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BURNING EXAMINATION OF A CNG DIRECT INJECTION SPARK IGNITION ENGINE

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ABSTRACT

Associate in Nursing experimental study was allotted on a passionate compressed fossil fuel direct injection (CNG-DI) engine with a compression magnitude relation (CR) of fourteen and a central injection BTDC) to system. many injection temporal arrangement parameters from early injection temporal arrangement (300 BTDC) were BTDC) to full direct injection (120 partial direct injection (180 BTDC injection temporal arrangement experiment was allotted to simulate investigated. The three hundred the performance of a port injection engine and therefore the result's used as a benchmark for engine performance. the total DI resulted in a very 2 hundredth higher performance than the first BTDC injection temporal arrangement injection timing for low engine accelerates to 2750 rev. a hundred and eighty shows the very best performance over an intensive vary of engine speed as a result of it's an identical meter potency to full DI. However, the sooner injection temporal arrangement allowed for a higher air–fuel commixture and offers superior performance for engine speeds on top of 4500 rev. The engine performance might be explained by analysis of the warmth unleash rate that shows that at low and intermediate engine speeds of 2000 and 3000, the total DI and partial DI resulted within the quickest heat unleash rate whereas at a high engine speed of 5000 rev, the simulated port injection operation resulted within the quickest heat unleash rate.

1.INTRODUCTION

The use of fossil fuel within the transportation sector has been increasing over the years. this is often additional supported by the increasing concern on environmental issues and energy security. the event of fossil fuel as a fuel closely followed the expansion of car conversion from each gasoline- and diesel-fuelled engines to fossil fuel fuelled in several countries. provision systems are getting important components within the vehicle conversion method (Kato et al., 1999; Catania et al., 2000). within the spark ignition (SI) engine class, provision systems are often classified as mechanical device, single/multi port injection, and direct injection. For fossil fuel vehicles, the primary generation provision system is that the mixer system and this has progressed to the a lot of refined single- and multi-port injection systems. However, with fossil fuel because the fuel, spark ignition engine performance drops to twenty (Mello et al., 2006). it absolutely was conjointly expressed that the performance drop is thanks to lower meter and thermal efficiencies.

The feasibleness of implementing direct injection systems in CNG engines has been investigated by a couple of researchers. Huang et al. (2003a) mentioned the chance of a right away injection system in a very CNG engine employing a speedy compression machine (RCM) with a ten metallic element and ascertained that the injection temporal arrangement considerably affected the intensity of fuel stratification before ignition that successively affects the combustion behaviour of a CNG-DI engine. Hayashida et al. (1999) tried that injection temporal arrangement may increase engine meter potency and brake power whereas the most effective fuel air commixture occur with the injection events around water valve closing (IVC): later confirmed by Zeng et al. (2006). Wang and Watson (2000) had shown that direct injection of CNG has lower organic compound emission compared to port injection. These previous investigations had diode to the notion that dominant the injection temporal arrangement in a very direct injection system may additional increase the CNG engine performance. However, these previous researchers conducted their experiment on either a speedy compression machine or a reborn hydrocarbon fuelled engine within which the compression magnitude relation was maintained close to the knock limiting price of hydrocarbon. so as to completely utilize the aptitude of CNG fuel, that contains a higher knock limit, the current analysis was conducted on a passionate engine with a compression magnitude relation of fourteen. The objectives of this analysis area unit to analyze the impact of injection temporal arrangement on the performance, emissions and combustion behaviour of the CNGDI engine. The results of variable the injection temporal arrangement on the performance of a CNG-DI engine at wide-open throttle (WOT) and a large vary of engine speeds area unit conferred.

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2.MATERIALS AND METHODS PROCESS

This analysis was supported the experimental study conducted at the Centre for Automotives analysis (CAR) in Universiti Teknologi PETRONAS (UTP). The check conducted follows the SAE customary on engine performance and emission testing. The experimental found out is shown in Figure one. Wide-open throttle is laid out in this experiment as representative of full load condition. The equivalence magnitude relation was unbroken constant at one.0, and therefore the ignition temporal arrangement was adjusted via the engine management unit (ECU) to get the most effective torsion reading (MBT). The engine speed vary was 2000–5000 rev. BTDC The injection temporal arrangement was varied from a really early injection temporal arrangement at three hundred BTDC BTDC) to a late injection temporal arrangement at 120 (intake valve getting down to open at 372 BTDC). In Figure a pair of, the first injection temporal arrangement with the start (intake valve shut at 132 BTDC is to simulate port injection provision system. At Associate in Nursing SOI of injection (SOI) at three hundred BTDC, a partial direct injection was achieved wherever the injection starts while of a hundred and eighty the valve is open and ends once the valve is closed.

for injection events once the valve closed. It ought to be noted that full DI is restricted by the ignition temporal arrangement for safety reasons. Hence, in our investigation, all injection events were completed before ignition occurred. All the experiments were conducted with a stable operation with a five-hitter COV of IMEP.

Equipment

The engine utilized in this experiment could be a four-stroke spark ignition single cylinder analysis engine. Table one elaborates the specification of the experimental engine. A fuel pressure regulator was accustomed management the fuel rail pressure and stabilize the gismo pressure. Engine management parameters like injection temporal arrangement, ignition temporal arrangement and airfuel magnitude relation were managementled via the engine control unit (ECU). injector position relative to the intake and valve. The gismo is positioned at the centre of the combustion chamber between the intake and valve whereas Figure 3(b) shows the gismo position relative to the plug position, that is slightly offset at Associate in Nursing angle. A changed long tip plug was utilized in order to achieve deeper into the combustion zone to assure combustion of the CNG fuel. Table three highlights the provision system designed for CNG operation for a fuel rail pressure of eighteen bar. The fuel rail pressure is adjustable from eight to twenty bar, with a provide from a CNG tank controlled at two hundred bar. Commercially on the market CNG fuel was utilized in this experiment. The CNG composition in Asian country is given in Table three, concerning the datasheet given by PETRONAS.

3.RESULTS AND DISCUSSION

The effects of variable the injection temporal arrangement on the CNG-DI engine area unit shown in Figure four and five. The engine performance is conferred in terms of torsion, power, BMEP, and BSFC to explain the engine output for numerous injection temporal arrangement conditions. At lower engine speed, the total DI resulted in 10%–20% higher torsion compared to early injection temporal arrangement. the most torsion was achieved by DI for engine speeds below 2750 rev. However, early injection temporal arrangement resulted in a very higher torsion at engine speeds on top of 4500 rev. Partial DI and full DI resulted in 15 August 1945 higher power compared to the BTDC for speeds of but 2750 rev. because the engine speed will increase to 3500�300 BTDC injection temporal arrangement drops below that�rpm, the performance of the engine with a hundred and twenty BTDC injection temporal arrangement.

The different torsion and power output of full DI, partial DI and port simulated area unit primarily thanks to the impact of meter potency. this will be ascertained in Figure half dozen. The meter potency shows Associate in Nursing increasing trend because the injection temporal arrangement is stupid. contains a higher meter potency (0.83–0.94) compared to partial DI�Full DI of a hundred and twenty BTDC severally. These results agree 180° BTDC and early injection temporal arrangement at three hundred with the results from Zeng et al. (2006) wherever the increasing meter potency could also be due toa lesser disturbance to the intake flow because the injection temporal arrangement is stupid. consistent with Zeng et al. (2006), the pressure can increase thanks to the injection method. the rise of in-cylinder pressure can cut back the pressure distinction between incylinder and atmospherical and within the finish it'll cut back the intake speed. Reduced intake speed can cut back the quantity of air getting into the cylinder for a given time house throughout the intake strokes. The performance of the engine is considerably full of the meter potency at engine speeds below 4500 rev. at intervals this vary of engine speed, full DI and partial DI givs higher power output. what is more, partial DI has the combined impact of high meter potency with adequate commixture time that provides a most engine performance between 2750 and 4500 rev.

At engine speeds below 3000 rev, the operation with full DI resulted within the highest Night and lowest CO levels. a better level of Night emission indicates a better combustion temperature because the N content within the air can solely expertise break-up to form Night if the temperature of the combustion is on top of 2000 °C. a better combustion temperature indicates that a higher combustion method happens within the cylinder. Another indicator of fine combustion is lower CO emissions, that occur thanks to the wholeness of the combustion method. what is more, these results were confirmed by the pressure reading of full DI that shows the very best results compared to alternative injection timings as shown by Figure seven. It are often finished that full DI provides higher combustion at a 2000 rev engine speed. At engine speeds on top of 3500 rev, CO production is sort of equal for partial and port simulated DI. However, Night production is higher for partial DI because of higher combustion as conjointly shown within the combustion analysis.

DI system. From the experimental results, every form of injection temporal arrangement was optimized for a selected operational condition. Late injection temporal arrangement (full DI) has higher combustion results at 2000 rev as shown in Figure 8(a). the most pressure for full DI reaches fifty nine bars that is on top of alternative injection timings. the higher combustion with a full DI system may well be thanks to a better turbulence level within the combustion chamber that's indicated by a quicker heat unleash rate, particularly for 10%–90% of the combustion method (Figure 8b). A quicker period of the first stage of the combustion method is additionally shown in Figure 8(c) wherever full DI systems show quicker burning periods compared to alternative injection timings. The partial DI method contains a similar burning rate to it of the port simulated, however with higher combustion efficiency: near full DI's result. the upper peak pressure and shorter combustion period shown by full DI in Figure 8(f) might thanks to the upper turbulence intensity at the most combustion stage. an identical result was according by Wang et al. (2008) in Associate in Nursing experiment with a relentless volume chamber. what is more, the initial combustion stage (Figure 8f) and therefore the ignition delay amount (Figure 8e) of full DI is quicker than those of the opposite injection timings, that powerfully indicates the existence of high charge stratification exploitation full DI system within the combustion chamber (Huang et al., 2003b). Thus, high charge stratification and quicker combustion period cause higher combustion potency for partial DI and full DI. However, these lower engine speed results area unit somewhat completely different from the results shown by Zeng et al. (2006). In their report, 180° BTDC injection temporal arrangement has the very best most pressure compared to alternative injection timings, earlier or later. These variations could also be thanks to a better injection pressure at lower compression ratios for a lean mixture of CNG.

But the most combustion stage, from 10%–90%, is generally full of the intensity of turbulence within the chamber. Turbulence tried to have an effect on the flame propagation within the SI engine. Higher turbulence levels will increase the flame speed in Associate in Nursing SI engine and shorten the combustion period. Full DI shows the shortest period among all the injection timings, whereas partial DI and port simulated injection have longer durations, consecutively (Figure 9f). it's shown that full DI creates a better turbulence intensity compared to alternative injection timings. A homogenised mixture of port simulated DI at 3000 rev causes the longer ignition delay and it conjointly contains a low turbulence intensity that will increase the combustion period. In the end, these results manufacture lower combustion potency.

The delay is clearly seen within the mass fraction burned (Figure 10c), wherever full DI starts to combust a couple of degrees before TDC, and has reduced combustion potency. Further, combustion potency decreases because the injection temporal arrangement is stupid, from 0.8% to 0.68% (Figure 10d), whereas port simulated injection contains a similar MFB as partial DI. Figure 10(d) shows that combustion potency is decreasing because the injection temporal arrangement is stupid. a unique trend has been shown by the impact of injection temporal arrangement on combustion potency compared to lower engine speeds. This shows that at high engine speed, the blending window is very important. larger commixture window provides higher combustion at high speed. The combustion period for all injection timings doesn't provide a lot of distinction for the 0%–90% combustion stage (Figure 10e). however it decreases because the injection temporal arrangement is advanced for the combustion stage 90%–100%. These ignition delay results shows that the delay amount is minimized because the injection temporal arrangement is stupid from port simulated to partial DI temporal arrangement, however will increase steeply once full DI is applied (Figure 10f). These results show that port simulated injection temporal arrangement is that the most fitted for prime engine rev as compared to partial DI and full DI operations.

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