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Experimental Investigation of the Temperature Variation and Vibrations at Different Loads at the Periphery of Single Cylinder Diesel Engine

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Abstract: *Engine head temperature and vibrations has considerable effect on performance, of the 4 stroke diesel engine. Present research work investigates the measurement of piston head temperature, frame temperature and vibration amplitudes at different load values. Thermal Imaging Camera was used to measure the temperature at various load conditions. Results showed that the maximum temperature on engine frame increases very rapidly as the load on the engine increases and engine head temperature along with minimum temperature on frame shows an increment but that is not so significant. In vibration analysis the displacement amplitude goes on increasing as the load on the engine increases. The velocity amplitude and acceleration amplitude both shows a decrement as initially and then increases with increase in load.*

Keywords: *vibration, frame temperature, velocity amplitude*

1. INTRODUCTION

The Engine head temperature is one of the major parameter which influences the performance of the 4 stroke diesel engine. It affects the overall efficiency, BHP, BSFC and the emission from the engine. The vibrations produced during the operation of the 4 stroke diesel engine have a very important impact on the engine stability and engine performance. Therefore for the optimum design of the 4 stroke diesel engine the analysis of these parameters is very important.

1.1 PREVIOUS RESEARCH

Singh R. C. et al.[1] have described the performance behaviors of a commercial diesel engine fueled with diesel and Jatropha based biodiesel (B100) at various loads (up to 100%) and compared using standard (conventional) and three new face profile designs (I, II & III) of piston rings. Face profiles of piston rings has considerable impact on engine's brake thermal efficiency (BTE), brake specific fuel consumption (BSFC), and mass flow rate, irrespective of fuels used. BTE of engine fueled with diesel increases 2-8% with new face profile design (III) of piston rings in comparison to standard (conventional) piston rings. BTE enhances 8-16% when engine is fueled with biodiesel using face profile design (III) on piston rings. Corresponding to increase in BTE, recorded reduction in BSFC (biodiesel) is 28-34%. John B. Heywood [2] explained the basics of Internal Combustion Engines. It contains a broadly based an extensive review of the fundamental principles which governs Internal Combustion Engine design and operation R.B. Gupta[3] elaborates fundamental point of view, how the fuel-air mixture within an Internal Combustion Engine cylinder is ignited and organizes the field. K.Sriniwasan[4] explains the propagation of flame front inside the combustion chamber and it also explains the various parameters are required for proper combustion or normal combustion inside the combustion chamber.

2. EXPERIMENTAL SETUP

The setup consists of single cylinder, four stroke, Diesel engine connected to eddy current type dynamometer for loading. It is provided with necessary instruments for combustion pressure and crank-angle measurements. These signals are interfaced to computer through engine indicator for Pθ–PV diagrams. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement. The set up has stand-alone panel box consisting of air box, fuel tank, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and engine indicator. Rotameters are provided for cooling water and calorimeter water flow measurement. The setup enables study of engine performance for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio and heat balance. Labview based Engine Performance Analysis software package "EnginesoftLV" is provided for on line performance evaluation. A computerized Diesel injection pressure measurement is optionally provided. Thermal Imaging Camera used to measure the temperature at various load conditions.

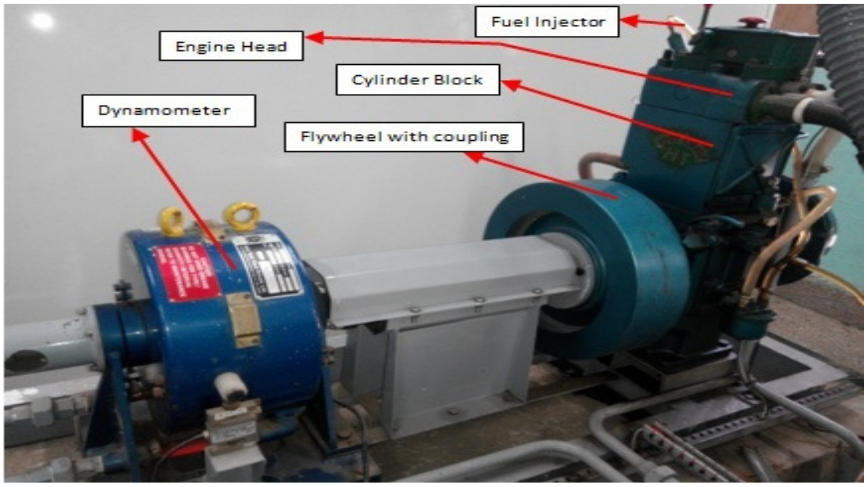


Fig. 1. Test Rig

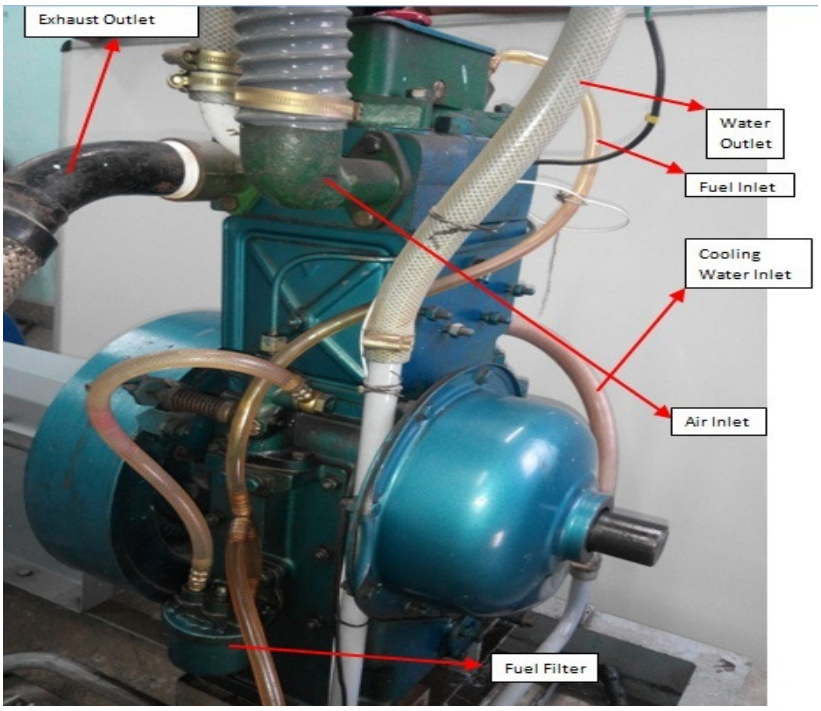


Fig. 2. Engine for experiments

TABLE 1: Specification of Engine Set-up

Engine test set up 1 cylinder, 4 stroke, Diesel engine								
System constants								
Orifice diameter (m)		0.02	Cylinder diameter (m), D				0.088	
Dynamometer arm length (m)		0.185	Stroke(m), L				0.11	
Coeff.of discharge for orifice, Cd		0.6	No of cylinders				1	
Ambient temperature (Deg C)		29	No.of rev./cycle				2	
Fuel density(kg/m3)		830	Specific heat of exhaust(kJ/kg0K)				1.1	
Fuel Calorific value (KJ/kg)		42000						

3. PERFORMANCE GRAPH

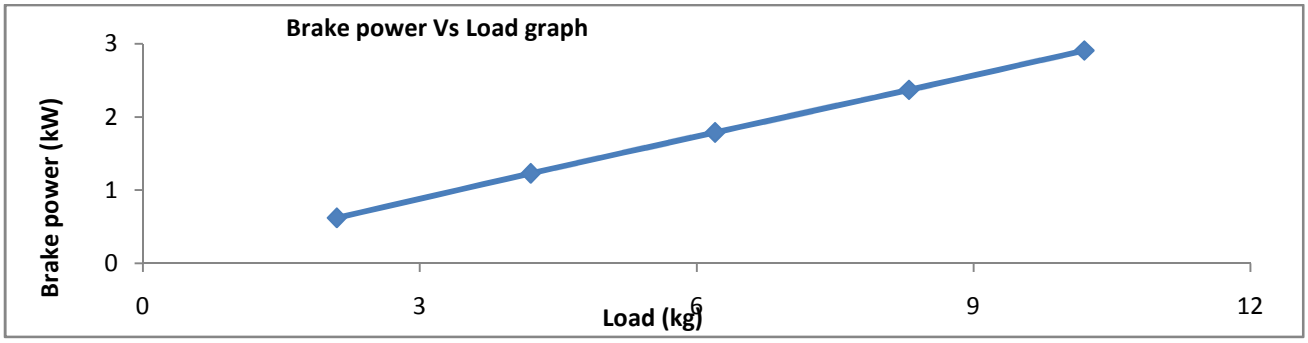


Fig. 3. Brake power vs Load graph

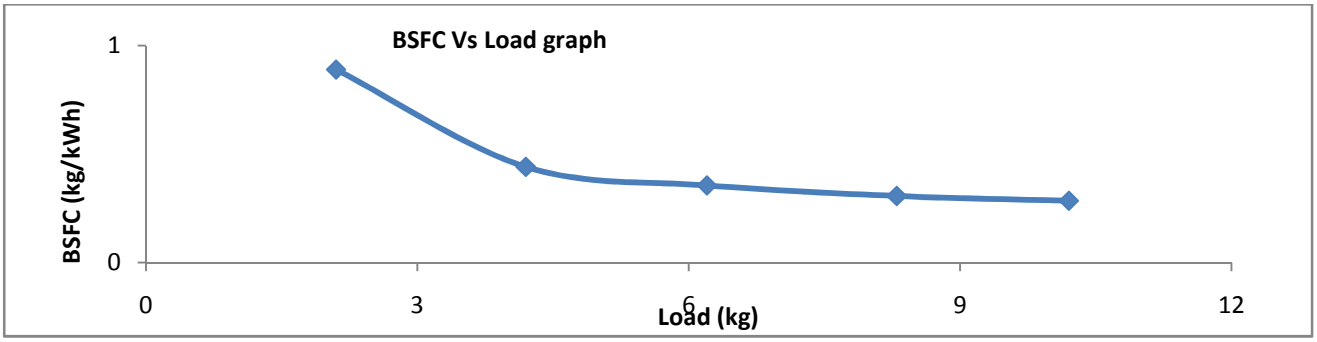


Fig. 4. BSFC vs Load graph

Brake Power is increasing with the increase of Load. BSFC decreases rapidly firstly and afterward decreases but with low rate with the increase of Load.

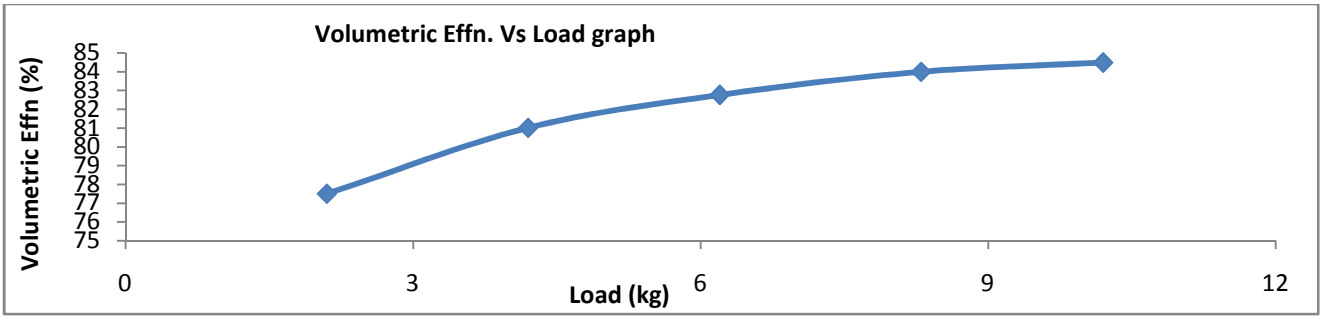


Fig. 5. Volumetric Efficiency vs Load graph

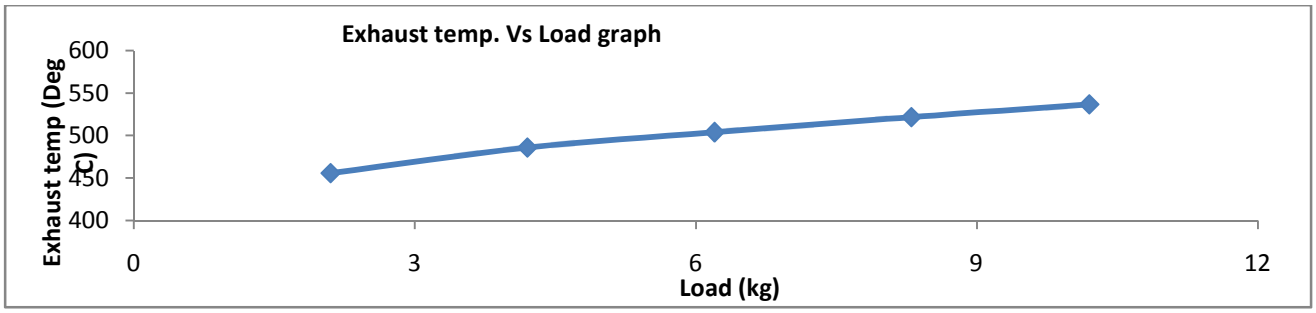


Fig. 6. Exhaust Temperature vs Load graph

- Volumetric Efficiency increases with the increase in Load but rate of increment keep on decreasing. Exhaust Temperature increases with the increase of Load.

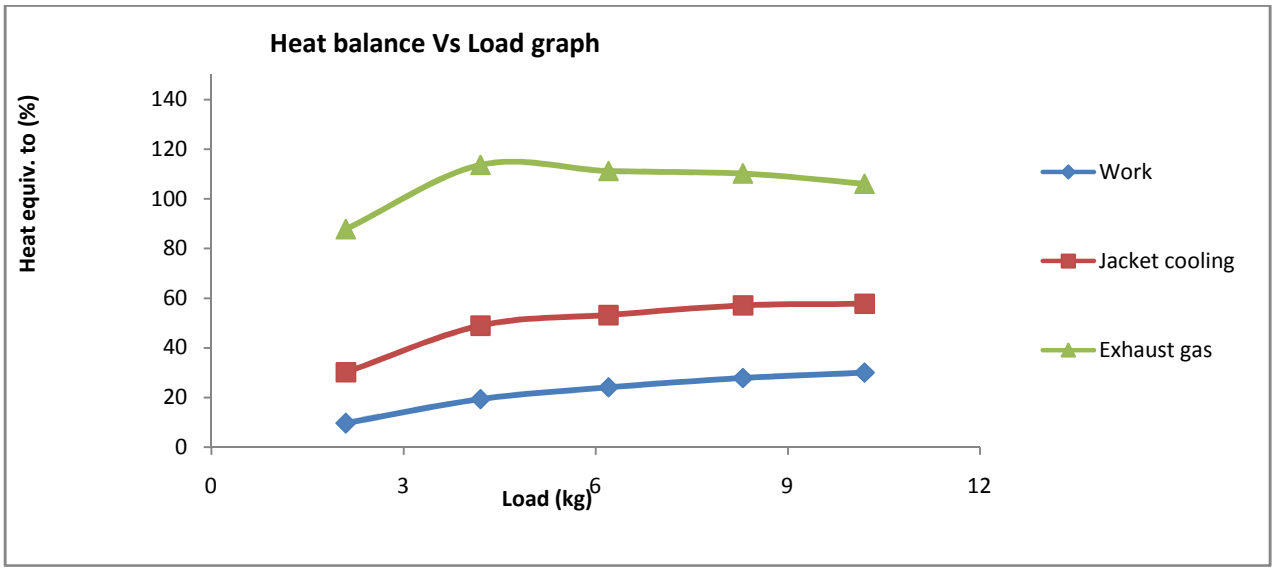


Fig. 7. Heat Balance vs Load graph

Percentage of Heat converted into Work is increases as we raise the load. Percentage of Heat taken by Cooling Jacket is also increases with the increase in Load. Percentage of Heat taken by Exhaust is initially increases with the increase in load up to 4 Kg, but afterward as we increases the load the percentage of heat in exhaust starts decreasing.

4. OBSERVATIONS

4.1 OBSERVATIONS ON THERMAL IMAGING CAMERA

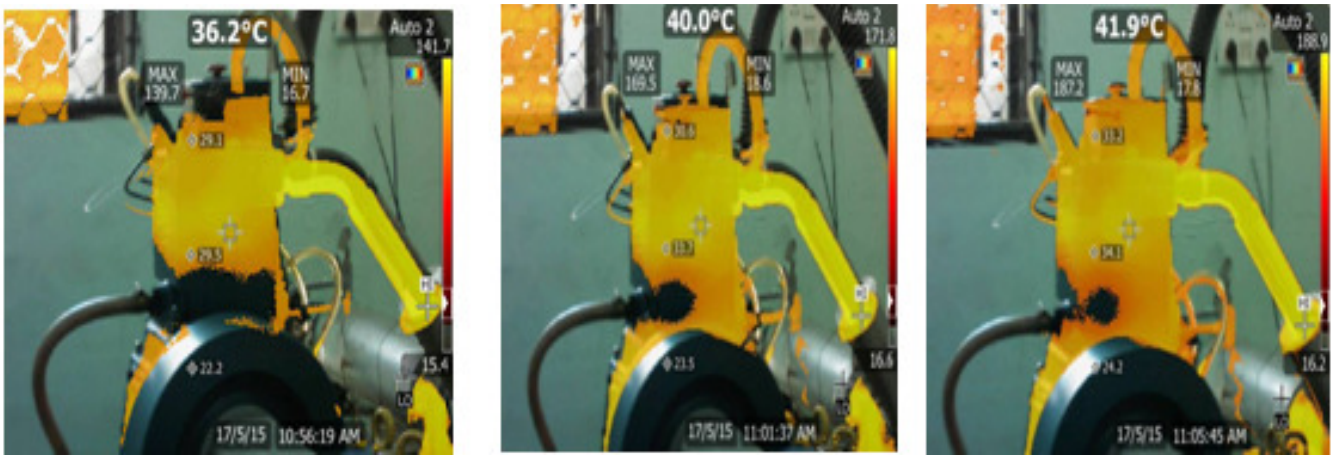


Fig. 8. Load 2.1Kg at 1557 RPM; Load 4.2 Kg at 1539 RPM; Load 6.2 Kg at 1516 RPM

Initially at load of 2.1 kg the temperature of Engine Head was 36.2 ◦C. Highest Temperature in the frame was at Exhaust outlet pipe of Engine which was 139.7◦C.Lowest Temperature in the frame was at Calorimeter, where water is entering into it, i.e 16.7◦C.

At load of 4.2 Kg the temperature of Engine Head was 40.0 ◦C. Highest Temperature in the frame was at Exhaust outlet pipe of Engine which was 169.5◦C.Lowest Temperature in the frame was at Calorimeter, where water is entering into it, i.e 18.6 ◦C.

At load of 6.2 Kg the temperature of Engine Head was 41.9 ◦C. Highest Temperature in the frame was at Exhaust outlet pipe of Engine which was 187.2◦C.Lowest Temperature in the frame was at Calorimeter, where water is entering into it, i.e 17.8 ◦C.

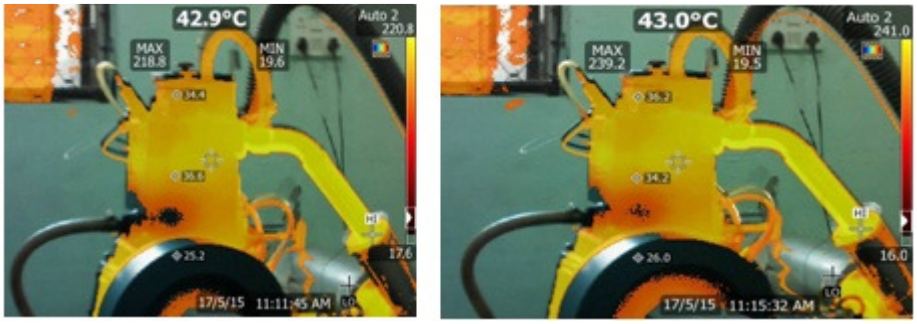


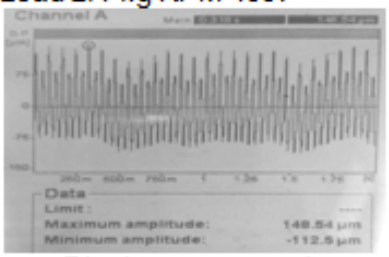
Fig. 9. Load 8.3 Kg at 1503 RPM; Load 10.2 Kg at 1499 RPM

At load of 8.3 Kg the temperature of Engine Head was 42.9 ◦C. Highest Temperature in the frame was at Exhaust outlet pipe of Engine which was 218.8 ◦C. Lowest Temperature in the frame was at Calorimeter, where water is entering into it, i.e 19.6 ◦C.

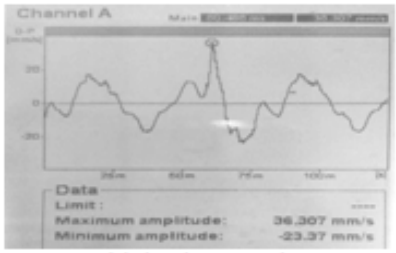
At load of 10.2 Kg the temperature of Engine Head was 43.0 ◦C. Highest Temperature in the frame was at Exhaust outlet pipe of Engine which was 239.2 ◦C. Lowest Temperature in the frame was at Calorimeter, where water is entering into it, i.e 19.5 ◦C

4.2 OBSERVATIONS ON VIBRATION MEASURING INSTRUMENT

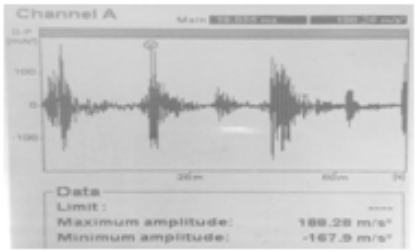
Load 2.1 kg RPM 1557



Displacement graph

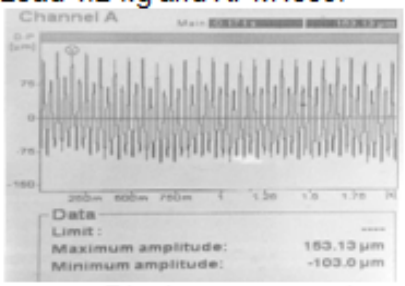


Velocity graph

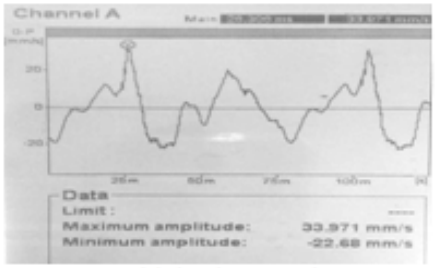


Acceleration graph

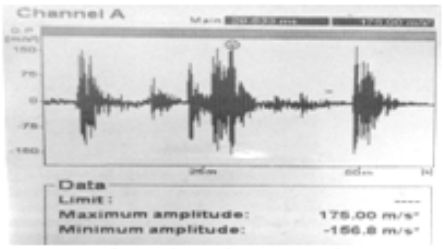
Load 4.2 kg and RPM1539:



Displacement graph

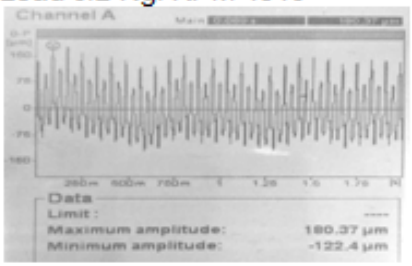


Velocity graph

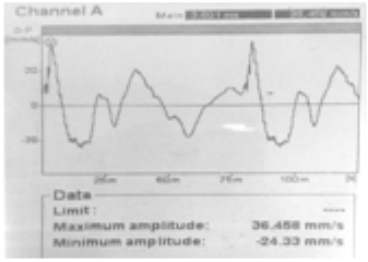


Acceleration graph

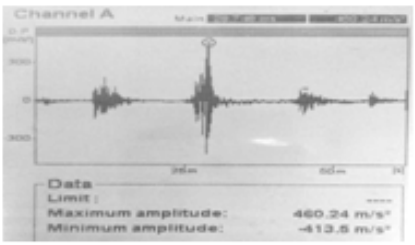
Load 6.2 Kg. RPM 1516



Displacement graph



Velocity graph



Acceleration graph

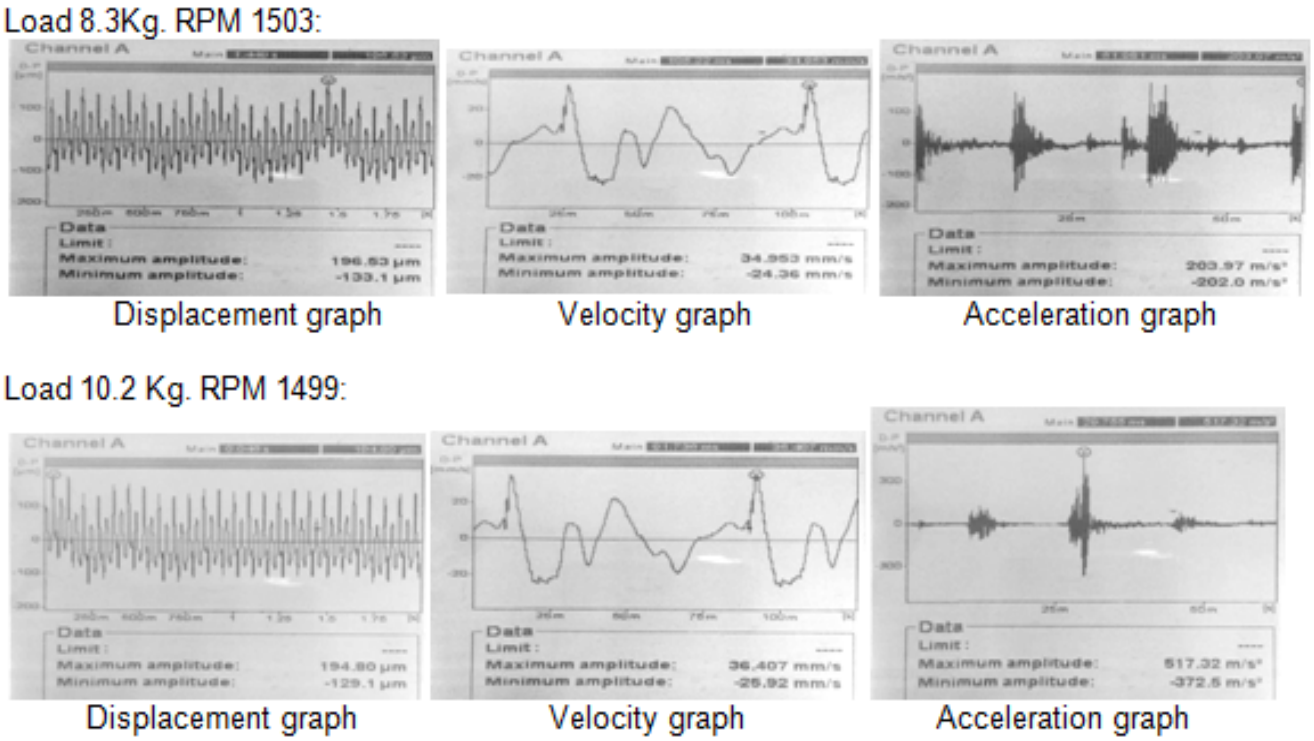


Fig. 10. Results

At load of 2.1 Kg the maximum amplitude on displacement was 148.54 µm. Maximum amplitude on velocity graph was 36.307 mm/s and maximum amplitude on acceleration was 188.28 m/s^2

At load of 4.2 Kg the maximum amplitude on displacement was 153.13µm. Maximum amplitude on velocity graph was 33.971mm/s and maximum amplitude on acceleration was 175.00m/s^2

At load of 6.2 Kg the maximum amplitude on displacement was 180.37µm. Maximum amplitude on velocity graph was 36.458mm/s and maximum amplitude on acceleration was 460.24 m/s^2

At Load of 8.3 Kg the maximum amplitude on displacement was 196.53µm. Maximum amplitude on velocity graph was 34.953mm/s and maximum amplitude on acceleration was 203.97 m/s^2

At Load of 10.2 Kg the maximum amplitude on displacement was 194.80µm. Maximum amplitude on velocity graph was 36.407mm/s and maximum amplitude on acceleration was 571.32 m/s^2

5. CONCLUSIONS

Temperature variation and Vibration in the Internal Combustion Engine with change in load conditions have been investigated. The maximum temperature on engine frame increases very rapidly as the load on the engine increases. The engine head temperature also shows an increment but that is not so significant. The minimum temperature on frame show a very little increment. In vibration analysis the displacement amplitude goes on increasing as the load on the engine increases. The velocity amplitude shows a decrement as the load increases initially then it increases at 6.2 Kg load further as the load is increased the velocity amplitude show a decrement. The acceleration amplitude show a little decrease as the load is increased then at a load of 6.2 Kg there is a sudden increment in the acceleration amplitude further as the load is increased the acceleration amplitude decreases.

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