CHAPTER- 10

CONCLUSIONS AND SCOPE FOR FUTURE WORK

The objective of the present experimental investigation using tobacco seed oil, pongamia oil and mahua oil as fuel for most popularly used agricultural segment engine to help the needy farmers in case of emergency situations has been achieved. Though the straight vegetable oils pose many challenges one can use them for emergency and short term applications by adopting technical tips from the researchers. However there is a need to compile the technical information pertaining to various capacities of the engines using different non edible oils available locally across the Globe for agricultural and rural sectors to habituate the end users to prepare their own fuel for self sufficiency and economical gains. Instead of using one species of non edible vegetable oil, if one can blend two varieties of the non edible vegetable oils the engine performance and fuel saving can be achieved. The garlic treatment is also effective in case of tobacco seed oil and pongamia oil. For mahua oil the garlic treatment is not much effective and there is a need to make further investigations by increasing the garlic quantity.

10.1 EXPERIMENTS WITH STRAIGHT VEGETABLE OILS

- When the engine is operated with tobacco seed oil at best injection pressure and timing of 260 bar and 26° BTDC over standard setting of injection pressure and timing of 205 bar and 23° BTDC, 19% decrease in brake specific fuel consumption, 15.7% increase in brake thermal efficiency at 80% load and lower emissions were observed. Combustion data at 80% load reveals the increase in peak pressure from 65.38 bar to 74.9 bar, maximum rate of pressure
rise increased from 3.77 bar /°Crank Angle to 4.85 bar/°Crank Angle, highest net heat release rate which increases from 35.9 Joules /°Crank Angle to 44.11 Joules/°Crank Angle, improvement of highest cumulative heat release from 1.14 kJ at 509 °Crank Angle to 1.17 kJ at 423 °Crank Angle and 4° and 2°Crank Angle advance for 5% and 90% mass fraction burnt clearly indicates enhanced combustion. Hence for this particular engine 260 bar fuel injection pressure and 26° BTDC fuel injection timing is a best option to run with neat tobacco seed oil.

- In case of pongamia oil at best fuel injection pressure and timing of 240 bar and 26° BTDC results in 23% lower brake specific fuel consumption, 18% improvement in brake thermal efficiency at 80% load and also reduced smoke emission when compared to engine manufacturer recommended fuel injection pressure of 205 bar and fuel injection timing of 23° BTDC. The combustion characteristics of pongamia oil at 80% load for best setting shows 9 bar and 1.45 bar /°Crank Angle improvement in peak pressure and maximum rate of pressure rise respectively. An increase of net heat release of 14.46 J/°Crank Angle with 9°Crank Angle advance compared to standard setting indicates reduced ignition delay which is essential for effective combustion is clearly seen. The 1° and 2°Crank Angle advance in case of best setting for 5% and 90% mass fraction burnt further strengthens the above statement.

- While using mahua oil at best fuel injection pressure and timing of 260 bar and 23° BTDC recorded in 7% lower brake specific fuel consumption, 6.1% improvement in brake thermal efficiency at the
point of maximum brake thermal efficiency. By simply increasing
the fuel injection pressure from 205 bar to 260 bar the peak
pressure increased from 58.87 to 75.53 bar which is higher than
base line diesel value. The increase in fuel injection is causing
1.5 bar /°Crank Angle improvement in maximum rate of pressure
rise with 6°Crank Angle advance. An increase of 2.31 J/°Crank
Angle net heat release rate for mahua oil at best setting is
observed. The 5% mass fraction burnt for mahua oil is coinciding
with diesel value. Hence mahua oil can be used at manufacturer’s
fuel injection timing by simply increasing the pressure from 205 bar
to 260 bar.

10.2 EXPERIMENTS WITH VEGETABLE OIL BLENDS

- In case of tobacco seed oil + mahua oil blend the brake specific fuel
  consumption and brake thermal efficiency values at 80% load are
  2.2% and 2.44% higher when compared to best setting operation
  with tobacco seed oil respectively. When compared to mahua oil
  operation 0.8% and 0.67% improvement in brake specific fuel
  consumption and brake thermal efficiency is observed with tobacco
  seed oil + mahua oil blend respectively. Compared to tobacco seed
  oil and mahua oil operation the blend developed lower pressure but
  slightly higher than base line diesel. The highest net heat release
  values of tobacco seed oil + mahua oil blend, tobacco seed oil and
  mahua oil are 41.35 (368°Crank Angle), 44.11(358°Crank Angle)
  and 38.85 (359°Crank Angle) J/°Crank Angle respectively. When
  compared to mahua oil operation alone the blend is resulting in
  improved net heat release. Blending of two non edible oils seems to
be a better option compared to individual non edible oil operation for achieving better performance. For tobacco seed oil + mahua oil blend the best fuel injection pressure and timing are 260 bar and 26° BTDC respectively.

- The brake specific fuel consumption and brake thermal efficiency of tobacco seed oil + pongamia oil blend at the point of maximum brake thermal efficiency is 4.8% and 2% respectively when compared to tobacco seed oil operation at best setting. When compared with pongamia oil 0.5% and 2% respectively. The 5% and 90% mass fraction burnt values are close to base line diesel values. The net heat release and cumulative heat release values in case of tobacco seed oil + pongamia oil blend are lower than base line diesel. The best fuel injection pressure and timing for tobacco seed oil + pongamia oil blend are 220 bar and 23° BTDC respectively. In this case simply adjusting the fuel injection pressure from 205 bar to 220 bar at manufacturers fuel injection timing of 23° BTDC the best performance results can be obtained with tobacco seed oil + pongamia oil blend.

- The pongamia oil + mahua oil blend appears to be a very good option as there is 11.1% and 4% decrease in brake specific fuel consumption compared to pongamia oil and mahua oil operation respectively at the maximum point of brake thermal efficiency. An improvement of 8.3% and 6.2% brake thermal efficiency over pongamia oil and mahua oil operation at 80% load with pongamia oil + mahua oil blend respectively. The highest peak pressure value of pongamia oil + mahua oil blend reflects the higher brake thermal
value high rate of pressure rise and also net heat release. The part load brake thermal efficiency in the initial loading condition is higher than base line diesel and we can recommend pongamia oil + mahua oil blend operation at best fuel injection pressure and timing of 220 bar and 23° BTDC.

- The brake specific fuel consumption and brake thermal efficiency of tobacco seed oil + pongamia oil + mahua oil blend at 80% load are 1.35% and 2.7% higher when compared to tobacco seed oil and mahua oil operation respectively. When compared to pongamia oil operation 4% lower brake specific fuel consumption is observed with tobacco seed oil + pongamia oil + mahua oil blend. The tobacco seed oil + pongamia oil + mahua oil blend develops 0.24% and 0.52% improvement in brake thermal efficiency with tobacco seed oil and pongamia oil respectively. When compared to mahua oil 1.52% lower brake thermal efficiency with tobacco seed oil + pongamia oil + mahua oil blend. The lower combustion parameters reveal that blending of three oils is not a better option.

10.3 EXPERIMENTS WITH GARLIC TREATED OILS

- At 80% load there is 0.54% decrease in brake specific fuel consumption and 0.48% increase of brake thermal efficiency with treated tobacco seed oil over tobacco seed oil indicates the effectiveness of garlic treatment given to the tobacco seed oil. The marginal increment in maximum peak pressure may be the reason for marginal improvement in brake thermal efficiency. In case of treated tobacco seed oil the cumulative heat release value almost equal to untreated tobacco seed oil operation at 17 °Crank Angle
earlier and this may be the reason for marginal improved performance with treated tobacco seed oil. More over with treated tobacco seed oil the fuel injection pressure is reduced from 260 bar to 220 bar and the fuel injection timing from 26°BTDC to 23°BTDC to achieve the best performance obtained with best setting for tobacco seed oil. This is highly advantageous for the agriculturists, who does not know the technical aspect of changing of fuel injection timing but he can be taught of the simple technique of increasing the fuel injection pressure.

- In case of treated pongamia oil at 80% load there is 4% decrease in brake specific fuel consumption and 3.86% improvement in brake thermal efficiency compared with pongamia oil at best injection pressure and timing. The 2° and 3°Crank Angle advance in case of treated pongamia oil for 5% and 90% mass fraction burnt clearly indicates enhanced combustion. More over with treated pongamia oil the fuel injection pressure is reduced from 260 bar to 240 bar and the fuel injection timing from 26°BTDC to 23°BTDC to achieve the best performance obtained with best setting for tobacco seed oil. Hence the garlic treatment is effective and the change of fuel injection timing can be avoided but fuel injection pressure can be increased to gain the maximum benefit.

- The garlic treatment for mahua oil is not that effective as in the case of tobacco seed oil and pongamia oil. Further investigations are needed to optimize the garlic quantity to achieve better results.
10.4 SCOPE FOR FUTURE WORK

1) Blending of oils can be done by varying the blend proportions to optimize the best blend among the oils used.

2) Garlic treatment can be extended to more number of oils to study its effectiveness on them.

3) Garlic treatment can be extended to blends to reap better results.

4) Endurance tests can be performed to study the long term operational difficulties.