

A LITERATURE REVIEW ON COMBINE EFFECT OF DI-METHYL ETHER (DME) AS AN ADDITIVE & THE INJECTION PRESSURE ON THE PERFORMANCE & EMISSION OF 4 STROKE C.I ENGINE

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Abstract: The aim of this study is to investigate the effects of DME as an additive on engine performance & emission characteristics in 4 stroke diesel engine. An investigation will occur on engine with supplying different flow rate of DME with intake air & vary the injection pressure of diesel fuel injector. Due to high cetane number of DME compared with diesel will improve ignition quality. Also DME has a superior vaporization quality than conventional diesel. So, it has an advantageous effect on combustion & emission compare with neat diesel.

Key words: Diesel, Di-methyl ether (DME), Injection pressure, Engine performance, Exhaust parameters

I. INTRODUCTION

The reserve of petroleum over the world is limited. It is very important to save petroleum fuels or find some substitutes. The precise scale of oil reserves left and the ultimate availability of fossil fuels worldwide are hard to determine. Petroleum energy is the basic energy source in the transportation and industrial fields. Many alternative or blend fuels are identified and tested successfully in the existing engine with and without engine modification. However, research is still continuing in this field to find the best alternative fuel for the existing diesel fuel.

As per current scenario, India is a diesel based economy. Diesel consumption is around five times the consumption of petrol. So, to reducing the pollution & achieve a great economical benefit, we have to find suitable alternatives for diesel engine and must be do research work on them.

DME has a higher cetane number than diesel, and hence can be used in diesel engines. It is completely safe with no adverse impact on health, and hence no health hazards are foreseen with widespread use of DME. It has no sulfur content, and hence does not produce Sox emissions. It has no direct carbon-carbon bond and hence has lower chances of soot formation.

Properties of Diesel & DME

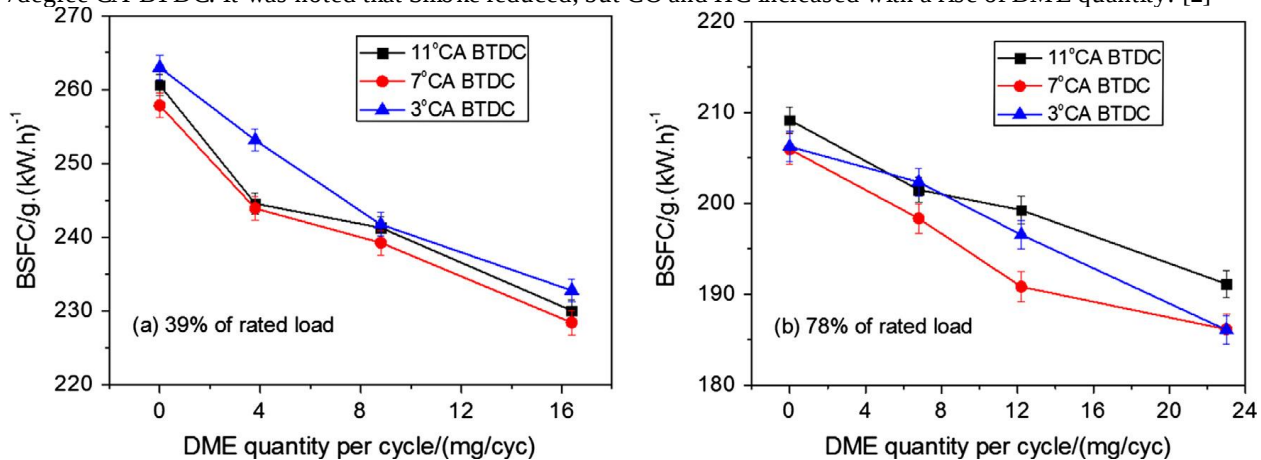
Properties (condition)	Unit	DME	Diesel
Chemical structure		CH ₃ -O-CH ₃	
Molar mass	g/mol	46	170
Carbon content	Mass%	52.2	86
Hydrogen content	Mass%	13	14
Oxygen content	Mass%	34.8	0
C-to-H ratio		0.337	0.516

Cetane number		>55	40-50
Auto-ignition temperature	K	508	523a
Stoichiometric A-F ratio		9	14.6
Lower heating value	Mj/kg	27.6	42.5

II. LITERATURE SURVEY

Su Han Park et al. (2014) had indicate in their article about the application characteristics of DME in CI engines, including its fuel properties, spray and atomization characteristics, combustion performance, and exhaust emission characteristics. They also said that Combustion of DME fuel is associated with low NO_x, HC, and CO emissions. In addition, PM emission of DME combustion is very low due to its molecular structure. Moreover, DME has superior atomization and vaporization characteristics than conventional diesel. A high exhaust gas recirculation (EGR) rate can be used in a DME engine to reduce NO_x emission without any increase in soot emission, because DME combustion is essentially soot-free. [1]

Ying Wang et al. (2013) had worked on the combustion and exhaust performance of a DME premixed charge compression ignition diesel engine. They analyzed that At the fixed direct-injection timing, BSFC decreased slightly with a rise of DME quantity due to CA50 closer to TDC. At a fixed DME quantity, BSFC was lowest when diesel was injected into cylinder at 7degree CA BTDC. It was noted that Smoke reduced, but CO and HC increased with a rise of DME quantity. [2]



As more DME was aspirated from port, No_x emission decreased firstly but this decreasing trend cease later. In this paper, the combustion scheme of the in-cylinder diesel injection combined with port premixing DME was proposed DME/air charge could be fed into combustion chambers before diesel combustion and DME premixed charge compression ignition diesel combustion can be achieved. in this proposal, DME is gaseous state at normal temperature and pressure and can mix uniformly with air in the inlet port owing to its low boiling point. The tests conducted in a two-cylinder, four-stroke, naturally aspirated, DICl diesel engine. The inlet and fuel system were reformed for the successful port DME premixed charge compression ignition diesel combustion. DME stored in a pressured tank, whose flowing rate was controlled by a one-way flow valve. Engine speed was maintained at 2100 r/min. Tests were carried out with different DME flowing rates of 3.8 mg/cyc, 8.8 mg/cyc and 16.4 mg/cyc at 39% load(40 N m); and with different DME flowing rates of 6.8 mg/cyc, 12.2 mg/cyc and 23.0 mg/cyc at 78% load (80 N m).

Jinyoung Jang et al. (2013) have studied the combustion characteristics on homogeneous charge compression ignition (HCCI) engine fuelled with DME, direct injection and exhaust gas recirculation (EGR) were used. The engine was a four-stroke, water-cooled, and single-cylinder double overhead camshaft (DOHC) engine. The DME fuel injector was placed upstream, 30 cm away from the intake port, to form a homogeneous air/fuel mixture and another injector was installed in cylinder to inject the fuel into the cylinder. Direct injection made combustion characteristics change from HCCI to traditional compression ignition (CI) by varying direct injection timing. During the combustion characteristics change from fully homogeneous combustion to mixing controlled like combustion, HCCI combustion with locally rich combustion took place and it was not only to increase IMEP gross but also to decrease hydrocarbon (HC) and carbon monoxide (CO) due to lack of mixing time[3].

G. Thomas et al. (2013) worked on number of experimental investigations conducted on DME combustion in the following topic areas; (a) potential of using DME as a diesel alternative, (b) DME blend fuels in CI engines, and (c) emissions from DME combustion. They also analyzed the effects of injection strategies. They conclude that advantages of DME combustion is the low emission levels of nitrous oxides (NO_x) and particulate matter (PM) when compared to diesel combustion. In this paper, the body of experimental and numerical research on gaseous and PM emissions from DME combustion is reviewed, with the objective being to identify promising methods for emission control in DME engines. [4]

Hyeonsook Yoon et al. (2012) have worked on single cylinder direct injection compression ignition (DICI) engine with a common-rail fuel injection system. DME was supplied through a commercial diesel common-rail injection system. Fuel was injected with a seven-hole solenoid type commercial diesel injector. Injection of DME was split in two position, one main injection & other post injection. They tested the combustion performance & emission by employed varying post injection timing & quantities. The fuel quantity from main injection with post injection was smaller than that of single injection because the fuel injection was split into two. This reduced the pressure rise rate and the heat release rate during main combustion. Hydrocarbon (HC) and carbon monoxide (CO) emissions were reduced with post injection close to the main injection. However, as the post injection timing was retarded, the post combustion temperature was lowered due to volume expansion during the expansion stroke. This increased the HC and CO emissions for late post injection timing. Oxides of nitrogen (NO_x) emissions were reduced with a post injection. The post combustion reduced the main fuel quantity by the split injection. This reduced NO_x production during the main combustion. Post combustion occurred at low in -cylinder gas temperature and released small amount of heat. Therefore, post combustion did not contribute in the production of NO_x emissions. [5]

Su Han Park et al. (2012) had studied overview of a dimethyl ether (DME) fuel application for a compression ignition diesel engine. In this article, they said that DME combustion is soot-free since it has no carbon carbon bonds, and has lower HC and CO emissions than that of diesel combustion. The NO_x emission from DME-fueled combustion can be reduced by the application of EGR (exhaust gas recirculation). They also discuss the properties of DME like vapor pressure, kinematic viscosity, cetane number, and the bulk modulus, oxygen content, latent heat, lower heating value etc. [6]

Wang Ying, et al. (2008) have carried out in their study Performance, emission and other features of three kinds of DME/diesel blend fuels and diesels are evaluated in a four-cylinder test engine. In our experiments the blend of 10%DME and 90%diesel is called DM10. Blend of 15% DME and 85%diesel is called DM15. Blend of 20%DME and 80% diesel is called DM20. The vapor pressure of DME/diesel blends is lower than that of pure DME and it decreases with an increase of diesel in blend fuel, which is beneficial to the elimination of vapor lock in the fuel supply system at engines. The impacts of DME content on emissions vary with engine operating conditions. At high load conditions, smoke emissions reduce about 58%–68% for blend fuel engine in comparison to that for diesel engine. At low loads, smoke emissions for blend fuel engine are almost comparable to that for diesel engine.

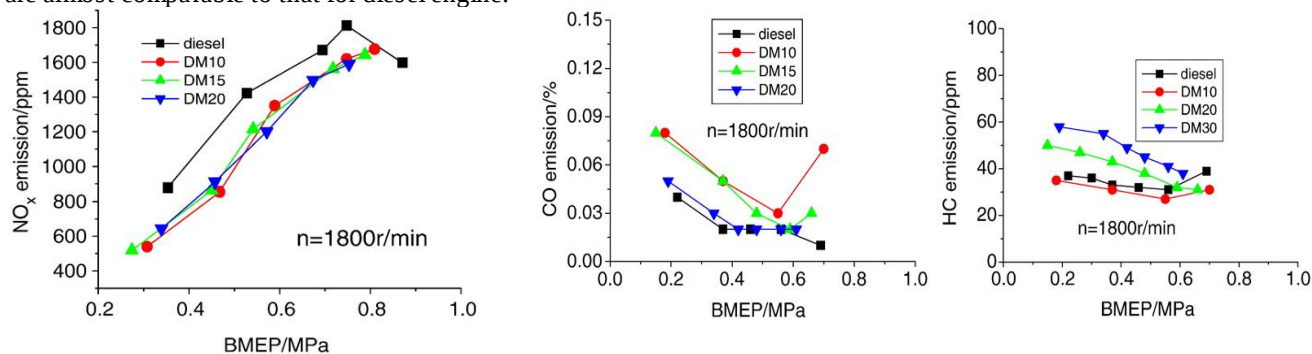


Fig. 2 The comparison of NO_x, CO & HC emissions among various fuels.

With the addition of DME, NO_x emissions decrease a little, while CO emissions and unburned HC emissions increase at most operating conditions. If the fuel supply advance angle is retarded appropriately, the power output would be improved somewhat and NO_x emission could be reduced further. [7]

Li Xinling, et al. (2008) have investigated the engine performance characteristics and both of regulated (CO, HC, NO_x, and smoke) and unregulated (ultrafine particle number, mass concentrations and size distribution) emissions for a turbocharged diesel engine fueled with DME at different engine loads and speeds have been carried out. The maximum torque and power at full load for DME are greater than that for diesel, particularly at low engine speed. The improvement in the fuel economy was observed at low engine speed for DME, compared with diesel. DME markedly reduces the emissions of HC by 40.1% and NO_x by 48.2%, on average, in comparison to diesel. DME is smoke free throughout all the engine conditions. [8]

Constantine Arcoumanis et al. (2007) had studied in this review the properties and application of di-methyl ether (DME) as a candidate fuel for compression-ignition engines. DME's diesel engine-compatible properties are its high cetane number and

low auto-ignition temperature .they concluded that V the soot formed in DME combustion should be almost zero at an oxygen content of 35% and no C–C bonds. NO_x emissions from DME CI engines and those from diesel fuel seem to vary depending on the engine conditions. HC emissions from DME are usually lower than or equal to those from the combustion of diesel fuel; DME has good mixing characteristics, so that the locations of the fuel-rich regions in the combustion period could be reduced, resulting in lower CO emissions. [9]

Zhang Bo et al. (2005) had studied the effect of DME on fuel consumption which is conducted in a 4 stroke one cylinder direct injection diesel engine. DME was first heated to pyrolyze & then resultant product gas was introduced into intake air. BSFC could be reduced a lot when emulsified fuel was fueled to diesel engine and DME was heated to about 1000 K before it being introduced into air intake. In this study, saving rate of BSFC up to 10% was obtained, while the saving rate of diesel fuel consumption reaches about 18%. Hydrogen produced in DME pyrolysis was considered main reason for the excellent fuel saving. In this experimental study, DME supplied to engine through screwed pipe and an electric heater. Screwed pipe is placed in exhaust pipe, where it is heated. When exhaust gas cannot offer enough heat energy for DME to arrive the high temperature to be fully pyrolyzed, the electrical heater could be turned on as a supplement. After that the pyrolyzed gas is cooled to about 400 K and introduced into the air intake of diesel engine and transported into the combustion chamber with the intake air. [10]

Wang Ying et al. (2005) had analyzed diesel engine performance by used DME/diesel fuel blends. They worked experiment with DME blends 10%,20%,30% by mass. The addition of DME to diesel fuel changes the physicochemical properties of the blends. cetane number, C/H ratio and oxygen content of the blends are enhanced, which has some favorable effects on the ignition and combustion of the blends. At high loads, the blends reduce smoke significantly with a little penalty on CO and HC emissions compared to diesel fuel. NO_x and CO₂ emissions of the blends are decreased somewhat. At low loads, the blends have slight effects on smoke reduction due to overall leaner mixture. The results indicate the potential of diesel reformation for clean combustion in diesel engines. [11]

III. CONCLUDING REMARKS

From the literature survey it is concluded that the DME used as a alternative fuel with diesel fuel or only DME applying into the engine cylinder, get a improving engine performance and a advantageous effect on engine than a only diesel fuel applying. Due to high cetane number of DME compare with diesel fuel, combustion quality was improve and the resulting overall engine performance also improve. Applying DME into engine cylinder effect on exhaust emission also occur. NO_x emission was reduced because of high cetane number & shortens the ignition delay period. DME has a low C/H ratio, lacks of C-C bonds, and has a high oxygen content. So CO & HC emission also decrease. But some certain operating condition the emission of CO & HC were increases. Due to good evaporation characteristics of DME, reduction of soot emission decreased from engine.

IV. SCOPE OF FUTURE WORK

In four stroke single cylinder diesel engine, diesel fuel will be supplied in engine cylinder. Another arrangement will be provided for the supply of DME into engine cylinder. DME will be supplied into engine cylinder with intake air. At this time the flow rate of DME will be observed. With supplying the DME into engine cylinder, injection pressure will be also change. So, we will obtain an effect of both of this on engine performance. Observation will be done with different reading of DME flow rate & injection pressure during engine operation. Thus engine performance parameters & exhaust gas analysis will be observed at the every stage of engine operation.

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