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Experimental Reduction of Combustion Noise at Idle Speed in a Single Cylinder CRDI Diesel Engine BT Optimizing the Fuel Injection Pressure

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Abstract: ***The design and development of modern internal combustion engines are marked by a reduction in exhaust gas emissions and increase in specific power and torque. Correspondingly, combustion noise excitation and fuel consumption also have to be reduced. These objectives can be achieved through the development of advanced combustion systems, the increased flexibility of fuel injection systems and ECUs. However, development of modern combustion systems and vehicle applications has become increasingly complex. Creating an exact, yet straightforward description of combustion noise is a very important task. The customer's subjective impression of the entire vehicle, regarding items such as diesel knock sensitivity, provides evidence to support its value. Additionally, customer requirements for combustion noise need to be met, which can be accomplished through optimization of the combustion system. For a long time now, the reduction of noise and vibration is one of the major concerns of carmakers for their Diesel engines. Cold and idle conditions are considered to be the most critical conditions for both combustion noise and pollutant emissions. These goals can be met through the development of advanced combustion systems and the increased flexibility of fuel injection systems and ECUs. This report presents the results of a study about the effects of Fuel Injection Pressure on the combustion process and on the combustion noise at the idle condition in a Single Cylinder CRDi Engine.***

Keywords: Single Cylinder CRDi Engine.

INTRODUCTION

The reduction of vibration and noise is one of the significant attentiveness toward making diesel engines for a long time now. Idle conditions are thought to be the most essential from the perspective of combustion noise. It is likewise the case for the pollutant emissions control. Idle and cold conditions are thought to be the most noticeably bad conditions in term of the control of emission of pollutant. It is also the situation for emission of noise. In such cases, the chamber walls and piston are cold or not as hot as in extreme as it could be in different conditions. The ignition and injection happen in an environment of cold which does not take part in the process of combustion positively. The temperatures of chamber and wall are mainly recognized as the key parameters for the emissions of a pollutant. We will attempt to bring down the diesel combustion noise by utilizing this new technology. This work assesses the parameters of injection on the process of combustion with respect to the emission of combustion noise.

DIESEL ENGINE & ITS COMPONENTS

A single cylinder engine is an essential configuration of a piston engine of an inner combustion engine. It is regularly observed on auto-rickshaws, mopeds, motorcycles, radio-controlled models, dirt bikes, go-karts and has numerous uses in garden machinery and portable tools. The engines having single cylinder are compact and simple, and will frequently deliver the most extreme power conceivable inside a given envelope. Single cylinder engines need more flywheel than engines with multi-cylinder, and the rotating mass is generally large, confining acceleration and sharp variations of speed. The main components of the diesel engine are as follows:

1. Combustion Chamber: A combustion chamber is the part of an engine in which fuel is burned. It is usually known as a cylinder. The specification of the engine is also specified by the volume of the combustion chamber.
2. Piston: It is the moving component that is contained by a cylinder and is made gas-tight by piston rings. Its purpose is to transfer force from expanding gas in the cylinder to the crankshaft via a piston rod and/or connecting rod.

3. The crankshaft, sometimes casually called to crank, is the part of an engine that translates reciprocating linear piston motion into rotation. To convert the reciprocating motion into rotation, the crankshaft has "crank throws" or "crankpins", additional bearing surfaces whose axis is offset from that of the crank, to which the "big ends" of the connecting rods from each cylinder attach.
4. Top Dead Center: In an internal combustion engine, the top dead center (TDC) is the maximum reach of the piston in the upper side of the cylinder. Top dead center of piston #1 is the datum point from which ignition system measurements are made and the firing order is determined.
5. Bottom Dead Center: The Bottom Dead Center (BDC) is the lowest position of the piston in the cylinder. In a four-stroke engine, the piston comes at BDC 2 times in a combustion cycle.

RELATED WORK

M Ajovalasit et.al [1] discussed the analysis of variation in the diesel engine idle vibration. The variations in the idle vibration of diesel engine brought about by fuels of diverse composition and their involvements to the variations in the vibrations of the steering wheel are evaluated. The time-frequency continuous wavelet form (CWT) and time-varying covariance method (TV-AutoCov) are utilized for obtaining the instantaneous and cyclic characteristics of the data of vibration obtained from two turbocharged four cylinders, four stroke diesel engine vehicles at idle under 12 diverse conditions of fuel. The outcomes of this work recommend the utilization of amplitude modulated signals for studying the subjective response of a human to idle vibration of diesel at the steering wheel in passenger cars.

Jaswinder Singh et.al [2] worked on the noise reduction in four-cylinder common rail direct injection diesel engine at idle speed. The development and design of current internal combustion engines are set apart by a diminishment in the torque and a power. This objective of this paper is a study of reduction of noise in four strokes common rail direct injection engine at idle speed. The idle speed is generally an engine's speed when the vehicle is not moving i.e. it is still. In the present days, this condition regularly comes at red lights, in traffic and in waiting while parked outside a residence or business and so on. This paper introduces a study about the impacts of the pressure of fuel injection on the process of combustion.

G.T. Zheng et.al [3] presented an analysis of internal combustion engine noise with time-frequency distribution. A procedure of analysis by utilizing time-frequency distribution has been produced for the investigation of noise signals of internal combustion engine. It gives an approach making utilization of focal points of both bilinear and linear time-frequency distribution yet avoiding their demerits. To distinguish necessities on the analysis of time-frequency and furthermore relate analysis of time-frequency with sources of noise**,** the noise signal composition is firstly talked about. An example of distinguishing sources of noise and recognizing the irregular state of an injector with the time-frequency distribution of noise signal for a diesel engine is likewise given.

Hai-Jian Chen et.al [4] discussed reduction of noise of single cylinder diesel engine based on the virtual prototype. In the view of one-dimensional and method of acoustic analysis and unsteady gas dynamics flow theory, an acoustic and thermodynamics model of single cylinder diesel engine was built up by utilizing GT-Power. A strategy joined with acoustic prediction and mechanic analysis was exhibited. With this strategy, the impact of the ratio of compression, outlet and inlet channels, timing of exhaust valve and intake valve on the noise and exciting force is examined. After that, the value of optimization of every factor is finding out for improving the muffler. The exhaust and intake noise of engine optimized is simulated with this model, the results of the simulation showed that the noise of intake reduces 1.1-1.4 dB and exhaust noise reduces 2.6-3 dB.

Masahiko Kondo et.al [5] discussed the development of technologies of reduction of noise for a small direct injection diesel engine. The DI diesel engine has a favourable position in terms of fuel economy; however demerits with respect to large combustion noise and exhaust emissions. For overcoming these demerits, the concept of MK (Modulated Kinetics) was proposed. This paper exhibits the investigation results concerning the ability of the new system of combustion for reducing the combustion noise and enhancing the performance of emission at the same time. As a result of applying heavy EGR and hindering the timing of injection, excitation forces of combustion are decreased with no expansion in exhaust emissions, and with a diminishment in the noise of fuel injection system.

W.C. Strahle et.al [6] presented cetane rating and load effects on combustion noise in Diesel Engines. Experiments have been performed on a single-cylinder air-cooled direct injection Diesel engine of four strokes for determining the association between radiated noise and combustion randomness. The reported tests have conveyed the engine to its greatest fuel flow condition and explored the Cetane rating effects. The tests have decisively shown that a considerable amount of the noise which is radiated is casually connected to the turbulence (randomness) of the process of combustion and not the history of mean pressure-time. Be that as it may, the higher the load, lesser the impact of the randomness on the total output of noise.

MOTIVATION

In these days, more thoughtfulness is being given to issues related to the environment. The noise was viewed as a fundamental, however evil, harmless. Today, unnecessary noise is considered a pollution type which, over the long haul, may bring about reduced hearing permanently, As a result, now authorities require that levels of noise are kept beneath certain predetermined points of confinement. The reduction of noise is one of the most elevated focus for development of IC engine in light of the fact that more severe limits on engine noise. Internal combustion engine noise has been obtaining huge consideration from manufacturers of automobiles. In this research work, I have reduced the noise of single cylinder combustion engine. This research is based on the following objectives:

1. To reduce the noise of single cylinder combustion engine.
2. To reduce the engine rmp at idle speed.
3. To implement low fuel consumption at idle speed.

EXPERIMENTAL ANALYSIS

This research involved trying various Idle Speed Set points to Open ECU from Laptop in a single cylinder Diesel Engine. The engine used for this experiment is an automotive single cylinder air cooled four stroke diesel engines. Diesel fuel is injected directly into the combustion chamber with common-rail fuel injection equipment. The idle speed is controlled by ECU based on the feedback from the crank sensor. From PC-based software, the idle speed set point to the ECU can be changed online.

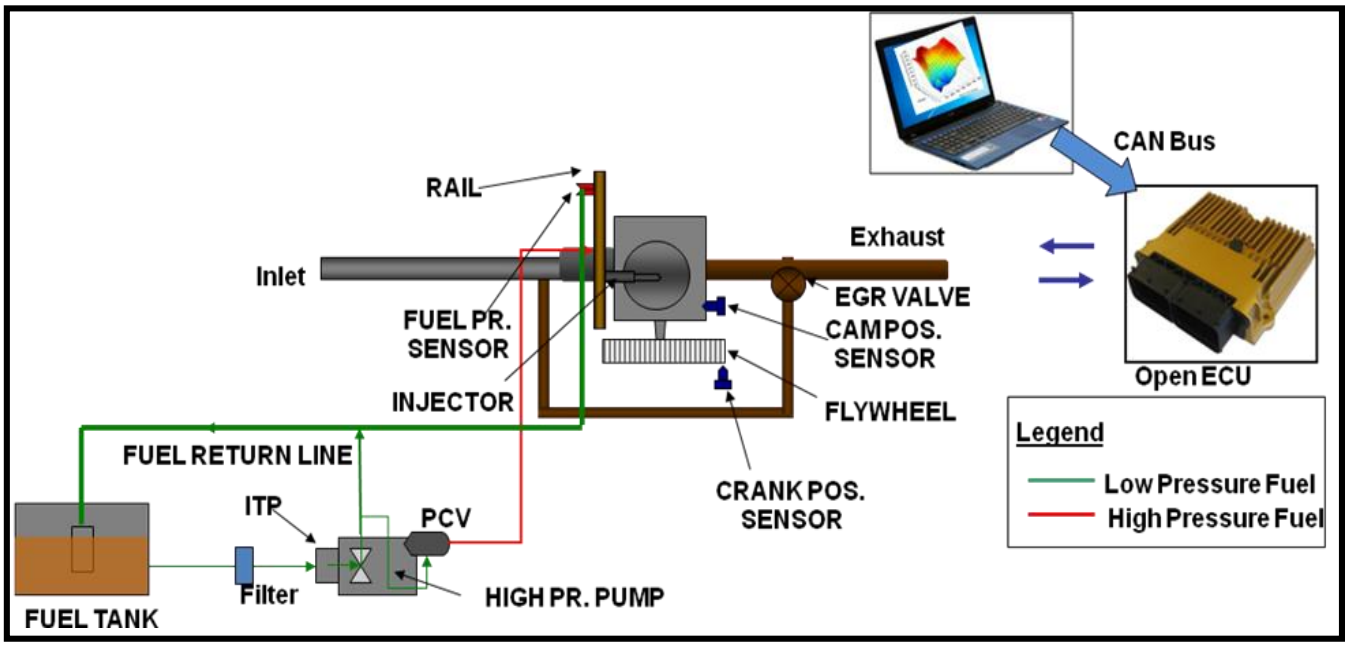

Table 1: Engine details

Engine	
No. of Cylinders	1
Application	Automotive (Multispeed)
Volume	430cc
Bore x Stroke (mm)	86 x 74
Compression Ratio	19.0:1
No. of Valves/Cyl	2
No. of Strokes	4
Ignition	CI
Camshaft	Push Rods
Cooling System	Air Cooled
Max. Torque	21.5 Nm@2200 rpm
Max. Power	8.2 bhp@3500 rpm

The main task of the experimental procedure is to study the engine combustion noise development at idle speed. Since the engine tested is of the automotive type, the main focus was on idle speed. For the experimental investigation, the engine was coupled to an Eddy Current Dynamometer; though no load was supposed to be applied at idle. In our experiment, different idle speed set-points will be tried in order to measure their impact on engine noise.

RESULTS & DISCUSSIONS

Table 1: Effect of change in pressure on Engine Speed

S.NO.	FUEL PRESSURE	ENGINE SPEED
1.	240	1000
2.	210	850
3.	205	800
4.	200	750

Table 2: Effect of change in pressure on Engine Temperature

S.NO.	FUEL PRESSURE	ENGINE TEMPERATURE (°C)
1.	240	41.4
2.	210	40.7
3.	205	39.7
4.	200	39.5

Table 3: Effect of Fuel Pressure on Engine Noise.

S.NO.	FUEL PRESSURE	NOISE
1.	240	51
2.	210	47.6
3.	205	46.24
4.	200	46.03

Table 4: Effect of Fuel Pressure on Combustion Pressure

S.NO.	FUEL PRESSURE	COMBUSTION PRESSURE
1.	240	52.7
2.	210	48.23
3.	205	46.3
4.	200	46.06

Table 5: Effect of Fuel Pressure on FMSP

S.NO.	Fuel Pressure	FMSP
1.	240	10.4
2.	210	7

3.	**205**	**6.5**
4.	**200**	**5.2**

CONCLUSION & FUTURE SCOPE

The end conclusion of this experiment is that reduction of noise takes place by optimizing the fuel pressure. On further increasing the value of fuel pressure and here observed that the noise of engine also increased. The amount of fuel pressure can cause an effect on engine noise. Air fuel pressure can also vary by using automotive operating software which may affect the various input parameters. Noise reduction can also be done in single cylinder petrol engines. Combustion of the single cylinder injection system can also vary by optimizing the input parameter.

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