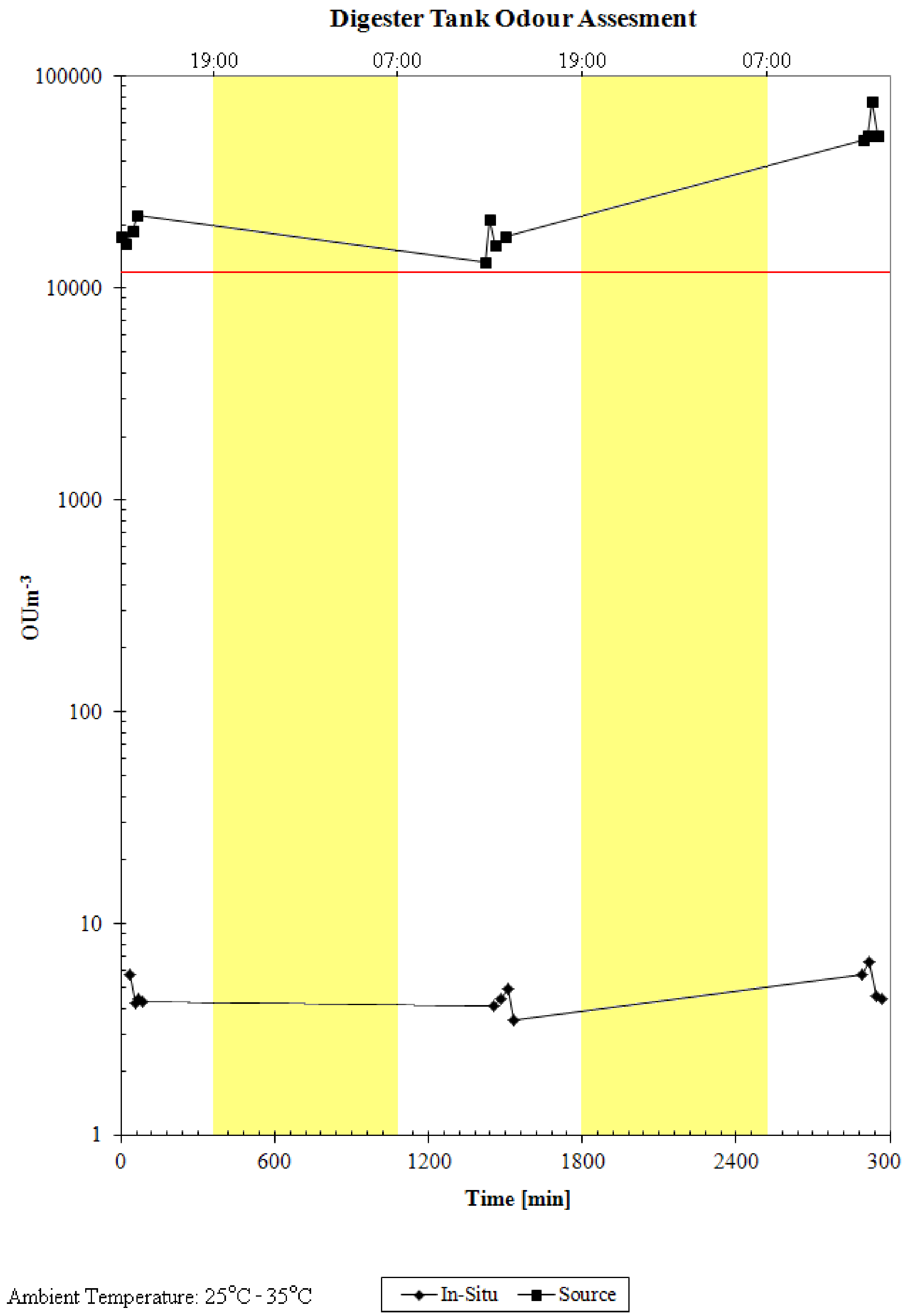


FIGURE 10. Digester tank odour assessment result for peak crop season

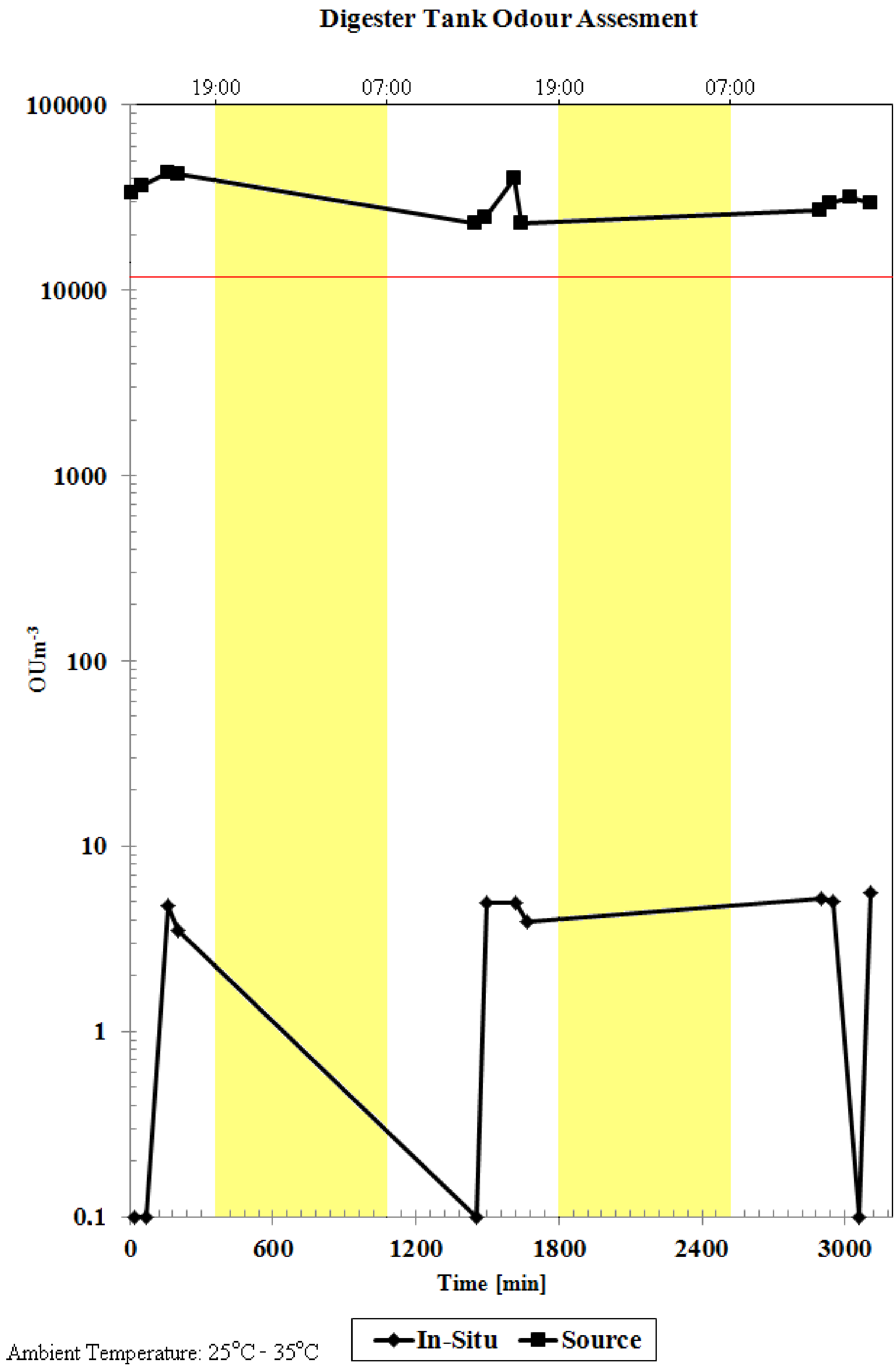


FIGURE 11. Digester tank odour assessment result for general average operation

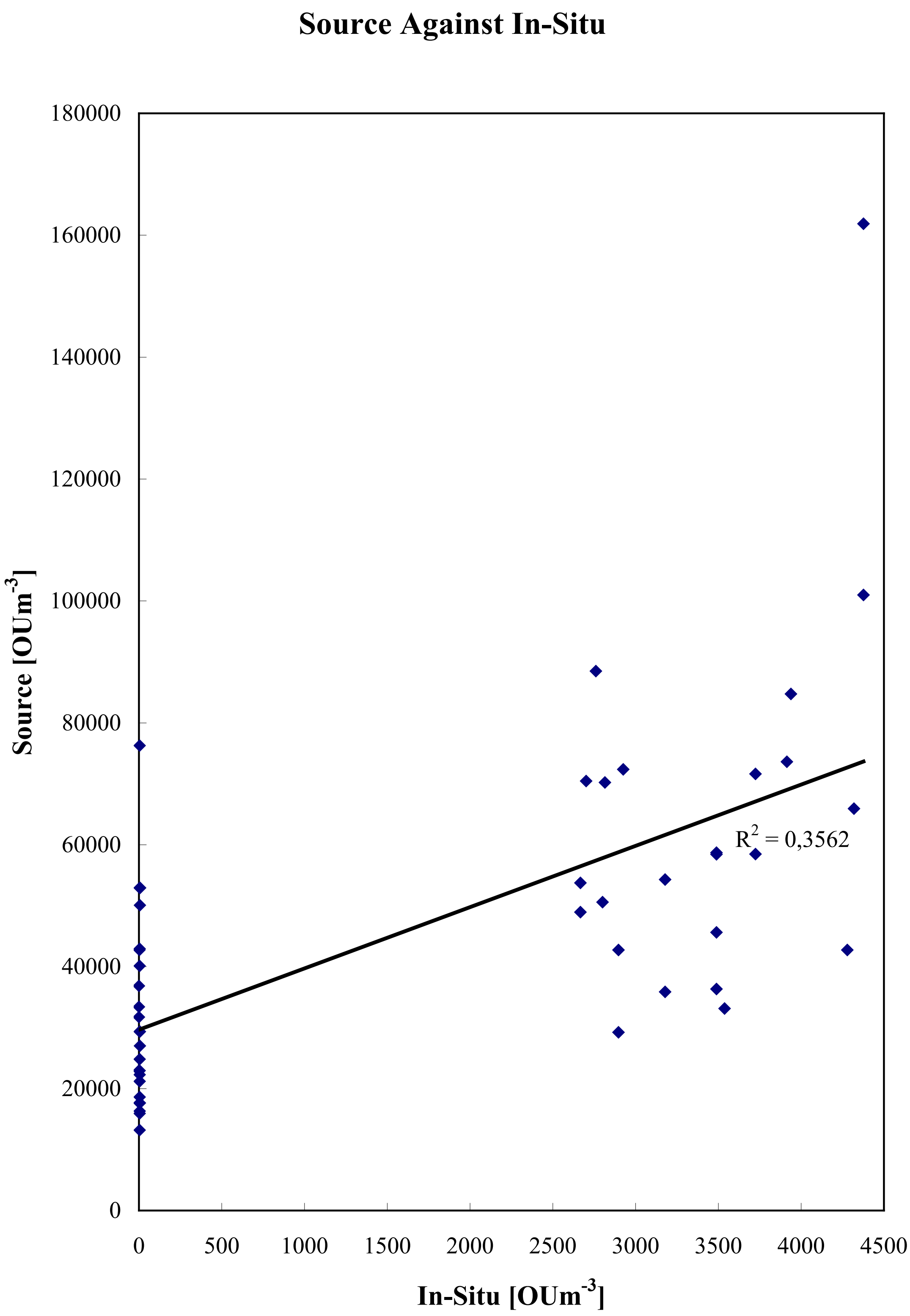


FIGURE 12. Correlation between source and *In-Situ* odour measurements

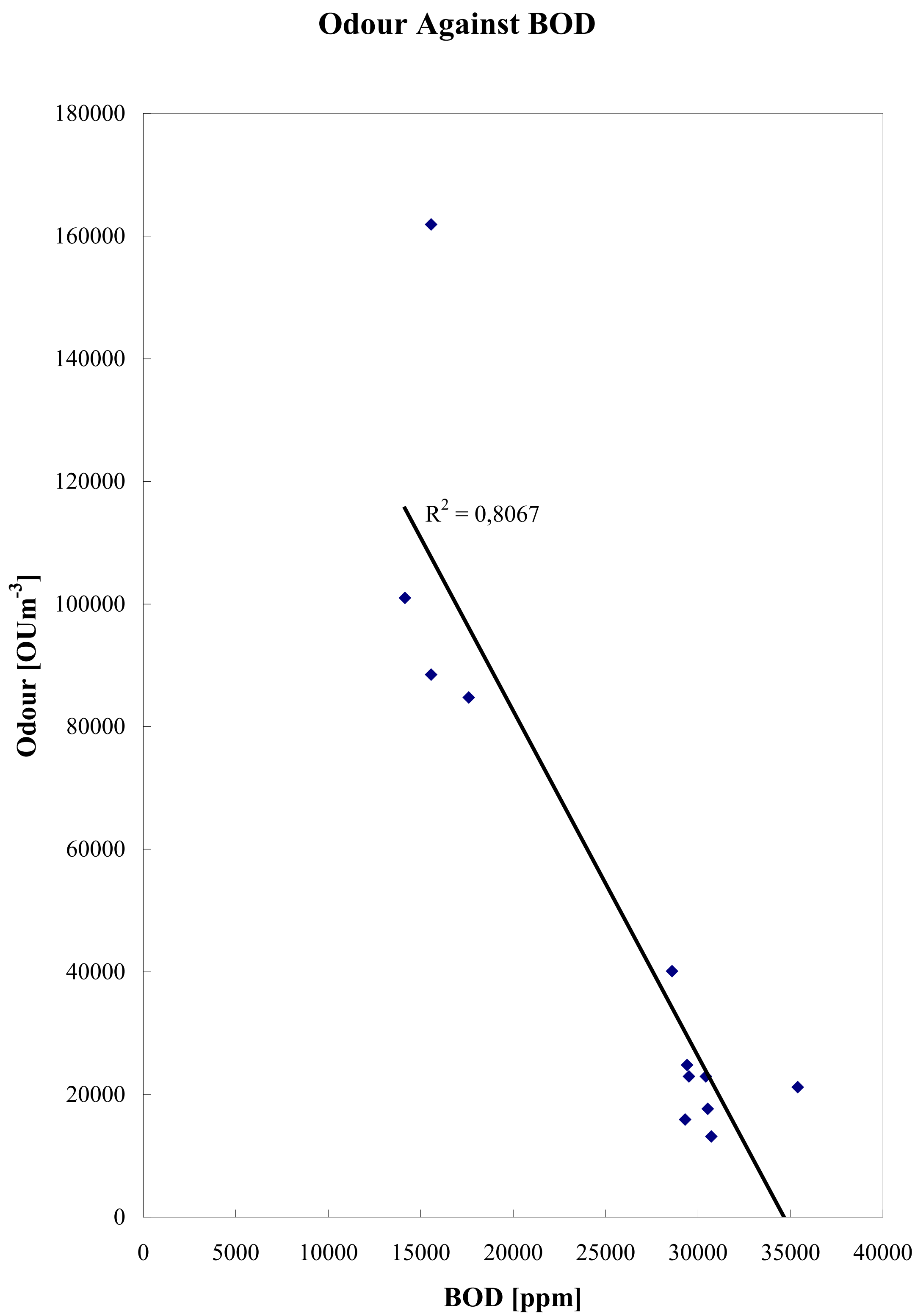


FIGURE 13. Correlation between odour and BOD

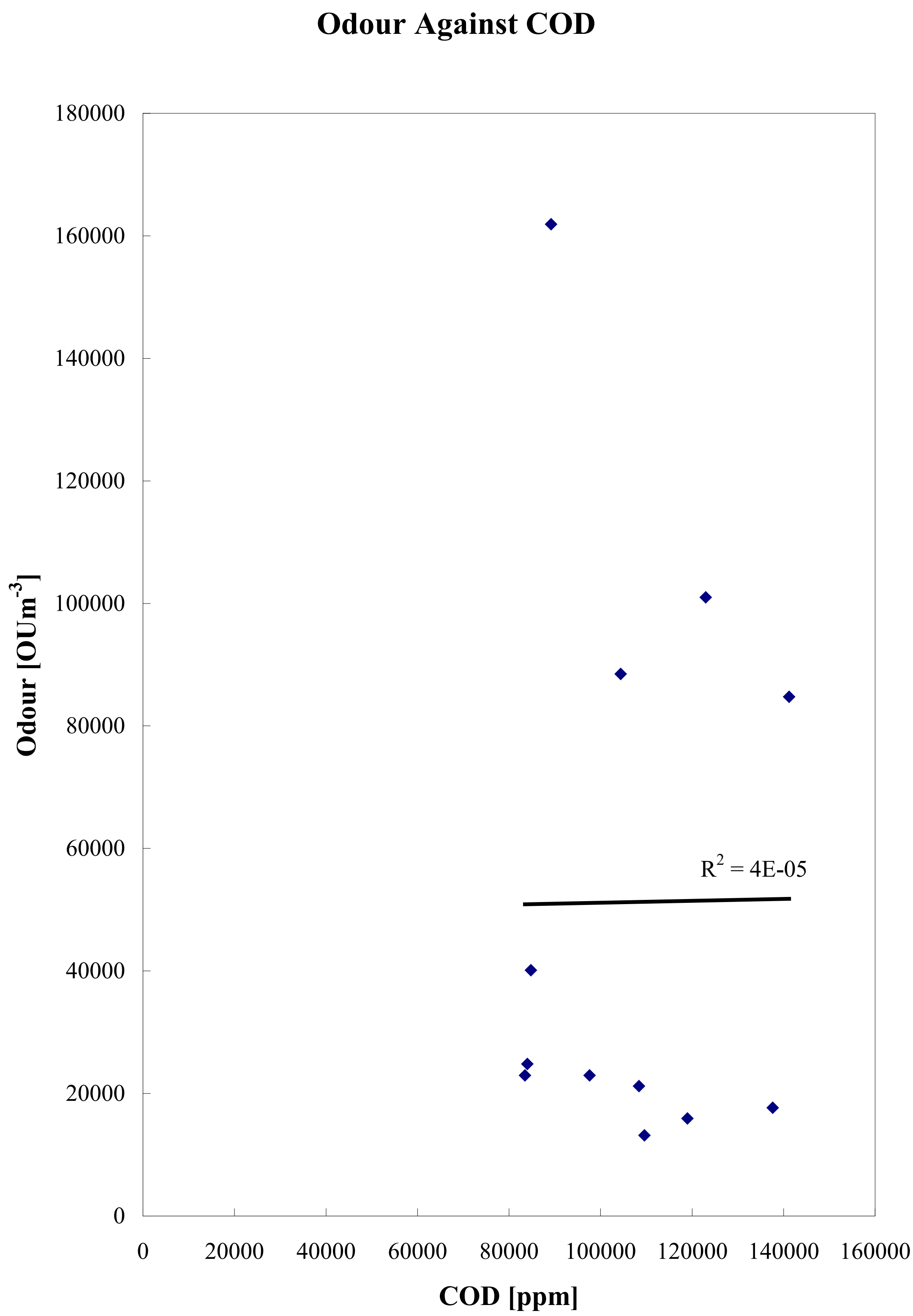


FIGURE 14. Correlation between odour and COD

dioxide and hydrogen, thus confident correlation ($R^2 \geq 0.95$) between BOD and odour emission level could hardly be achieved. Data analysis also shows poor correlation between BOD and COD with $R^2 = 0.0128$. Thus POME contains significant amount of chemicals other than biological digestible organic compounds.

There are four common methods to overcome the odour problem. Masking involves the use of high intensity pleasant scent vapour whereas neutralisation involves the use of suitable chemical to react with the odorous gases. Elimination removes the odorous gases source and quarantine collects the odorous gases into container. Masking and neutralisation method are suitable for small enclosed area but impractical for wide open palm oil mills. Biogas capture practice *via* covered lagoon and digester tank could solve the odour matter *via* quarantine. Research

FIGURE 15. Covered lagoon project site

FIGURE 16. Digester tank project site

effort toward zero discharge milling process would solve the odour matter *via* elimination.

CONCLUSION

Palm Oil Mill Effluent treatment plant is the odorous gases source and the biogas capture implementation could reduce the odour emission in palm oil mills. The survey observation showed that existing mills were unable comply the DOE odour emission proposal. Alternative approaches need to be counter proposed in the legislation drafting so that the millers compliance could be ensured while avoid the public sensory annoyance complaints.

ACKNOWLEDGEMENT

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DECLARATION OF COMPETING INTEREST

None.

REFERENCES

Bakhtari Ardevan and Medina Sidarta. 2016. Enhancing VDI3940 grid method via in-field olfactometry to obtain complete odor impact assessment. *Chemical Engineering Transactions* 54.

Balch Andrew, Gary Graham and Bianca Knaggs. 2015. FIDOL *Factors, Odor Nuisance and Risk: The Adaptation Of Field Based Odor Assessments Using A Field Olfactometer. A Discussion and Case Study.* Proceedings of CASANZ2015 Conference. Melbourne, 20-23 September 2015

DEFRA 2010. *Odour Guidance for Local Authorities.* Department for Environment, Food and Rural Affairs. United Kingdom.

Dinopolou G., Rudd T. and Lester J.N. 1987. Anaerobic acidogenesis of a complex wastewater: I. The influence of operational parameters on reactor performance. *Biotech. And Bioeng*. 31: 958 – 968.

Fatah Yah Abdul Manaf, Andrew Yap Kian Chung and N. Ravi Menon. 2012. Spray drying palm oil mill effluent. *Palm Oil Engineering Bulletin* 100:11-32.

Gurmit Singh; Lim Kim Huan; Teo Leng and David Lee Kow. 1999. *Oil Palm and the Environment – A Malaysian Perspective.* Malaysian Oil Palm Grower's Council.

Hassan, M. A. and Abd-Aziz, S. 2015. Waste and environmental management in the Malaysian palm oil industry in palm oil: Production, processing, characterization, and uses. *Technology & Engineering*. Loh, S K; Nasrin, A B; Mohamad Azri, S; Nurul Adela, B; Muzzammil, N; Daryl Jay, T; Stasha Eleanor, R A; Lim, W S; Choo, Y M and Kaltschmitt, M. 2017. First report on Malaysia's experiences and development in biogas capture and utilization from palm oil mill effluent under the Economic Transformation Programme: Current and future perspectives. *Renew. Sustain. Energy Rev.* 74: 1257-1274.

Ma Ah Ngan. 2000. *Management of Palm Oil Industrial Effluent. Advances in Oil Palm Research*. Volume II. Bangi: Malaysian Palm Oil Board.

Malaysian Standard. 2015. *Air Quality - Determination of Odour Concentration by Dynamic Olfactometry.* Shah Alam: SIRIM Berhad.

Mauskar J.M. 2008. *Guidelines on Odour Pollution & Its Control*. Delhi: Central Pollution Control Board.

Nurashikin Yaacof, Nastaein Qamaruz Zaman and Yusri Yusop. 2015. Odour intensity assessment at different area of a palm oil mill using olfactometry method. *Applied Mechanics and Materials* 802: 472-477. Startsev A N. 2017. The reaction mechanisms of H_2S decomposition into hydrogen and sulphur: Application of classical and biological thermodynamic. *Journal of Thermodynamic & Catalysis* 8(2). DOI: 10.4172/2157 – 7544.1000186.

Thauer R. K. 1998. Biochemistry of methanogenesis: A tribute to Marjory Stephenson. *Microbiology* 144: 2377-2406.

UK Environment Agency. 2007. Using science to create a better place. Review of odour character and thresholds. Science Report SC030170/SR2. United Kingdom: Environment Agency, Bristol.

APPENDIX

NOMENCLATURE

Symbol	Particular	SI Unit
C	Concentration	kgm^{-3}
F	Nutrient inflow rate	kgs^{-1}
I	Intensity	-
P	Pressure	Pa
R	Ideal gas constant	$Jmol^{-1}K^{-1}$
V	Volume	m3
k	Odorant Constant	-
m	Gas amount	mol
n	Odorant exponent	-

APPENDIX 1 ODOUR DESCRIPTORS

Pleasant odour descriptor with higher positive hedonic score whereas unpleasant odour descriptor with lower or greater negative figure as shown in Tables A1 and Table A2.

TABLE A1. Unpleasant odour descriptors and hedonic score

Description	Hedonic Score	Description	Hedonic Score	Description	Hedonic Score
Dry, powdery	-0.07	Sperm seminal	-1.04	Stale	-2.04
Yeasty	-0.07	Animal	-1.13	Burnt milk	-2.19
Burnt candle	-0.08	Gasoline	-1.16	Mouse	-2.20
Beery	-0.14	Mothballs	-1.25	Wet wool	-2.28
Rope	-0.16	Vinegar	-1.26	Household gas	-2.30
Garlic, onion	-0.17	Creosote	-1.35	Acid	-2.34
Crushed weeds	-0.21	Bitter	-1.38	Sulfides	-2.45
Alcoholic	-0.47	Oily, fatty	-1.41	Ammonia	-2.47
Cardboard	-0.54	Burnt paper	-1.47	Sweaty	-2.53
Camphor	-0.55	Burn, smoky	-1.53	Dirty linen	-2.55
Sauerkraut	-0.60	Ana esthetic	-1.54	Rotten fruit	-2.76
Fresh tobacco	-0.66	Disinfectant	-1.60	Stale tobacco	-2.83
Smoked fish	-0.69	Tar	-1.63	Sour milk	-2.91
Turpentine	-0.73	Chemical	-1.64	Burnt rubber	-3.01
Paint	-0.75	Blood	-1.64	Rancid	-3.15
Heavy	-0.79	Kerosene	-1.67	Urine	-3.34
Nail polish	-0.81	Cleaning fluid	-1.69	Sickening	-3.34
Varnish	-0.85	Sooty	-1.69	Faucal	-3.36
Chalky	-0.85	Mould	-1.94	Cat urine	-3.64
Medicinal	-0.89	Fishy	-1.98	Sewer odour	-3.68
Wet paper	-0.94			Putrid decayed	-3.74
Metallic	-0.94			Cadaverous	-3.75
New rubber	-0.96				

TABLE A2. Pleasant odour descriptors and hedonic score

Description	Hedonic Score	Description	Hedonic Score	Description	Hedonic Score
Fresh bread	3.53	Spicy	1.99	Eucalyptus	0.99
Rose	3.08	Peanut butter	1.99	Laurel leaves	0.97
Strawberry	2.93	Perfumery	1.96	Soapy	0.96
Orange	2.86	Grapefruit	1.95	Woody	0.94
Floral	2.79	Coconut	1.93	Light	0.91
Chocolate	2.78	Nutty	1.92	Dill	0.87
Citrus	2.72	Clove	1.67	Warm	0.78
Violets	2.68	Vegetable (C)	1.58	Grainy	0.63
Peach	2.67	Raisins	1.56	Geranium	0.57
Apple	2.61	Cool, cooling	1.53	Bean	0.54
Pineapple	2.59	Aromatic	1.41	Mushroom	0.52
Vanilla	2.57	Tea leaves	1.40	Fresh eggs	0.45
Cherry	2.55	Green pepper	1.39	Raw potato	0.26
Cinnamon	2.54	Celery	1.36	Musky	0.21
Fried chicken	2.53	Crushed grass	1.34	Black pepper	0.19
Fragrant	2.52	Hay	1.31	Cork	0.19
Lemon	2.50	Raw cucumber	1.30		
Peppermint	2.50	Leather	1.30		
Popcorn	2.47	Meat seasoning	1.27		
Melon	2.41	Oak wood	1.23		
Cooked meaty	2.34	Anise	1.21		
Coffee	2.33	Birch bark	1.18		
Caramel	2.32	Soupy	1.13		
Pear	2.26	Caraway	1.06		
Maple syrup	2.26	Malt	1.05		
Lavender	2.25	Incense	1.01		
Fruity	2.23	Molasses	1.00		
Fresh vegetable	2.19				
Cologne	2.16				
Cut grass	2.14				
Cedar wood	2.11				
Honey	2.08				
Grape juice	2.07				
Fresh butter	2.04				
Sweet	2.03				
Almond	2.01				
Banana	2.00				