

Vibration Analysis in DI Diesel Engine Using Diesel and Biodiesel

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Abstract— Engine knock is pinging sound, sometimes it may hear from an operating engine. A rapid auto-ignition of a portion of the fuel mixture in the cylinder generates a local pressure pulse, leading to pressure oscillations, propagating across the cylinder. These oscillations create noise outside the engine, which is called “knock”. Knocking in engine has some unfavourable effects such as increase in engine pollution, decrease in engine efficiency, considerable rise in engine specific fuel consumption and possibility of structural harms to engine in a long-term period. Thus, detection and prevention of this problem is of high importance. For this Analysis, the Experimental work is carried out to measure the vibration fuelled in diesel and biodiesel B20 (Mahua MEOM) at different load (20%, 40%, 60%, 80% and 100%).

Keywords— Biodiesel, Combustion, Cylinder pressure, Knocking, Vibration.

I. INTRODUCTION

The increased number of automobiles in recent years has resulted in great demand for diesel and petrol. This has led to the development of renewable energy. Energy from biomass and more specific bio-diesel is one of the opportunities that could cover the future. The bio-diesel is derived from vegetable oil and transesterified vegetable oil are promising alternative fuel for diesel engine. The rapid growth of transportation systems mostly using internal combustion (IC) engines has led to a wide range of challenges demanding immediate attention. Maintenance and condition monitoring of an IC engine is a very crucial activity required to ensure optimum performance and minimum load on the environment, by restricting emissions to bare minimum levels.

In most of the studies with biodiesel fuel, the researchers concentrated on the engine performance measured through thermal efficiency, power output, specific fuel consumption, emissions, etc. The long term effects are yet to be studied. Assessment of the impact of these fuels with different operating parameters on engine life is extrapolated from short-term trials without giving any weight age to the maintenance problems arising with these changes. Also the quality of combustion depends on these parameters leading to

erratic or smooth running of the engine. The irregular and erratic combustion inside the combustion chamber results in knocking leading to erosion and damage to combustion chamber and piston head. This also sets the engine to vibrate more leading to early failure of structure and parts. Therefore to anticipate the maintenance requirements and quality of combustion in the cylinder of CI engines, vibration signatures may provide a strong diagnostic tool.

Misfire in IC engine is a major factor leading to undetected emissions and performance reduction [1]. The monitoring of fuel combustion processes in internal combustion engines has in recent years become increasingly important due to a continuous demand of lower fuel consumption and increasingly stringent emission legislation. One of the most efficient and straightforward ways to monitor the fuel combustions is to measure the in-cylinder pressures, which contain extensive information about the fuel combustion process and can easily be used for balancing the cylinder-wise torques and detecting misfire [2].

A vibration is indicating the malfunction of engine. That is varying the injection profile strongly affect the bulk motion settling inside the combustion chamber. The maximum amplitude of the vibration provides information about combustion intensity, high amplitude may indicate early ignition or presence of a large amount of fuel in the cylinder prior to ignition, lower amplitude may indicate late ignition, injection malfunction or engine compression malfunction [3].

II. MEASURING VIBRATORY ACCELERATION

Most modern vibration measurements are made by measuring acceleration. If velocity or displacement data are required, the acceleration data can be integrated (velocity) or double integrated (displacement). Some accelerometer signal conditioners have built-in integrators for that purpose. Accelerometers (acceleration sensors, pickups, or transducers) are available in a wide variety of sizes, shapes, performance characteristics, and prices. The five basic transducer types are servo force balance; crystal-type or piezoelectric; or silicon strain gauge type; integral electronics piezoelectric; and variable capacitance. Despite the different electromechanical

transduction mechanisms, all use a variation of the spring mass system, and are classified as seismic transducers [4].

The VM-6360 is a small portable vibration meter, suitable for general vibration measurement on machinery, motors, pumps and compressors etc. It utilizes an external accelerometer and magnetic base to improve frequency response and provide a more repeatable vibration reading. The electronic stethoscope allows the user to listen for bearing defects or other mechanical faults while taking readings. The VM-6360 displays both English and Metric units. Vibration velocity is shown in mm/s, rms. Supplied with carry case, piezoelectric accelerometer, magnetic mount, spike probe and operation manual.

Effects of Vibration

Vibration can cause damage to structures and machine sub-assemblies, resulting in disoperation, excessive wear, or even fatigue failure. Vibration may have adverse effects on human beings. The primary effects are task-performance interference; motion sickness; breathing and speech disturbance; and a hand-tool disease known as “white finger”, where the nerves in the fingers are permanently damaged, resulting in loss of touch sensitivity.

III. EXPERIMENTAL INVESTIGATION

The experimental tests were carried on a single cylinder, four strokes and water cooled, Kirloskar TV 1 diesel engine Fig 1. The Specifications of the Test Engine are listed in table 1. It is coupled with an Eddy current dynamometer. The dynamometer was interfaced to a control panel. The engine always runs at 1500rpm. Experimental tests have been carried out to evaluate the performance, and emission characteristics of a diesel engine when fuelled with biodiesel (Mahua MEOM) and its blends of 20%, 40%, 60%, 80% and 100% of biodiesel with diesel fuel separately. Based on the performance and emission the B20 is selected as the best blend and the work is carried out to measure the vibration fuelled in diesel and biodiesel at different load (20%, 40%, 60%, 80% and 100%). Digital Vibration Meter Model: Equinox-VM 6360 is used to measure the vibration in three different positions, one is Head of the engine cylinder, second one is engine crank, and third one is engine bottom.

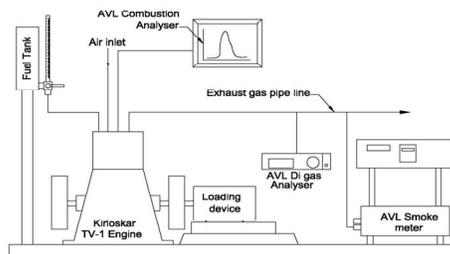


Fig 1 Test Engine

Type	Vertical inline diesel engine, four stroke, water cooled.
No of cylinder	Single cylinder
Bore × Stroke	87.5 mm × 110 mm
Compression ratio	17.5:1
Brake power	5.2 Kw
Speed	1500 rpm
Dynamometer	Eddy current

Table 1 Specifications of the Test Engine

IV. RESULTS AND DISCUSSIONS

Generally diesel engines are run under load to garner the efficiency advantage. The vibration of the engine in running condition with diesel as well as biodiesel implementation is measured at three positions with help of vibration meter. The first one is on the bottom of the engine. The first one is bottom of the engine. The vibration is measured in terms of acceleration.

From Fig 2 to 7 shows the comparison of time and acceleration of time at various load condition with diesel and bio diesel as fuel. In acceleration is higher in bio diesel at head position, the other position crank and bottom is lowered compared with diesel. This is due to higher viscosity of biodiesel. Biodiesel always shows a lower peak pressure than mineral diesel. The start of combustion reflects the variation in ignition delay because the fuel pump and injector setting were kept identical for all fuels. Combustion starts later for biodiesel owing to the longer ignition delay. The ignition delay is longer the actual bring of the first few droplets gets accumulated in the chamber. Such a situation produces the extreme pressure differentials and violent gas vibrations known as knocking. In head position the following results are observed: A minimum acceleration (228.490m/sec²) is measured for with diesel at 40% load. Another observation is seen for biodiesel with lesser acceleration (305.947m/sec²) for 100% load. In crank position the following results are observed: For 20% loads acceleration measured is 170.070 m/sec² in biodiesel. A higher acceleration is observed as 241.953 m/sec² at 20% load with diesel. In general for all load the vibration measured is lower Diesel. In bottom position the following results are observed: A minimum acceleration 218.580 m/sec² is measured with biodiesel at 20% load. Another observation is seen for diesel with higher acceleration as 330.770 m/sec² at 80% load.

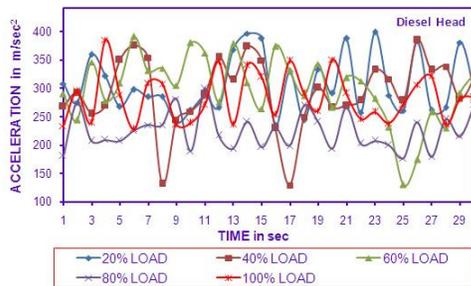


Fig 2. Time Vs Acceleration (Diesel Head)

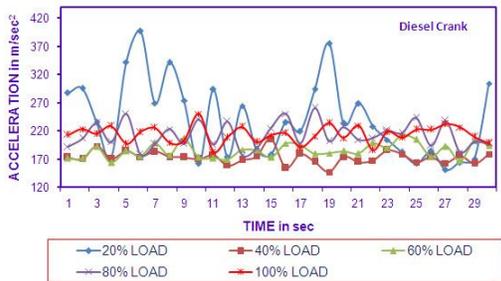


Fig 3. Time Vs Acceleration (Diesel crank)

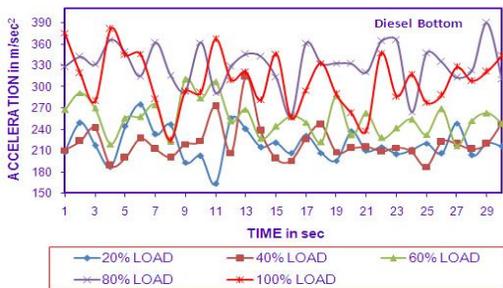


Fig 4. Time Vs Acceleration (Diesel Bottom)

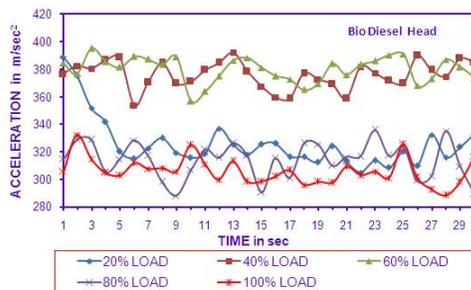


Fig 5. Time Vs Acceleration (Biodiesel Head)

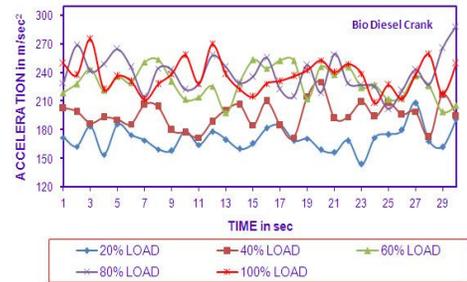


Fig 6. Time Vs Acceleration (Biodiesel crank)

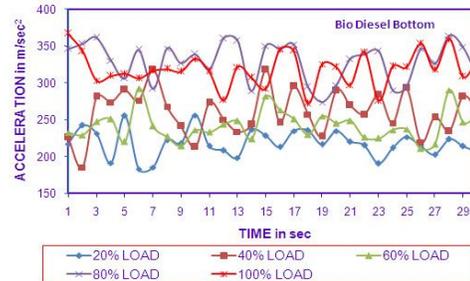


Fig 7. Time Vs Acceleration (Biodiesel Bottom)

V. CONCLUSION

Diesel fuel in the conventional diesel engine is replaced totally with biodiesel (Mahua) and various trials made with different loads. The performance emission and engine vibration are measured and analyzed for the run of both biodiesel and diesel. Based on the result the following conclusions are drawn:

- In acceleration is higher in bio diesel at head position, the other position crank and bottom is lowered compared with diesel.
- The maximum vibration amplitude is related to the rate of pressure rise and the maximum pressure in the cylinder during ignition. When the rate of pressure rise increases the vibration amplitude also increases.

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