CHAPTER 3

OBJECTIVES AND METHODOLOGY

3.1 PROBLEM DEFINITION

From the analysis of literature it is found that many researchers prepared the biodiesel derived from the different sources such as pongamia oil, mahua oil, frying oil, jatropha oil etc. (Karmee and Anju Chadha 2005, Sukumarpuhan et al 2005, Encinar et al 2005, Serio et al 2006, Amish P. Vyas et al 2009) and this prepared biodiesel partially replaced the diesel in diesel engine. Some of the authors used ethanol for replacement of diesel. In most of literature 99.7% pure commercial ethanol was used to study the properties of blends or performance and emissions characteristics of engines (Xing cai et al 2004, De-gang Li et al 2005, Hansen et al 2005). It is also found that there is no phase separation when anhydrous ethanol was blended with diesel (Rakopoulos et al 2007(b), Magin Lapuerta et al 2008, Rakopoulos et al 2008). Phase separation of blended fuels are mainly depends on the purity of the ethanol used. Preparation of 99.7% pure bioethanol from biomass is more expensive and economically unviable. In this present investigation bioethanol was prepared from sugar molasses and purified to 98% and then blended with diesel. In order to avoid the phase separation, biodiesel was added as an additive and it derived from the locally available materials. Physical properties of biodiesel derived from different vegetable are not similar and hence it has different influence on engine performance and emissions characteristics. Therefore, in this present research a complete and
comprehensive analysis has been made by blending bioethanol derived from sugar molasses with diesel using suitable additives.

3.2 OBJECTIVES OF THE STUDY

Based on the review of literature, the following objectives are framed for the present work.

- To obtain the maximum bioethanol concentration from sugar molasses.
- To obtain the maximum yield of ester from cottonseed oil and pongamia oil.
- To study the stability of the blended fuels with different percentage of bioethanol-diesel blends with suitable additives.
- To study the fuel properties such as relative density, flash point, viscosity and calorific value of the blended fuels with different percentage of bioethanol-diesel blends and suitable additives.
- To study the diesel engine performance for different proportions of bioethanol-diesel blended with suitable additives.
- To study the exhaust emissions characteristics of a diesel engine for different proportions of bioethanol-diesel blended with suitable additives.
- To study the combustion parameters such as cylinder pressure, heat release rate, cumulative heat release rate, ignition delay and combustion duration for selected fuel blends.
- To predict the engine performance and emissions parameters for various percentages of load and blend ratios using ANN.
The present work involves detailed experimental investigations and prediction of performance and emission parameters to achieve the above mentioned objectives. The experimental investigation is aimed at collecting performance and emission data at standard injection timing for different bioethanol-diesel blends with different additives. These data can be used to train ANNs to predict the performance and emission parameters for various engine operating conditions.

3.3 METHODOLOGY

The step by step methodology is used to investigate the above research problem in the present study.

- Optimization of the operating parameters such as pH, temperature, concentration of yeast and concentration of sugar molasses for obtaining the maximum bioethanol concentration from sugar molasses.

- Optimization of the operating parameters such as speed of the stirrer, reaction time and quantity of catalyst for obtaining the maximum yield of ester from cottonseed oil and pungamia oil.

- Stability tests for different percentage of bioethanol-diesel blends with suitable additives to identify the stable fuel blends.

- The important fuel properties such as relative density, flash point, viscosity and calorific value of stable blended fuels were measured using ASTM specified equipments.

- To study the performance, exhaust emissions and combustion characteristics of the engine using the stable blended fuels.
The detailed experimental methodology is described in Figure 3.1.

Figure 3.1 Experimental methodology
The different category of fuels tested in these investigations is given in Table 3.1.

### Table 3.1 Test Matrix of Fuel Tested

<table>
<thead>
<tr>
<th>CASE</th>
<th>FUELS USED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type I. Reference data with diesel</strong></td>
<td>Diesel</td>
</tr>
<tr>
<td><strong>Type II. Bioethanol- Diesel blends with EEPO as additive</strong></td>
<td>E5P10D85, E10P10D80, E15P10D75, E20P10D70</td>
</tr>
<tr>
<td></td>
<td>E25P10D65, E30P15D55</td>
</tr>
<tr>
<td><strong>Type III. Bioethanol- Diesel blends with n-Butanol as additive</strong></td>
<td>E5Z3D92, E10Z3D87, E15Z3D82, E20Z3D77</td>
</tr>
<tr>
<td></td>
<td>E25Z5D70, E30Z5D65</td>
</tr>
<tr>
<td><strong>Type IV. Bioethanol- Diesel blends with MECSO as additive</strong></td>
<td>E5B10D85, E10B10D80, E15B10D75, E20B15D65</td>
</tr>
<tr>
<td></td>
<td>E25B15D60, E30B15D55</td>
</tr>
</tbody>
</table>

D - Diesel, E - Bioethanol, Z - n-butanol
P - Ethyl Ester of Pongamia Oil (EEPO)
B-Methyl Ester of Cotton Seed Oil (MECSO)
E5P10D85 - 5% of Bioethanol
- 10% of Ethyl Ester of Pongamia Oil (EEPO)
- 85% of Diesel
3.4 SALIENT FEATURE OF THE PRESENT WORK

The salient features of the present work can be summarized as follows:

- Optimization of various parameters to maximize the production of bioethanol, methyl ester of cotton seed oil and ethyl ester of pongamia oil.
- Inhouse prepared bioethanol, methyl ester of cotton seed oil, ethyl ester of pongamia oil, commercial grade high speed diesel oil and n-butanol have been used as fuels.
- Stability test have been conducted for different bioethanol-diesel blends with additives.
- The important properties of different bioethanol-diesel blends with additives have been measured.
- Performance parameters such as brake thermal efficiency and exhaust gas temperature and emissions parameters such as HC, CO, CO₂, NOx and smoke have been measured at each operating point and compared with diesel engine.
- Combustion parameters such as cylinder pressure, heat release rate, cumulative heat release rate, ignition delay and combustion duration for selected fuel blends have been computed.
- To train the Artificial Neural Network model using MATLAB 7.2 to predict the engine performance and emissions parameters.

To achieve the above stated objectives, a detailed experimental investigation has been carried out. The details of production of bioethanol, production of MECSO and EEPO, stability analysis and engine experimental setup are explained in chapter 4.