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Optimization of Fuel Injection Pump Parameters of TATA Engines by Using Diesel and Biodiesel

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Abstract

Often called 'the heart of the engine' the fuel injection system is without any doubt one of the most important systems. It meters the fuel delivery according to engine requirements, it generates the high injection pressure required for fuel atomization, for air-fuel mixing and for combustion and it contributes to the fuel distribution in the combustion system-hence it significantly affects engine performance emissions and noise. The components of the fuel injection system require accurate design standards, proper selection of materials and high precision manufacturing processes. They lend themselves to mass production techniques and they become complex and costly. As the applications of diesel engines diversified so did the fuel injection systems. Along with the conventional pump-line nozzle systems new concepts evolved such as distributor pumps, common-rail systems, accumulator systems, unit pumps, and unit injectors, etc. In addition, the 'intelligence' of electronics enhanced the capability of the 'muscle power' of hydraulics making the combustion system much more flexible and responsive to new parameters: pressure, temperature, engine speed, etc. Combustion can be thus optimized for best performance, emissions, smooth operation etc., according to the needs of the application. The net result of this integration is an advanced diesel engine with high power density, very low emissions, low noise and superior drivability. Probably the most dynamic application of advances in fuel injection and electronic management is in the area of light-duty vehicles (passenger cars, light trucks, sport utilities) where constraints of high performance, low emissions, low noise, low cost, etc., render optimization very challenging. The research and development in fuel injection systems. Fuel injection is systems for supplying high pressurize fuel to maximum mixing of fuel with air in an internal combustion engine. Direct Injection (DI) Systems as used in DI engines, in which the fuel is injected directly into a combustion chamber formed in the cylinder itself. ***Keywords:*** *Accumulator, Optimization and Direct Injection (DI).*

1. Introduction

The fuel-injection system which is the most vital component in the working of CI engine. The engine performance (power output, efficiency) is greatly dependent on the effectiveness of the fuel injection system and its parameters. Therefore the function of a fuel injection pump is to pump metered quantity of fuel into the cylinder at the right time it's essential while testing a fuel injection pump to test and calibrate the injection timing of the various injectors and the quantity of fuel injected per injection.

2. Literature Review

Breda Kegl, Marko Kegl, and Stanislav Pehan [1] presented an optimization procedure of a fuel injection system of a bus diesel engine. Attention is focused on the differences resulting from using two different types of fuel: diesel and biodiesel. The proposed design procedure relies on the assumption that the atomization of fuel spray influences the diesel engine performance, fuel consumption, and harmful emission significantly. As a measure of spray atomization, the mean diameter is employed and introduced into the objective function. The design problem is formulated in the form of a multi objective optimization problem, taking into account the ESC 13 mode test for diesel engines of commercial vehicles. The design variables of the injection system are related to the shape of the cam profile, to the nozzle geometry, and to the control parameters influencing the injection quantity and timing. The geometrical properties of the cam profile and the injection parameters are kept within acceptable limits by the imposed constraints. The results of optimization using diesel and biodiesel are compared to each other to show the influence of fuel type on final design and performance of the system.

Breda Kegl [7] has presented the paper deals with numerical& experimental analysis of injection process using

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biodiesel/mineral diesel fuel blends with the aim to search for the potentials to reduce engine harmful emissions. The considered fuels are neat biodiesel from rapeseed oil and its blends with mineral diesel. For the numerical analysis a one-dimensional mathematical model is employed. In order to model accurately the investigated fuels, the employed empirical expressions for their properties are determined by experiments. To verify the mathematical model and the empirical expressions, experiments and numerical simulation are run on a mechanical control diesel fuel injection M system at several operating regimes. Injection process at many different operating regimes and using several fuel blends are then investigated numerically.

T. Ganapathy , R.P. Gakkhar , K. Murugesan [19] have studied the Influence of injection timing on performance, combustion and emission characteristics of Jatropha biodiesel engine The study of effect of injection timing along with engine operating parameters in Jatropha biodiesel engine is important as they significantly affect its performance and emissions. The present paper focuses on the experimental investigation of the influence of injection timing, load torque and engine speed on the performance, combustion and emission characteristics of Jatropha biodiesel engine. For this purpose, the experiments were conducted using full factorial design consisting of (33) with 27 runs for each fuel, diesel and Jatropha biodiesel.

StanislavPehan , Marta SvoljsakJerman , Marko Kegl , Breda Kegl [6] had studied the influence of biodiesel on some tribology characteristics of a bus diesel engine with a mechanically controlled fuel injection system. The tests have been performed on a fully equipped engine test bed, on a fuel injection test bed and on a discharge coefficient testing device. The tested fuel was neat biodiesel produced from rapeseed. Attention was focused on the biodiesel influence on the pump plunger surface roughness, on the carbon deposits in the combustion chamber, on the injector and in the injector nozzle hole. The pump plunger surface was analyzed by experimentally determined roughness parameters and by a microscope. The carbon deposits at fuel injector and in the combustion chamber were examined using endoscopic inspection. The deposits in the injector nozzle were investigated indirectly by measuring the nozzle discharge coefficient. Numerical simulation has been performed in order to estimate the influence of the discharge coefficient variation on the computed injection characteristics.

3. Identified Gaps in the Literature

Most of the researchers have investigated the influence of the Fuel injection parameters like Injection characteristics, engine performance, Fuel characteristics etc. on the Fuel injection process output. Limited work is being done on the study of the setting parameters of Fuel injection process and parametric analysis of fuel injection pump. The influence of process setting parameters on the Fuel delivery characteristics and Fuel injection pump performance has not been fully explored. Very limited work has been observed on the effect of biodiesel on Fuel injection pump performance.

4. Problem Formulation

In fuel injection process, the variations in input process parameters such as Number of strokes, control rack travel and RPM affects seriously on the fuel delivery of the pump which affect the performance of fuel injection process. With the help of company (micobosch) standard test specification manuals and discussion with concern authorized workshop peoples and also with the help of research paper it strongly felt that performance of fuel injection process bears a direct relationship input parameters mentioned above. So that in this investigation we will optimize the fuel delivered by fuel injection pump by setting the control parameters at optimum level without affecting the engine performance. Also we have analyzed the effect of biodiesel on fuel injection pump parameters.

5. Research Methodology

In present study, the use of Design of Experiments (DOE) technique is being done to identify the significant parameters and optimization of identified parameters. The design of experiments technique is a very powerful tool, which permits us to carry out the modeling and analysis of the influence of process variables

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on the response variables. Among the available methods, Taguchi design is one of the most powerful DOE methods for analyzing of experiments. Taguchi and Konishi had developed Taguchi technique.

4. Conclusions

The Taguchi method will be applied to find an optimal setting of the fuel injection process. The result from the Taguchi method chooses an optimal solution from combinations of factors if it gives maximized normalized combined S/N ratio of targeted outputs. Future investigation leaves a wide scope for the researcher to study on optimization of fuel injection pump using other biodiesel and their effects.

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