Feature Article

MPOB-BEE High Efficient Methane Fermentation System for Electricity Generation

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INTRODUCTION

Biogas Environmental Engineering Sdn Bhd (BEE) is a company engaged and specialised in research, engineering design, construction and management of methane renewable energy development and environmental protection. The company's core business is utilisation of anaerobic digestion technology to process industrial organic waste water from food and beverage industries, concentrated animal farm operations and palm oil mills.

A biogas harnessing system developed in collaboration between Biogas Environmental Engineering Sdn Bhd (BEE) and Malaysian Palm Oil Board (MPOB) has been installed, and is currently in operation at Tee Teh Palm Oil Mill, Rompin, Pahang (*Figure 1*). The biogas harnessing system is a highly efficient methane fermentation system using the USR 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 2*). 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 biogas production rate of 27-30 m^3 m^{-3} of POME (*Table 1*).

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Figure 1. Biogas storage tank and high efficient methane fermentation system.

TABLE 1. PERFORMANCE CHARACTERISTIC OF THE BIOGAS SYSTEM

Parameter	Performance characteristics
Raw effluent	
COD (ppm)	44 000-83 000
BOD (ppm)	14 000-34 000
Discharge after digester tank	
COD (ppm)	1 400-2 500
BOD (ppm)	50-270
Composition of biogas	
Methane (%)	56-64
Carbon dioxide (%)	35-41
Hydrogen sulphide (ppm)	217-1 418
Volume of biogas (m^3 m^{-3} POME)	26.6-30.0

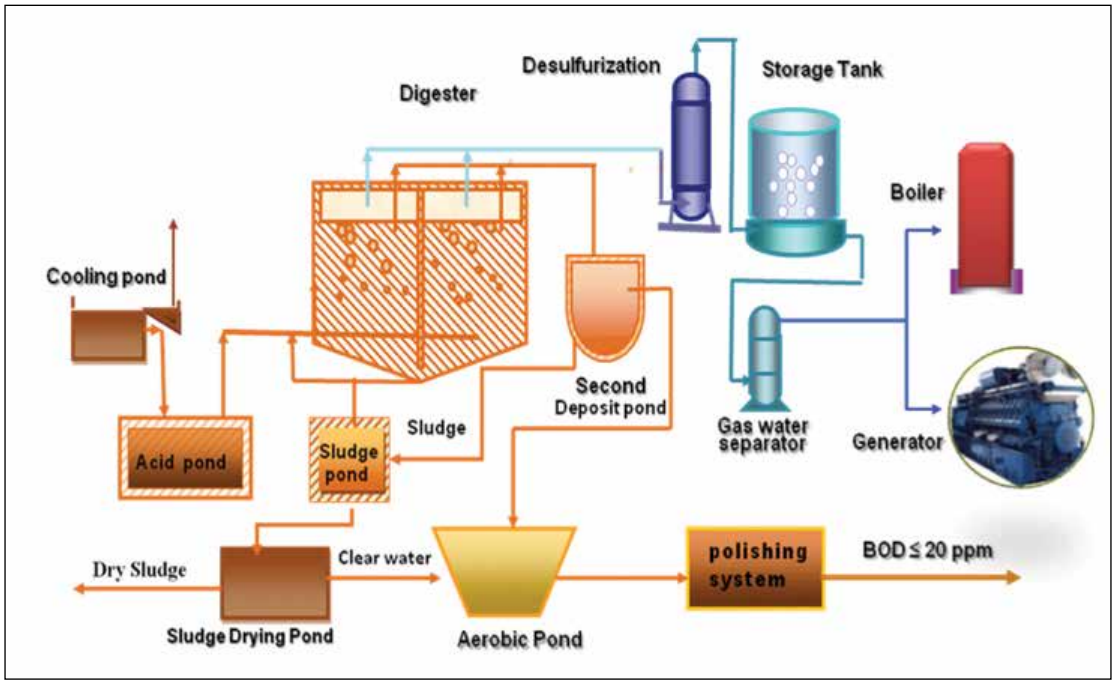

Figure 2. Biogas system for POME.

TECHNICAL CHARACTERISTICS

1. Life span of materials used *i.e.* steel concrete or enamel tank is more than 30 years;
2. High loading factor 6-8 kg COD $m^{-3}d$, thus implies:
   a. Shorter HRT compared to other systems (CSTR system, COD loading factor 3-4 kg COD $m^{-3}d$);
   b. Smaller volume of digester tank is required to treat POME, and hence a lower construction cost.
3. COD, BOD reduction rate of 90%-95% (assessment by MPOB)
4. The quality of biogas produced is good:
   a. H_2S content: 217-1418 ppm - Other systems has higher H_2S
   b. CH_4 content > 60%
   c. Water content is low
5. The system, with less moving parts, is easier to operate at a stable level; reinforced concrete steel or enamel sheet are better erosion-resisting materials, thus very much lowers the maintenance cost.

BIOGAS UTILISATION-ELECTRICITY GENERATION

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 gas water separator to remove the condensate water, and then directed to the gas engine for electricity generation after desulfurization. The combustion chamber of the gas generator installed at Tee Teh Palm Oil Mill (*Figure 3*) showed evidence of having been in operation for > 10 000 hr without any damage. The gas generator is in 24 hr operation and the electricity generated is supplied to the mill workers' quarters.

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 grid-connected electricity generation amounting to 1-1.5 MW, sale of saved palm fibre and shell, biofertiliser production, and savings from reduced diesel consumption.

TRACK RECORD

With the success of the above, plus active promotion under the Palm Oil National Key Economic Area (NKEA) Entry Point Project No. 5 (building biogas facilities at mills across Malaysia), a few more biogas plants have been installed: Three in Indonesia and two in Malaysia (Adong Palm Oil Mill - Sarawak in 2013, *Figure 4* and Ladang Sabah Palm Oil Mill - Sabah in 2014, *Figure 5*). One more biogas plant is under construction in Malaysia (*http://www.bee-sb.com/page/en/project.php*).

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

Figure 4. Biogas digester tank at Adong Palm Oil Mill.

Figure 5. Biogas digester tank at Ladang Sabah Palm Oil Mill.