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Performance and Vibration Analysis of Di Diesel Engine with Bio Diesel

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Abstract

Mahua oil is one of the best alternative fuels for diesel engines. Due to its higher viscosity Mahua oil needs transesterification. The author conducted several experiments on diesel, Mahua Oil Methyl Ester and Di Methyl Carbonate as additive. It has been observed change in the thermal efficiency with better and smoother efficiency rise in the case of 6% additive in biodiesel. There is a thermal efficiency rise of 1.08% at full load operation of the engine for 6% additive over the conventional diesel and the difference of increase with respect to biodiesel is 1.04%. There is uniform and sustained combustion with reasonably better rise in the amplitude in 6 milliseconds in the case of 6% additive in biodiesel which can be observed in the figure 6.25 In the case of other fuel samples with more additive the combustion became dull or spectrum became gray in color indicating incomplete combustion /combustion with detonation to some extent.

Introduction

In the present work, neat MOME-DMC additive blends are experimented in lieu of the neat diesel fuel. Pure Mahua oil methyl ester itself has advantages in the operation of engine. Attention is bestowed upon the reduction of HC, NO, CO2, CO and smoke emissions, and the same is successfully achieved with the 6% DMC and 94% MOME blend fuel. With the introduction of new fuel, fuel economy and vibration tendency have been observed to investigate the viability. Vibration on the engine cylinder in three directions and on the foundation were measured and analyzed to elicit information about the nature of combustion since the combustion itself is the exciter.

Experimentation

The experiments were conducted on the engine operated at normal room temperatures of 28^0 C to 33^0 C in the Department of Marine Engineering, Andhra University. Hybrid fuel of Mahua Oil Methyl Ester MOME and with DMC as additive is taken up at five (3%, 6%, 9%, 12% and 15%) different percentages by volume. Neat diesel oil and pure biodiesels are also implemented at five discrete part load conditions to enable for comparison. The data collection is done independently for the above said oils. The engine is run at 1500 rpm continuously for one hour in order to achieve thermal equilibrium under operating conditions. After this period, the combustion pressure is monitored at each degree of crank revolution for every load on the engine. Fuel consumption measured at all loads and the engine vibrations were also recorded at full load. From the P-θ signatures obtained, the net heat release rates have been derived for the above said esters with the software designed based on the Gatowski heat release rate model. Exhaust gas emissions and smoke measurements were also made at different loads. The DELTA 1600-L measures the exhaust emissions of carbon monoxide, carbon dioxide, hydro carbon by the means of infrared measurement. Oxygen and Nitrogen monoxide are measured. DIESEL TUNE 114 smoke meter is used to find out the smoke density of the samples. Vibration studies have been made to verify any abnormal combustion compared to diesel and MOME with DMC blends. Study of frequency spectrums and time waves presents the clear picture about combustion.

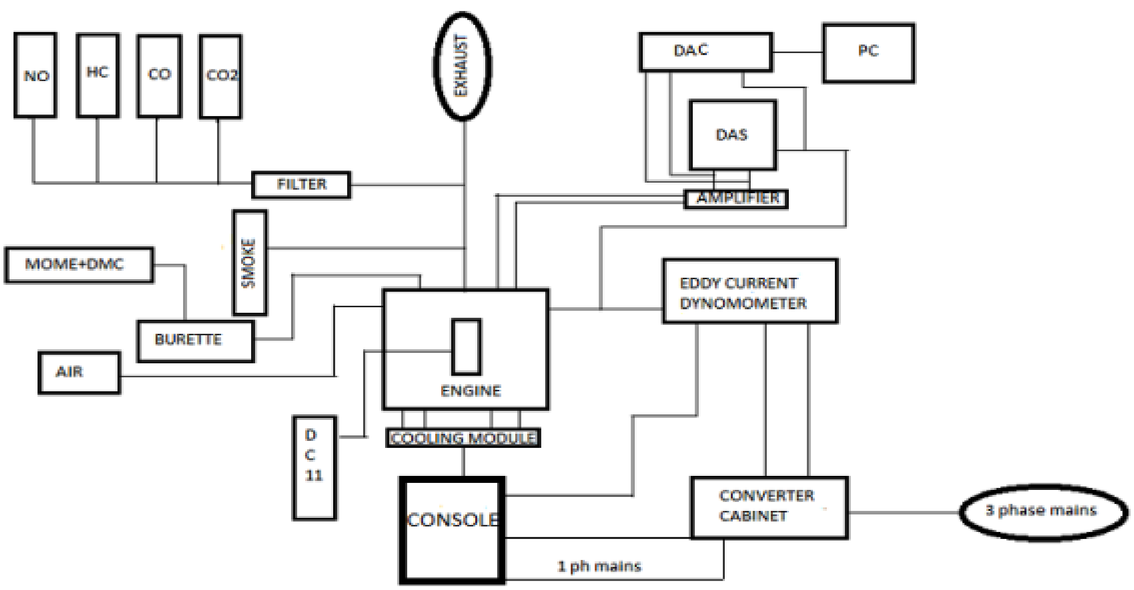

Fig.1

Results & discussion

Mahua Oil Methyl Ester (MOME) with the various percentages of Di Methyl Carbonate (DMC) ranging from 3%, 6%, 9%, 12% and 15% by volume was taken as fuel samples and experiments were conducted. Various parameters like specific fuel consumption, thermal efficiency, heat release rates, exhaust temperatures, smoke levels, exhaust components and engine cylinder vibration were studied and conclusions were drawn.DMC has calorific value of 15780 kJ /kg and viscosity of 0.664 cSt and with cetane number of 35. The molecular oxygen content is 53.3% with stoichiometric air-fuel ratio of 3.5 with chemical formula of $C_3H_6O_3$.The motive behind mixing of DMC is to facilitate viscosity reduction of the total blend to improve the injection properties and to supplement more Oxygen to upgrade the combustion propensity.

FFT velocity spectrums give better combustion trend than acceleration plots recorded by the vibration spectrum analyzer. The figures from 3to 5 envisage the velocity spectrums of vibration on the cylinder head in vertical direction. The spectrums in the vertical direction give the meaningful samples since they were recorded in the direction of torque conversion and piston movement. The amplitude rise of velocity within 1000 Hz present complete information of the combustion inside the cylinder. The velocity spectrum of the vibration for 6% additive in biodiesel presents smoother combustion than other samples including the neat biodiesel operation of the engine at full load. Figures 6 to 8 represent the time waves of vibration for the fuel samples tested at full load running of the engine. The working cycle encompasses 80 milli seconds of time and the combustion explosion take nearly 6 milliseconds. There is uniform and sustained combustion with reasonably better rise in the amplitude in 6 milliseconds in the case of 6% additive in biodiesel which can be observed in the figure 6.25 In the case of other fuel samples with more additive the combustion became dull or spectrum became gray in color indicating incomplete combustion

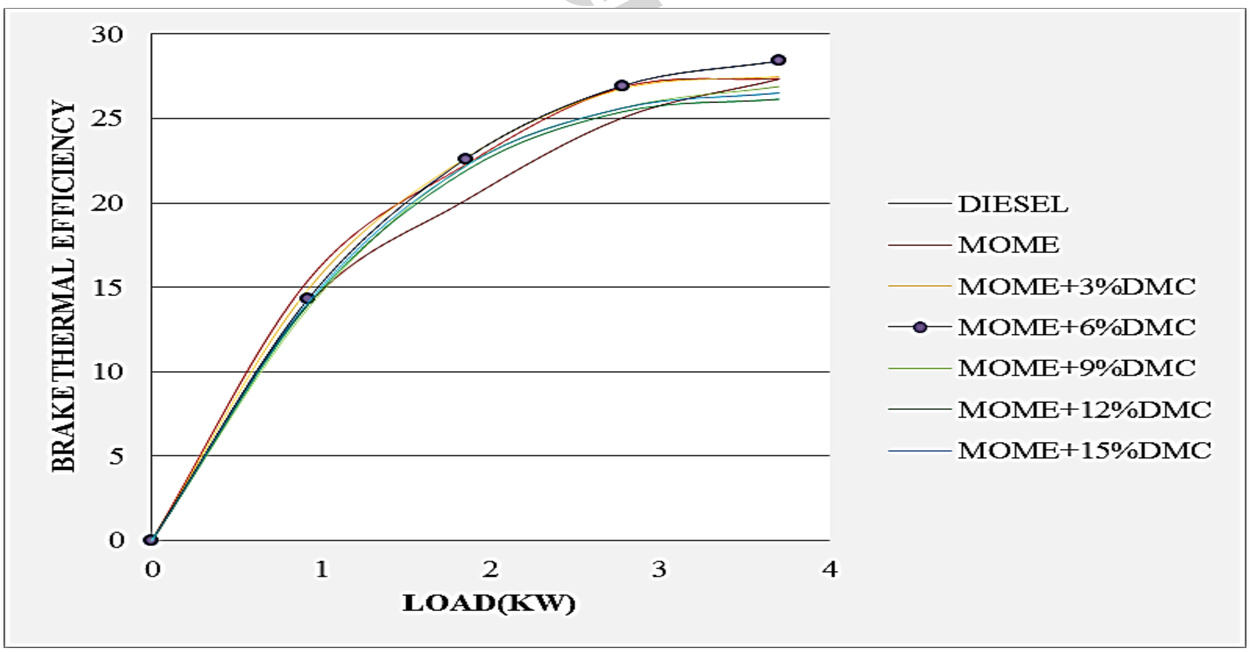

Fig.2

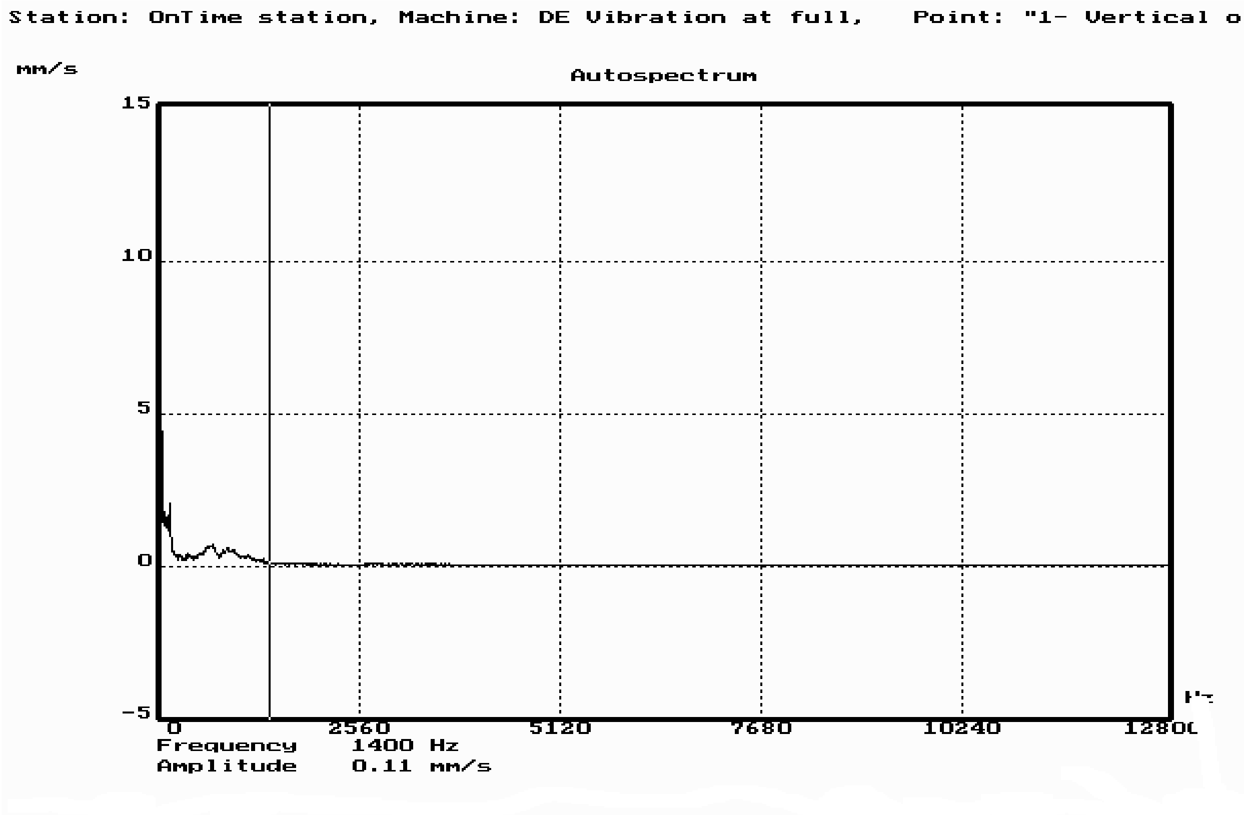

Fig.3 F FT spectrum at full load recorded vertical on the cylinder head with the real time injection of DIESEL**.**

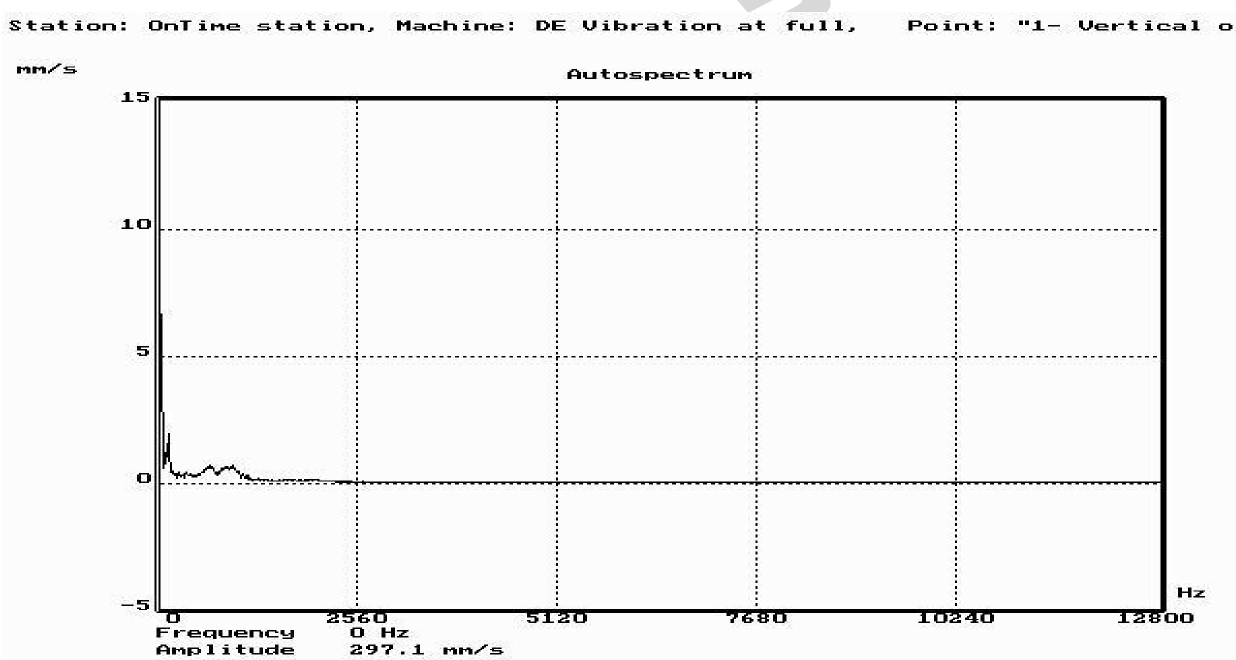

Fig. 4 FFT spectrum at full load recorded vertical on the cylinder With real time injection of MOME

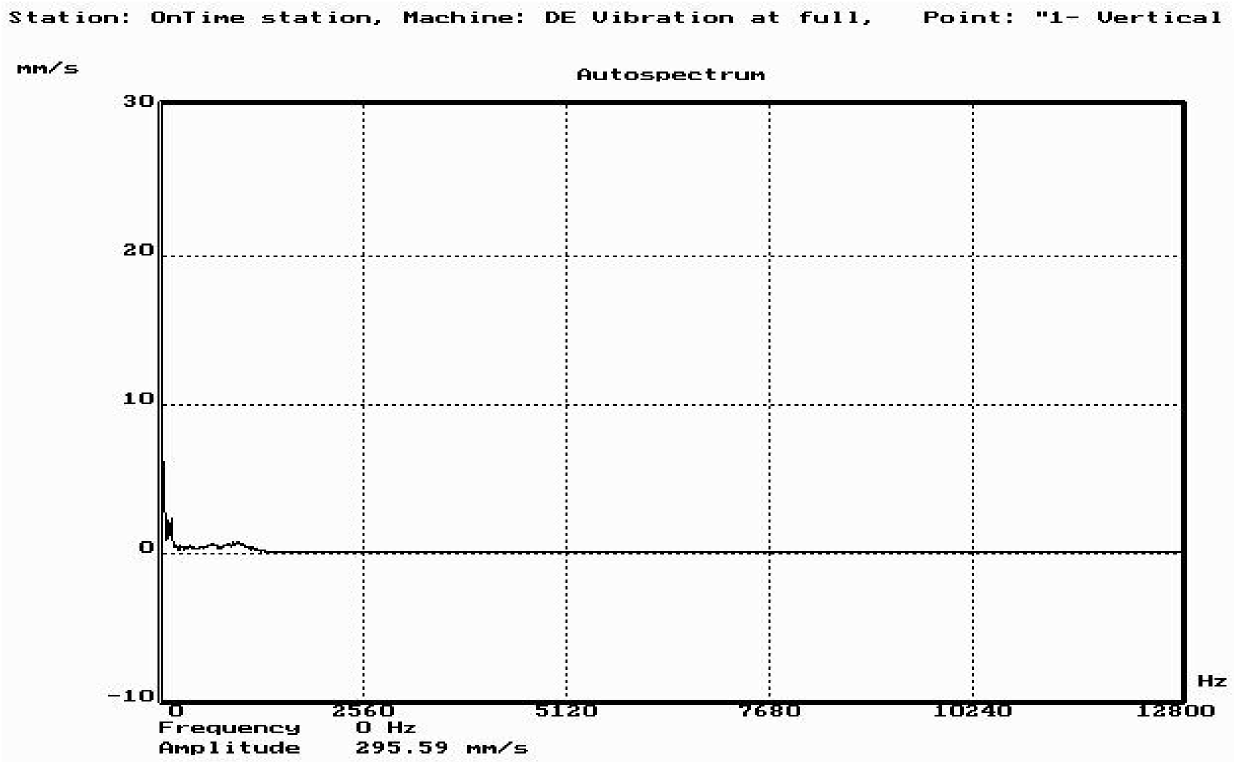

Fig.5 FFT spectrum at full load recorded vertical on the cylinder head with real time injection of MOME plus 6%additive

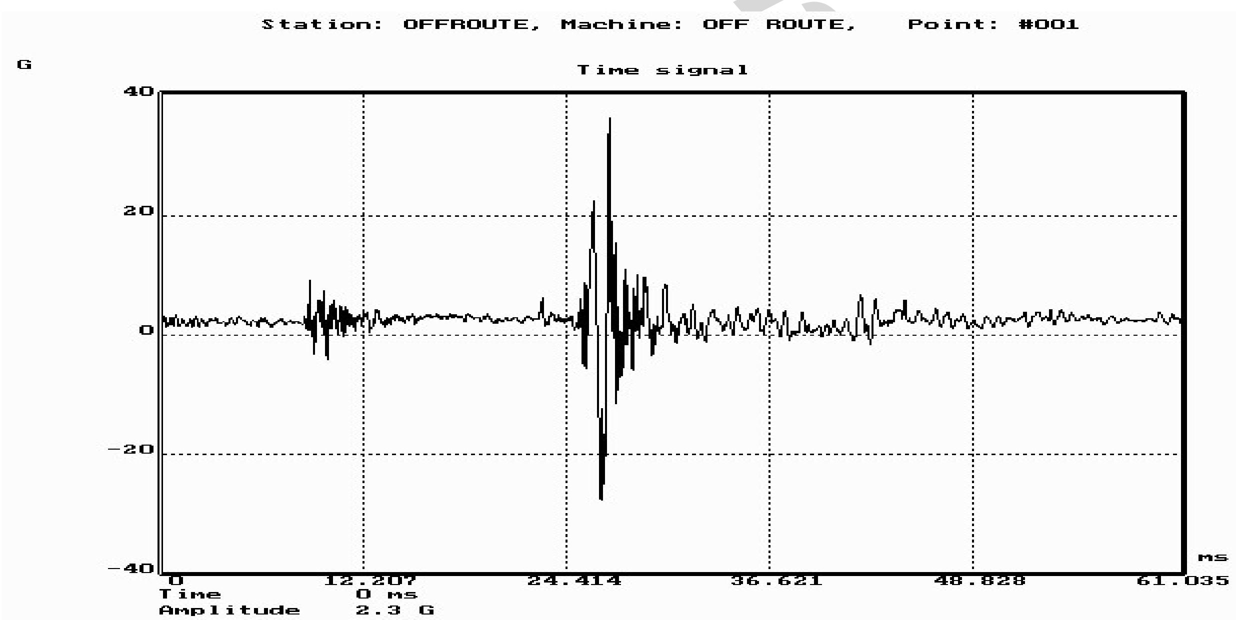

Fig.6 Time wave form recorded vertical on the cylinder head with real time injection of Diesel at full load

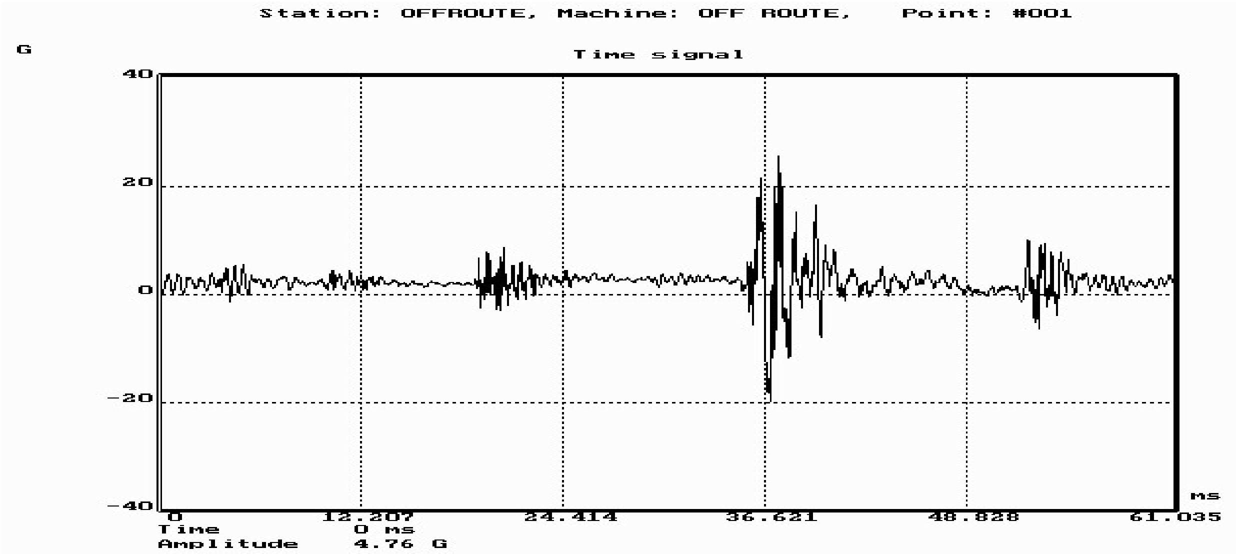

Fig.7. Time wave form recorded vertical on the cylinder head With real time injection of MOME at full load.

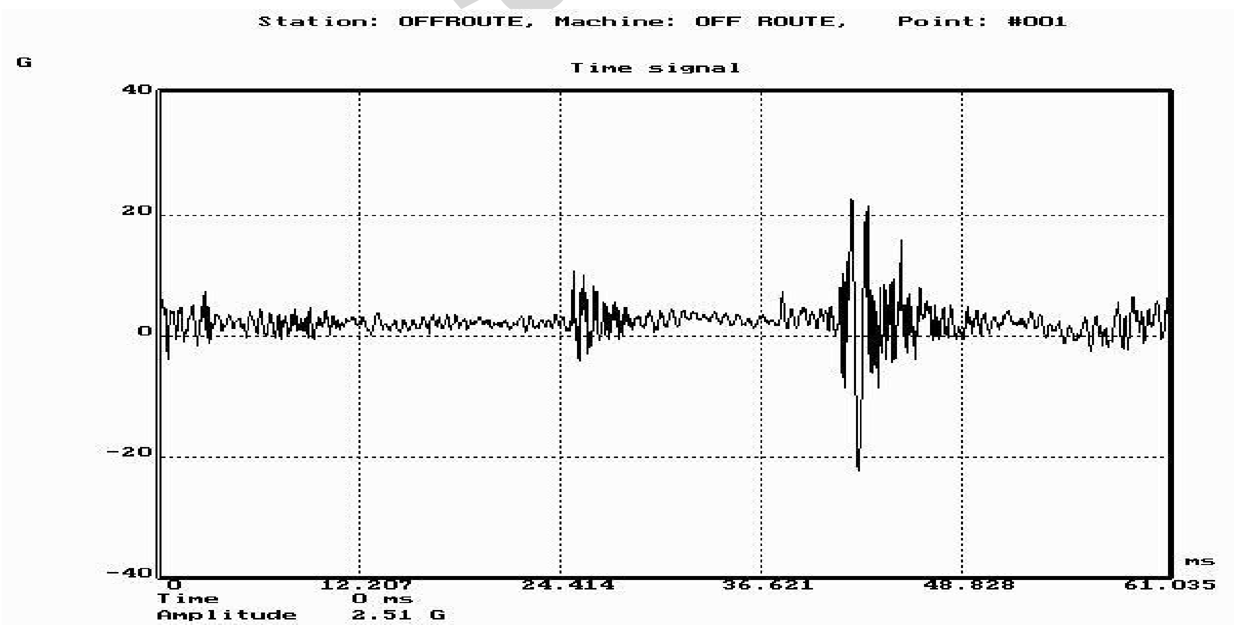

Fig.8 Time wave form recorded vertical on the cylinder head with real time injection of MOME plus 6% additive at full load

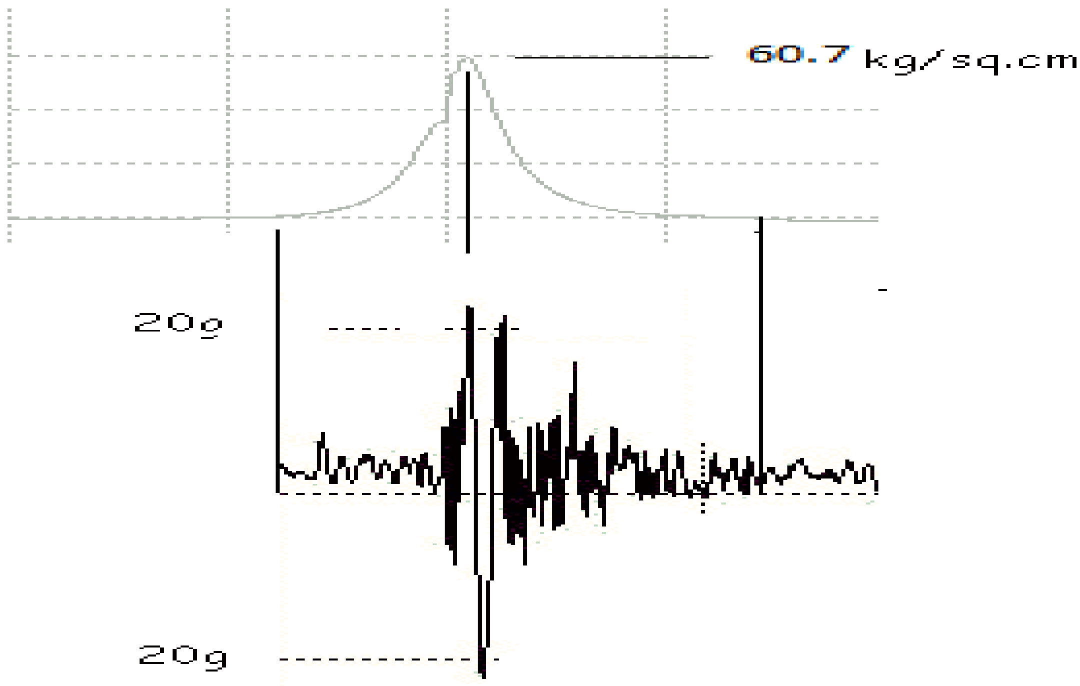

Fig.9. 6% additive in MOME

CONCLUSION

1. The trend of thermal efficiency is better with good finish at full load operation of the engine from **Fig2** & **Fig.9** The HC emission reduced by 11.6%for6%DMC blend with MOME at full load. Compared to diesel the emissions are considerably reduced for all the blends with MOME and better smoke reduction at full load operation.
2. In all blended fuel versions, MOME with 6%DMC leads to maximum efficiency.
3. There is a fall in exhaust gas temperatures in the engine at higher percentages of DMC. This may be due to lower heat release rates in diffused combustion zone by virtue of lower calorific value of the blended fuel.
4. BSFC increases with the increase of additive and incase of 6%DMC in Biodiesel fuel there is an increase of 0.0613 kg/kWh (0.3048 kg/kWh for diesel at full Load and 0.3661 kg/kWh for6% additive in biodiesel).
5. CO emission reduced considerably i.e. up to 20% and CO2 emission increases up to 5% may be due to oxygenated additive.
6. NO emission decreased by 15% up to 75% of full load. HC is reduced up to 40%.It is obvious that there is no trade off between HC and NOx because both have decreased to cognizable extent.
7. Engine cylinder vibration signatures corroborate with the combustion performance to adjudicate better engine performance with the 6% additive fuel sample.

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