Co-composting for Sustainable Crude Palm Oil Production in Malaysia

By: Engr. Ooi Ho Seng, M.I.E.M, P. Eng. and Engr. S. Kumar S. Subramaniam, M.I.E.M, P. Eng.

Co-composting of palm oil mill waste is the best solution for the sustainable development of both the palm oil industry and the environment. Sustainable palm oil production includes the implementation of better mill management practices such as the treatment of effluent and the recycling of oil mill by-products. Conventional methods of waste treatment and disposal by oil palm mills are not environmentally friendly and result in large amount of CH_4 and CO_2 (methane and carbon dioxide gases) being emitted into the atmosphere.

A composting plant can be setup as a Clean Development Mechanism (CDM) project to use all solid waste produced by a conventional palm oil mill, namely, empty fruit bunch (EFB), boiler ash, decanter cake and about 30%-50% of the palm oil mill effluent (POME) to produce bio-organic fertiliser. A conventional palm oil mill can be upgraded to the new two-phase decanter system and the amount of waste produced by the mill will be reduced to less than 0.2 tonnes of slurry, 0.15 tonnes of condensate and 0.10 tonnes of wash water per tonne of FFB. This enables the entire palm oil mill waste to be used for composting.

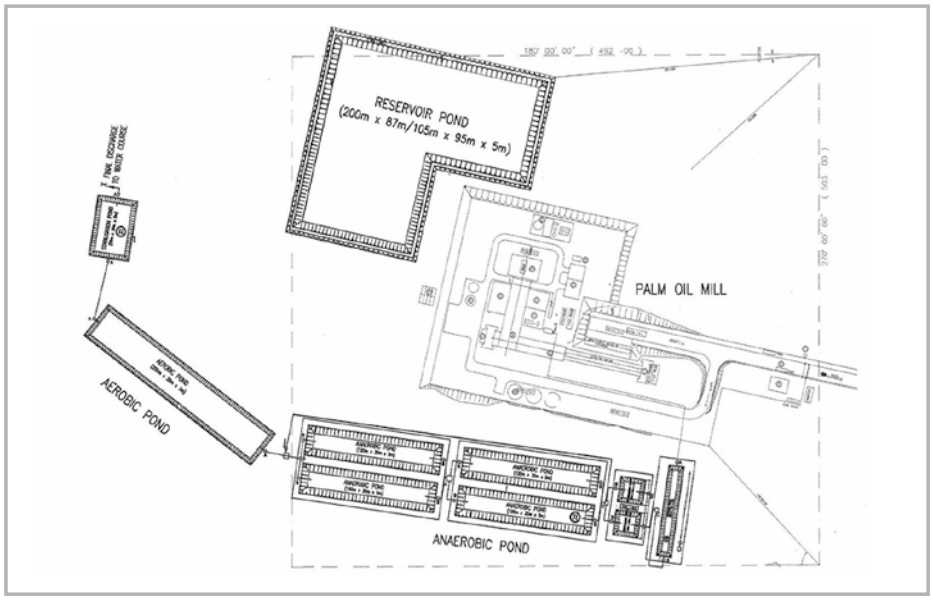

Figure 1: Conventional palm oil mill with POME treatment ponds

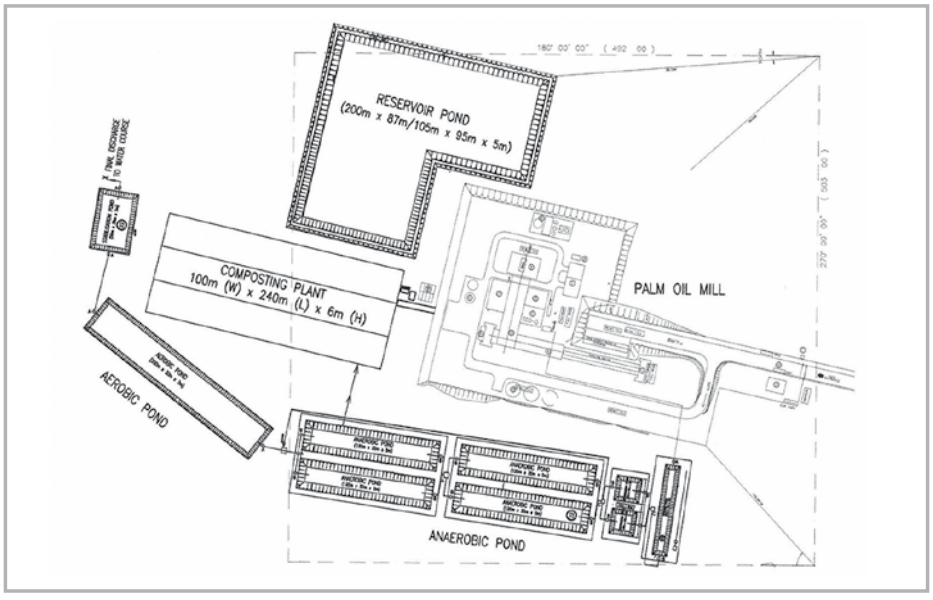

Figure 2: Conventional palm oil mill with POME treatment ponds and compost plant

INTRODUCTION

With the prevailing high crude palm oil prices in the international market, there is increasing environmental concern that this will lead to more forests being cleared to plant oil palm in Malaysia and Indonesia. Environmentalists and governments in the developed world do not take kindly to the clearing of tropical jungles in the third world because it destroys not only the biodiversity that exists in the forest, thus endangering certain flora and fauna, but also causes air pollution, haze and climate change. The open burning method of forest clearing is claimed to be a major contributor to global warming, and there is now a very strong lobby, which is exerting much political pressure, against the oil palm plantations in Southeast Asia.

The Roundtable on Sustainable Palm Oil (RSPO), which was formed in August 2003, has included the implementation of better plantation and mill management practices into its definition of sustainable palm oil production. This includes:

- Land management, and soil and water conservation
- Zero burning replanting technique
- Integrated pest management
- Effluent treatment and recycling of oil mill by-products
- Conservation and enhancement of biodiversity

(To be continued on page 24)

- Welfare and human capital
- Total quality and environment management

Studies by Frank *et. al.* (2008) have shown that co-composting of EFB and POME is the most sustainable solution that fulfils the Criteria of the Round Table on Sustainable Palm Oil Production (Anon., RSPO, 2005), which include 'Waste is reduced, recycled, and disposed of in an environmentally responsible manner' and 'Plans to reduce pollution and emissions including greenhouse gases are developed, implemented and monitored'. Their financial analysis has shown that the co-composting of EFB and POME has the highest profitability of all the alternatives they have studied which include recovering biogas from POME and the use of biomass such as EFB, shells and fibres as an energy source.

CO-COMPOSTING OF PALM OIL MILL WASTES

Composting is one of the most efficient ways to treat palm oil mill waste. Composting involves the decomposition of the organic matters that exist in the waste, and the requirements for composting are adequate moisture and oxygen, suitable temperature range and a carbon to nitrogen ratio of less than 30:1.

The fibres from EFB provide the carbon sources while POME (or decanter slurry plus condensate and wash water) provide the nitrogen source. The fibres, slurry and liquid waste combine to provide the composting materials. The composting process involves aerobic fermentation during which organic materials are broken down into carbon dioxide, water, minerals and stabilised organic matter. At the end of the composting period, a dark brown, porous, spongy, somewhat gummy, and pleasantly earthy smelling compost is produced. The compost may be recycled back into the estate.

The decomposition of the organic materials in the waste occurs as a result of the metabolic action of microorganisms which may or may not exist naturally in the waste products. The application of O_3 microbes will ensure that the right microbes for fast composting are provided and nurtured within the composting materials to trigger, accelerate and sustain the composting process.

CONVENTIONAL PALM OIL MILL WITH POME TREATMENT PLANT

There are about 400 palm oil mills in Malaysia. Crude Palm Oil (CPO) is extracted from the processing of fresh fruit bunches (FFB), which are processed within 24 hours of harvest. The estimated amount of waste from a typical palm oil mill for every tonne of FFB processed are:

- 0.6-0.8m^3 of POME
- 0.23 tonnes of EFB
- 0.035 tonnes of decanter solids
- 0.02 tonnes of boiler ash (from burning of fibre and kernel shells)

The conventional methods of waste treatment and disposal are:

- EFB – mulching and composting (outdoor method)
- Decanter solids – dumping in the oil palm fields
- POME – pond system (Figure 1) , polishing, land discharge, water course discharge
- Boiler ash – dumping in the oil palm fields

The above conventional methods of waste treatment and disposal are not environmentally friendly and result in large amount of CH_4 and CO_2 (methane and carbon dioxide gases) being emitted into the atmosphere.

Referring to Figure 1, the POME treatment plant comprises a series of ponds, starting with two cooling ponds; then two acidification ponds, four anaerobic ponds, one aerobic pond and, finally, one stabilisation pond. A polishing plant is usually required to bring the BOD level of the water from the last pond down to < 20ppm (DOE Sabah requirements) before it is discharged into the water courses.

CONVENTIONAL PALM OIL MILL WITH COMPOST PLANT AND POME TREATMENT PLANT

Lately, a number of palm oil mills have embarked on the construction of a compost plant as shown in Figure 2 to use up the entire solid waste and 30-50% of the POME that are produced by the palm oil mill.

A composting plant has been setup in Lahad Datu, Sabah as a CDM project to use the waste produced by the 45 tonne-per-hour capacity conventional palm oil mill (Ooi *et. al.*, 2007). These waste, namely, effluent (POME), EFB, boiler ash and decanter cake, are converted into bio-organic fertiliser. The composting plant has been in operation since April 2007 and the validation of the CERs (Certified Emission Reduction) was completed in September 2007.

(To be continued on page 26)

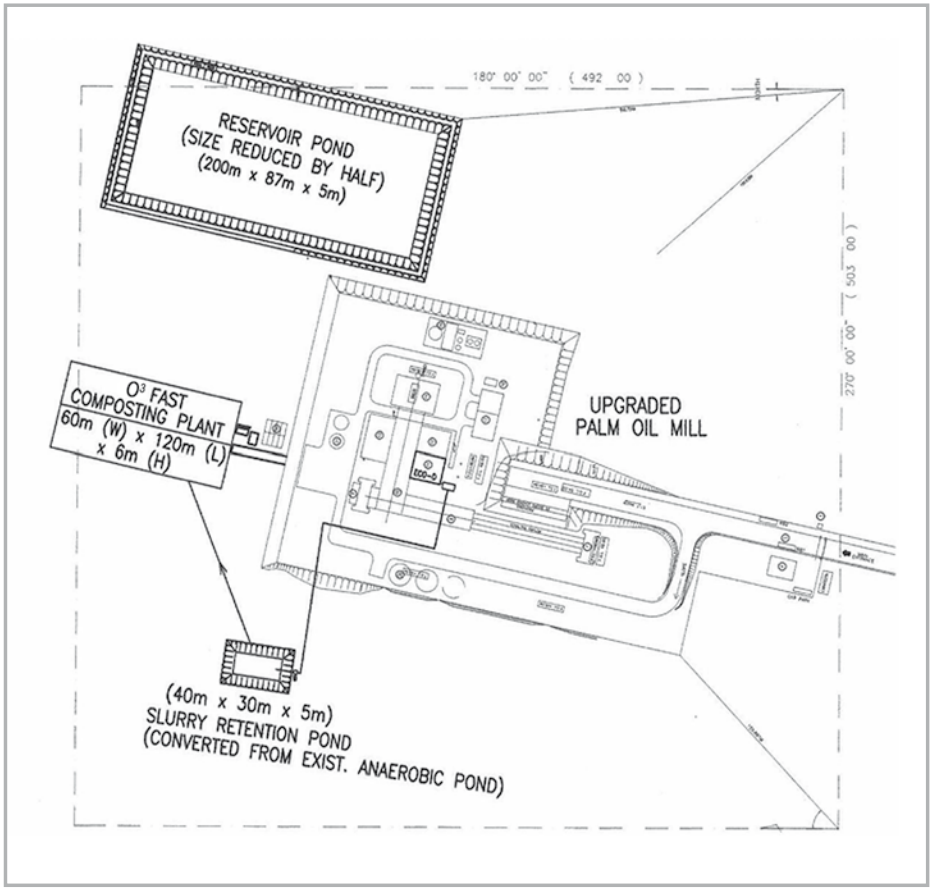

Figure 3: Upgraded palm oil mill with compost plant

UPGRADED PALM OIL MILL WITH COMPOST PLANT

A second CDM composting plant is being setup in Sandakan to use the Zero Waste Discharge Solution (Ooi *et. al.*, 2007) to treat the entire waste produced by the 45 tonne-per-hour palm oil mill. The Zero Waste Discharge Solution involves:

- the installation of a new two-phase (solid/water phase and oil phase) decanter system to upgrade the palm oil mill performance, and
- the setting up of a composting plant to use the entire palm oil mill waste.

With the upgrading of the palm oil mill to use the new two-phase decanter system (refer to Appendix A), the amount of waste produced by the mill is reduced to less than 0.2 tonnes of slurry, 0.15 tonnes of condensate and 0.10 tonnes of wash water per tonne of FFB. The entire palm oil mill waste is used for composting.

As shown in Figure 3, the mill is operating without any POME treatment ponds. This is a paradigm shift for conventional mill operations and the absolute direction to look into in the future. All that is required is a small slurry retention pond. The energy that was required for operating the POME treatment plant is re-channelled to the compost plant. Benefits of the Zero Waste Discharge Solution are:

- The liquid waste is reduced from about 0.75 tonnes of POME to < 0.2 tonnes of slurry; 0.15 tonnes of condensate; and 0.1 tonnes of wash water per tonne of FFB
- The oil loss at the oil room is reduced
- The total water used is halved. Hence, lesser chemicals are being used for water treatment and the required size of the water reservoir is halved.
- Oil is recovered from the shredded EFB and overall oil recovery is increased
- The overall amount of methane gas emission is reduced
- No more desilting activities of the effluent ponds
- No more discharge of effluent to water course or land
- Zero waste to be discharged from the mill
- Additional income from the sale of CERs
- No more maintenance cost of recycling pumps, aerators, *etc*
- Savings in EFB disposal cost
- Able to manage waste in a controlled environment and produce 100% organic fertiliser
- Overall power consumption in the mill is reduced and can be channelled to compost plant

CLOSING REMARKS

To successfully implement the zero waste discharge solution, it is important that the solution provider understand the miller's needs fully and is able to provide complete solutions that solve the waste problems faced by the particular miller. It is not enough to just supply the microbes, or provide the composting technology or install the machinery. The services provided by the solution provider must extend beyond that of a technology provider.

CONCLUSION

Co-composting of palm oil mill waste is the best solution for the sustainable development of both the palm oil industry and the environment. The zero waste discharge solution involves upgrading the palm oil mill to reduce the amount of liquid waste and this enables the entire palm oil mill waste to be utilised by the composting plant. Zero waste is being discharged from the mill.

ACKNOWLEDGEMENT

The authors and O³ Solutions Sdn Bhd thank the owners of Timora Estate Sdn Bhd at Lahad Datu and Pembangunan Ladang Hassan Sdn Bhd at Sandakan for permission to report the findings of the CDM projects done for them on turnkey basis.

APPENDIX A

The New Two-Phase Decanter System

In the new two-phase decanter process, no dilution water is added at the press station. The vertical clarifier tank and the sludge tank are not required. The slurry that is discharged from the decanter is only about 0.15-0.18 tonnes/tonnes of FFB and the composition of decanter slurry is 79-81% water, 1.1-1.8% oil residue and 16-18% non-oily solids. ■

REFERENCES

[1] Anon. RSPO (2005). RSPO principles and criteria for sustainable palm oil production. http://www.sustainable-palmoil.org/

[2] Frank Schuchardt, Klaus Wulfert and Tjahono Herawan (2008). Protect the Environment and make profit from the waste in Palm Oil Industry (private communications).

[3] Ooi Ho Seng, Kumar Subramaniam, S. Thiagarajan (2007) Zero Waste Discharge from Palm Oil Mills. The Planters, Kuala Lumpur, 83 (979): 671-681.

[4] Kumar Subramaniam, Ooi Ho Seng, S. Thiagarajan (2007) Zero Waste Discharge Solution for Palm Oil Mills. Proceedings of 25th Conference of the ASEAN Federation of Engineering Organisations, held at Cebu City, Philippines, November 27-29, 2007.

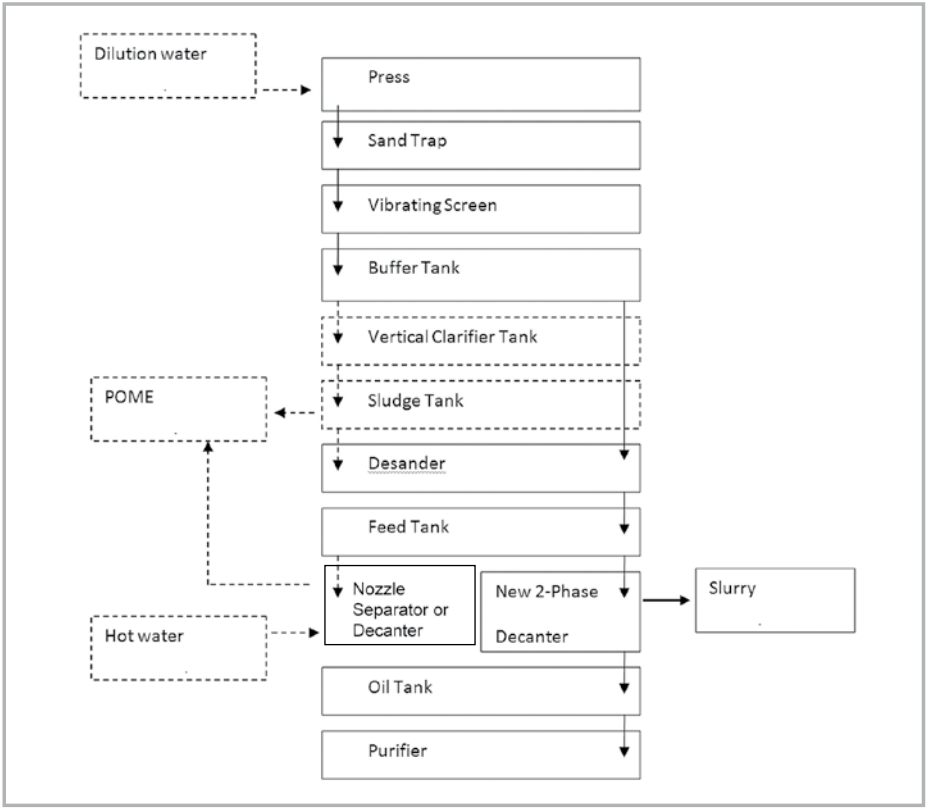

Figure 4: Conventional separator versus the new two-phase decanter