A BIOGAS TRAPPING FACILITY FOR HANDLING PALM OIL MILL EFFLUENT (POME)

LOH SOH KHEANG; LYNDA LIAN DAZHI; MUHAMAD AZRI SUKIRAN and CHOO YUEN MAY

564

MPOB INFORMATION SERIES • ISSN 1511-7871 • JUNE 2011 MPOB TT No. 491

Palm oil mill effluent (POME) generated by the milling process has a high soluble organic content, and biochemical oxygen demand/chemical oxygen demand (BOD/COD) > 0.45. This is indicative that it is a good source material for biological performance, especially in a tropical climate such as in Malaysia, thus making anaerobic digestion the most economical and most applicable technology to treat POME. POME in the current open ponding system generates a huge amount of biogas which contains methane that has a global warming potential 21 times that of carbon dioxide. Hence, if biogas is harnessed, the emission of greenhouse gases can be reduced, while energy is generated for multiple applications, and thus climate change can be potentially mitigated and the palm oil industry will be more sustainable.

Biogas harnessing from POME can be carried out using a number of local or foreign technologies. Anaerobic digestion can be conducted in a closed-tank anaerobic digester system, an open digester tank, or in a covered lagoon. Currently, the established techniques used for treating wastewater in anaerobic digestion systems are the continuous stirred-tank reactor (CSTR), the up-flow anaerobic sludge blanket/bed (UASB), or the more advanced expanded granular sludge bed, (EGSB) and the up-flow solids reactor (USR). These are among the most commonly used technologies in Malaysia.

TECHNOLOGY INNOVATION

High Efficient Methane Fermentation System

The biogas harnessing system that has been developed is a highly efficient methane fermentation system using the USR concept with advancement by employing specialty microorganisms. The biogas system consists of a cooling pond, two acidification ponds, a concrete-steel digester tank or an enameled assembly tank, a biogas floating storage tank and a discharging pond (*Figure 1*).

In this system, wastewater is pumped into several separate compartments in the digester tank in a controlled manner via pump stations. Before the wastewater is pumped, some pre-treatment is conducted to break down the big molecules of the sludge for easy biodegradation by microorganisms later on. No stirring is required as the sludge solids in the wastewater will settle in the conical base at the bottom of the digester tank where active specialty microorganisms are bred. The settled solids thus form a fixed thick base and will be continuously digested and consumed by the microorganisms over a longer solid retention time (SRT) and microbiological retention time (MRT) separated from the liquid phase on top compared to hydraulic retention time (HRT). Sugars dissolved in the liquid waste stream can be converted quickly into gas in the liquid phase with a shorter HRT.

TECHNICAL CHARACTERISTICS

i. *Controlled feeding*

If acidogenic bacteria grow too fast, pH will go down, thus inhibiting the growth of methanogenic bacteria. In addition, the growth of methanogenic bacteria will be affected when there is a lack of raw materials. A good growth rate of the methanogenic bacteria in this system is achieved by controlling the total number of bacteria in *in vivo* fermentation as well as the *in vivo* fermentation concentration.

ii. *Shorter hydraulic retention time*

With a recognised higher COD loading factor for the USR system, HRT of 7-9 days can be accomplished (based on measurements conducted on site). This implies that a digester tank of a smaller

ISSN 1511-7871
9 771511 787001

Malaysian Palm Oil Board, Ministry of Plantation Industries and Commodities, Malaysia
P. O. Box 10620, 50720 Kuala Lumpur, Malaysia. Tel: 03-8769 4400 Fax: 03-8925 9446 Website: www.mpob.gov.my

MPOB

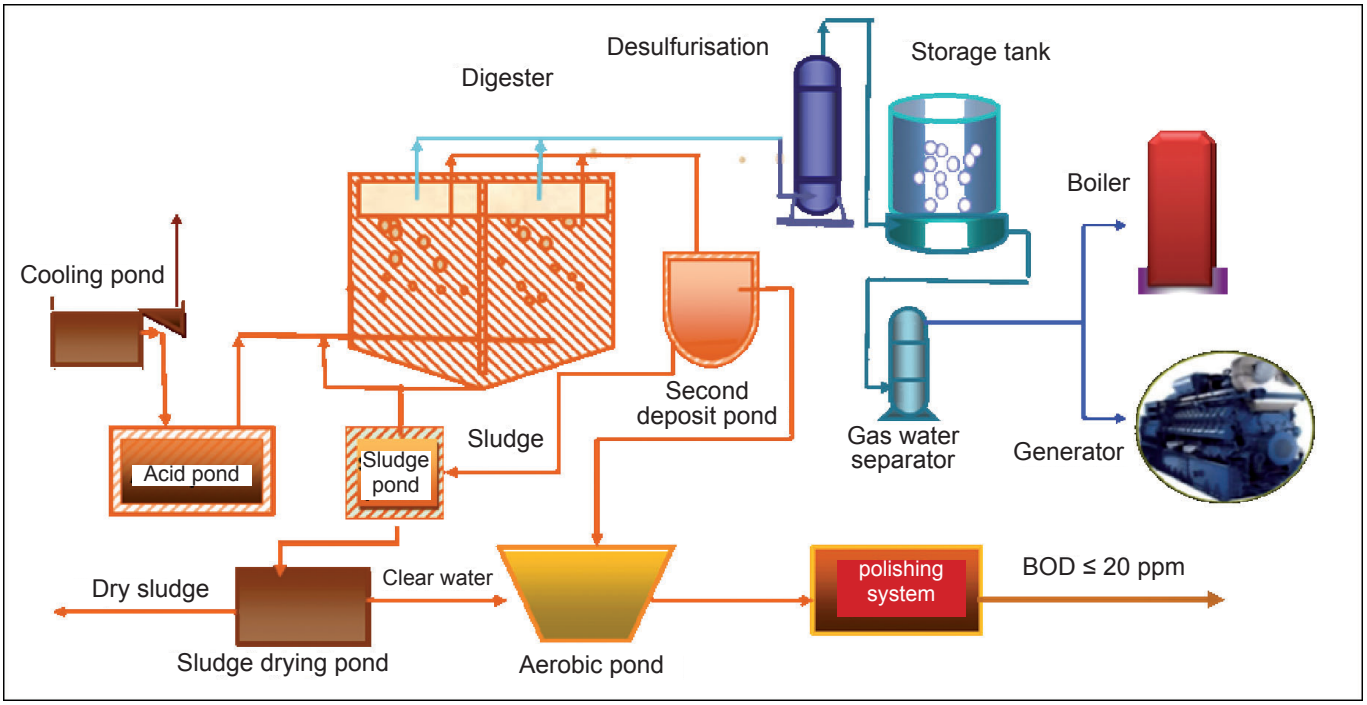

Figure 1. Biogas system for POME.

volume will be required to treat POME, and hence a lower construction cost. However, HRT will increase if the COD of incoming POME is high.

iii. *Biogas system performance*

Evaluation/monitoring of the biogas system performance over a year with sampling of 42 sets of wastewater showed that the system is technically mature, and is highly efficient, with a COD/BOD removal rate of 90%-95% and a production rate of 27-30 m^3 biogas m^{-3} of POME (*Table 1*). The system preserves the sludge in the sludge bed deposited at the bottom of the digester tank with SRT > HRT, thus ensuring that the COD/BOD removal rate is high.

SYSTEM REFERENCE

This highly efficient methane fermentation system developed in collaboration with Biogas Environmental Engineering Sdn Bhd (BEE) has

TABLE 1. PERFORMANCE CHARACTERISTICS OF THE BIOGAS SYSTEM

Parameter	Performance characteristics
Raw effluent	
COD (ppm)	44 000-83 000
BOD (ppm)	14 000-34 000
Final discharge	
COD (ppm)	1400-2500
BOD (ppm)	50-270
Composition of biogas	
Methane (%)	56-64
Carbon dioxide (%)	35-41
Hydrogen sulphide (ppm)	217-1418
Volume of biogas (m^3 biogas m^{-3} POME)	26.6-30.0

been installed, and is currently in operation at Tee Teh Palm Oil Mill, Rompin, Pahang (*Figure 2*).

ELECTRICITY GENERATION FROM CAPTURED BIOGAS

The biogas captured is led through the biogas piping system from the top of the anaerobic digester tank to the biogas storage tank. The gas is first run through the splitter of gas and water to remove the condensate water, and then directed to the gas engine for electricity generation after desulfurisation. The combustion chamber (*Figure 3*) of the gas generator installed at Tee Teh Palm Oil Mill showed evidence of having been in operation for > 10 000 hr without any damage. The electricity generated is supplied to the workers' quarters of the mill.

Figure 2. High efficient methane fermentation system.

Figure 3. Condition of the combustion chamber of a gas generator using biogas for > 10 000 hr.

ECONOMIC ANALYSIS

The investment cost for the installation of the biogas trapping facility is estimated to be RM 4-6 million, depending on the capacity of the palm oil mill. A payback period of 2-4 years can be achieved with revenues from on-grid electricity generation amounting to 1-1.5 MW, sale of saved palm fibre, biofertiliser production, and savings from reduced diesel consumption.

COMMERCIAL EXPLOITATION

Promotion of the technology will be jointly conducted by MPOB and BEE. BEE is responsible for the commercial exploitation and marketing of the technology to interested parties.

CONCLUSION

Harnessing biogas can reduce the carbon footprint as well as improve the sustainable development of the palm oil industry. This, in fact, is currently the most desirable operating condition for the industry to withstand criticism, and to rebut the negative allegations against palm oil from NGOs. By harvesting biogas, the palm oil industry can kill two birds with one stone, *i.e.* mitigate global warming as well as increase revenue via this green initiative, with the current support and incentives already put in place by the government.

For more information, kindly contact:

Director-General
MPOB
P. O. Box 10620
50720 Kuala Lumpur, Malaysia.
Tel: 03-8769 4400
Fax: 03-8925 9446
www.mpob.gov.my