A Comparative Study of Different Methods of Using Animal Fat as a Fuel in a Compression Ignition Engine

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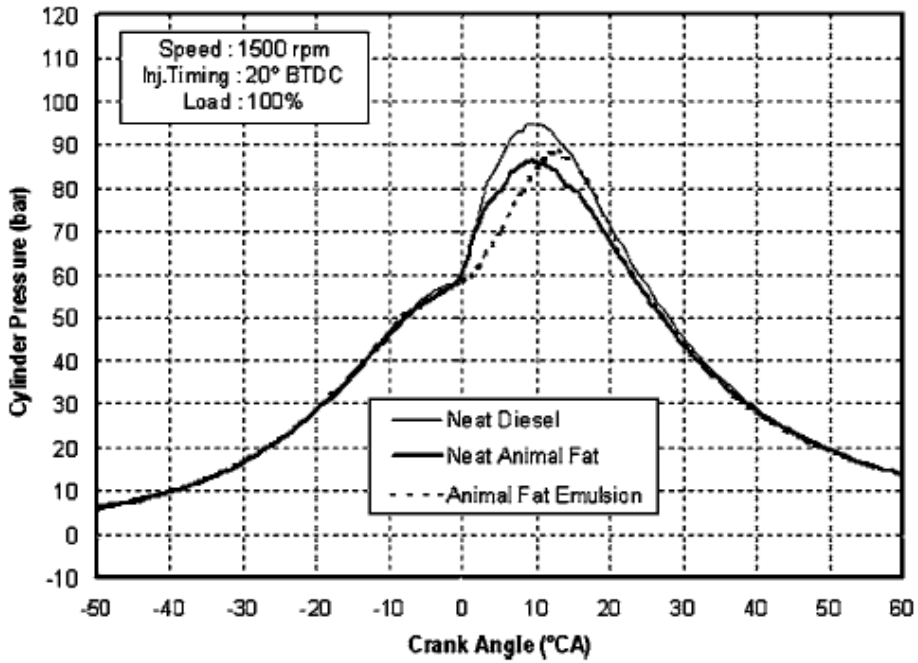
Introduction

- Motives for using animal fat as fuel:
  Energy Crisis, Global Warming, etc.
- This article reports on the emissions and combustion characteristics of a diesel engine fueled by animal prepared with different methods.
- Comparison is made for these cases:
  - Neat diesel and neat animal fat at normal temperature
  - Animal fat with preheating at 70 °C and emulsions of animal fat with methanol
  - Neat animal fat and emulsions of animal fat with ethanol

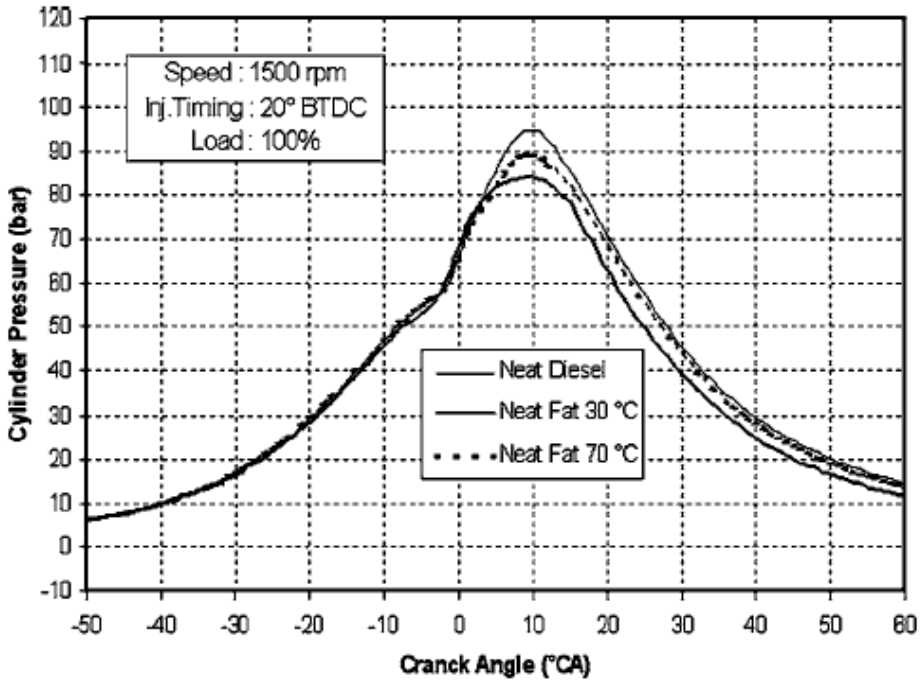
Results and Discussion



Neat animal fat and animal fat emulsions have lower peak pressures.

Cylinder pressure crank-angle diagram with methanol animal fat emulsion at maximum power output.

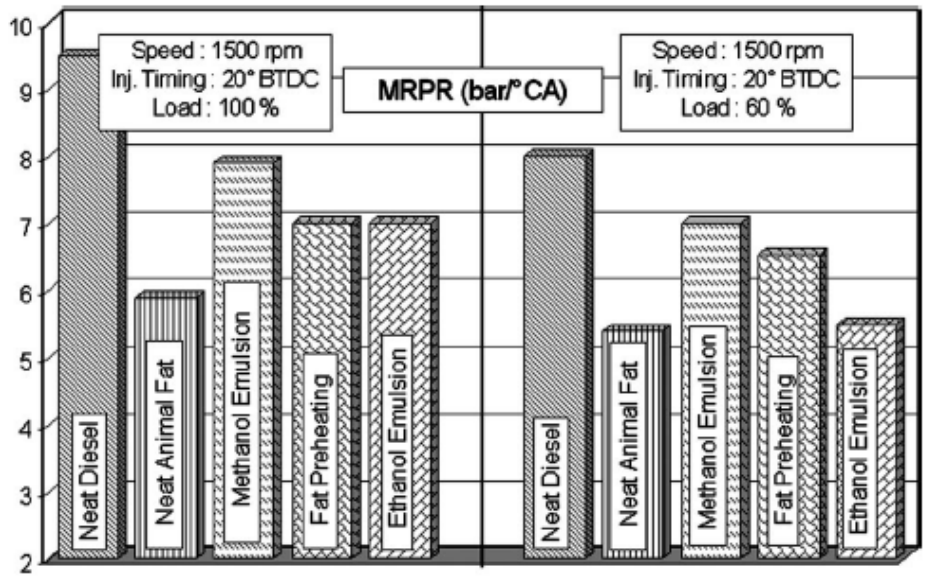
Results and Discussion



Neat animal fat results in lower peak pressures.

Cylinder pressure crank-angle diagram with preheated fat at maximum power output.

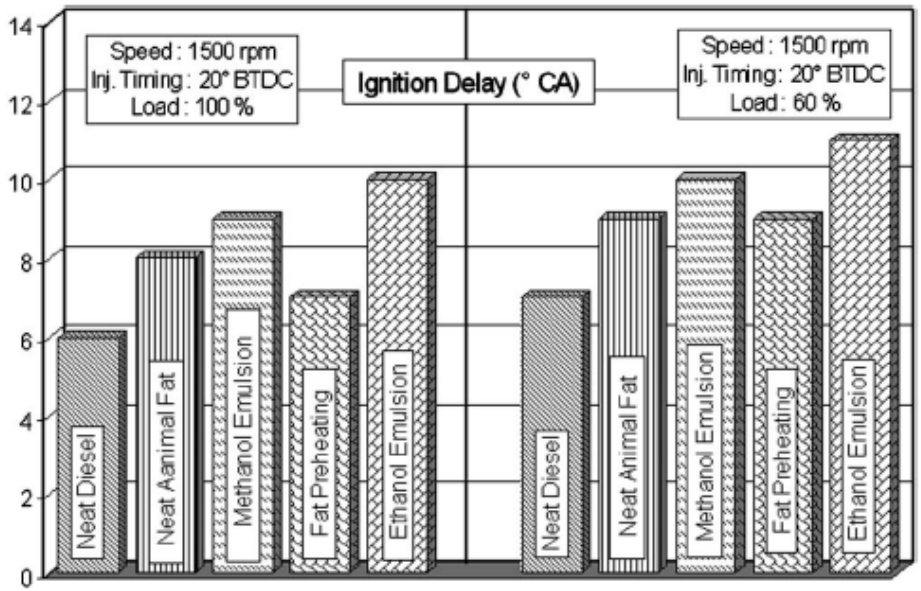
Results and Discussion



Higher viscosity and poor volatility of the neat animal fat at normal temperature result in lower peak pressure and maximum rate of pressure rise as compared to neat diesel.

Variation of maximum rate of pressure rise with different methods.

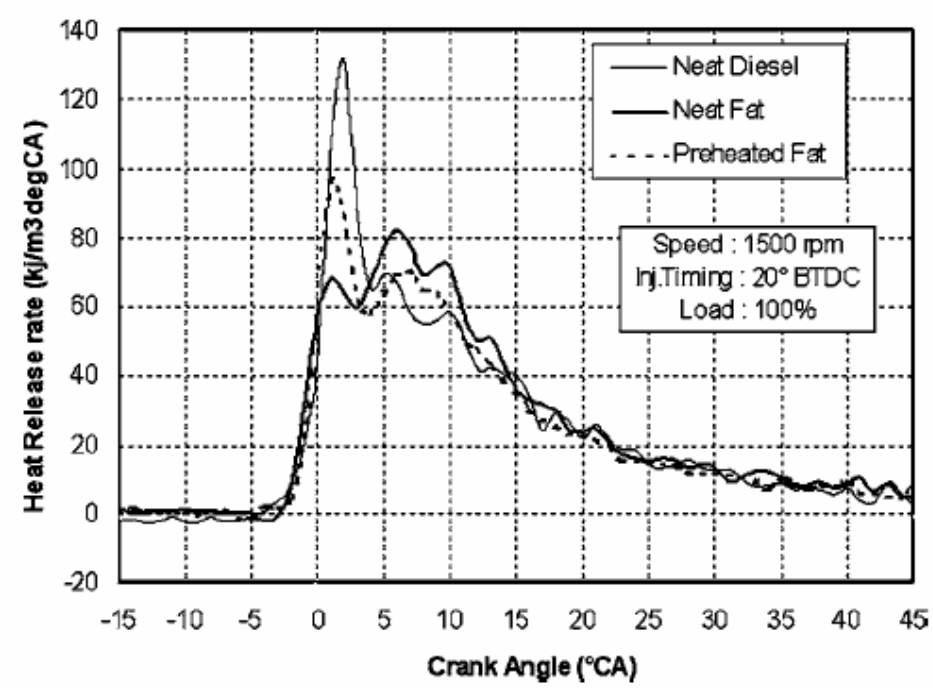
Results and Discussion



Variation of ignition delay with different methods.

Neat fats exhibit longer combustion duration due to the injection of larger quantities of animal fat than diesel for the same load conditions. The heating value of animal fat is lower than diesel fuel.

Results and Discussion



The heat release rate is calculated by performing the first law analysis of the average pressure versus crank-angle variations:

$$dQ = \left(\frac{\gamma}{\gamma - 1}\right) P dV + \left(\frac{1}{\gamma - 1}\right) V dP$$

where γ is the ratio of specific heats, P is the cylinder pressure and V is the instantaneous volume.

Variation of heat release rate with preheated animal fat at peak power output.

Results and Discussions

Methods	Neat fuel operation		Emulsified fuel	
Fuels	Neat fat	Preheated fat	Methanol	Ethanol
SEC	↑	↑	↑	↑
EGT	↑	↑	↑	↑
Smoke	↓	↓	↓	↓
NO	↓	↑	↓	↓
CO	↑	↓	↓	↓
HC	↑	↑	↓	↓
PP	↓	↓	↓	↓
MPPR	↓	↓	↓	↓
ID	↑	↑	↑	↑
CD	↑	↑	↑	↑
HRR	↓	↑	↑	↑

Summary of the results obtained with different fuels tested and their effects relative to base diesel at peak power output.

Emulsions of animal fat with alcohols show considerable improvement in SEC and reduction in exhaust gas temperature, hydrocarbon, and carbon monoxide emissions.

Conclusion

- Preheated animal fat and emulsions of animal fat with methanol/ethanol can be used as fuel in a diesel engine with improved performance and reduced emissions as compared to neat fat. Emulsification of animal fat with methanol and/or ethanol can be preferred as better methods to use animal fat efficiently in a diesel engine with a drastic reduction in all emissions as compared to fat preheating.
- Preheating can lead to a slight improvement in engine performance and emissions without modifying the fuel.
- Measures must be taken to control NO emissions with fat preheating.