CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 CONCLUSION

Experiments were conducted in a four stroke single cylinder, naturally aspirated, water cooled, direct injection diesel engine to study the effects of diesel and ignition improver blends on combustion, performance and emissions. Three ignition improver blends such as Di-ethylene glycol dimethyl ether, 2-Butoxy ethanol and 2-Ethoxy ethanol in the proportions of 6% and 12% by volume were prepared and tested. In this work a simulation code using two zone thermodynamic combustion model has been developed and implemented in a full cycle simulation of a direct injection diesel engine for the purpose of predicting the combustion characteristics, engine performance and the emissions of NOx and smoke. Based on the experimental and theoretical results, the following conclusions are drawn:

- The peak cylinder pressure for 6% 2-Ethoxy ethanol blend is higher than that of diesel fuel and other blended fuels. The peak pressure with the addition of 6% 2EE blend is higher due to the improvement in preparation of air fuel mixture as a result of low fuel viscosity. The peak cylinder pressure variation between diesel and ignition improver blends is about 2 to 7 percent only.
- The rate of pressure rise is smooth with the use of ignition improver blends. The variation of rate of pressure rise between the diesel and ignition improver blend is nominal.

- The peak heat release rate of 6% 2-Ethoxy ethanol blend is higher than that of diesel fuel and other blended fuels. Maximum heat release of 2 to 7 percent is observed with ignition improver addition at medium and high loads.

- DGM blends and 6% 2EE blend reduces the specific energy consumption where as 2BE blends and 12% 2EE blend increase the specific energy consumption slightly. The specific energy consumption for DGM blends and 6% 2EE blend has improved by 5% and 10% compared to diesel fuel.

- Addition of DGM blends and 6% 2EE blend increases the thermal efficiency compared to diesel fuel whereas 2BE blends and 12% 2EE blend decreases the efficiency. It is observed that at full load the brake thermal efficiency for 6% 2-Ethoxy ethanol blend has improved by 10.35% compared to diesel fuel and the improvement in thermal efficiency is due to improved combustion.

- All the ignition improvers reduce the carbon monoxide emission compared to diesel fuel. 6% 2-Ethoxy ethanol blend decreases the CO emission by 31.2% compared to diesel fuel.

- Reduction in the HC emissions is observed with the addition of ignition improver blends due to the presence of oxygen in the blended fuels compared to diesel fuel. HC emission decreases by 18.75% with the addition of 6% 2-Ethoxy ethanol blend to diesel fuel.
The formation of Nitrogen oxide emission is increased for all the three ignition improver blends to diesel fuel. NO\textsubscript{x} emission is slightly increased by 4.65% at 20% load and by 14.47% at full load condition with the addition of 2-Butoxy ethanol blend to diesel fuel. The oxygen content in the ignition improvers increase the combustion chamber temperature, which leads to higher NO\textsubscript{x} emissions.

All the ignition improver blends are showing better results in reduction of smoke. There is a significant decrease in the smoke intensity with the addition of DGM blends followed by 2-Ethoxy ethanol blend at part loads. Ignition improvers are less effective in reducing smoke intensity at full load. Presence of oxygen in the ignition improvers reduces the smoke intensity.

The simulation code developed is effectively used to estimate the combustion, performance parameters and emissions of NO\textsubscript{x} and smoke. The predicted results agree well with the experimental results.

The simulation code developed can predict the performance and emissions of any ignition improvers with minimum inputs such as calorific value, chemical formula, air fuel ratio, rpm and viscosity.

From the above detailed research studies, it has been concluded that 2-Ethoxy ethanol blend is found to be the optimum blend for diesel fuel at lower blending level in terms of engine performance and emission characteristics.
6.2 SCOPE FOR FURTHER STUDY

1. High price and poor availability of ignition improvers pose a certain barrier for common applications. Increase in the production of ignition improvers will result in low price and more common use.

2. Further study is required to optimize engine systems for use with ignition improvers for greater emission reduction and the present study can be extended to multi cylinder engines.

3. Impact on human health and on atmospheric reactions need to be further explored.

4. The study of nitrogen oxides, carbon monoxide and hydro carbon emission over a wide range of blending level can be analyzed for advanced engine testing to meet stringent emission norms.

5. The two zone combustion model could be further improved by simulating the ignition improver combustion using CFD technique.