講演番号	139

Application of Next-Generation Biodiesel Fuel HVO to an Inline 6-Cylinder 3.3L Diesel Engine

Yusuke Nishioka [1)] Takeru Matsuo [1)] Tomoyuki Kanda [1)] Daisuke Fukuda [1)]

Jun Kanzaki [1)] Makoto Namba [1)] Sangkyu Kim [1)] Daisuke Shimo [1)]

1) Mazda Motor Corporation
3-1, Shinchi, Fuchu-cho, Aki-gun Hiroshima 730-8670, Japan

KEY WORDS: **Heat engine, Compression ignition engine, Fuel/Alternative fuel, Performance**

To rapidly and effectively reduce CO_2 emissions from a well-to-wheel and lifecycle perspective, a multi-solution approach combining high-efficiency internal combustion engines with carbon-neutral fuels is important. The authors have focused on Hydrotreated Vegetable Oil (HVO), a paraffinic fuel standardized under EN15940, as a next-generation biodiesel fuel. However, due to its high cetane number, concerns remain regarding its impact on ignition behavior, exhaust emission characteristics, and durability when applied as a drop-in fuel.

In this study, a Distribution Controlled Partially Premixed Compression Ignition (DCPCI) combustion concept was developed to enable the use of 100% HVO in an inline six-cylinder 3.3 L diesel engine without requiring any fuel-specific hardware or control modifications. The DCPCI concept spatially separates fuel sprays by combining a dual-zone egg-shaped piston bowl with multi-stage fuel injection, thereby suppressing spray–spray interference even under high-cetane-number fuel conditions.

The validity of the DCPCI concept was verified through combustion visualization experiments using a rapid compression expansion machine (RCEM) and computational fluid dynamics (CFD) analysis. The visualization results demonstrated that the dual-zone egg-shaped combustion chamber effectively suppressed spray interference during the late combustion phase and significantly reduced soot formation compared with a conventional stepped-lip piston bowl. Furthermore, CFD analysis confirmed that although ignition timing advanced due to the high cetane number of HVO, the mixture distribution was equivalent to that of conventional diesel fuel.

Next, engine unit evaluations were conducted over a wide range of operating conditions using conventional diesel fuel and 100% HVO. The results demonstrated that torque characteristics, exhaust emission characteristics, combustion noise, maximum in-cylinder pressure, and exhaust gas temperature were comparable between the two fuels. In addition, THC and CO emissions were reduced by 30–50% when using HVO compared with diesel fuel.

Furthermore, durability testing under European on-road conditions was conducted to evaluate component reliability and temporal changes in exhaust emissions. The results confirmed that even after the durability test, no practical issues attributable to the use of HVO were observed with respect to exhaust emission performance, wear of fuel system sliding components, lubrication performance, or rubber components.

These results demonstrate that the DCPCI combustion concept enables the use of HVO as a drop-in fuel in an inline six-cylinder 3.3 L diesel engine, achieving performance, exhaust emission characteristics, and durability equivalent to those of conventional diesel fuel.

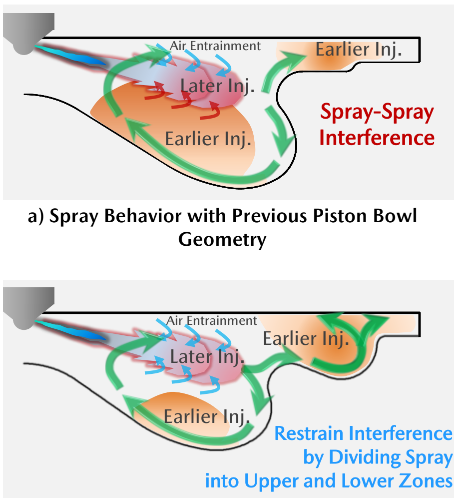

Fig.1 Combustion Concept of DCPCI

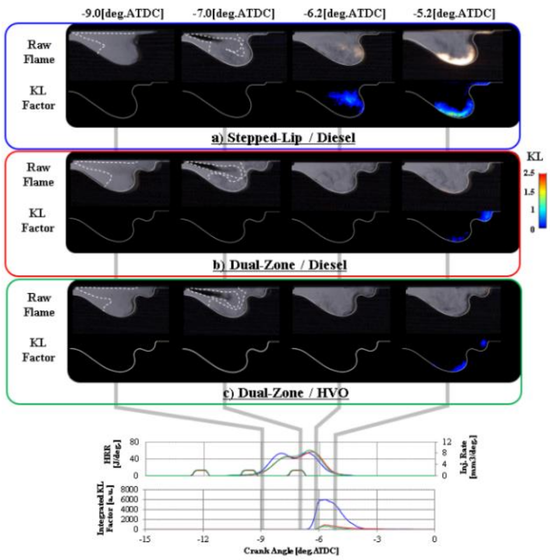

Fig.2 Results of Combustion Visualization Measurements Using the RCEM and Two-color Method Analysis