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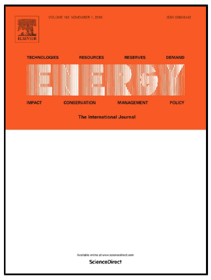

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Combined effect of inlet pressure, total cycle energy, and start of injection on low load Reactivity Controlled Compression Ignition combustion and emission characteristics in a multi-cylinder heavy-duty engine fueled with gasoline/diesel

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Abstract: Reactivity controlled compression ignition (RCCI) is demonstrated as a controllable high efficiency and clean combustion strategy, which is confirmed to be affected by either inlet pressure (IP), total cycle energy (E_{total}), or start of injection (SOI). This paper discussed their combined effect on low load RCCI combustion and emission characteristics in a multi-cylinder heavy-duty engine fueled with gasoline/diesel. Results show that low temperature heat release (LTHR) only occurs when SOI is sufficiently advanced. Combustion duration (CD) is lengthened, shortened and unchanged with SOI advance under different E_{total}s, while lengthened with IP increase. NO_X emission first increases and then decreases with SOI advance, and declines with IP increase or E_{total} decrease. Trend CO changes with SOI or IP becomes opposite at the lowest E_{total}, comparing with that at relatively high E_{total}s. HC emission decreases with SOI advance or E_{total} increase, while it is insensitive to IP. Trend number of nuclear particle (Num_n) changes with IP becomes opposite at the highest E_{total}, comparing with that at relatively low E_{total}s, while Num_n decreases with SOI advance or E_{total} increase. Both number of aggregated particle (Num_a) and soot first decreases and then increases with SOI advance, and decreases with E_{total} decrease or IP increase.

Key words: RCCI, combustion and emission characteristics, low loads, inlet pressure, total cycle energy, start of injection

1. Introduction

The atmospheric suspended particulate matters with the tiny diameter (like PM2.5) are the major component of haze and the nitrogen oxides (NO_X) are the crime culprit resulting in pollution problems such as acid rain and photochemical smog [1]. A large number of diesel engines are one of the most important sources of tiny atmospheric suspended particulate matters (PM) and NO_X. In the face of the huge challenge of high efficiency and clean combustion of the internal combustion engine, all kinds of advanced combustion methods came into being. The homogeneous charge compression ignition (HCCI) proposed at the end of the last century received unanimous approval [2]. This combustion mode, characterized by no flame front propagation[3] and homogeneous combustion of the mixture[4], simultaneously limits NO_X and soot formation[5] and thus achieves the high attention of the worldwide disciplines and industries of the internal combustion engine[6]. However, due to such disadvantages as the difficult control of combustion phasing, combustion process and combustion noise, the HCCI combustion mode cannot expand to a high load [7].As the research constantly deepens, the scholars gradually find that the optimal global fuel reactivity required by HCCI operating under different loads is different [8, 9]. When HCCI engines operates under low loads (e.g. brake mean effective pressure (BMEP) <0.2 MPa), the pure diesel (CN ≈45) with good auto-ignition qualities can be used as fuel to improve combustion. When the load increases, the BMEP of the HCCI engines can be extended to 1.6 MPa by decreasing the global fuel reactivity (CN ≈27) and thus to slow down the chemical reaction rate and delay the auto-ignition [10, 11]. Inspired by this, the scholars have proposed a new combustion concept - Reactive Controlled Compression Ignition (RCCI) [12, 13]. By the injection of the low reactivity fuel through intake port and direct injection of the high reactivity fuel into cylinder as well as the adjustment of the ratio of the port-injected fuel energy to the total

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