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EXPERIMENTAL INVESTIGATION ON DIESEL ENGINE BY VARYING THE INJECTION PRESSURE

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ABSTRACT

Aim of the experimental analysis is to study on conversion of single cylinder diesel engine to a CRDI (common rail direct injection) and experimentally investigate the how injection affects the performance of the CRDI engine and emission parameters. Diesel engines are widely used, the market share for Diesel powered passenger cars is increasing in world and more than a third of the car buyers choose Diesel-powered cars. From the literature review it is noticed that majority of the work done by the researchers in diesel engine is based on blends using bio-fuels & this work was carried out on direct injection not on CRDI engine. Hence single cylinder diesel engine converted to CRDI was selected and performance was done on it to optimize performance and emissions.

Keywords:ECU (Engine Control unit), Injection Pressure, Diesel Engine, CRDI unit (common rail direct injection), Particulate matters (PM) etc.

I.INTRODUCTION

The common rail system prototype was developed in the late 1960s by Robert Huber of Switzerland and the technology further developed by Dr. Marco Ganser at the Swiss Federal Institute of Technology in Zurich, later of Ganser- Hydromag AG (est.1995) in Obergeri. The first successful usage in a production vehicle began in Japan by the mid-1990s. Dr. Shohei Itoh and Masahiko Miyaki of the Denso Corporation, a Japanese automotive parts manufacturer, developed the common rail fuel system for heavy duty vehicles and turned it into practical use on their ECD-U2 common-rail system mounted on the Hino Rising Ranger truck and sold for general use in 1995. Denso claims the first commercial high pressure common rail system in 1995.

Modern common rail systemsworking on the same principle, are governed by an engine control unit (ECU) which opens each injector electronically. This was devoloped prototyped in the 1990s with collaboration between Magneti Marelli, Centro Ricerche Fiat and Elasis. After re-search and development by the Fiat Group, the design was acquired by the German company Robert Bosch GmbH for completion of development and recement for mass-production.

Direct fuel-injection systems have to build up pressure a new for each and every injection cycle while the new common rail (line) engines maintain constant pressure regardless of the injection sequence. This pressure then remains permanently available throughout the fuel line. The electronic control unit (ECU) modifies injection pressure precisely and as needed, based on data obtained from sensors on the cam and crankshafts. This technique allows fuel to be injected as needed, saving fuel and more accurately measured and timed mixture spray in the combustion chamber significantly reducing unburned fuel gives CRDI the potential to meet future emission guidelines such as Euro V. CRDI engines are now being used in almost all Mercedes-Benz, Toyota, Hyundai, Ford and many other diesel auto mobiles.

The Diesel engine, due to its associated fuel consumption efficiency and durability, has become a popular power source for many vehicles. The market share for Diesel powered passenger cars is increasing in world and more than a third of the car buyers choose Diesel-powered cars. Unfortunately, compared to the conventional, catalyst equipped, gasoline engine Diesel engine is notorious for being a source of particulate matter and nitrogen oxides (NOx) emissions in more amount. In order to improve air quality, legislation regarding emissions from mobile sources has tightened considerably over the past 20 years.

The break thermal efficiency of an engine improves if the injection pressure increases because at higher pressure fuel injection results in the better atomization and mixing of fuel and air. The emissions such as NOx need to be controlled as they are dangerous to humans as well as the nature.The project deals with converting a single cylinder four stroke diesel engine to a CRDI engine. This needs addition of some components such as ECU, fuel rail, wiring harness, high pressure fuel pump and different sensors to the conventional engine.

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II.EXPERIMENTAL SETUP

Fig: 2.1

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The setup consists of single cylinder, four strokes, CRDI VCR (Variable Compression Ratio) engine connected to eddy current dynamometer. It is provided with necessary instruments for combustion pressure, crank-angle, airflow, fuel flow, temperatures and load measurements. These signals are interfaced to computer through high speed data acquisition device. The setup has stand-alone panel box consisting of air box, twin fuel tank, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and piezo powering unit. Rotameter are provided for engine cooling water flow measurement.

CRDI VCR engine works with programmable Open ECU for Diesel injection, fuel injector, common rail with rail pressure sensor and pressure regulating valve, crank position sensor, fuel pump and wiring harness. The setup enables study of CRDI VCR engine performancewith programmable ECU at different compression ratios and with different EGREngine performance study includes brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, Air fuel ratio, heat balance and combustion analysis.

III.SETUP SPECIFICATIONS

Product	CRDI VCR Engine test (Computerized) Code 244
Engine	Make Kirloskar, Single cylinder, 4 strokes, water cooled, stroke 110 mm, bore 87.5 mm, 661 cc. Power 3.5 KW, 1500 rpm, CR range 12-18.
Dynamometer	Type eddy current, water cooled with loading unit
Propeller shaft	Make Hindustan Hardy, with universal joints
ECU	Model NIRA i7r (with solenoid injector driver) with programmable ECU software and Calibration cable
Common rail	With pressure sensor and pressure regulating valve
EGR	SS, Water cooled
Injector	Type Solenoid driven
Piezo sensor	Make PCB USA, Combustion: Range 350Bar with low noise cable
Crank angle sensor	Make Kubler Germany, Resolution 1 Deg, Speed 5500 RPM with TDC pulse.
Data acquisition device	Make NI Instrument USA, NI USB-6210, 16-bit, 250kS/s.

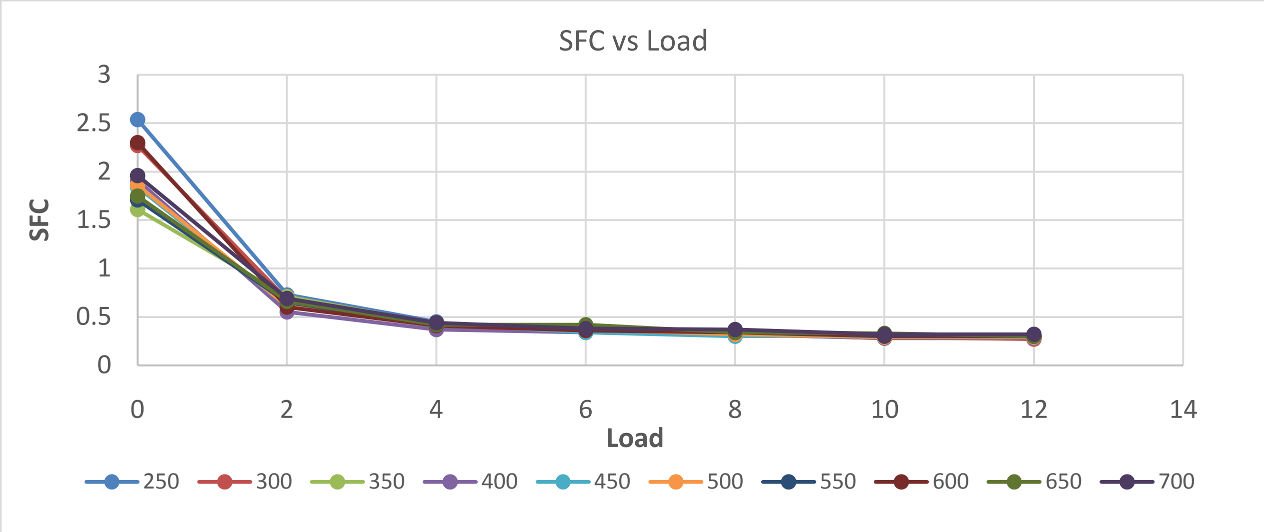
Temperature sensor	Make Radix, Type RTD, PT100 and Thermocouple, Type K
Temperature transmitter	Make ABUSTEK USA, Type two wire, Input RTD PT100, Range 0–100 Deg C, Output 4–20 mA and Type two wire, Input Thermocouple,
Load sensor	Make VPG Sensotronics, Load cell, type strain gauge, range 0-50 Kg
Fuel flow transmitter	Make Yokogawa Japan, DP transmitter, Range 0-500 mm WC
Fuel tank	Capacity 15 lit, Type: Duel compartment, with fuel metering pipe of glass
Air flow transmitter	Make Wika Germany, Pressure transmitter, Range (-) 250 mm WC
Air box	M S fabricated with orifice meter and manometer
Software	“Engine soft” Engine performance analysis software
Rotameter	Make Eureka, Engine cooling 40-400 LPH
Overall dimensions	W 2000 x D 2500 x H 1500 mm

Table: 3.1

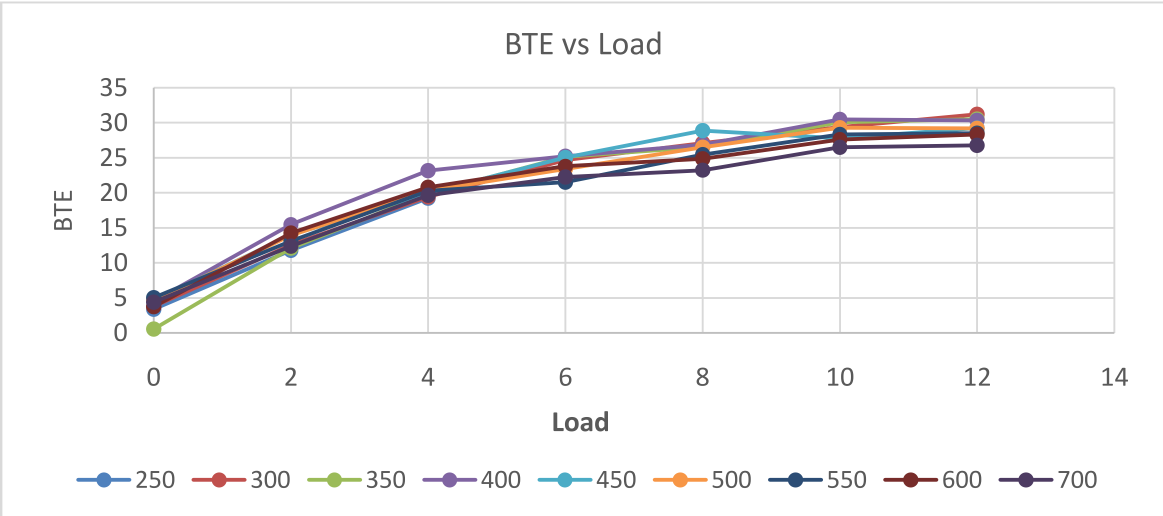
IV.RESULT AND DISCUSSIONS

First, we conducted test on single cylinder diesel engine at various pressures ranging from 250-700 bar with interval of 50 bar. At each injection pressure load on engine increased from 0-12 kg with interval of 2kg and readings of performance and emissions were recorded. It found that performance was not greatly affect by injection pressure, as load and pressure increases break thermal efficiency increases and specific fuel consumption decreases. In case of emissions it shows large variations with change in injection pressure.

4.1 Performance analysis:

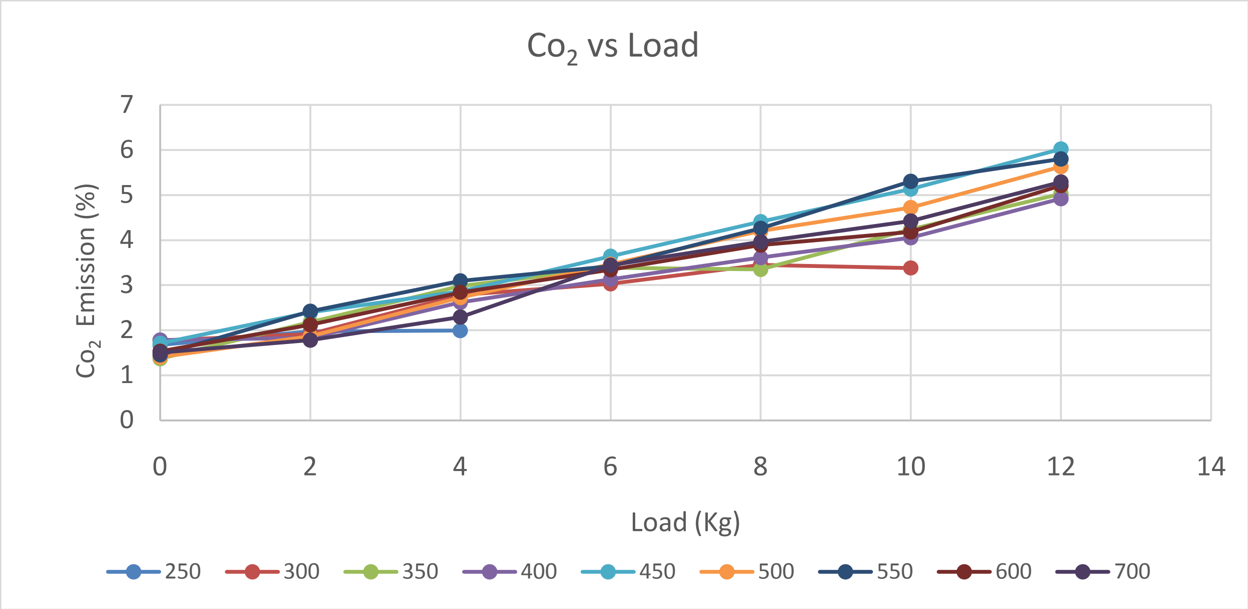


Graph: 4.1

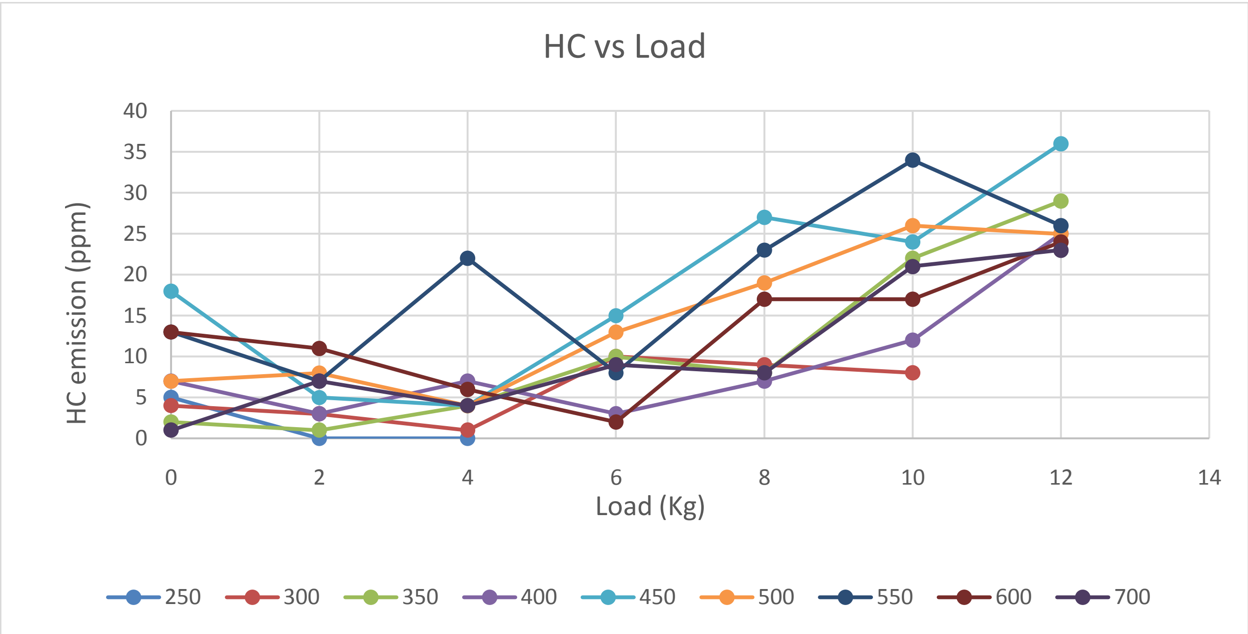


Graph: 4.2

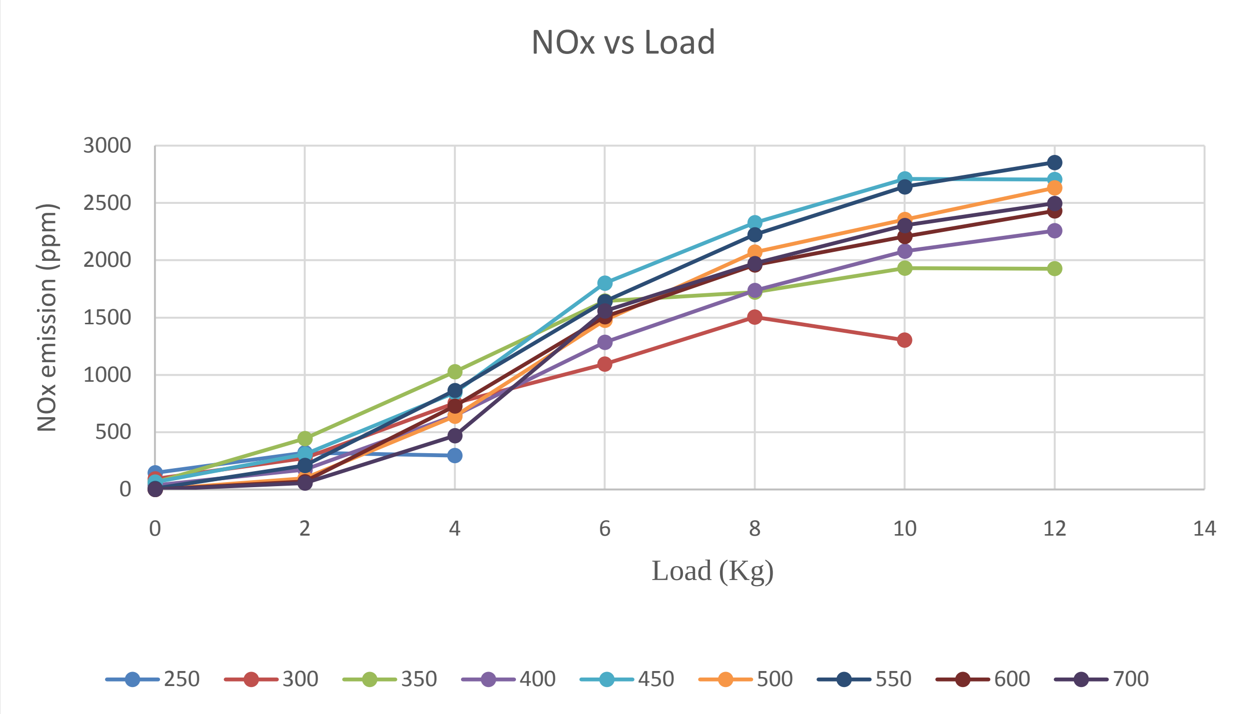
4.2 Emission analysis:



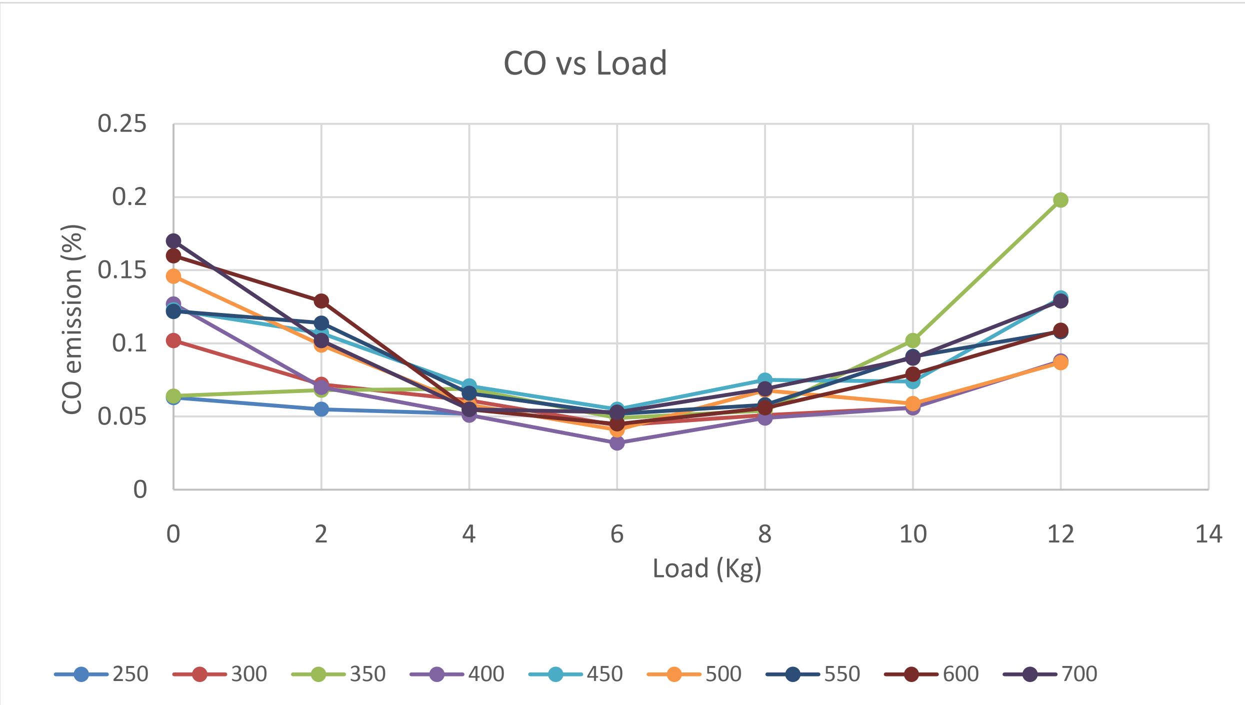
Graph: 4.3



Graph: 4.4



Graph: 4.5



Graph: 4.6

V.CONCLUSION

1) It is found that performance was not much affected by injection pressure, as load and pressure increases break thermal efficiency increases and specific fuel consumption decreases.
2) In case of emissions it shows large variations with change in injection pressure. NOx and PM are shows variation at different injection pressures and load on engine.
3) From performance analysis it is found that at 600 bar injection pressure we get optimum break thermal efficiency (BTE) and specific fuel consumption (SFC).
4) From emission analysis Co_2 content in emission increases with increase in injection pressure as well as in load.
5) NO_X content in emission also increases with increasing injection pressure and load on engine. CO emission first decrease with increasing load up to certain level and then starts to increase.
6) At 600 bar injection pressure both performance and emission parameters found to be at optimum value.

VI.FUTURE SCOPE

Performance of the developed CRDI engine is analyzed with basic testing methodology. Further addition of ECU controlled parts such as turbocharger, cooled EGR, variable timing valve setup can be done and optimize the parameters for enhancing the performance of the engine. Also, this current CRDI engine can be incorporated as a variable compression ratio engine with a programmable CRDI engine which can help the researchers to carry out the test.

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