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Effect of Octane Number of PRF in Homogeneous Charge Compression Ignition (HCCI) Combustion

S.M. Hoseinalipour†*, H. Askari† , M. Baghsheikhi†, S.A. Jazayeri‡

†Mechanical Engng. Department, Iran Univesrity of Science and Technology, Iran

‡ Mechanical Engng. Department, Khaje Nasir Toosi University of Technology, Iran

*alipour@iust.ac.ir

Abstract:

HCCI combustion has been drawing a considerable attention due to its high efficiency, lower nitrogen oxide (NOx) and particulate matter (PM) emissions. The HCCI combustion process can accept a variety of fuel types. Since ignition occurs in an HCCI engine by auto-ignition of the fuel/air mixture, therefore the kind of fuel and especially its Octane number have a significant impact on both engine performance and emissions. In this work a thermodynamic single-zone model is used in order to investigate the effect of a variety of PRF fuel mixtures, with different Octane numbers, on the performance and emission of HCCI engine. PRF is a mixture of n-heptane and iso-Octane with different number of moles for each one. In this article six different mixtures of PRF with Octane numbers from 0 to 50 have been used. The results showed that the PRF with the Octane number of 20 produces maximum performance and minimum CO concentration.

Keywords: IC engine, HCCI, Octane number, PRF, Performance

Introduction:

HCCI is characterized by the fact that the fuel and air are mixed before combustion starts and the mixture auto-ignites as a result of the temperature and pressure increase in the compression stroke. Thus HCCI engine is similar to a SI engine in the sense that both engines use premixed charge and similar to a CI engine as both rely on auto-ignition to initiate combustion. HCCI combustion of diesel-like fuels displays a peculiar two-stage heat release, the first stage of the heat release curve is associated with low temperature kinetic reactions, and the time delay between the first and main heat releases is attributed to the ‘‘negative temperature coefficient (NTC) regime’’ which locates between the two heat release stages [1,2]. There is no discernable flame propagation in HCCI combustion.

The concept of HCCI was initially investigated for gasoline applications in 1979, by Onishi et al. [3] in order to increase combustion stability of two-stroke engines. They found that significant reductions in emissions and an improvement in fuel economy could be obtained by creating conditions that led to spontaneous ignition of the in-cylinder charge. Stable HCCI combustion could be achieved between low and high load limits with gasoline at a compression ratio of 7.5:1 over the engine speed range from 1000 to 4000 rpm. In 1983 Najt and Foster [4] extended the work to four-stroke engines and attempted to gain additional understanding of the underlying physics of HCCI combustion. They concluded that HCCI auto-ignition is controlled by low temperature (below 1000 K) chemistry and the bulk energy release is controlled by the high temperature (above 1000 K) chemistry dominated by CO oxidation. HCCI researchers have investigated different fuels such as iso-Octane, ethanol [5-8], natural gas [5-10], hydrogen [11], gasoline [8,12-15], diesel fuel [8,12,14,16], n-heptane [6,8,15-19], methanol [17], propane [20] and n-pentane [21]. These studies have shown that fuels with higher volatility like hydrogen and ethanol mix better with air to form