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Research Article

Cold Testing of IC Engines using Solar Energy

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Abstract

Cold testing of IC engines is becoming essential with the growing demand for environment friendly testing processes. This paper explains the processes of hot and cold testing and gives an example of sample calculations needed to energise a test bed using solar energy.

Keywords: *Hot testing, Cold Testing, Emissions*

1. Introduction

The demand for transportation vehicles is rapidly increasing and hence, IC engines have gained a lot of importance. During the development of an IC engine all the parameters affecting design, manufacturing and performance must be considered. It becomes necessary to conduct tests on the engine and determine the measures to be taken to improve engine performance.
Inefficient engines and testing techniques release many harmful pollutants to the atmosphere.

2. Emissions

These are the constituents which are produced due to burnt and unburnt combustion of fuel and air, coming out of the exhaust from the combustion chamber of internal combustion engine. These particulates and other harmful particles into the atmosphere create various problems to humans and also damage the environment which causes death to humans and loss of crops.

There are many harmful pollutants present in the emissions from industries and automobiles of which some are mentioned below.

Particulate matter: These include microscopic particles and due to their small size, they cause irritation in nose and lungs and exposure to these particles cause wheezing.

Carbon monoxide(CO): It is a poisonous gas produced due to incomplete combustion of fossil fuels .Humans can experience headache ,fatigue and it may also interferes with bloods ability to carry oxygen to the brain ,heart in presence of these gases.

Nitrogen oxide (NO): These are produced when fuel is burned and are responsible for ozone depletion and creates respiratory problems

Hydrocarbons or volatile substances: These components are mainly responsible for producing smog due to evaporated unburned fuel.

The effects of these are coughing and difficult or painful breathing, asthma, bronchitis, eye irritation, weakening of the heart and premature death.

3. Testing of Engines

The engineer designs the engine based on parameters like indicated power, brake power, brake specific fuel consumption, emissions from the exhaust, engine cooling, maintenance tasks, cost etc. While developing the engine, the engineer must develop many designs and then select the best one. Later, the engine components are manufactured according to design dimensions and given surface finish with suitable manufacturing tolerances. Later to verify the working and various parameters, the engineer must evaluate the performance. This performance evaluation can be done by two processes, either by hot testing or cold testing of the engines.

Hot testing of engines consists of firing the engine and application of torque load to the crank shaft. This type of testing requires engine coolant and an eddy current dynamometer is commonly used for the same.
But with more strict norms companies are trying to reduce their carbon footprint either by using alternative sources of energy or by developing new techniques which are eco-friendly and provide greater efficiency.

So, we see that in hot testing we have to test run the engines which basically adds more pollutants in the environment and also its not economical however developments in the field of light vehicle internal combustion engine cold test technology has enabled almost all global Original Equipment Manufacturers to eliminate the necessity for production hot test.

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Therefore, an engine need not be fired for a detailed test to be performed. Hence the name cold test.

4. Hot Testing

It starts with an engine using fuel and torque load is applied to the crank shaft while running the engine. For this type of testing engine coolant is required and an eddy current dyno is typically used to apply the load to the crank shaft. The engine is fixed up mechanically or automatically depending on the type of equipment. After the engine is fixed, the computer system controls the machine to fire the engine and command variable speed and torque loads. The computer system also interfaces with the Engine Control Module (ECM) to check status and error codes produced by the ECM. Data is obtained continuously during the test and is estimated to limits to determine accept/reject status.

Most of the Indian automobile manufacturers rely primarily on hot testing. The cycle time is nearly 1-2 Hrs which includes 45 minutes Running in, 6 Speed Performance, Leakage testing, Noise checking and Connection /Disconnections etc. This testing type consumes plenty of Diesel / Water / Power during testing. Total numbers of beds, cycle time and manpower required are also more. If any defect is observed during testing, it consumes further resources for rectification on test bed.

Fig.1 Hot testing of Engines

5. Cold Testing

Cold Testing is done at the end of main Assembly Conveyor to check the Engine build without actually firing the Engine. This will not allow any assembly defect to pass down the testing line. It eliminates further full Performance testing and only firing testing to check fuel circuit integrity, use of in Process Equipment's (IPV) at critical assembly operations to ensure inbuilt quality and early detection of defects are used. Performance testing only on Sample / Audit basis.

The purpose is to detect the defects and mechanical integrity after assembly in Dynamic Cold condition. The engine is fixed automatically and a variable speed drive at various speeds spins the crank shaft. A computer obtains high speed analog data from pressure and torque transducers placed on the machine. Data is also gathered from crank and cam sensors placed on the engine. The gathered data is examined using special algorithms and limits are used to the results calculated from the waveforms to find out the accept/reject status. The time of cycle is 3 min which includes testing, connection and disconnection

The drive adaptors are fitted at earlier station and removed after Cold test station. Engine is transferred to Cold Test Bench. Various connections are done, sensors are fitted and Engine is rotated with external device. The typical power required to drive a cold test bed is approximately 20 KW.

Following tests and measurements are carried out:

- Breakaway and Running Torque measurement to check the mechanical integrity of Crank mechanism and valve train.
- Exhaust Manifold pressure build up and Intake Manifold depression measurement to check Combustion chamber defects.
- Oil Pressure and Oil temperature measurements to check Oil circuit defects.
- Common Rail system check.
- Noise and Vibration check (NVH)

Figure 2 Cold Testing of Engines

6. Concept

The Cold Testing beds are currently being energized by electricity produced from coal or other such non-renewable sources. To further reduce carbon footprint, the Testing Beds can use Solar energy as a mode of energy. If the energy is insufficient it can be coupled with electricity from the grid or any other renewable energy resource. This way a lot of energy is saved and the engines are tested within short time saving fuel and manpower cost.

The sample solar panel used in this case has specifications Material – Silicon Polycrystalline, Orientation – South Facing 20 degrees, No. of cells in each module – 72, Price of each module – Rs. 15000, Capacity of each module – 250 W, Efficiency of each module – 20%, Life of each module – 25 years

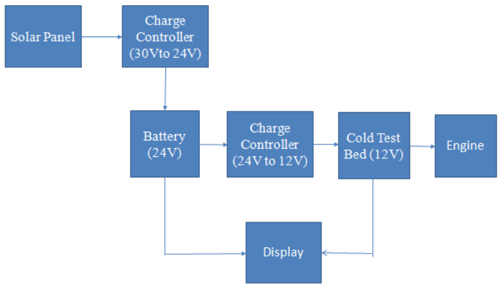

Figure 3 Flow diagram for sample installation

Total load of sample cold test bed = 28 kW
Inverter
For 1 kW load, 1.6 kW inverter (due to energy losses from DC to AC) is needed. Hence for 28 kW load, 44.8 kW inverter is needed.
Inverter specification is 1.6 kW, 24 V
Total no. of inverters required = 28

Total current for load
Power = voltage(V)*current(I)
28000 W = 24V*current
Current = 1167 A

Battery Selection
No. of Hours of battery backup = 4 Hours
Battery capacity (Ah) = [{Total Load(W)}*{hours of backup}]/ 24 V
In this case, battery capacity = 4666 Ah ≈ 5000 Ah
We will use 10 batteries (in parallel) of 500 Ah

Size of Solar Panel
Charging current of battery (A) = 1/10 Battery Capacity(AH)=500A
Total current = 1167 + 500 = 1667 A
Since 250W solar panels have a voltage of 30V,
Power = V*I = 30*1667 ≈ 50,000 W
No. of panels = 50,000 / 250 = 200 Panels

This is the requirement for the sample cold test bed for this project.

Concluding remarks and scope for future work

With stricter emission norms and threat to our environment by greenhouse gases, industries are adopting new technologies and techniques to curb pollution. To reduce the pollution and for efficient testing of engines, we need better and more efficient methods which will reduce the use of conventional power resources and release lesser pollutants into the air.

While testing engines we use cold testing which reduces carbon footprint and is also economical. We can use solar power by integrating it with cold testing by which we can move towards more clean energy.

If this concept works as desired, it can be extended to other fields as well, hence reducing the gross annual cost for the industry and also helping in preserving the environment.

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