THE EFFICIENCIES OF SMALL SCALE BIOGAS DIGESTERS IN PIG MANURE TREATMENT IN THE MEKONG DELTA

Nguyen Thi Thuy Nghiem[1], Tran Van Khai[2], Nguyen Thanh Phong[1]

[1]Hoa Sen University, [2] Asian Power Corporation

ABSTRACT

Biogas digester for treatment of pig manure was rapidly gaining interest in both farmers and scientists in the Mekong delta. The largest advantage of anaerobic digestion is energy recovery. Biogas collected from biogas digester is used as a substitute for fossil fuels to produce heat; whereas digestion can be used as a fertilizer or soil conditioner. Due to animal husbandry and biogas digester development, abundant effluence produced courses environmental problems. There are increasing concerns about manure treatment ability of the biogas digesters. However, many different models of biogas digester are available on the market and therefore it is unknown which one can treat pig manure efficiency. The study was conducted in four different models of biogas digester: polyethylene (PE), high density polyethylene (HDPE), fixed dome and composite models. In average, the reduction of TSS, BOD_5, COD and oDM of HDPE system were 73%, 63%, 79% and 61% respectively. The results also showed that fixed dome model was the most efficient in pig manure treatment compared to other models.

Keywords: *biogas, digester, anaerobic, BOD_5, COD, oDM, TSS, PE, HDPE, fixed dome and composite*

1. INTRODUCTION

The animal husbandry has increased in Viet Nam recently. The development of the animal husbandry courses environmental pollution (Thanh, 2003). Most of animal manure is not treated and discharged directly to the water bodies. The polluted water is harmful for humans and animals. In fact, the manure creates environmental problems such as greenhouse gas emissions and unpleasant odours.

The treatment for the manure is essentially. Biogas digester was widely used for pig manure treatment. The treatment based on the activities of microorganisms that transform organic substances into biogas (Appels et al., 2008). Biogas is used as renewable energy source, and nutrients in the residue can be recovered in agriculture as fertilizer or soil conditioner (Møller et al., 2009). In addition, biogas digester is attracting attention as an effective method to reduce GHG emissions according to Kyoto protocol (Møller et al., 2009). Actually, many studies have been conducted to show the benefits of biogas digester treatment, for instance the works of (Ngan, et al., 2012; Ngan, 2011) showed that the advantages and disadvantages of different biogas models. However, most of the previous studies considered only on biogas production or investment cost. There is still missing data

concerning the efficiency of different biogas models and results are sometimes conflicting. For example, the reductions of Biology oxygen demand (BOD), Chemical oxygen demand (COD), Organic dry matter (oDM) associated to the different digester models were often excluded in previous studies. In fact, the treatment efficiency of each model may be different. The aim of this research is to investigate and evaluate the reduction of pollutants from different biogas plants: polyethylene (PE), high density polyethylene (HDPE), fixed dome and composite model.

2. MATERIALS AND METHODS

The study was conducted in Cho Gao district, Tien Giang province. This is one of the most concentrated area of animal husbandry in Mekong Delta that they have not had the right solution or perfunctory measures to solve this problem. According to the conducted survey showed that most of treatment systems are traditional models such as PE, Composite and fixed dome, which have many disadvantages during operation process. Therefore, the investigation was conducted to compare and evaluate removal efficiencies of HDPE and other materials like PE, composite and fixed dome. In all, 2 PE, 2 HDPE, 2 composite and 2 fixed dome models were investigated in the study.

In this study, HDPE biogas system is designed in cylindrical structure and its volume is $9m^3$ to handle all of manure of 25 adult pigs in 30 days. Besides that other traditional systems like PE, Composite and fixed dome, which have the same input and output parameters, are operated in different places.

In the study, the influents and effluents of investigated models were collected and measured waste water quality parameters such as temperature, pH, TSS, BOD, COD, turbidity, Dry matter (DM) and oDM. Temperature and pH measurements were conducted at the biogas systems by pH detector, thermometer; whereas, TSS, BOD, COD, turbidity, DM and oDM were analyzed in the laboratory of Hoa Sen university.

Samples were collected directly from the effluent of the digesters at 8 am, when pigs are fed and cleaned completely. This work is repeated one time per week during 45 days. Collected samples are preserved at the low temperature and transported follow by TCVN 4556-1988 Standard before analyzing in Hoa Sen's laboratory. All of parameters are conducted by Standard Method. BOD was analyzed by biological oxygen demand of microorganism after 5 days. The moisture content was determined by drying the samples at 105°C until the weight was unvarying. The percentage of moisture content was calculated in relation to the initial weight. The drying samples were then burned at 550^oC for oDM measurement. COD was determined by $K_2Cr_2O_7$ and titration.

The results are analyzed by Microsoft Excel 2013 to export the average removal efficiencies and chart.

3. RESULTS AND DISCUSSION

3.1. Temperature and pH

The average temperature and pH at different biogas digesters were shown in Tab. 1. The mean temperature was 30^oC. It is mesophilic temperature for anaerobic digestion

process. There were no significant differences in the four types of digester. The temperature in the composite and HDPE were slightly higher than PE and fixed dome models. The differences could be explained by absorbing sunlight of the black material. Mean pH value in four models was 7.5, which was an optimum condition for anaerobic decomposition process (optimum value from 6.8 to 7.5, (Dung, et al., 2010).

Table 1. *The temperature and pH in the four models*

	PE	Composite	Fixed dome	HDPE
Temperature (T^0)	30	30.5	29	30.5
pH	8	8	7.5	6.8

3.2. The removal efficiencies of COD, BOD_5 and oDM

The average removal efficiencies of COD, BOD_5 and oDM were shown by figure 1. The results showed that the removal efficiencies of fixed dome were the best. In average, the model could remove 93.32, 80.15 and 74.11% of COD, BOD_5 and oDM respectively. The second efficient model was HDPE with 78.9, 63.13 and 60.73% of COD, BOD_5 and oDM respectively. 60% and 30% of COD was decreased after the PE and composite biogas digesters. Composite model was inefficient in COD reduction.

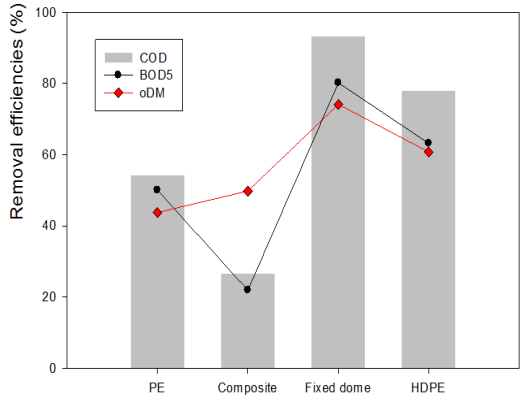

Figure 1. *The removal efficiencies of COD, BOD_5 and oDM*

3.3. The removal efficiencies of TSS, turbidity and DM

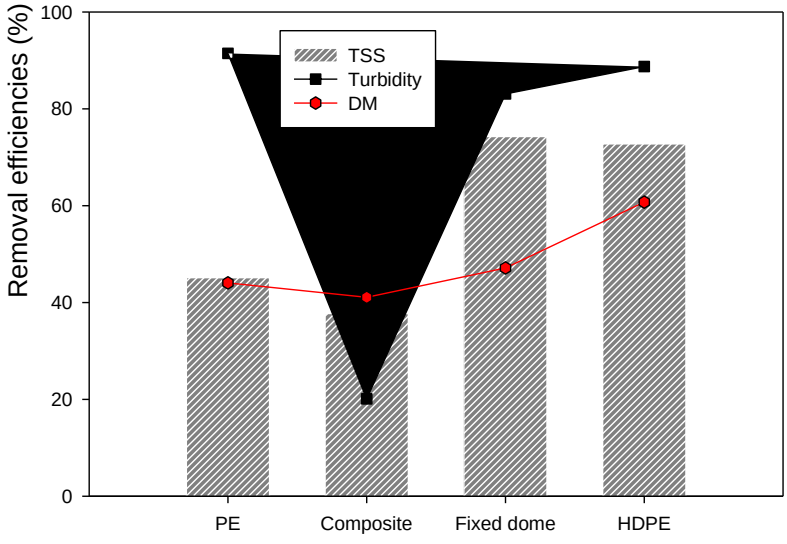

Figure 2. *The removal efficiencies of TSS, turbidity and DM*

The average removal efficiencies of TSS, turbidity and DM of four biogas system were illustrated in the figure 2. Fixed dome had the highest of TSS reduction. Mean TSS reduction was 74.28%. However, turbidity and DM were lower than the removal efficiencies of PE and HDPE with 83.07% and 47.14%, respectively. The removal efficiencies of HDPE system were high for both indicators with 72.75%, 88.72% and 63.25% of TSS, turbidity and DM respectively. PE achieved the highest turbidity reduction with 91.43% but TSS and DM were only 45.14% and 44.05%. The removal efficiency of the composite model was the lowest with 37.74%, 20.11% and 41.07%, respectively. These results are in line with previous researches (Nguyen, 2011) and (Ngan, et al., 2012).

4. CONCLUSIONS

The investigated biogas digesters were operated in good conditions. All digesters generated biogas. Produced biogas was used mainly for cooking. The four models were shown that the digesters could reduce COD, BOD, oDM and TSS, but the reductions were different at four models. Fixed dome model was the most efficient in pig manure treatment compared to other models, whereas, composite model could remove only 30% of COD. For the HDPE digester, it was recommended for small scale farmer due to low cost investment and high efficiency in pig manure treatment.

REFERENCES

[1] Appels, L., Baeyens, J., Degrève, J. and Dewil, R. 2008. Principles and potential of the anaerobic digestion of waste-activated sludge. Progress in Energy and Combustion Science, 34, 755-781.

[2] Møller, J., Boldrin, A. and Christensen, T. H. 2009. Anaerobic digestion and digestate use: accounting of greenhouse gases and global warming contribution. Waste Management and Research, 27, 813-824.

[3] Nguyen, C. N., 2011, Small-scale anaerobic digesters in Vietnam - development and challenges, Journal of Vietnamese environment, vol. 1, pp. 12-18.

[4] Ngan, Vo Chau; Phan, Trung Hieu; Vo, Hoang Nam, 2012, Review on the most popular anaerobic digester models in the Mekong Delta, Journal of Vietnamese environment, vol. 2, pp. 8-19.

[5] Ngo Đinh Ngoc Giao, Ngo Đuc Đat, 2014, Thực hành hóa kỹ thuật môi trường, TP. Hồ Chí Minh

[6] Nguyen Lan Dung, Nguyen Khac Tich, Nguyen Quang Khai, 2010, Hỏi đáp về công nghệ khí sinh học, Nông Nghiệp.

[7] Thanh, N. X., 2003, Giáo trình Công nghệ vi sinh vật trong sản xuất nông nghiệp và xử lý ô nhiễm môi trường, Nông nghiệp.

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– Email: nghiemnguyen1912@gmail.com