Performance Analysis of Fuel Injector in CRDI System by ICEM CFD

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ABSTRACT

Common Rail Direct Injection (CRDI) system is one of the most advanced technologies used in current diesel engines. CRDI has maximum injection pressure of 1800 bar where as conventional Direct Injection (DI) system generates around 300 bar. Conventional DI system has to create optimum injection pressure repeatedly for each operating cycle. But in case of CRDI system, it maintains the constant injection pressure level throughout the engine operating cycle. This advancement improves the fuel atomization process which directly leads to improved engine performance, fuel efficiency and lower emission level. This research work is based on the analysis to identify the possible methods to improve the CRDI system performance. The various parameters such as fuel injection pressure, combustion chamber temperature that are included in engine combustion have greater influence in engine's performance, fuel economy and emission. The simulation analysis were carried out for various injection pressure between 500 bar to 1800 bar using ANSYS FLUENT. A fuel injection system was modelled using PTC CREO V3.0. The influence of temperature on engine performance, fuel economy and emissions has been analysed. The optimum injection pressure for improved engine performance with lesser emission level has been predicted for various engine configuration and impact of fuel properties such as viscosity, flow velocity, inlet properties, fuel economy and emissions are also analysed.

KEY WORDS: Atomization, Injection pressure.

1. INTRODUCTION

As always emission control legislation is the driving force behind all injection system innovations and one of the latest of these is high pressure common rail injection systems. One inherent problem with most injection systems is the lack of control of injection pressures. The fuel injection is the key point of engine and it plays important role to improve the performance of engine. Common rail engines have been used in marine and locomotive applications for some time. The Cooper-Bessemer invented the hydraulically operated common rail diesel engine, also known as a modified common rail. Vickers used common rail systems in submarine engines at 1916. Doxford Engines Ltd., used common rail system in opposed-piston heavy marine engines from 1921 to 1980 whereby a multi-cylinder reciprocating. Camshaft-operated mechanical timing valves were used to supply the spring-loaded Brice/CAV/Lucas injectors, which injected through the side of the cylinder into the chamber formed between the pistons. Early engines had a pair of timing cams, one for ahead running and one for astern. Later engines had two injectors per cylinder, and the final series of constant-pressure turbocharged engines were fitted with four injectors per cylinder. This system was used for the injection of both diesel oil and heavy fuel oil. The common rail system is suitable for all types of road cars with diesel engines. The main suppliers of modern common rail systems are Robert Bosch GmbH, Delphi, Denso, and Siemens VDO.

Armored Fight Vehicles (AFVs) play an important role in any war scenario. The recent development in diesel engine is CRDI system with electronic fuel injection system. It provides better performance of engine compare to conventional engines. Conventional fuel injection pumps used uprated 1000 hp engine do not have a feature for regulating fuel as function of charge air temperature, coolant temperature and shutdown mechanism for low engine oil pressure and low coolant level. These features are essential for operation at high ambient temperature and also for fool proof engine performance. CVRDE has developed Electronic Fuel Injection system (EFIS) jointly with Indian Institute of Technology, Madras, to introduce electronic governor in place of mechanical governor, to Develop microprocessor based engine

Controller unit is introducing for actuator to regulate the fuel delivery for up-rated 100 HP engine. The ECFIS (Engine Control Fuel Injection System) consist of sensors, actuators, control system and software. The system senses the engine speed, load, charge air temperature and accelerator pedal position. The input data is fed into the electronic controller, which gives signal to the actuator and that in turn moves the control rack. Indigenously developed microprocessor based controllers and actuator have been integrated with fuel injection pump (FIP) and is evaluated in FIP test bench. FIP integrated with the engine also been evaluated in the test bed. The system successfully control the fuelling based on charge air temperature, coolant temperature, etc., and met all the system requirements.

2. MATERIALS AND METHOD

Modelling of fuel injector: The fuel injector is designed by using PTC CREO version 3.0 modeling software. It is advancement from proE modeling software. The dimensions are taken; Length of the nozzle is 27 mm, diameter