

# Effects of hydrogen addition to pre-chamber gas engines on engine performance

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As hydrogen fuel is added to a natural gas engine with a pre-chamber premixed combustion system, a risk of abnormal combustion such as knocking is concerned. This study focused on co-combustion of natural gas and hydrogen to know how hydrogen addition affected on engine performance and how much ratio of hydrogen could be added without abnormal combustion and other negative effects. In this study, a single-cylinder test engine with a pre-chamber (Fig.1) was used to evaluate combustion and emission characteristics of 13A-class city gas by adding hydrogen.

In order to determine the applicability of hydrogen fuel to pre-chamber gas engines, the effects of CNG and hydrogen co-combustion on various engine performances were experimentally investigated, with the results shown in Figure 2. The main conclusion is as follows.

- (1) Increasing the hydrogen energy share ratio activates combustion and improves thermal efficiency, but NO<sub>x</sub> emissions and knock severity become worse. Spark ignition timing can not be advanced due to knocking. In other words, the higher the hydrogen energy share ratio, the more the operating range is limited.
- (2) Hydrogen addition up to 10-20 LHV% reduces unburned methane which has over 20 times higher global warming potential, indicating that hydrogen addition effectively contributes to the reduction of greenhouse gas emissions.

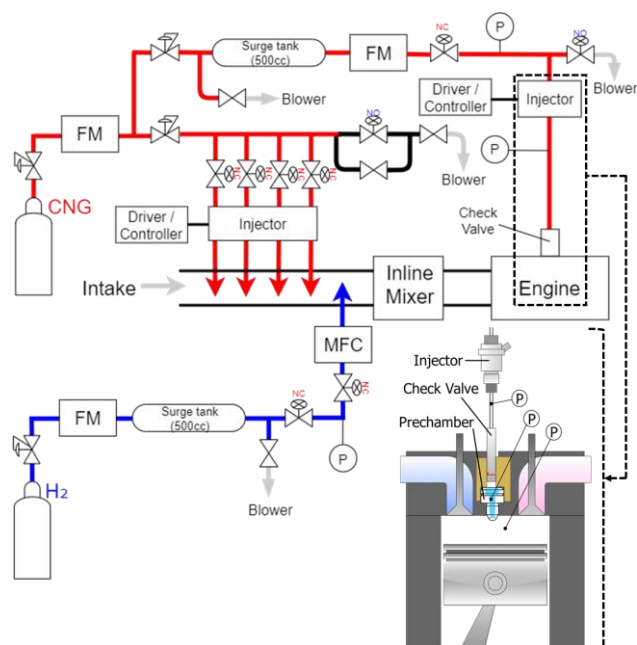


Fig.1 Fuel supply procedure for prechamber and main chamber

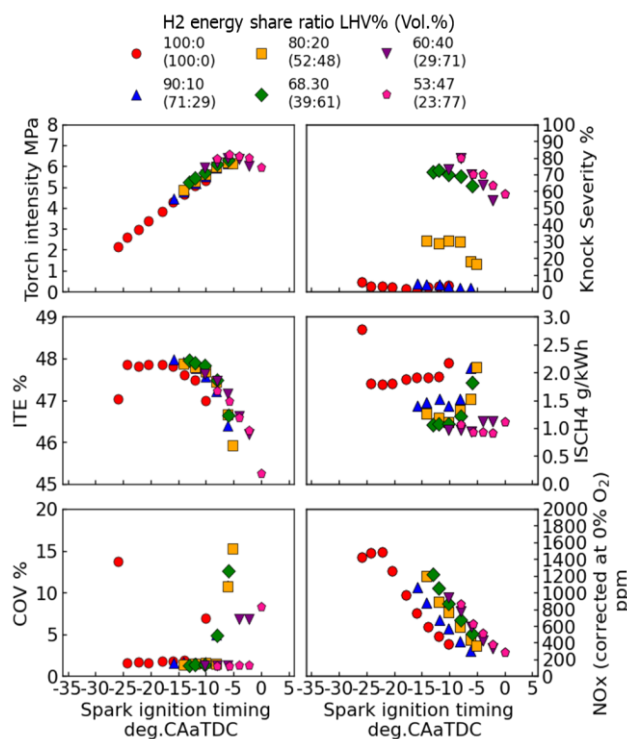


Fig.2 Engine performance using city gas/H<sub>2</sub> with changing hydrogen energy share ratio (H<sub>2</sub>: 0~47 LHV%)