講演番号	231

文献番号	20225231

Potential for hydrocarbon fuels to extend the lean limit of super lean-burn engines (partIII)

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KEY WORDS: **Heat engine, Spark ignition engine, Combustion analysis, Automobile fuel**(A1)

In the previous report, in order to expand the lean limit of the super lean burn engine, as a fuel technology, the authors showed that we can expand the lean limit in the super lean burn engineand improve the thermal efficiency by controlling the composition and molecular structure of the fuel In this report, following the previous report, we decided to do the further investigation about the fuel composition suitable for the super lean burn engine. Specifically, we used a fuel based on high-octane gasoline surrogate fuel (S5H, Fuel1) and had a specific composition changed to a lighter or heavier one, such as isooctane(C8) to isopentane(C5). We also investigated the effect of the amount of aromatic compounds on the lean limit by changing the amount of aromatic compounds contained in the fuel.

As shown in Fig. 1, it was found that the lean limit differs depending on the fuel. Further examination revealed that the difference in fuel composition affects the combustion period, so the effect of fuel composition was examined separately for the initial combustion period and the late combustion period.

Furthermore, in order to utilize it from the viewpoint of commercialization, we compared the performance of existing fuels with fuels produced by mixing heavy and light feedstocks produced at refineries based on the obtained results.The summary is shown below.

(1) As shown in figure 2, it was shown that the lean limit expand as the combustion period from the ignition timing to CA95 (95% combustion timing) is shorter. When the combustion period was further subdivided and investigated, it was found that the difference in fuel composition changes was in the early combustion period represented by SA-CA2 and the late combustion period represented by CA50-95.

(2) There is a difference in the combustion period by making the fuel composition lighter / heavier, but the tendency of the effect when the fuel composition is made lighter / heavier is not constant, and it differs depending on the initial combustion period and the late combustion period. It cannot be unequivocally defined by the expression of lightening / heavy weighting.

(3) When light olefins are used, both the initial combustion period and the late combustion period were shortend,which may leads to the expantion of the lean limit. In addition, the increase in aromatic content prolonged both the initial combustion period and the late combustion period, reducing the lean limit.

(4) Based on these findings, we created a fuel with an increased amount of light olefins using refinery feedstocks and reduced aromatic components as much as possible, and evaluated it in an engine test. As a result, as shown in figure 3, the lean limit was expanded and thermal efficiency was improved compared to existing high-octane gasoline.

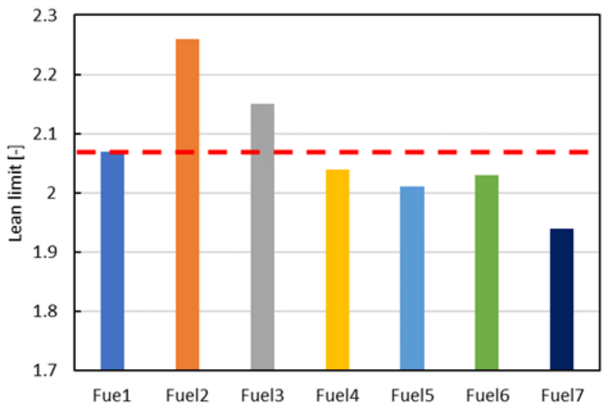

fig. 1 The result of lean limits

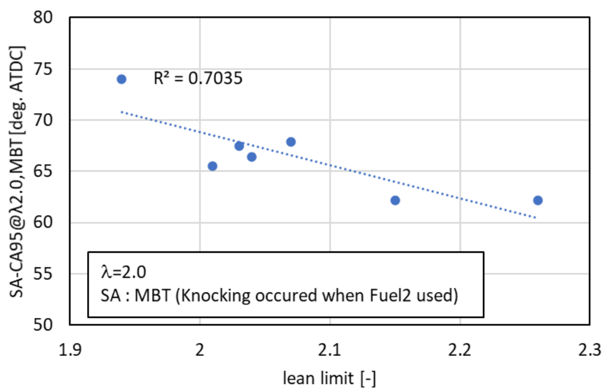

fig. 2 Relationship of lean limit and combustion duration

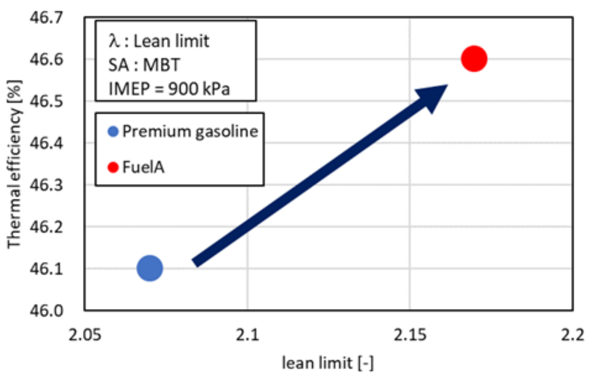

fig. 3 The relationship of lean limit and thermal efficiency