

Performance and Characteristics of a CI Engine Using DME (Dimethyl Ether)

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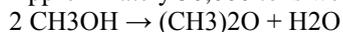
ABSTRACT: This Improvement of fuel properties essential for suppression of pollutant and optimization of engine performance. One way is use of additives. Oxygenated additives were conventionally recommended for gasoline. But now day's oxygenated additives are widely considered for diesel fuel also. This paper reviews the available oxygenated additives and compares their effect on exhaust gas emission with help of conference papers and journals. During study of available material It is found that, oxygenated are effective method for reducing PM, CO and HC without significant increase in the NOx emission.

KEYWORDS: Diesel engine; DME; Oxygen content; Emission; NOx

I. INTRODUCTION

Demand for cleaner burning diesel fuels is growing worldwide, as governmental regulations make emission reduction necessary. In the USA and some European countries, future regulations that will take effect in 2007 and later require diesel engine and vehicle manufacturers to review all aspects of the vehicle system design Therefore, much research has focused on screening of oxygenated fuel additives, including alcohols, esters and ethers. Dimethyl ether (DME) is regarded as one of the promising alternative fuels or oxygen additives for diesel engines, with its advantages of a high cetane number and oxygen content. Over the past ten years, researchers have begun to consider the use of DME as a fuel. Because its cetane number and ignition temperature are close to that of diesel fuel, DME was thought to be an excellent substitute for use in compression ignition engines.

Approximately 50,000 tons were produced in 1985 in Western Europe by dehydration of methanol:[3]



The required methanol is obtained from synthesis gas (syngas).[4] In principle, the methanol could be obtained from organic waste or biomass. Other possible improvements call for a dual catalyst system that permits both methanol synthesis and dehydration in the same process unit, with no methanol isolation and purification.[4][5] Both the one-step and two-step processes above are commercially available. Currently, there is more widespread application of the two-step process since it is relatively simple and start-up costs are relatively low. It is worth mentioning that there is a developing one-step liquid-phase process.[4][6] The largest use of DME is as the feedstock for the production of the methylating agent, dimethyl sulfate, which entails its reaction with sulfur trioxide:



This application consumes several thousand tons of DME annually.

DME can also be converted into acetic acid using carbonylation technology related to the Monsanto acetic acid process:[3]



DME is a low-temperature solvent and extraction agent, applicable to specialised laboratory procedures. Its usefulness is limited by its low boiling point (-23 °C), but the same property facilitates its removal from reaction mixtures. DME is the precursor to the useful alkylating agent, trimethyloxonium tetrafluoroborate.[7]

The first strategy tested liquid direct injection in a compression-ignition (diesel) engine utilizing highly advanced injection timings. Ammonia was used with dimethyl ether (DME) in a duel fuel combustion strategy. Ammonia was mixed with DME prior to injection. DME was chosen as a diesel substitute for its close fuel properties to ammonia. Three ammonia-DME ratios were tested: 100%DME, 60%DME-40%NH₃, and 40%DME-60%NH₃. Engine speeds of 1900 rpm and 2500 rpm were used based on the operational capability of 40%DME-60%NH₃.

Operation at 40%DME-60%NH₃ required injection timing ranging from 90-340. Highly advanced injection timings resulted in homogeneous charge compression ignition combustion (HCCI). Cycle-to-cycle variations were reduced with increased load. NO_x, NH₃, CO, CO₂, and HC were reduced with increased load for 40%DME-60%NH₃. Low temperature combustion from low in-cylinder temperature from ammonia vaporization resulted in low NO_x emissions meeting EPA emissions standards for small engine operation.

The second strategy tested gaseous direct injection of ammonia in a spark-ignition (gasoline) engine. A CFR engine was operated at idle using the existing gasoline port injection system. Ammonia was directly injected using a solenoid injector. A ruthenium catalyst was implementing to partially decompose ammonia into hydrogen. Testing was performed over a range of seven performance modes using gasoline, gasoline-ammonia, and gasoline-ammonia with ruthenium catalyst. Injection timings of 270, 320, and 370 BTDC were used.

Gasoline-ammonia showed little improvement in break specific energy consumption and CO₂, and exhibited increased levels of NO_x and HC over performance modes using gasoline only. Due to ammonia's low flammability limits and slow flame speed combustion efficiency was reduced. With the ruthenium catalyst Improvements in flywheel power were seen over performance modes without catalyst. The peak in-cylinder pressure was increased, and the start of ignition was advanced over both gasoline-ammonia and gasoline only performance modes. There was a significant reduction in NO_x and NH₃ present in the exhaust. Hydrogen present in the fuel increased combustion efficiency due to high flammability limits and high flame speed. Improvements in combustion efficiency resulted in reduced CO and HC over both gasoline-ammonia and gasoline only performance modes.

II. PERFORMANCE GRAPHS

LOAD VS BRAKE THARMAL EFFICIENCY

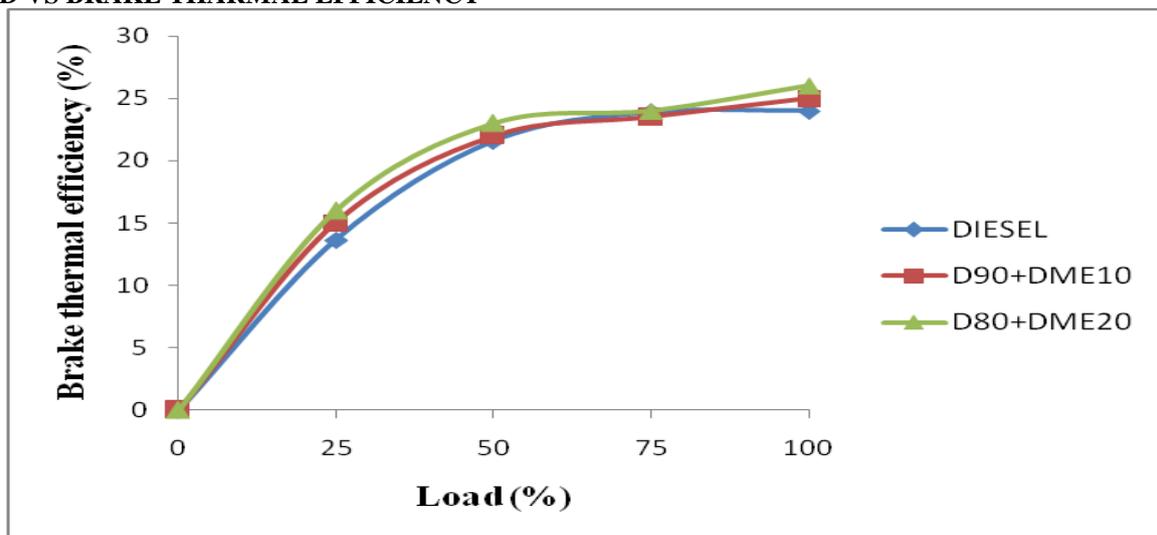


Fig 1 Load vs Brake Thermal efficiency

From Fig1 Load vs brake thermal efficiency the efficiency is increased by using DME. As percentage of DME increases the brake thermal efficiency also increases. This is due to low calorific value of DME. If calorific value decreases the brake thermal efficiency increases.

LOAD VS NO_x(Emission)

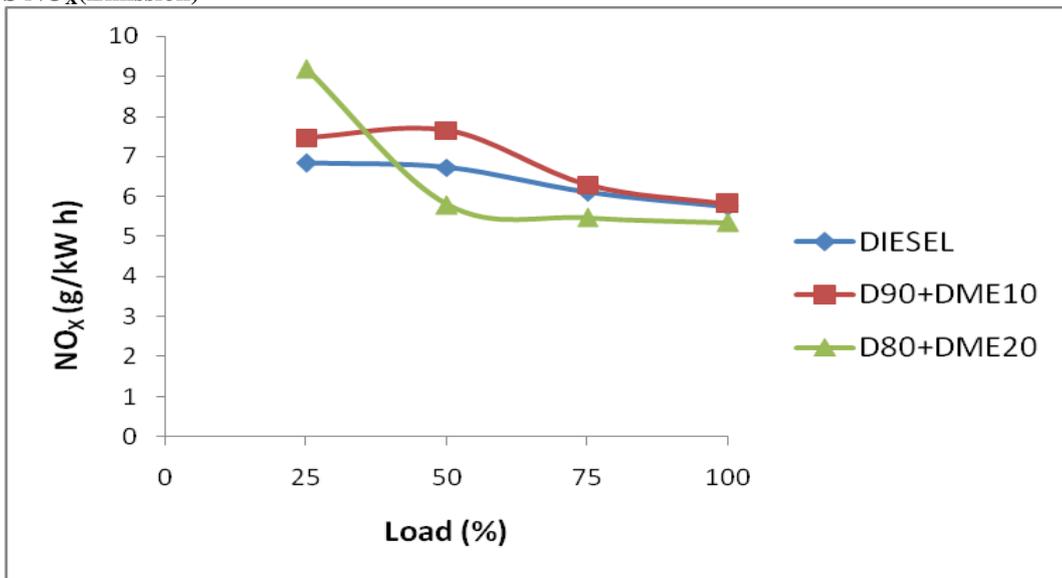


Fig 2 Load vs NO_x

From fig 2 the nitrous oxide increases as DME percentage is increased to diesel. This is due to increases the temperature of combustion. DME increases the combustion gas temperature and when temperature increases the NO_x increases. This is due to incomplete combustion.

LOAD VS SMOKE

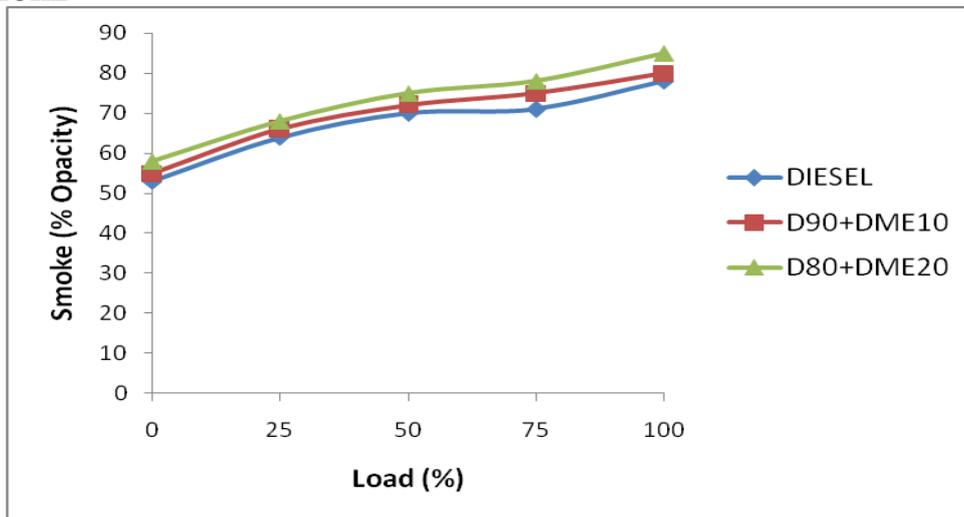


Fig 3 Load vs Smoke

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From Fig 3 The percentage of smoke increases as DME is added to diesel. This is due to incomplete combustion of the combustion product. When DME is added to diesel the combustion become incomplete. So, the smoke emission is more as percentage of DME increases.

III. CONCLUSION

- 1) Brake Thermal efficiency increases when DME percentage increases. Because of low calorific value of DME.
- 2) The NO_x emission increases as DME is added to diesel. Because the combustion temperature increases as DME is added to diesel.
- 3) The Smoke emission increses as DME is added to diesel. This is due to incomplete combustion of fuel.

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