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ENGINE AND EMISSIONS, FUELS AND LUBRICANTS

Experimental Study on the Combustion and Emission Characteristics of Methanol/Gasoline Fuels in Direct Injection Miller Cycle Gasoline Engines

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Abstract
This study explores the thermal efficiency of high compression ratio Miller cycle engines and the impact of methanol and methanol/gasoline blends on combustion and emissions. Comparative experiments were conducted to investigate the thermal efficiencies of the Miller cycle compared to the conventional Otto cycle at different compression ratios and how methanol affects combustion and emissions. The results show that under high-speed and high-load conditions, the Miller cycle offers higher thermal efficiency and better tolerance to high compression ratios than the Otto cycle. In experiments conducted at 2000 rpm and 0.66 MPa GIMEP, using the Miller cycle with compression ratios of 11.5 and 14.5 increased thermal efficiency by about 0.6 and 0.8 percentage points compared to the Otto cycle. Using methanol/gasoline blends can advance the combustion phase without changing the load, further improving the engine's thermal efficiency. Burning pure methanol under heavy load significantly improves combustion; it increases in-cylinder pressure by about 30%, thermal efficiency by 7.2 percentage points, and NOx emissions by 80% compared to gasoline. Furthermore, using methanol fuel significantly increases nucleation mode particles and decreases accumulation mode particles, with peak values shifting to smaller diameters.

Keywords High compression ratio · Miller cycle engines · Methanol/gasoline blends · Thermal efficiency · Combustion · Emissions

1 Introduction

Global energy consumption's rapid growth, mainly from fossil fuels, has led to significant environmental pollution and climate change. Fossil fuel combustion, mainly emitting carbon dioxide (CO_2), significantly contributes to the greenhouse impact. Additionally, pollutants like nitrogen oxides (NOx), carbon monoxide (CO), and particulate matter (PM) from vehicle exhausts threaten human health and environmental quality. The global call for improved energy efficiency and reduced environmental pollution is growing more urgent. This requires a unified effort to adopt renewable energy sources, enhance energy conservation, and develop cleaner technologies. These strategies aim to mitigate pollution's adverse effects and contribute to global ecosystem and public health sustainability. It is critical (Halloran, 2007). Implementing stricter emissions regulations, advancing vehicle technology for lowering emissions, encouraging the shift from fossil fuels to renewable sources such as solar, wind, and hydroelectric power, and raising public energy conservation awareness are essential to tackle these environmental challenges.

Amidst the pressing need to address the environmental and health impacts caused by the combustion of fossil fuels, the automotive industry stands at the forefront of seeking technological innovations that can reconcile the growing demand for energy efficiency with the imperative to reduce emissions. The transition towards more sustainable energy sources and the implementation of cleaner technologies are pivotal in this quest. In this context, the development

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