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DESIGNING OF COMMON RAIL FUEL INJECTION SYSTEM SIMULATOR

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ABSTRACT

A typical rail injector is a direct injection system designed around a high-pressure fuel rail feeding solenoid instead of a low-pressure pump feed injector (or pump nozzle). The common rail injection system A fuel supply system in which a typical manifold or rail is supplied by two or more high-pressure pumps. Timing valves specify the timing and degree of fuel delivery to the cylinder injectors. Common rail technology advantages are smokeless operation, lower, steady running speeds (down to about 10 rpm for 2-stroke engines) and reduced fuel consumption at part-load. For mechanical injection systems, the fuel injection pressure is a function of the engine speed and engine load. As the injection pressure decreases at lower loads, the fuel droplets grow larger and there is not enough time for these droplets to complete combustion. The effect would be black smoke. A manifold running along the engine's length at just below the cylinder cover level is the common rail. A microcontroller-based electronic control fuel system simulator with the EUI C-4.4 Caterpillar engine platform has been completed. The Electronic Engine system, and particularly the EUI Engine C-4.4 (Electronic Unit Injectors) system can be recognized and understand by this simulators.

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

INTRODUCTION

A fuel supply system in which two or more high-pressure pumps supply a common manifold or rail. Timing valves determine the timing and extent of fuel delivery to the cylinder injectors. Smokeless operation, lower, steady running speeds (down to around 10 rpm for 2-stroke engines) and reduced fuel consumption at part-load are the advantages of common rail technology. The fuel injection pressure for mechanical injection systems is a function of engine speed and engine load. The fuel droplets grow larger as the injection pressure drops at lower loads, and there is not enough time for these droplets to complete combustion. Black smoke are the result. A manifold running at just below the cylinder cover level along the length of the engine is the common rail. It provides the fuel oil with a certain storage volume, and has provisions for damping pressure waves. Fuel is supplied to the regular fuel injection valves from the common rail via a separate injection control unit for each engine cylinder. The control units regulate the fuel injection timing, control the injected fuel volume, and set the shape of the injection pattern. In each cylinder cover, the three fuel injection valves are independently operated so that they can be programmed to function separately or as required in unison.

Many researchers conduct study common rail fuel system. Experiments were performed to investigate the effect of injection pressure and timing of injections on the temporal evolution of injection rate and length of injection in a specially built experiment rig fitted with a standard rail injection system [1]. Results and discussion on experimental studies on high-speed direct injection light-duty diesel engine test beds are presented for evaluation and review of the effects on all controlled emission gases and torque output of key adjustable parameters of the system of fuel injection [2]. To observe the spray evolution, a constant volume chamber and high-speed camera were used and a common-rail system was used to adjust the injection pressure [3]. An accurate engine fuel injection quantity management technique for high-pressure common rail (HPCR) injection systems using an on-line calibration process based on iterative learning control (ILC) [4]. Commercial No. 2 diesel fuel, biodiesel (FAME) derived from waste cooking oil (B100), 20 percent biodiesel

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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 examined for spray and atomization characteristics [5]. In a common-rail system for diesel engines, the dynamic behavior of the injection pressure is considered. The CFD code has been developed to simulate the unsteady flow in the pipes connecting the rail with the injection holes and with the control volume [6]. In order to investigate the macroscopic and microscopic spray characteristics of di-n-butyl ether (DBE)/biodiesel blends, pure biodiesel and 0# diesel at various injection and ambient pressures, the schlieren process and the particle/droplet image analysis technique were adopted [7]. Modeling and control of a novel pressure management mechanism for the Internal Combustion Engine (ICE) fuel injection system of the Common Rail (CR) [8].
In this study, the common rail fuel injection system was developed. The simulator was created as a learning material in fundamental engine subject.

METHODOLOGY

An electronic fuel system control system on the C-4.4 caterpillar engine used in this research is the D3K XL unit. A brief overview of the model briefly illustrated by the actual engine system is shown in figure 1. The basic concept of the ECM caterpillar model to process input data is the sensor part that emits a frequency signal or a PWM signal that aims to change the desired output as a parameter. Before developing the common rail injection system simulator, the system was first simulated considering the basic system of the electronic control system of EUI C-4.4. The common rail simulator was designed following the flow model of fuel.

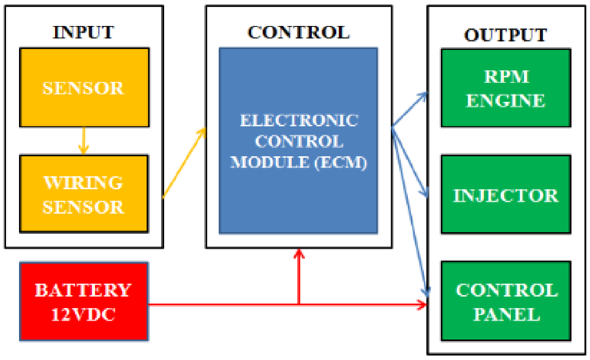

Fig. 1. Control system D3K XL Caterpillar

Figure 1 show the design schematic control system of common rail simulator. The common rail injector simulator consists of four injector with controlling by throttle. The gear chamsaft will input signal considering engine speed to ECM. The engine rotating speed shows in the monitor.

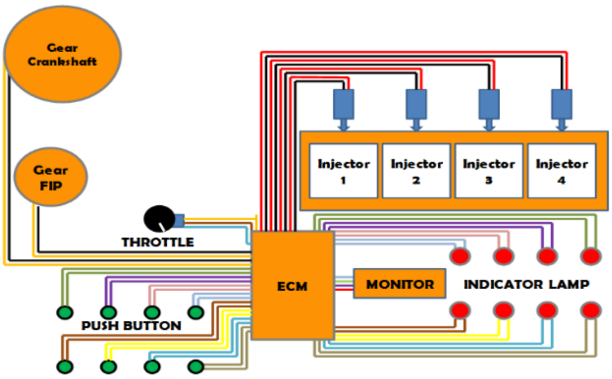

Fig. 2. Design schematic control system of common rail simulator

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Figure 3 show the Design and dimension of common rail fuel system simulator. The dimension of the common rail fuel injection simulator is easy and safe as a learning tool. The height of the props should be modified as a learning tool so that it can be tailored for users who may use these props so that they are easy to use and have no side effects that interfere with the inner body's function.

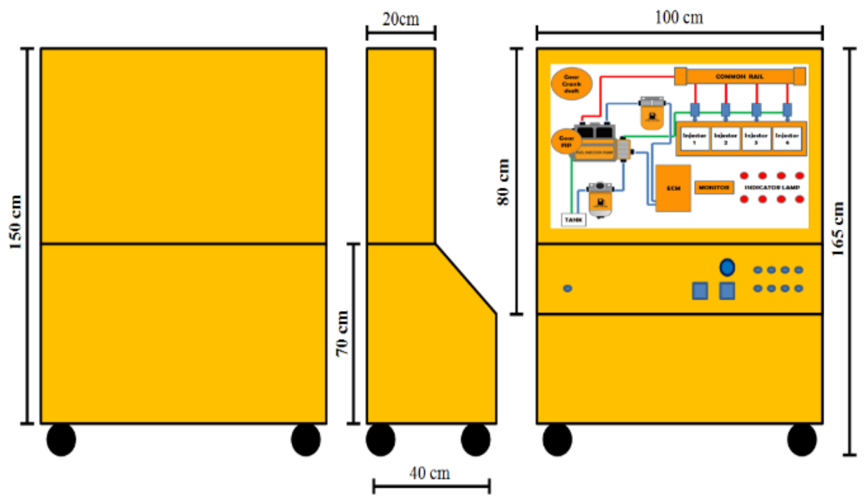

Fig. 3. Design and dimension of common rail fuel system simulator

The frame of the common rail fuel system simulator was constructed using the square hollow pipe section with a dimension of 35 mm. As for the cover for all sides of the simulator, the plywood with thickness 5 mm and size dimensions 2,440 mm × 1,220 mm was used. The frame to be built also needs welding wire and screws as materials to link the hollow iron frame to bind the parts to each other as well as screws to attach the plywood to the frame that has been created.

As for the Electronic Control Module (ECM), the microcontroller Arduino MEGA 2560 was used. The program using C language was uploaded to the IC Atmega to control the flow of fuel. There is a switch or push button to change the parameter from high to low as a signal to the microcontroller. Simulation for throttle position was created to show the sensor's disturbance and then the result will show on the LCD. The Solenoid control valve water was used as the electronic unit injector component. The component is used for controlling the water flow by using electric power 12 Volt DC. The manufacture of this injector simulation uses the solenoid and a ¼ inch fitting that will be attached to the solenoid and requires a sprayer that aims to fog up the fluid being sprayed and also requires tape to provide a seal aimed at preventing leakage.

RESULTS

The common rail fuel system simulator was calibrated to make sure the condition of all components well. Firstly, the simulator voltage measured to compare with the literature is shown in figure 3. Then, the feature of the fuel system was tested to ensure the simulator sensor can operate adequately. Secondly, the oil pressure sensor was diagnostic by using an LCD monitor to show the diagnostic code 036-0100-03. Thirdly, the throttle position sensor was tested to ensure that when the diagnostic code 036-0091-13 is showed, the engine can not reach in high idle. The diagnostic code number 036-1785-03 is showed when the boost temperature sensor is working and the indicator lamp was on.

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Fig. 4. Voltage calibration

The coolant temperature sensor in this simulator is working correctly with showing the diagnostic code number 036-0110-03. The next step is to test the simulation of the fuel rail pressure sensor on the props here. The writer gets the results according to the function that has been made and works properly. There are no problems, the monitor screen displays the diagnostic code 036-1797-03, the engine has shut down and the indicator light is on.

CONCLUSION

The summary of the result is shown below

1. The fuel system simulator with electronic control based on a microcontroller with the EUI C-4.4 Caterpillar Engine engine model has been completed.
2. Learning using the fuel system trainer with Electronic Control on the Electronic Unit Injector (EUI) using the C-4.4 Caterpillar Engine model will be much more efficient and safe.
3. This simulator can recognize and understand the Electronic Engine's basic operating system, especially the EUI Engine C-4.4 (Electronic Unit Injector) System.

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