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Effect on Cylinder pressure and Exhaust gas temperature analysis of DI diesel engine with use of Super Charger

[1]Arumugam K, [2]Senthilkumaar JS, [3]Umanath K

[1,3]Department of Mechanical Engineering, Vel Tech High Tech Dr. Rangarajan Dr. Sankunthala Engineering College, Chennai, Tamilnadu, India
[2]Department of Mechanical Engineering, Bahrathidasan Engineering College, Nattrampalli, Vellore District, Tamilnadu, India

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ABSTRACT

The present work has carried out to enhance the engine performance of Cylinder pressure and Exhaust Gas Temperature (EGT) with the use of a supercharger. Experiments were conducted on a single cylinder DI diesel engine. Effects of supercharger on combustion of a diesel engine were investigated. Tests were performed on diesel engine under different load conditions. Results Indicated that, The Cylinder Pressure of the diesel engine increased with the increase in fuel injection pressure because of improved atomization and better mixing process at higher injection pressures. The Exhaust gas temperature increases with an increase in engine load due to the increase in exhaust gas mass flow rate

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INTRODUCTION

Ming Zheng, *et al*. Investigated Thus, it's necessary to review the various means that for reducing Nox with relevance performance and disadvantages. Exhaust gas recirculation may be a technique within which a vicinity of the exhaust gases was fed back to the manifold. Nishimura, M., *et al*. (1997) printed a replacement style of low NOx, the burner was studied for application to a regenerative burner system in associate industrial chamber. The fuel is separately by on associate individual basis injected at an angle to the axis of the air stream. As a result, commixture of fuel and air is suppressed at the initial stage of combustion, and combustion progresses gently. Consequently, terribly uniform combustion is obtained, self-recirculation of the flue gas is achieved, and emission of NOx is significantly cut back, beside a decrease within the quantity of soot produced. The experiments were conducted underneath the conditions of preheated air temperature of my 100°C and a chamber temperature of 1000-1340°C. NOx, emission from the low NOx burner is underneath 50 ppm corrected to 11%. A regenerative burner system with this new NOx low NOx burner was applied to an important forge chamber. It absolutely was confirmed that the low NOx burner meets Japanese environmental rules. The energy saving is 55%. Pranav Patel, *et al*. Investigated, Supercharging of intake air may be a technique to enhance the combustion characteristics of internal-combustion engine. The usage of supercharger in diesel engines reduces the running price, however lower the heating price. Weinberg, F.J., (1996) looked into the preheating of flammable mixture by recycling heat from exhaust gases has been thought-about as an efficient methodology not just for combustion of low calorific fuels however additionally for fuel conservation. It's been referred to as heat recirculating combustion, within which reactants are heated before the flame zone by heat transport from the burnt product while not commixture two streams. Dheeraj Joshi, *et al*. Investigated the increase in intake air temperature decreases the unit air charge and additionally reduces the thermal potency. Niranjan, Shijo Thomas, *et al*. Investigated cooled EGR is employed to cut back thermal asphyxiation and therefore the increase in the Equivalence Ratio (ER). Katsuki, M., *et al*. Looked into the energy saving achieved at the same time by heat recirculation has become additional engaging from the associate ecological purpose of red. Still, to take pleasure from the energy saving brought by a high rate of warmth recirculation by applying extremely preheated air combustion to generic industrial furnaces, a price reduction of gas emission is required. The likelihood of low gas emission from extremely preheated air combustion is intensively mentioned. Dilution of the air with burned gases and combustion occurring in the air with a low oxygen

Corresponding Author: Umanath K, Department of Mechanical Engineering, Vel Tech High Tech Dr. Rangarajan Dr. Sankunthala Engineering College, Chennai, Tamilnadu, India.
E-mail: umanath_me@rediffmail.com

concentration are shown to be essential elements in realizing low gas emissions. This has a semiconductor diode to advanced chamber technology. Deepak Agarwal, *et al*. Investigated EGR is principally put in in diesel engines to cut back Nox formation by lowering the native combustion temperature and therefore the concentration of chemical element. Within the case of replacement of the EGR that decreases the exhaust emissions consequently. Plessing, T., *et al*. Investigated within the optically accessible combustion chamber, the reaction zones of Flameless chemical reaction were visualized and burning and commixture regions were recognized. The fast flame structure is compared to measurements in turbulent premixed flames. Solely disconnected reaction zones as a result of robust flame stretch ensuing from high flow velocities were observed. In the flow field before the burner, recent gas was mixed with the new exhaust gases. The recent gas was diluted and heated at the same time. Flameless chemical reaction might solely be discovered if the temperature of the unborn mixture was higher than 950 K. The temperature rise between the unborn and the burnt side of the reaction zones, varied between 200 and 400 K, looking on the dilution of the unborn mixture with exhaust gases. This temperature rise was compared with a theoretical analysis of a temperature equation for the well-stirred reactor. It is shown that Flameless chemical reaction takes place within the well-stirred reactor regime. Most native temperatures below 1650 K were measured. The OH concentration within the combustion zones of Flameless chemical reaction is below in no preheated undiluted turbulent premixed flames. Kumaraswamy A B. *et al*. Investigated Since the precise heat capability of the exhaust gas has been additional, it absorbed additional heat, thereby reducing the high temperatures out there at the time of combustion. Cooled EGR has minimal impact on the specific fuel consumption and additionally it reduces the Nox and hydrocarbons to an excellent extent. Choi, G. M., *Et al*. (2001) Characteristics the combustion with extremely preheated air were studied to grasp the modification of combustion regime and therefore the understanding of the compatibility between high functioning and low gas emission. It absolutely was found that combustion was sustained even at an extremely low concentration of oxygen, if the combustion air were preheated on top of the auto-firing temperature of the fuel. As associate application of the rule, we will cut back gas emission by dilution of the combustion air with many recirculated burned gases within the bedroom. Dilution makes the oxygen content of the oxidizer low, that decreases temperature fluctuations inside the flame still because the mean temperature, therefore, low gas emission. The present work was carried out to measure the engine performance and combustion characteristics with the combined effects of Supercharger on a single cylinder diesel engine.

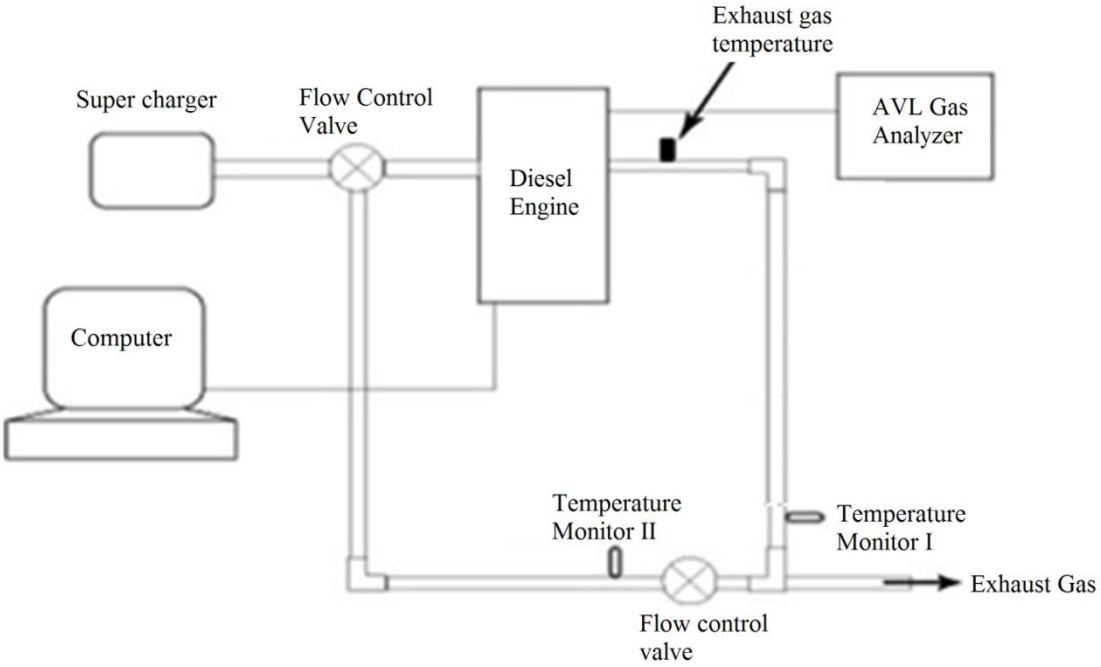

Fig. 1: Experimental setup with Super Charger.

Experimental setup:

An experimental study was dispensed on one cylinder 4.4 kW air cooled DI internal-combustion engine (TAF-1) is shown in Figure. 1. Specification of the check setup is shown in Table.1. The AVL GH14D Pressure, electrical device was set in an exceedingly hole trained through the plate into the combustion chamber to measure the cylinder pressure. The detector consists of metal diaphragm, that deflects stressed. AVL 365C angle encoder was

wanting to convert the analog price of angle into digital, electrical signal. DAQ card was connected to the encoder to judge the electrical signals and verify the crank spatial relation. AVL 3066A02 Piezo charge electronic equipment was wanting to convert the electrical charge output of the pressure electrical device into the voltage. K-typethermometer was hooked up with internal-combustion engine to live the exhaust gas temperature. Electrical measuring system five KVA AC generator (220 V, 1500 rpm) was coupled to the engine byversatile coupling for measure the brake power of the engine. Panel board consists of meter, meterswitches and fuse, load cell indicator and temperature indicator. Cooled Exhaust gas recirculation (EGR) system adopted with internal-combustion engine analyzes the engine combustion and emission characteristics.

Table 1: Direct Injection Diesel engine specifications.

Particulars	Specifications
Load type	Eddy current dynamometer
	Four stroke, constant speed, direct injection
Injection valve open	23.4 degree before TDC
Stroke length	110 mm
Maximum power	4.4 KW at 1500 rpm
Maximum torque	28 N-m at 1500 rpm
Cylinder bore	87.5 mm
Compression ratio	17.5:1
Fuel	Diesel

RESULTS AND DISCUSSIONS

Availability of waste heat from i.c. Engine:

The quantity of waste heat contained in an exhaust gas is a function of both the temperature and the mass flow rate of the exhaust gas. In order to enable heat transfer and recovery, it is necessary that the waste heat source temperature is higher than the heat sink temperature. Moreover, the magnitude of the temperature difference between the heat source and sink is an important determinant of waste heat utility or "quality". The source and sink temperature difference influences the rate at which heat is transferred per unit surface area of recovery system, and the maximum theoretical efficiency of converting thermal from the heat source to another form of energy (i.e., mechanical or electrical). Finally, the temperature range has an important function for the selection of waste heat recovery system designs. Exhaustive literature was made in the measurement of exhaust temperature of internal combustion engine of automotive vehicles and stationary engines.

Heat loss through the exhaust in internal combustion engine:

From the Engine and dynamometer specification, the heat loss through the exhaust gas from internal combustion is calculated as follows.

Specifications Internal Combustion Engine:

Volumetric efficiency ηv =0.8 to 0.9
Density diesel fuel = 0.84 to 0.85gm/cc
Calorific value of diesel =42 to 45mj/kg
Density air fuel = 10167kg/m3
Specific heat of exhaust gas =1.1 to 1.25kj/kgok

Effective radius:

R =255+25/2 =140mm

Compression Ratio:

r =Vc+Vs/Vc
17.5Vc =Vc+6.61x10-4
Vc =4 x 10-5m3

Total volume:

Vt =Vc+Vs
=4 x 10-5+6.691 x 10-4
=7.01 x 10-4m^3

Mass flow rate of fuel:

mf = s.f.c x power
=220 x 5.9
=0.3177gm/sec

Volume rate:

Vr = swept volume x speed
=vs x n
=6.61 x 10-4 x 1500/2
=0.49573/ min
=8.262 x 10-3m^3/sec

Volume of air:

Ⅱv =Volume of air/ Swept volume
=Va/ρa x n x vs

Va =na x ρ x vs
=0.9 x 1.16 x 1500/2 x 6.61 x 10-4
=0.5175gm/min
=8.625gm/sec

Mass flow rate of exhaust gas:

me =mf+ma
=8.625+0.3177
=8.9427gm/hr
=8.9427 x 10-3gm/sec

Heat loss in exhaust gas:

Qe =me x cp x Δt
=8.9427 x 10-3 x 1.1 x (450-30)
=4.13kj/sec (or kW)

Therefore the total energy loss from diesel engines is 29.21%. Hence the loss of heat energy through the exhaust gas exhausted from I.C. Engine into the environment 29.21% energy. The exhaust gas heat energy is experimentally measured by an Ultrasonic interferometer (Model F-05). The experimental investigation of the engine operated at various injection pressures at different load conditions is studied in detail and presented. The exhaust gas in an internal combustion engine carries about 25% of the heat of combustion. In the present work, attempts have been made to recover the maximum possible heat from the exhaust gas through a baffled shell and tube heat exchanger and the performance values of the diesel engine operated with heat exchanger are discussed.

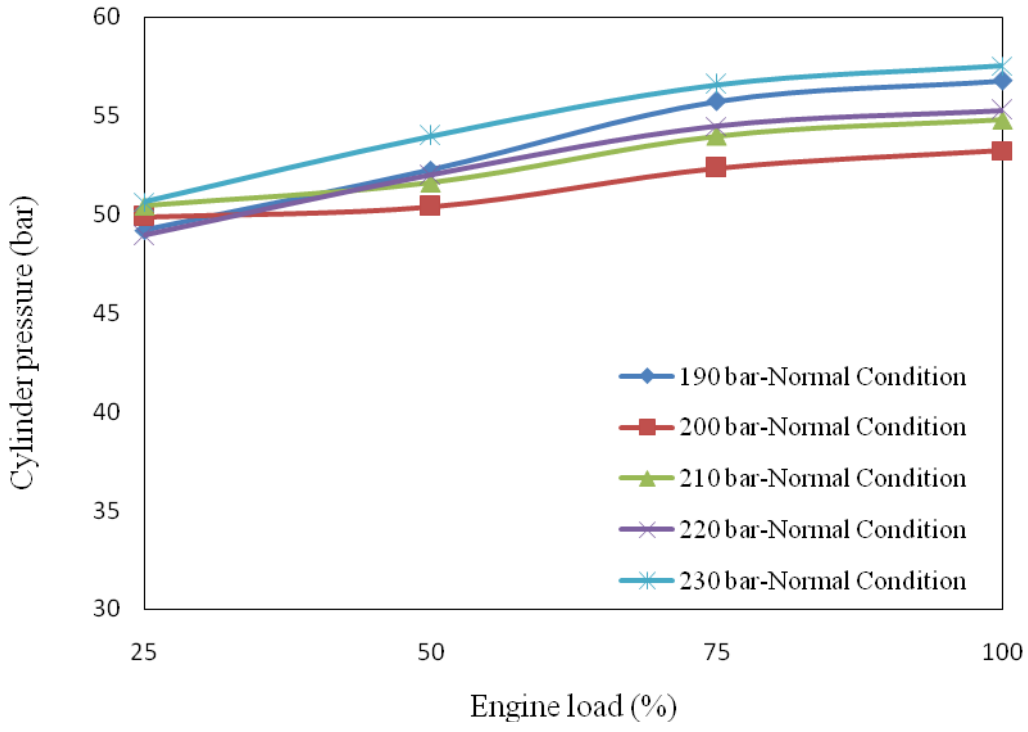

Fig. 2: Effect of Cylinder Pressure on Normal Condition.

Effect of Cylinder Pressure on Normal Engine Condition:

The variation of brake Cylinder Pressure with Engine load for different injection pressure at normal condition engine results is shown in Fig. 2. The Cylinder Pressure of the diesel engine increased with the increase in fuel injection pressure because of improved atomization and better mixing process at higher injection pressures. It is observed from the graph shows that Cylinder Pressure is ranges from 48 bar to 58 bar with respect to injection pressure is ranges from 190 bar to 230 bar respectively. As for this experimental results the maximum Cylinder Pressure was obtained at 230 bar injection pressure in all loading conditions.

Effect of Exhaust gas temperature on Normal Engine Condition:

Initially, Engine baseline tests were conducted at normal engine condition to estimate energy available in the exhaust gas. The variation of Exhaust gas temperature with engine load for different injection pressure is shown in Fig. 3. The temperature of the exhaust gas has a linear relationship with engine loads for different injection pressure. It is observed from graph shows that, Exhaust gas temperature increases with increase in injection pressure. It can be seen that, EGT increases with an increase in engine load due to the increase in exhaust gas mass flow rate. This indicates that more amount of heat recovery will be feasible at full load operating condition of the engine. The compromise between maximum exhaust gas temperature or minimum brake specific fuel consumption (bsfc) of the engine was found at 230 bar injection pressure. The exhaust gas temperature of this pressure was found to be 310°C.

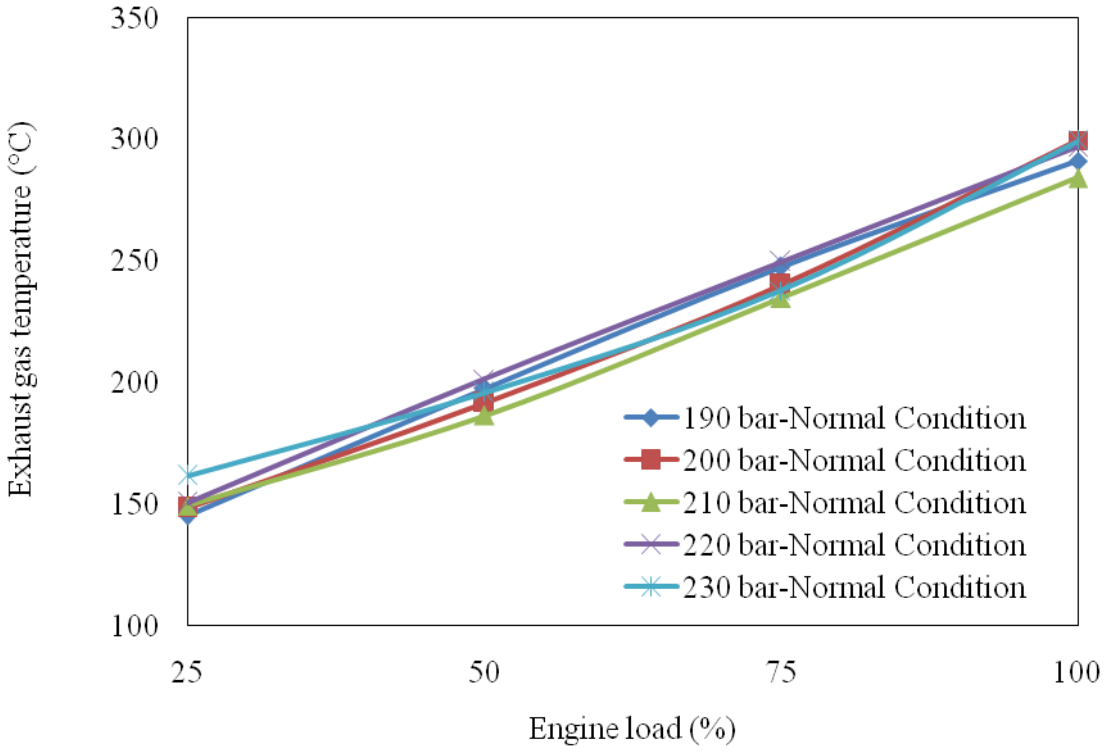

Fig. 3: Effect of Exhaust gas temperature on Normal Condition.

Effect of Cylinder Pressure on Supercharger condition:

The variation of brake Cylinder Pressure with Engine load for different injection pressure with Super Charger Condition engine results is shown in Fig. 4. The Cylinder Pressure of the diesel engine increased with the increase in fuel injection pressure because of improved atomization and better mixing process at higher injection pressures. It is observed from the graph plotted that Cylinder Pressure is ranges from 44 bar to 57 bar with respect to injection pressure is ranges from 190 bar to 230 bar respectively. As for this experimental results the maximum Cylinder Pressure was obtained at 230 bar injection pressure in all loading conditions.

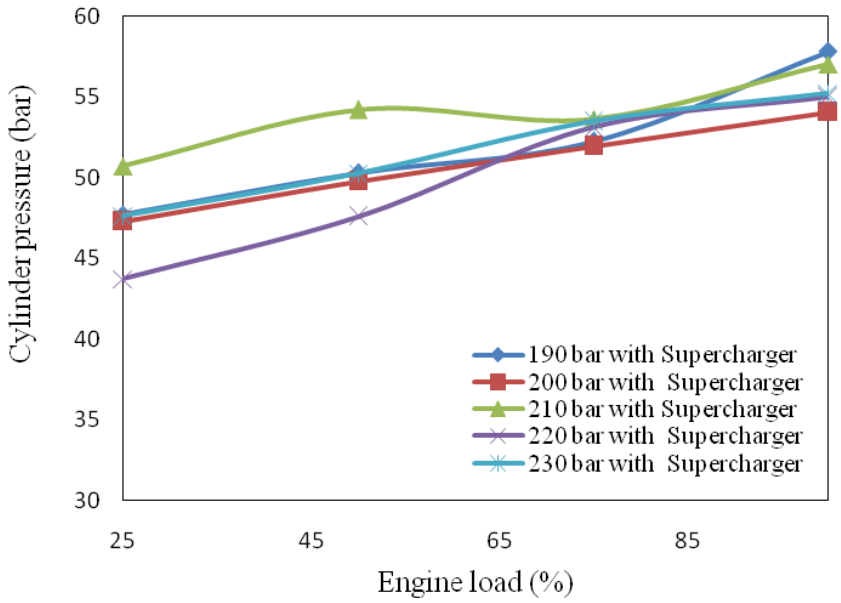

Fig. 4: Effect of Cylinder Pressure with Supercharger.

Effect of Exhaust gas temperature with Supercharger:

Initially, Engine baseline tests were conducted at normal engine condition to estimate energy available in the exhaust gas. The variation of Exhaust gas temperature with engine load for different injection pressure is shown in Fig. 5. The temperature of the exhaust gas has a linear relationship with engine loads for different injection pressure. It is observed from the graph plotted that, Exhaust gas temperature increases with increase in injection pressure. It can be seen that, EGT increases with an increase in engine load due to the increase in exhaust gas mass flow rate. This indicates that more amount of heat recovery will be feasible at full load operating condition of the engine. The compromise between maximum exhaust gas temperature or minimum brake specific fuel consumption (bsfc) of the engine was found at 230 bar injection pressure. The exhaust gas temperature of this pressure was found to be 310°C.

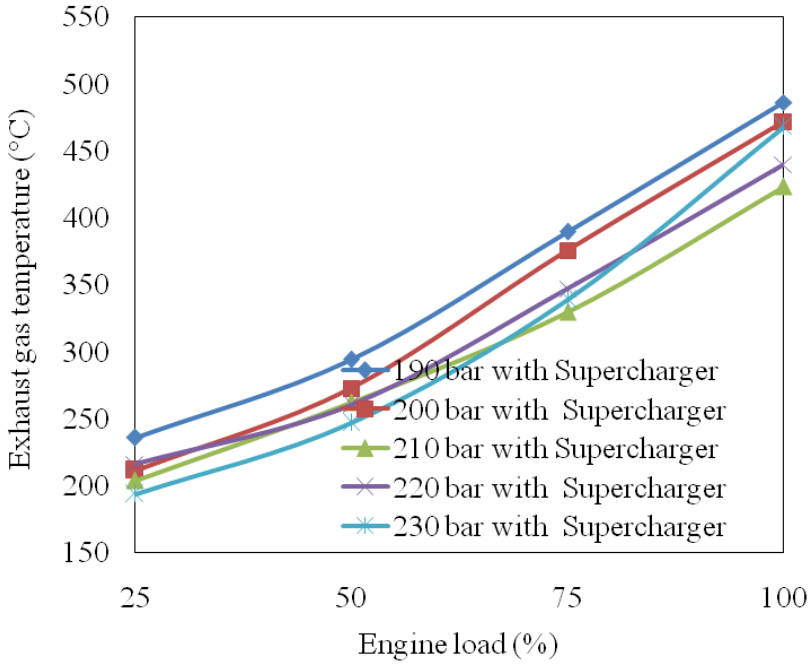

Fig. 5: Effect of Exhaust gas temperature with Supercharger.

Conclusion:

1. Super Charger is a technique for reducing the NO_x emission. Experimental investigations were conducted to study the effect of supercharger on combustion and emissions, smoke intensity of various load condition of a diesel engine.
2. Exhaust gases, lower the oxygen concentration in the combustion chamber and increase the specific heat of the intake air mixture results in lower flame temperatures.
3. Supercharger feed more volume of atmospheric air in the combustion chamber results in ensuring the complete combustion.
4. Exhaust gas temperature increases with increase in injection pressure. It can be seen that, EGT increases with an increase in engine load due to the increase in exhaust gas mass flow rate.
5. Experimental results the maximum Cylinder Pressure were obtained at 230 bar injection pressure in all loading conditions

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