OVERVIEW ON THE DEVELOPMENT OF BIOGAS TECHNOLOGY IN LIVESTOCK SECTOR IN MALAYSIA

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ABSTRACT. The continuous increase in livestock waste has led to increasing environmental pollution and problem of flies, especially to residents living in the vicinity. Application of biogas technology has been considered to be an effective approach in livestock waste management that can mitigate those problems. The use of this technology, in return, can bring economic benefits to farmers in terms of cooking gas and electricity supply. This study elucidates the development stage of biogas plants in livestock sector throughout Malaysia. In 2018, fifteen biogas plants were developed in Malaysia: seven plants built on cattle farms, four on pig farms, three on poultry farms and one on a buffalo farm. However, only 40% of the plants were found still functioning and another 60% were non-functional due to several technical factors like poor maintenance, design and construction errors, improper planning and monitoring as well as lack of technical knowledge to run the system consistently.

Keywords: biogas, biogas plant, environmental pollution, livestock waste management

INTRODUCTION

The trend in increasing livestock production to achieve self-sufficiency level will increase livestock waste that may lead to increasing environmental pollution and problem of flies. Several methods and technologies have been introduced to mitigate, once of which was the biogas system as a waste management technology. Thousands of biogas plants were installed all over the world in the last decades (Abdeen M.O., 2012).

Biogas system is the only waste management technology that can reduce environmental issues and at the same time bring profit to farmers by using biogas for cooking and generating electricity (Roos K. *et al*., 2012). In addition, the sludge produced from the anaerobic fermentation process can be used as fertiliser for agricultural use. However, raw biogas is corrosive and has to undergo treatment to remove hydrogen sulphide (H_2S) which tends to reduce the lifetime of the combustion engine (Om P. *et al*., 2015).

In 2018, there were fifteen biogas plants developed in Malaysia that used livestock waste, with two more biogas plants planned on a pig and on a dairy cattle farm located in Johor and Sabah, respectively (Nurul Aini M.Y. *et al*., 2018). In Malaysia, the capacity of the biogas digester have been classified as small-scale (<1,000 m^3), medium-scale (1,000 m^3 to 10,000 m^3) and large-scale (>10,000 m^3). Materials used to

construct a biogas digester are, for example, concrete, fibreglass, stainless steel, brick and high-density polyethylene (HDPE). The total cost to build a biogas plant depends on the capacity of the plant. The construction cost can be as low as MYR4,500 and as high as MYR30 million per plant. Most biogas plant designs in Malaysia have been adopted from China, Germany, Indonesia and Thailand. The objective of this study was to evaluate the state of existing biogas plants of animal waste in Malaysia.

MATERIAL AND METHODS

In order to achieve the objective of the study, technical visits were held at each biogas plant of livestock waste in Malaysia from April to July 2018. The list of these plants were obtained from the all state departments of veterinary services. Based on the secondary data collected from each state, fifteen biogas plants were found installed up to 2018. The status of biogas plants and technical information regarding on digester capacity, digester type and material as well as construction and maintenance costs were recorded through observation and interviews during field trips.

RESULTS AND DISCUSSION

Type of Biogas Digesters and Plants

Cattle Farms

As at 2018, seven biogas plants were installed on cattle farms. Farms C1 and C2 were set up in Selangor and Johor, respectively. Another five biogas plants were installed in Sabah under the state government programme, an initiative undertaken to encourage environment-friendly farming.

The plant in C1 was installed in Semenyih, Selangor. There were 56 dairy cattle in C1 and the capacity of the underground concrete bio-digester was 50 m^3 (Figure 1). Its construction cost around MYR100,000 and the farm operator had to spend MYR2,000 per year on maintenance. The biogas produced at C1 was used for cooking and generating electricity. The consumption of commercial cooking fuel was reduced up to 50%. However, the plant stopped functioning after seven years of operation due to lack of monitoring and maintenance.

C2, in Ayer Hitam, Johor had a bio-digester volume of 10 m^3 (Figure 2). The bio-digester was constructed from stainless steel at a cost of MYR143,000. During the planning period, the farm management intended to use biogas for pasteurisation of milk. Nevertheless, it was never commissioned as the farm practised a semi-intensive management system in which all cattle were released out to the paddock for grazing, resulting in insufficient substrate for anaerobic digestion in the bio-digester.

C3, in Keningau, Sabah constructed a 32 m^3 bio-digester from bricks (Figure 3). The farm management spent around MYR45,000 to build the plant in 2010 and it was functioning until the time of this study. One of the success factors of the plant was that the farm management had appointed a farm worker to closely monitor and regularly conduct maintenance. Biogas produced from were used to heat milk for feeding

Figure 1. Plant in C1, bio-digester

Figure 2. Plant in C2, bio-digester

Figure 3. Plant in C3, bio-digester

Figure 4. Plant in C4, bio-digester

Figure 5. Fibreglass digester

Figure 6. Plant in S1, bio-digester

calves. The farm had no need to purchase commercial cooking gas.

In 2011, the Sabah state government established a cattle farm (C4) in Tenom, equipped with a bio-digester (Figure 4) intended to be managed by the local communities in surrounding villages. The bio-digester was constructed from concrete at a cost of MYR50,000. However, the system was not used due to internal and management issues among villagers.

The Sabah state government had also disseminated 6 m^3 bio-digester (Figure 5) to small-scale cattle farmers around Keningau and Semporna. The purpose was to use biogas to heat water generally used for cleaning farm equipment. The MYR4,000 bio-digester was provided to selected farmers and the participants had to invest around MYR500 to install the bio-digester by themselves. This was one of the initiatives to encourage green technology among farmers but unfortunately the farmers were not given clear explanations on the correct way to install the bio-digester to ensure continuous operation without major issues. As a consequence, only one biogas plant in Semporna was found functioning while the rest were damaged and non-functional. After a few years, the Sabah state government established another programme in which evacuated solar tubes as a water heating system were given to selected small livestock farmers. The solar system was easier to install and need no regular maintenance, therefore likely to be well received.

Pig Farms

Data recorded until 2018, listed four biogas plants installed in pig farms in Muar, Johor (S1 and S2) and Perak (S3 and S4). Another biogas plant was planned for Segamat, Johor where the farm management intended to adopt the biogas system design from Thailand.

Plants in S1 and S2 were built in 2012 under the same farm management. The installations cost between MYR3.5 million to MYR4 million each. The standing pig population (SPP) in S1 and S2 were 12,500 and 13,000 heads, respectively.

The plant in S1 plant had a capacity of 12,000 m^3. Its main purpose was to supply biogas to the incinerator used for disposing swine carcasses.

The plant in S2, was built for generating electricity but there was no further technical information regarding it. It was dormant after a trial period due to several technical problems. Several improvements were made in an attempt to resolve the problems and eventually, construction and design errors were cited to be the major factors of its failure. The farm management decided abandon the project due to the high cost of fixing and reconstructing it.

The bio-digesters in S1 and S2 were made of steel plates with self-locking bolts and concrete (Figure 6 and Figure 7), respectively.

The plants in S3 and S4 used high-density polyethylene (HDPE) as the gas holder (Figure 8). The SPP of S3 and S4 were 50,000 and 36,000 pigs, respectively. The capacity of bio-digester in S4 was 34,000 m^3 at a cost of MYR5 million. Construction of the

Figure 7. Plant in S2, bio-digester

Figure 8. HDPE gas holder

Figure 9. Plant in P2, bio-digester

Figure 10. Plant in P3, bio-digester

Figure 11. Plant in B1, bio-digester

plant in S3, was allocated MYR4.5 million. There was record of its size. Expenditure of both plants was around MYR12,000 to MYR15,000 per month in order to ensure a smooth production of biogas with continuously supply to the generators for farm application.

The plants in S3 and S4 were found to be still functioning. The management in each had appointed a dedicated technical team to focus on plant monitoring and maintenance, one of the factors that had contributed to the success of the plants.

Poultry Farms

In 2018, there were three biogas plants, using poultry waste, in farms P1, P2 and P3 located in Johor, Negeri Sembilan and Kedah, respectively. The plant in P1 was found still functioning. The plants in P2 and P3 were dormant since their completion.

P1 has a population of 1.2 million laying hens and the farm management spent around MYR7.8 million to develop the biogas system with a capacity of 22,000 m^3.

The plant in P1 was considered commercial scale. It has a covered lagoon concept in which an HDPE plastic sheet used as gas holder and the biogas produced was transformed to electrical energy for domestic use. The farm managed to save up to MYR3.88 million of electricity consumption after two years of operation and expected to attain a return of investment after 3 to 4 years of operation. The management of P1 had appointed technical expertise with engineers and technicians monitoring and maintaining the plant to ensure the smooth running of the system.

The plants of P2 and P3 were built at a cost of MYR30 million and MYR23 million, respectively, under the same farm management. The were constructed from concrete and steel plates with self-locking bolts (Figure 9 and Figure 10). Despite the high installation cost, the plant at P2 was inactive due to design and construction errors. After spending a few million Ringgit to reconstruct the system, the plant still failed to operate and the farm management had then decided not to pursue the project. The plant in P3 was still under construction since 2012 and is expected to be completed by 2019.

Buffalo Farms

In 2011, a fibreglass biogas plant was installed in a buffalo farm (B1) at Tobiar, Kedah (Figure 11). The construction work, nevertheless, was abandoned and remained incomplete by the appointed contractor. No further action has been taken by the farm management to pursue the project in the future.

CONCLUSION

The execution of a biogas system in the livestock sector is a suitable approach to minimise environmental pollution and problem of flies that cause discomfort to residents living in the vicinity. The use of biogas technology in the livestock sector is extremely low compared to other agriculture sectors arising from many factors. The authority could play a role by providing a guaranteed refund to the farmers who implement the biogas system in their farms

even in a small-scale capacity. In addition, a standard structure of a biogas plant can be introduced and promoted as a guide and to encourage the expansion of the biogas programme. A salient factor which could be contributory to the success of the biogas system in Malaysia in the near future is the appointment of technical expertise in particular areas.

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