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ORIGINAL CONTRIBUTION

Optimization of Injection System Parameter for CRDI Small Cylinder Diesel Engine by using Response Surface Method

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Abstract This paper represents an experimental as well as statistical investigation of a laboratory-scale single-cylinder diesel engine. The study involved retrofitting the mechanical fuel supply system with a simple version of the common rail direct injection (CRDI) system. The CRDI injection system parameters such as injection pressure, pilot injection timing, the start of main injection timing, and the quantity of fuel injection percentage during the pilot and main injection period were considered in the study. The study was performed to optimize system parameters with respect to performance and emission aspects. These aspects mainly include reducing brake-specific fuel consumption (BSFC), emissions such as carbon monoxide (CO), nitrogen oxides (NOx), smoke, and hydrocarbon (HC), and increase brake thermal efficiency. The regression equations were derived considering the interactive effects between injection pressures, the pilot as well as main injection timing and quantity of percentage injection. The surface plots derived from the regression equations were used to analyse the effect of system parameters. Diesel injection at a pressure of 600 bar, main injection at 15° CA bTDC (crank angle before top dead centre), pilot injection at 40° CA bTDC, and fuel injection percentage at 10–90 were found to be optimum for the CRDI single-cylinder diesel engine. The further validation of optimum parameters was done by conducting a confirmatory test on the engine. The maximum prediction error was found to be 3.37%.

Keywords Split injection · Injection pressure · Injection timing · Response surface methodology · Performance characteristics · Emission characteristics

Abbreviations

bTDC	Before top dead centre
aTDC	After top dead centre
TDC	Top dead centre
RSM	Response surface method
CRDI	Common rail direct injection
BTE	Brake thermal efficiency
BSFC	Brake-specific fuel consumption
SOMI	Start of main injection
SOPI	Start of pilot injection
IP	Injection pressure
HC	Hydrocarbon
CO	Carbon monoxide
NOx	Nitrogen oxides
CA	Crank angle

Introduction

Exhaust gases emitted from I.C. Engines used in the stationary and mobile application are among the major sources of pollution in most cities in developing countries like India [1]. In order to curb pollution, the government of these countries has implemented stringent emission norms. Most of the small single-cylinder diesel engines still use a conventional non-electronic injection system for supplying the required quantity of fuel at the time of combustion stroke, but such a conventional injection system does not have precise command on the fuel injection process, and in

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