CHAPTER 5

CONCLUSION

5.1 SUMMARY

A detailed review of the various literatures related to biodiesel production, usage in engines and generation of biogas from oil cakes was made. In the present investigation, the tree borne oil seed of Pongamia pinnata was subjected to transesterification process and converted to biodiesel. Blends of Pongamia pinnata methyl ester (PPME) and diesel in varying proportions by volume were prepared and characterized. Performance and exhaust emission analysis on an unmodified diesel engine fueled with the blends of PPME and diesel was carried out in order to find the extent to which PPME could replace petro diesel. Energy and exergy analysis of diesel and biodiesel combustion in diesel engine was also studied to further ascertain the eco-friendly nature of biodiesel. The de-oiled cake remained after extraction of oil was subjected to biomethanation process in a batch type digester to evaluate the methane generation potential of the cake and to study the variation of parameters such as pH, BOD, COD, ammonia nitrogen and total nitrogen during the gas generation.

5.2 CONCLUSION

The following observations are arrived at based on this study.

- The biodiesel (PPME) from Pongamia Pinnata has higher flash point, fire point, kinematic viscosity and lower specific gravity and calorific value in comparison with diesel.
- The unmodified diesel engine provided satisfactory performance with all the blends and neat biodiesel (B100) without much compromise to power output.
- The performance analysis revealed that the blends B 20 and B 40 are better than diesel based on BSEC.
- The exhaust emission analysis revealed that the blends B 40 and B 60 are superior to diesel due to their reduced CO, CO$_2$, UBHC and NO$_x$ emissions.
- The exergy analysis confirmed that the exergy destruction and exergy loss index are less for PPME than that of diesel. For all the blends of biodiesel other than neat biodiesel, the exergy destruction per unit energy generation is less than diesel, ascertaining the environment friendly nature of PPME.
- From the biomethanation of de-oiled cake, it is observed that 1 kg of the de-oiled cake of Pongamia pinnata is capable of producing 185 liters of clean biogas with 66 % methane and 33 % CO$_2$ in a batch type digester without any special measure to control the factors affecting gas generation. It would be possible to generate more amount of biogas using a continuous feed type digester and special measure to control the parameters.

It is concluded that biodiesel (PPME) up to 40 % (B40) could replace diesel in unmodified diesel engine applications for getting required power output with reduced emission so as to achieve energy efficiency, environmental protection and rural economic development. Exergy loss index is an important measure to levy taxation on the fossil fuel usage, based on the extent to which the fuel destructs the environment. This measure will definitely result in curtail of fossil fuel usage and promotion of renewable
energy sources. For developing countries like India, which is one among the top five CO\textsubscript{2} emitting countries of the world, exergy destruction based taxation is of timely need.

If the oil cake obtained after extracting the oil from the Pongamia pinnata is used as a direct manure without generating biogas, it will result in the gradual emission and accumulation of methane into the atmosphere. According to the United Nations Forum for Climate Change (UNFCC), methane gas is 21 times more vulnerable than CO\textsubscript{2} in causing global warming and environmental destruction. Therefore it is clearly evident that the process of biogas generation from the de-oiled cake of Pongamia pinnata not only helps in getting substantial amount of an environment friendly clean source of energy but also gives protection to the environment. Also the sludge from the digester with its improved N, P, K values is better manure than the raw cake for agriculture.

5.3 SCOPE FOR FUTURE WORK

The present study could be extended with prime focus on the following aspects.

- Experimental investigation of a biodiesel fueled diesel engine with minor modifications in the engine such as change in injection timing, exhaust gas re-circulation and preheating of oil with exhaust gas temperature etc.

- A long run study of the engine fueled with biodiesel to study the effect on the lubricating system.

- Devising a methodology for entropy based taxation.

- Biogas generation from the de-oiled cake with special measure to control the factors affecting the gas generation.