Multi-Injection Performance Optimization Study for a High Pressure Direct Injection Common Rail Diesel Engine

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ABSTRACT

The main purpose of this study is to establish the multiple injection performance optimization methodology for a high pressure Direct Injection Common Rail (DICR) diesel engine. The hardware and software of the engine control system were combined with the engine dynamometer display real-time performance parameters so that the engine control parameter tuning and multi-objective optimization rules can be integrated and the engine performance be verified at the same time by dynamometer experiments. This study has built the fuel consumption and pollution models of vehicle driving cycle which then was converted into engine torque and speed by using the real vehicle parameters. Several key points were sorted from the corresponding map data for steady state estimation measurement. The selected key points control parameters were changed to reduce the overall exhaust emissions. Experimental design optimization analysis software will emphasize three filtered driving cycle key points with both single injection and double injection analysis. The engine performance response surface functions were built and used to find optimal control parameters by using multiple targets goal-attainment optimization search program. The predicted diesel engines single and multiple injection performance, include brake torque, specific fuel consumption and four major emissions, were compared and optimized to reduce fuel consumption and emissions. The four corresponding engine control parameters include the pre-injection and main injection timings and injection durations were calculated and validated by engine dynamometer tests. The engine combustion heat release and its rate were calculated by using engine combustion pressure – crank angle data and validated with combustion analyzer under different engine operating conditions. Single injection and double injection combustion analysis were conducted and compared. The dynamic relationship between control and the response performance can be used for future reference in developing of DICR diesel engine management systems. By experimental design and multi-objective optimization search, the experiments time and expanse can be reduced and the efficiency of engine parameters calibration and adjustment can thus be improved.

Keywords: DICR diesel engine multiple fuel injection control system, Diesel engine multiple injection performance optimization, Design of experiment Multi-objective optimization search, Diesel engine combustion analysis.
尋四行程直接噴射共軌式柴油引擎燃燒分析模組建立

實驗相關設

第三章 柴油引擎多次噴油性能最佳化分
析

柴油引擎單噴與雙噴油耗污染最佳化驗
證

第四章 柴油引擎多次噴射性能燃燒分
析

雙噴控制參數對扭力的影
響

單次噴射與二次噴射燃燒分析比
較

第五章 結論與建
議

參考文
獻

附錄

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