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FUEL INJECTION SYSTEM OF ENGINE C-4.4 FOR LEARNING AID

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ABSTRACT
Direct injection systems are typically constructed around high-pressure fuel rail feeding solenoids rather than low-pressure pump feed injectors. A conventional rail injector is an example of this type of system (or pump nozzle). The common rail injection system is a type of fuel supply system in which two or more high-pressure pumps are used to supply a typical manifold or rail with fuel. The time of fuel delivery to the cylinder injectors is controlled by timing valves, which also determine the degree of fuel delivery. The elimination of smoke during operation, lower and more consistent running speeds (down to roughly 10 rpm for 2-stroke engines), and lower fuel usage at part-load are all advantages offered by common rail technology. The fuel injection pressure in mechanical injection systems is determined by the speed of the engine as well as the load on the engine. When the injection pressure is lowered at lower loads, the fuel droplets grow larger, but there is not enough time for the fuel droplets to finish combusting since there is not enough time. The result would be a cloud of black smoke. The common rail is a manifold that runs the length of the engine immediately below the level where the cylinder covers are located. An electronic control fuel system for learning help using the EUI C-4.4 Caterpillar engine platform that was built on a microcontroller has been finished. This particular type of simulator is able to recognize and comprehend the Electronic Engine system, in particular the EUI Engine C-4.4 (Electronic Unit Injectors) system.

KEYWORDS:
Injection system, Common rail, engine, caterpillar, simulator.

INTRODUCTION

A method of supplying fuel that utilizes two or more high-pressure pumps that feed into a single manifold or rail. The timing of fuel delivery to the cylinder injectors is controlled, in part, by valves that are known as timing valves. The advantages of using common rail technology include a smokeless operation, lower and more consistent running speeds (down to approximately 10 revolutions per minute for 2-stroke engines), and reduced fuel consumption at part-load. When using a mechanical injection system, the fuel injection pressure is determined by the engine speed as well as the load on the engine. At lower loads, the injection pressure will reduce, which will cause the fuel droplets to grow larger. However, there will not be enough time for these droplets to complete their combustion. The end effect is producing black smoke. The common rail is comprised of a manifold that travels the length of the engine and is positioned slightly below the level of the cylinder cap. It allows for a specified volume of storage to be provided for the fuel oil, and it includes mechanisms for dampening pressure waves. A separate injection control unit for each engine cylinder is responsible for delivering gasoline from the common rail to the regular fuel injection valves in the engine. The control units are responsible for regulating the timing of the fuel injection, controlling the volume of fuel that is injected, and setting the shape of the injection pattern. Each cylinder cover contains three fuel injection valves, each of which can be independently operated so that they can be individually programmed or, if necessary, worked in conjunction with one another.
A large number of researchers are now studying the common rail fuel system. The results and discussion of experimental studies conducted on high-speed direct injection light-duty diesel engine test beds are presented in this article for the purpose of evaluating and reviewing the effects that key adjustable parameters of the

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system of fuel injection have on all controlled emission gases and torque output [1]. It is important to take into account the dynamic behavior of the injection pressure when designing a common-rail system for diesel engines. The unsteady flow in the pipes that connect the rail with the injection holes and with the control volume has been modeled using the CFD code, which has been developed to simulate the flow [2]. A method for the precise management of the quantity of engine fuel injected into high-pressure common rail (HPCR) injection systems by using an on-line calibration process that is based on iterative learning control (ILC) [3]. In order to investigate the effect that injection pressure and timing of injections have on the temporal evolution of injection rate and length of injection, experiments were carried out in a specially built experiment rig that was equipped with a standard rail injection system. The rig was used to perform the experiments [4]. A constant volume chamber and a high-speed camera were used in order to observe the evolution of the spray, and a common-rail system was utilized in order to adjust the injection pressure [5]. The schlieren process and the particle/droplet image analysis technique were utilized in order to investigate the macroscopic and microscopic spray characteristics of di-n-butyl ether (DBE)/biodiesel blends, pure biodiesel, and diesel at various injection and ambient pressures. This was done in order to determine the characteristics of the spray at both the macroscopic and microscopic levels [6]. The common rail fuel injection system of a diesel engine is the focus of this body of research work. It is critical to tune the fuel injection system so that each injection is subjected to conditions that are comparable [7]. The spray and atomization characteristics of commercial diesel fuel, biodiesel (FAME) derived from waste cooking oil (B100), 20 percent biodiesel mixed diesel fuel (B20), renewable diesel fuel manufactured in-house, and civil aircraft jet fuel (Jet-A) using the common rail fuel injection system were investigated [8]. The modeling and control of a novel pressure management mechanism for the fuel injection system of the Common Rail Internal Combustion Engine (ICE) [9].
The common rail fuel injection system was developed as part of this research project. The simulator was designed to serve as a teaching tool for subjects relating to fundamental engines.

METHODOLOGY

The D3K XL unit is an electronic fuel system control system that is installed on the C-4.4 caterpillar engine that was utilized in this research. Basic control system of D3K XL Caterpillar is shown in Figure 1. The figure 1 provides a high-level overview of the model and illustrates it with a brief illustration of the actual engine system. The fundamental notion of the ECM caterpillar model for processing input data is the sensor component that outputs a frequency signal or a PWM signal with the intention of modifying the intended output as a parameter. The system was initially simulated taking into consideration the fundamental system of the electronic control system of EUI C-4.4. This was done before the development of the common rail injection system simulator. The flow model of gasoline was followed closely during the development of the common rail simulator.

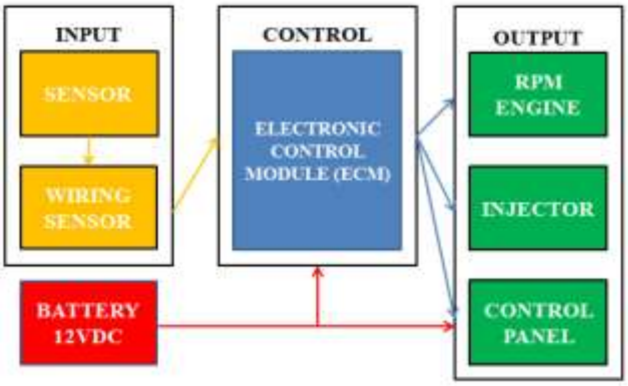

Fig. 1. Basic Control system D3K XL Caterpillar

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The control system design schematic for the common rail simulator is shown in Figure 2. The four injectors in the common rail injector simulator are controlled by a throttle. The gear shift will input a signal to the ECM that takes engine speed into account. The monitor displays the engine's rotational speed.

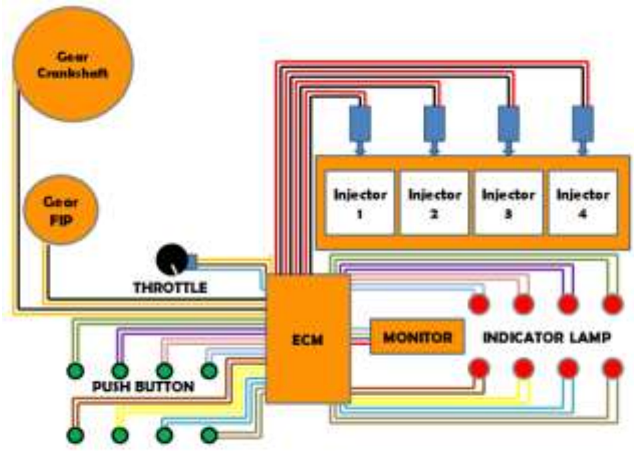

Fig. 2. Schematic Design of control system

The design and dimensions of the common rail fuel system simulator are illustrated in Figure 3. As a learning tool, the simulator for common rail fuel injection is of a simple and secure size. As a learning tool, the height of the props should be adjusted such that they are easy to use and do not interfere with the function of the inner body.

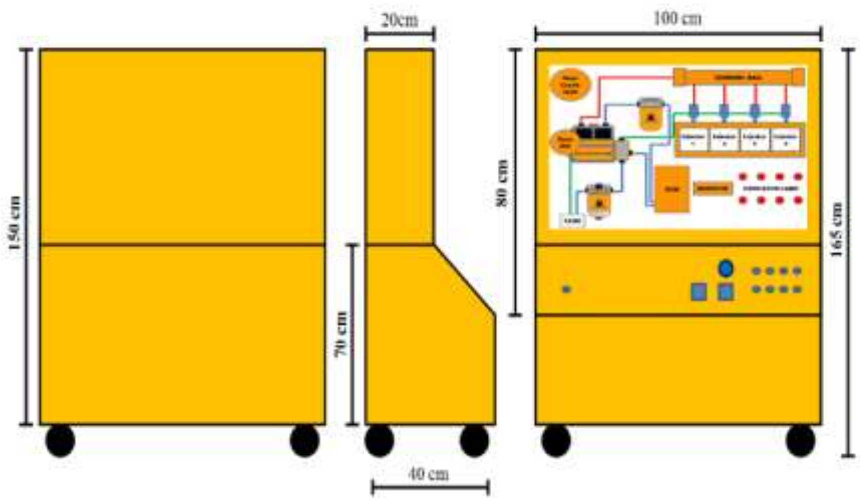

Fig. 3. Design and dimension of common rail fuel system simulator

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The 35-millimeter-square hollow pipe portion was used to build the simulator's structure for the common rail fuel system. Plywood measuring 2,440 mm by 1,220 mm, with a thickness of 5 mm, was utilized to cover all sides of the simulator. In addition to the hollow iron frame, welding wire and screws are required to join the various components together and secure the plywood to the finished structure.
Using square hollow pipe sections with a dimension of 35 mm, the common rail fuel system simulator's structure was built. Plywood with a 5 mm thickness and measurements of 2,440 mm 1,220 mm was utilized to cover the simulator's entire exterior. In addition to the materials listed above, the hollow iron frame needs welding wire and screws to bind the various components together. Additionally, plywood needs screws to be attached to the formed frame.
The Arduino MEGA 2560 microcontroller served as the Electronic Control Module (ECM). To manage the fuel flow, a C-based software was uploaded to the IC Atmega. As a signal to the microcontroller, there is a switch or push button to change the parameter from high to low. To demonstrate the sensor's disruption, a simulation for throttle position was developed, and the outcome is displayed on the LCD. The electronic unit injector component was the solenoid control valve water. The part is used to regulate water flow using 12 volt direct current electricity. The solenoid, a 1/4-inch fitting that will be attached to the solenoid, a sprayer to fog the fluid being sprayed, and tape to establish a seal to prevent leaking are all needed to make this injector simulation.

RESULTS

The calibration of the simulator for the common rail fuel system ensured that all components are in good condition. Figure 4 shows the measured voltage of the simulator for comparison with previous research. Then, the fuel system's feature was evaluated to guarantee that the simulator sensor can perform effectively. Second, an LCD monitor displayed the diagnostic code 036-0100-03 on the oil pressure sensor's LCD display. Thirdly, the throttle position sensor was examined to ensure that when the diagnostic code 036-0091-13 is displayed, the engine cannot attain a high idle speed. When the boost temperature sensor is functional and the indicator bulb is on, the diagnostic code 036-1785-03 is displayed.

Fig. 4. Measured Voltage of Simulator

This simulator's coolant temperature sensor is functioning properly, displaying diagnostic code 036-0110-03. Next, the modeling of the fuel rail pressure sensor on the propellers will be tested. The writer obtains results consistent with the defined function and operates correctly. The monitor screen displays diagnostic code 036-1797-03, the engine has shut down, and the indicator light is illuminated.

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CONCLUSION

The outcome is summarized in the section below.

1. The EUI C-4.4 Caterpillar Engine engine model fuel system simulator with electronic control based on a microcontroller has been built.
2. The use of the fuel system trainer with Electronic Control on the Electronic Unit Injector (EUI) utilizing the C-4.4 Caterpillar Engine model would significantly improve efficiency and safety.
3. This simulator is capable of recognizing and comprehending the Electronic Engine's fundamental operating system, in particular the EUI Engine C-4.4 (Electronic Unit Injector) System.

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