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Analysis of Emission Data by using Testbed for Euro VI Norms

Shweta Baraskar[1], Prof. Rajesh Shekokar[2]

Student, Electronics and Telecommunication, RMD Sinhgad College of Engineering, Pune, India[1]

Assistant Professor, Electronics and Telecommunication, RMD Sinhgad College of Engineering, Pune, India[2]

Abstract: The testing of the engine is useful for giving the idea about the overall performance and the emission of the engine. Now a day, the emission factors which are coming out of the engine from the exhaust line affecting the environment on large scale or we can say, the emission coming out of the engine is playing the vital role in the air pollution. We have to reduce the emission factors, so we will be able to maintain the healthy air in the environment. As we are only focusing on the engine emission, we have to analyze the engine. The analysis of engine is the combination of the performance analysis and the emission analysis. For analyzing the engine, we have run the engine in the particular emission cycle. The output of the emission cycle is giving the idea about the engine performance and the engine emission. And, this paper is giving the idea about the whole testbed setup, emission cycle, norms of emission for the diesel engine.

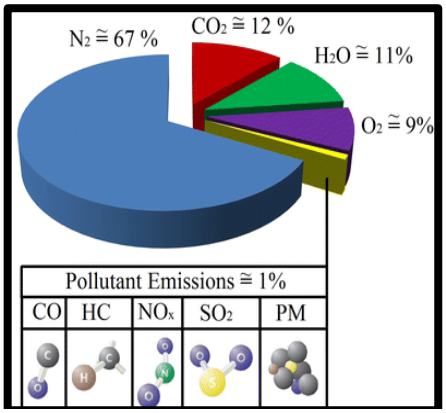
Keywords: WHTC, WHSC

I. INTRODUCTION

Engine Testing is a unique, well-organized and comprehensive collection of the different aspects of engine and vehicle testing equipment and infrastructure for anyone involved in facility design and management, physical testing and the maintenance, upgrading and troubleshooting of testing equipment. Designed so that its chapters can all stand alone to be read in sequence or out of order as needed, Engine Testing is also an ideal resource for automotive engineers required to perform testing functions whose jobs do not involve engine testing on a regular basis. This recognized standard reference for the subject is now enhanced with new chapters on hybrid testing, OBD (On-Board Diagnostics) and sensor signals from modern engines. A sophisticated engine test stand houses several sensors (or transducers), data acquisition features and actuators to control the engine state. The sensors would measure several physical variables of interest.

Research and Development (R&D) activities on engines at automobile OEMs have necessitated sophisticated engine test stands. Automobile OEMs are usually interested in developing engines that meet the following threefold objectives:

- to provide high fuel efficiency
- to improve drivability and durability
- to be in compliance to relevant emission legislation



Emission factors means which will lead to cause the pollution.

- NOx = Nitrogen Oxides
- PM = Particulate Matter

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- CO = Carbon Monoxide
- HC = Hydrocarbons
- SO2 = Sulphur Oxide

II. EMISSION STANDARDS

Emission standards are the legal requirements governing air pollutants released into the atmosphere. Emission standards set quantitative limits on the permissible amount of specific air pollutants that may be released from specific sources over specific timeframes. They are generally designed to achieve air quality standards and to protect human life.

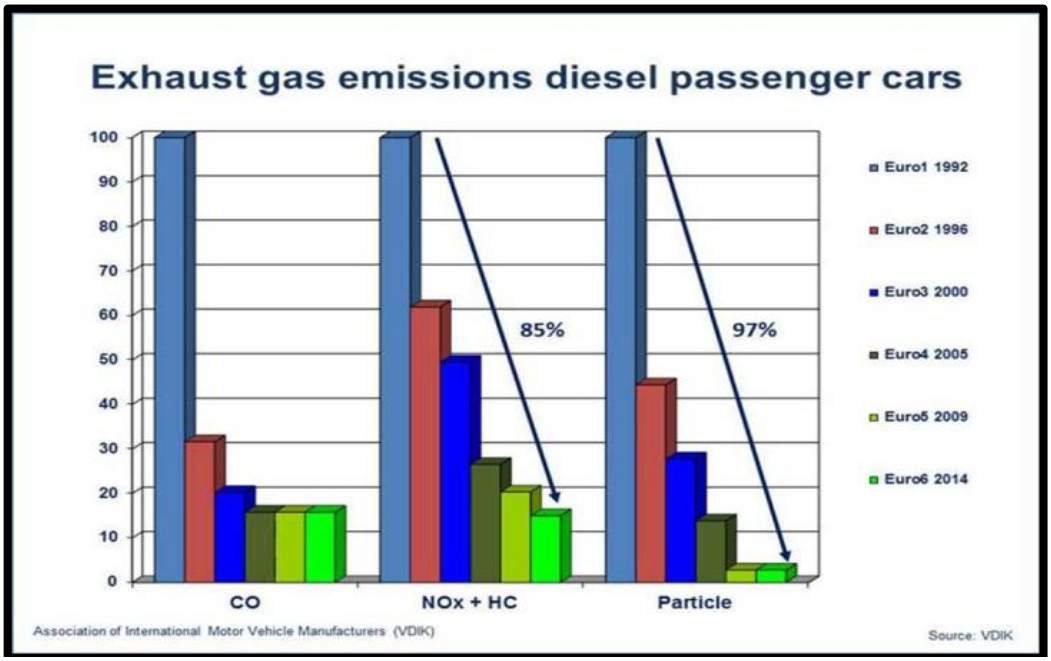

Chart -1: Comparison of Emission Standards

The Euro 6 standard imposes a further, significant reduction in NOx emissions from diesel engines (a 67% reduction compared to Euro 5) and establishes similar standards for petrol and diesel.

Exhaust Gas Recirculation (EGR) – replacing some of the intake air (containing 80% nitrogen) with recycled exhaust gas – reduces the amount of nitrogen available to be oxidized to NOx during combustion but further exhaust after treatment may be required in addition to the Diesel Particulate Filters required to meet Euro 5.

Euro 6 diesel cars may also be fitted with:

- A NOx absorber (Lean NOx Trap) which stores NOx and reduces it to Nitrogen over a catalyst
- Selective Catalytic Reduction (SCR) which uses an additive (Diesel Exhaust Fluid (DEF) or Ad Blue) containing urea injected into the exhaust to convert NOx into Nitrogen and water.

Euro 6 emission limits (diesel)

- CO – 0.50 g/km
- HC+NOx–0.17g/km
- NOx – 0.08 g/km
- PM – 0.005 g/km

III. PERFORMANCE ANALYSIS

Fig 1 is showing the basic testbed setup. It is giving the basic idea about which devices connected in testbed. What is the sequence of the devices.

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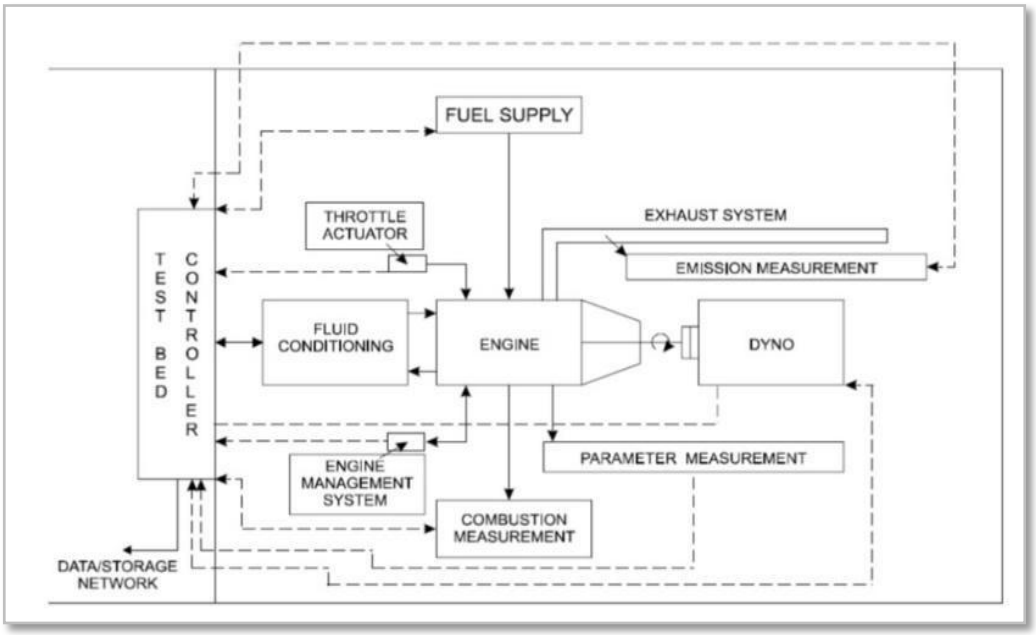

Fig -1: Basic Testbed Setup

This is the list of Sensors used in test bed:
1.Pressure transducer
2.Temperature sensor (RTD, J type, K type)
3.Peak cylinder pressure sensor
4.Frequency meter
5.Orifice sensor (blow by measurement)
6.Coriolis sensor (opacimeter)

Following devices, we are connecting in the testbed for checking the performance of the engine.
1. Air flow meter (kg\h): It will give information about the rate of air flow in engine.
2. Water flow meter(l\min): It will give information about the rate of air flow in engine.
3.Coolant conditioning unit(l\min): It will give an idea about the path of the coolant. Heat exchanger is get used in it. Pressure of coolant is also get observed.
4. Fuel conditioning unit(kg\h): It will give an idea about the path of the fuel. Pressure of fuel is also get observed.
5. Smoke meter (FSN): White paper is used in the device. The input is taken from the exhaust pipeline. The solid particles are collected over the paper, after doing weight of that paper, the measurement of PM is done.
6. Opacimeter (%): The input is taken from the exhaust pipeline. The opacity of the exhaust gas is get observed in this device.
7.Blow by meter(LPM): It is used to check the blow by of the engine. It works as a differential amplifier.
8. Emission benches(g\kwh): The analysis and measurement of the emission factors is done with this device.
9.After treatment system (ATS) It is used for reduction of the exhaust gases.

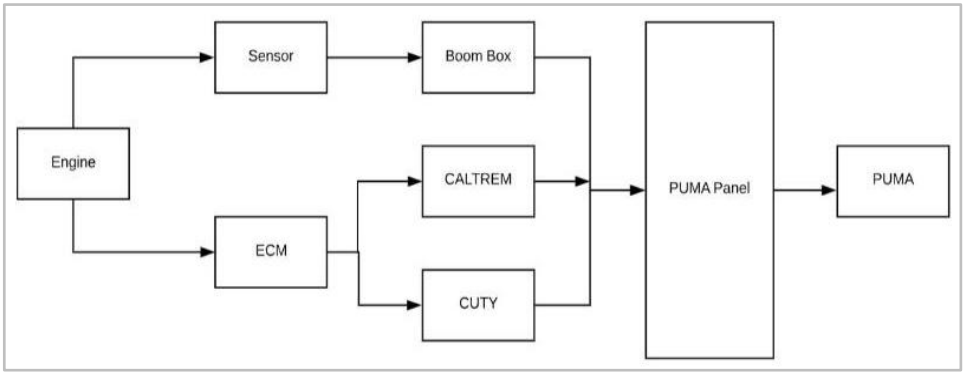

Fig -2: Generalized Data Acquisition System

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Fig 2 is showing the generalized data acquisition system. The sensors are connected to the engine, the connection of the sensor is connected to the puma panel via boom box. From puma panel the input is provide to the PUMA PC. The ECM of engine is connected to the puma panel through Cuty and Calterm Softwares, and from puma panel the input is given to the Puma pc.

1. PUMA: Testbed Automation software. It is the global industry standard for testbed automation. It is suitable for all types of electrified testbeds or for conventional test environments.
2. CUTY & CALTERM: These application Softwares are used for communicating with ECM.They communicate with ECM independently. Calterm is used to configure the ECM i.e. for uploading and downloading the calibration in ECM and Cuty is used to Communicate ECM data to Puma automation system. Due to development in ECM software and engine families, advance product ids are used.

III-A Emission cycles

An emission test cycle is a protocol contained in an emission standard to allow repeatable and comparable measurement of exhaust emissions for different engines or vehicles. Test cycles specify the specific conditions under which the engine or vehicle is operated during the emission test. There are many different test cycles issued by various national and international governments and working groups. Specified parameters in a test cycle include a range of operating temperature, speed, and load. Ideally these are specified to accurately and realistically represent the range of conditions under which the vehicle or engine will be operated in actual use.
Depending on the performance states the two cycles are designed for Euro 6:
1.WHSC: World Harmonized Steady State Cycle
2. WHTC: World Harmonized Transient Cycle

1. WHSC: The WHSC is a ramped steady-state test cycle, with a sequence of steady-state engine test modes with defined speed and torque criteria at each mode and defined ramps between these modes. The parameters of the WHSC are listed in Table-1.

Mode	Speed	Load	Weighting Factor	Mode Length †
-	%	%	-	s
0	Motoring	-	0.24	-
1	0	0	0.17/2	210
2	55	100	0.02	50
3	55	25	0.10	250
4	55	70	0.03	75
5	35	100	0.02	50
6	25	25	0.08	200
7	45	70	0.03	75
8	45	25	0.06	150
9	55	50	0.05	125
10	75	100	0.02	50
11	35	50	0.08	200
12	35	25	0.10	250
13	0	0	0.17/2	210
Total			1	1895
† Including 20 s ramp				

Table -1: Modes for WHSC.

The WHSC is run from a hot start, following engine preconditioning at mode 9. The idle mode is separated in two modes, mode 1 at the beginning and mode 13 at the end of the test cycle. Mode 0 is not run, but is only accounted for mathematically by a weighting factor of 0.24 and zero emissions and power. The speed and torque combination for the WHSC is shown in Figure 3. The duration of the WHSC is 1895 sec. the behaviour of the WHSC is steady and it looks like a step. The waveform for the WHSC is looking like a step.

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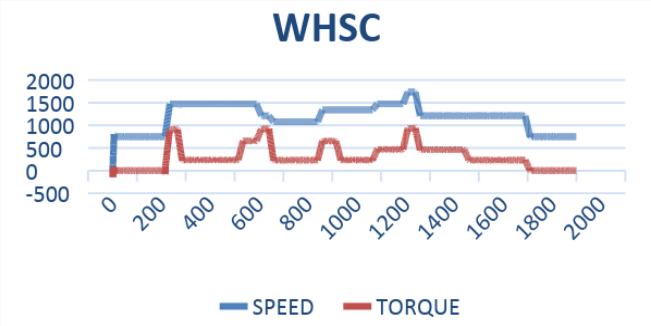

Fig -3: Waveform for WHSC.

2. WHTC: The WHTC test is a transient engine dynamometer schedule defined by the global technical regulation. WHTC testing requirements were adopted for the first time by the Euro VI emission regulation for heavy-duty engines. The WHTC is a transient test of 1800 s duration, with several motoring segments. Normalized engine speed and torque values over the WHTC cycle are schematically shown in Figure 4.

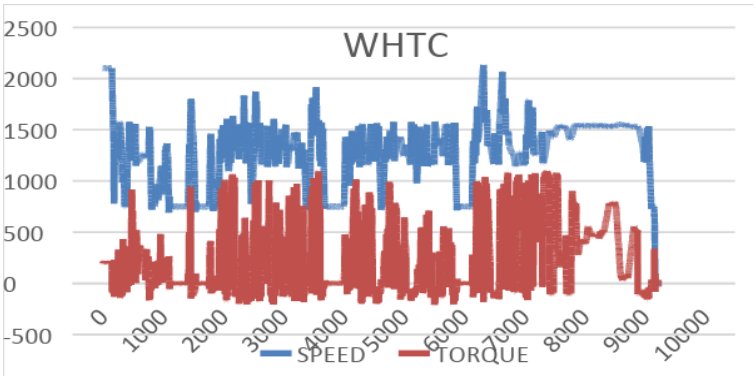

Fig -4: Waveform for WHTC.

IV. CONCLUSION

This paper is giving the basic idea about the engine's performance and emission analysis. The analysis of the engine is done on the basis of the emission cycles. By conducting emission cycles, we can observe the performance of the engine by observing speed and torque behaviour. The emission analysis is done by observing the emission factors present in the exhaust of the engine.

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BIOGRAPHIES

Ms. Shweta Baraskar is M.E. Student, studying VLSI and Embedded system in RMD Sinhgad college of Engineering, Pune. Author has her personal interest in the domain of Image Processing.

Prof. Rajesh U. Shekokar is working as an Assistant Professor in Department of E&TC. His area of interest in the domain of VLSI and Embedded System.