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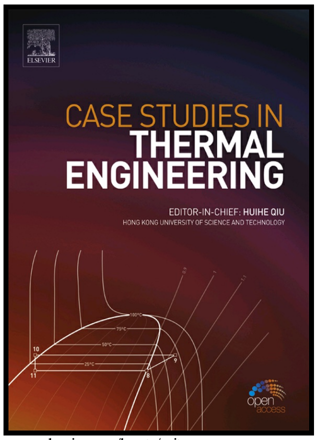

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Abstract

Cleaner diesel engines have been successively developed to meet a compromised solution for issues concerning performance and emission regulation. Combustion and exhaust gas after-treatment technologies are exhaustively settled to resolve those problems. A key improvement of the emissions is diesel dual fuel combustion that increases operating range of the premixed combustion. The main aim of this work is to explore the heat release, fuel consumption, and thermal efficiency of a single cylinder diesel dual fuel engine. An intake port fuel injection of gasoline with the flow rates between 0 and 0.06 g/s was accomplished to form a premixed charge prior to induction into the combustion chamber and ignition by the main diesel fuel. The engine was operated on medium load at 1,700 rpm without exhaust gas recirculation. An engine indicating system composed of a cylinder pressure transducer and a shaft encoder was used to investigate combustion characteristics based on the first law of thermodynamics. The combustion of higher gasoline pre-mixer increased heat release rates, shortened combustion duration, and increased maximum cylinder pressure than neat diesel combustion. Increasing gasoline proportion reduced the diesel fuel and total fuel consumptions. This enhanced the engine thermal efficiency over the diesel baseline combustion.

Keywords: combustion; diesel; dual fuel; efficiency; gasoline; heat release

1. Introduction

Diesel engines in present are widely used by various applications. Many efforts have been tested and developed to overcome some hindrances in aspects of engine thermal efficiency due to fuel-air burning that releases heat converted to useful power output, and exhaust gas emissions. Inefficiency of fuel-air burning within limited time in diesel engine often occurs as liquid diesel fuel is injected into compressed air at elevated temperature mainly under mixing-controlled combustion mode. By this scenario, the fuel and air mixture is heterogeneous that requires further enhancement of air insertion into fuel jet spray and fuel propagation over air-occupied space. To resolve for this obstacle, diesel dual fuel (DDF) engine is one of the promising technologies to promote more homogeneous premixed charges by adding a relatively low cetane number fuel prior to be compressed and ignited by the main diesel fuel. This enhances benefits in many facets depending on fuel types and operating conditions.

A numbers of publications concerning DDF engine using gaseous fuel pre-mixtures such as compressed natural gas (CNG), liquefied petroleum gas (LPG), hydrogen (H_2), and biogas have been revealed. Ambarita (2017) [1] explored the effects of biogas flow rate and methane concentration on the performance and emissions of the compression ignition (CI) engine running in dual-fuel mode. The diesel replacement ratio was varied from 15.3% to 87.5% at the engine load and speed of 1.5 kW and 1,500 rpm. Verma et al. (2017) [2] compared the performance and analyzed emissions of the pilot DDF engine with biogas, CNG and H_2 as main fuels. Kumaraswamy and Prasad (2012) [3] investigated the performance of LPG-DDF engine with exhaust gas recirculation. The H_2-DDF operation can achieve higher thermal efficiency than a conventional diesel operation at high load.

Liquid ethanol contained fuels have been also used as a pre-mixture for DDF engines. A neat ethanol port fuel injection for dual-fuel combustion in heavy duty engine was trial by Sarjovaara et al. (2013) [4] and a maximum ethanol/diesel mass ratio of around 90% was achieved at high load conditions. Later on, the E85 ethanol/gasoline blended fuel was tested for charge air temperature effects on DDF mode and reported in Sarjovaara et al. (2015) [5]. For emissions, Sarjovaara and Larmi (2015) [6] explored the incremental carbon monoxide and hydrocarbon but the diminishing