

Title: Utilization of biogas released from palm oil mill effluent for power generation using self-preheated reactor

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Abstract: In palm oil mills, for one ton crude palm oil (CPO) production, 70 m³ biogas is released from palm oil mill effluent (POME) which can endanger the environment. Palm oil mills without appropriate strategies for biogas collection can participate in greenhouse gases (GHGs) generation actively. In this paper, a typical palm oil mill with annual capacity of 300,000 ton oil palm production and 3 MW electricity demand is considered as a pilot plant and feasibility of power generation by POME biogas is modeled by Aspen Plus considering flameless mode in combustion system. A new design of lab-scale flameless reactor called self-preheated flameless combustion (SPFC) system is presented and employed in power generation modeling. In SPFC system, the flameless chamber is employed as a heater to preheat an oxidizer over the self-ignition temperature of the fuel. A helical stainless steel pipe (called self-preheating pipe) is installed inside the chamber to conduct the oxidizer from exhaust zone to the combustion zone inside the chamber and preheat oxidizer. In the flameless mode, the diluted oxidizer is injected to the helical pipe from the exhaust zone and the preheated oxidizer at the burner is conducted to the flameless furnace through a distributor. In SPFC system external heater for preheating oxidizer is removed and the rate of power generation increases. The results show that 10.8 MW power could be generated in ultra-lean POME biogas SPFC. However, the rate of pollutant especially CO₂ and NO_x is high in this circumstances. In stoichiometric condition, 4 MW power could be available in stable conditions with lower pollutant formation. Since, hydrogen is one of the ingredients of POME biogas, calculations confirm that the rate of power generation increases around 0.7 MW when just 2% hydrogen is added to biogas.