CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The three main objectives as mentioned earlier in the first chapter have been proven through this study. The study demonstrated that the production of biogas using POME wastewater as substrate along with simultaneous wastewater treatment. In this research study, the result verified that a mesophilic anaerobic treatment using a SCAR was highly effective for the purification of POME wastewater and the production of biogas from POME wastewater at different HRTs varying between 12 days and 2 days. High stability and good performance of the SCAR were accomplished and maintained regardless of dropped in COD removal efficiency, low biogas production rate and high VFA level at low HRT.

The COD removal efficiency decreased from 87.08 % to 38.2 % as HRT decreased. Moreover, the SCAR was confirmed to be more efficient in the POME treatment at HRT of 12 days with 87.08 % COD removal efficiency than the open anaerobic digester (Yacob, S. *et al*., 2005) and the CSTR (Tong, S.L. and Jaafar, A.B., 2006) as stated in Table 4.3. At the same time, the SCAR required low HRT in order to achieve high COD removal efficiency compared with open anaerobic digester digester (Yacob, S. *et al*., 2005) and the CSTR (Tong, S.L. and Jaafar, A.B., 2006) as shown in Table 4.3. In the meantime, the VFA concentration increased from 11569.71 mg CH_3COOH/L to 16956.00 mg CH_3COOH/L with a decrease in HRT. Additionally, the biogas production rate of the SCAR decreased

from 3000 ml biogas/day to 604 ml biogas/day as the HRT decreased from 12 days to 2 days. Meanwhile, the CH_4 content decreased from 24.05 % to 10.64 % with a decrease in HRT whereas the CO_2 and H_2 contents increased from 31.45 % to 39.63 % and from 4.35 % to 8.15 %, respectively, with a decrease in HRT. Besides that, the CH_4: CO_2 fraction decreased from 0.76 to 0.27 with a decrease in HRT. These results proved that the SCAR was instability between acidogenesis ad methanogenesis population at low HRT.

High COD removal efficiencies (87.08 %) and high biogas production rate (3000 ml biogas/day) with 24.05 % of CH_4 content, 31.45 % of CO_2 content and 4.35 % of H_2 content can be achieved by the SCAR when operated at HRT of 12 days. Under the operating conditions evaluated in this investigation, a HRT of 12 days is recommended in order to ensure a good system-efficiency. The high performance may be attributable to the adequate acclimatization of the biomass and start-up of the reactor performed to minimize the undesirable wash-out of slow-growing methanogenic bacteria.

The highest methane yield with HRT of 12 days was 0.025 L CH_4 /g $COD_{removed}$. A correlation was established between CH_4 emission and COD where 0.025 L of CH_4 for every gram of COD removed.

5.2 Recommendations

The adopted reactor configuration, nature of parent bacterial consortia/inoculum, nature and characteristics of wastewater, flow pattern and operating conditions along with OLR and HRT will have influence on the overall biogas production and COD removal efficiency. As a result, the palm oil industries in Malaysia need to have excellent knowledge regarding these factors in order to obtain enhanced process control for the anaerobic treatment of POME wastewater. Hence a number of limitations that should be addressed and new directions to be explored in future research are shown as below, although the present study totally fulfills its objectives.

1. The COD removal in the steady state conditions should be improved in order to increase the VFA biodegradation.
2. COD removal efficiency and biogas emission estimation should be based on field measurement, since the mill's activities which affect the quality and quantity of POME discharged and the seasonal cropping of oil palm severely govern the anaerobic process.
3. Reactor design should comply with the recommended closed anaerobic reactor design considerations.
4. Presence of toxic materials and inhibitors, nutrients requirements and alkalinity should be monitored and maintained during the reactor startup.
5. The identification of the species of anaerobe bacteria that are present in the anaerobic digestion process should be carried out.
6. A gas-solid separator device should be installed at the top of a SCAR.
7. Biodegradation of POME wastewater can also be increased by two stages SCAR.
8. Last but not least, the advanced detection method of the total and individual VFA concentrations should be applied in order to have better understanding of the changes of the total and individual VFA concentrations during anaerobic digestion.