CHAPTER 7

Conclusions and Suggestion for the Future Works

7.1 Conclusions

In this work, modification of small diesel engine into SI engine with 100% producer gas as fuel was carried out. Performance of the modified small engine was evaluated against diesel engine. The small producer gas engine was found to work well in the low and high engine speeds. Modifying diesel engine into SI producer gas engine, combustion chamber, CR, ignition timing, air gas mixer, push rod and bolt or stud of cylinder head were needed to change this may be achieved by using addition thickness of gasket and changed piston head dimension.

The small producer gas engine was found to be able to operate with producer gas successfully. The COV of the producer gas engine was between 1.75-3.0%. The cavity combustion chamber showed slightly less than the bath tub combustion chamber. The minimum COV of producer gas engine occurred at 1300 rpm and 1500 rpm respectively. Engine torque, brake power and BTE of the small producer gas engine were found to increase with engine speed and load, while the BSFC of engine was decreased. Comparison with original diesel engine, the engine torque and power of the small producer gas engine was similar low engine speed. The diesel engine tended to have higher torque and power at above 1500 rpm. The brake thermal efficiency of small producer gas engine was lower than diesel engine in all engine speeds and loads, with average of 20.3% and 35% in cavity and bath tub combustion chamber respectively. The BSEC of small producer gas engine was higher than diesel engine in all engine speed and load. The highest performance of small producer engine depended on adjusting optimum ignition timing with varied engine speed. The optimum ignition timing of the small producer gas engine in bath tub combustion chamber were between 20° to 25° BTDC at 1100 rpm, 25° to 30° BTDC at 1300 rpm, 32.5° to 37.5° BTDC at 1500 rpm and 37.5° to 42.5° BTDC of 1700 rpm. For the cavity combustion chamber were between 30° to 35° BTDC at 1100 rpm, 35° to 40° BTDC at 1300 rpm, 40° to 45° BTDC at 1500 rpm and 45° to 50° BTDC of 1700 rpm. The best conditions of small producer gas engine in bath tub combustion chamber occurred at 14:1 of CR, 1700 rpm, full load and 40° BTDC. The engine torque, brake power, BTE, and BSFC were 18.61 Nm, 3.31 kW, 18.77% and 0.94 kg/kWh, respectively. For the cavity combustion chamber, it was similar to bath tub combustion chamber. Except ignition timing was at 45° BTDC. The engine torque, brake power, BTE, and BSFC were to 18.05 Nm, 3.21 kW, 23.90% and 0.74 kg/kWh, respectively.

The CO emission was slightly reduced with increasing load. The CO emission of the producer gas engine was found to be higher than the diesel engine for all loads and speeds. Cavity combustion chamber showed a lower CO emission than bath tub combustion chamber. The minimum CO emission of small producer gas engine was 0.28% at 1500 rpm on full load. For the diesel engine, it was 0.010 % at 1900 rpm on full load. The HC emissions tended to decrease with increasing load and engine speed. HC emissions of diesel engine were less than the small producer gas engine at all engine speeds and loads. The use of the cavity combustion chamber produced less HC emissions than the bath tub combustion chamber. The minimum HC emission of diesel and small producer gas engine were similar between 3-3.5 ppm at highest engine speed on full load. The noise of diesel engine was constant with increase load while the producer gas engine, noise increased with engine load. In low load and low engine speed, the noise of diesel engine is higher than producer gas engine, but the diesel’s noise is less than producer gas engine with high load and engine speed. The noise of producer gas engine and diesel engine was similar between of 94.5-96.7 dB. Smoke density of small producer gas engine was very low while that of diesel engine tended to increase with engine speed and load. The highest smoke density of small producer gas engine and diesel engine were 1.9 % and 11.60 %, respectively.

The use of cavity combustion chamber had a wider range of applications, compared to bath tub combustion chamber. The model of a gas engine was acceptable and can be used to predict the performance of producer gas engines. The average percentage error of torque, brake power, BTE and BSFC were within 6.50%. The thermodynamics model can be used successfully to simulate performance of SI engine. The fuel cost of small producer gas engine depends on the type of biomass. The fuel cost for a generator with charcoal was between of 7.4-9.4 Baht/kWh. They were 10.90 Baht/kWh and 1.6-2.0 Baht/kWh for diesel and longan wood, respectively.

7.2 Suggestion for the future works

The result of experimental analysis and reviews give a few suggestions for further research in development of SI producer gas engine. Recommendations for the future works are as follow.

- To achieve high power output and thermal efficiency of the SI producer gas engine, the future work should find the optimum CR for producer gas operation. This research predicted to be in a range of 14:1 to 17:1.

- Due to knocking in SI producer gas engine at high engine speed and CR, experiments may use twin spark plug and installing at suitable position. This may lead to decreased knock of the engine.

- Configuration of combustion chamber of SI producer gas engine should be considered with focus in squid ratio from combustion chamber geometry that affects knock, power output and exhausts emission.