Methane catalyst studies with a natural gas engine research facility

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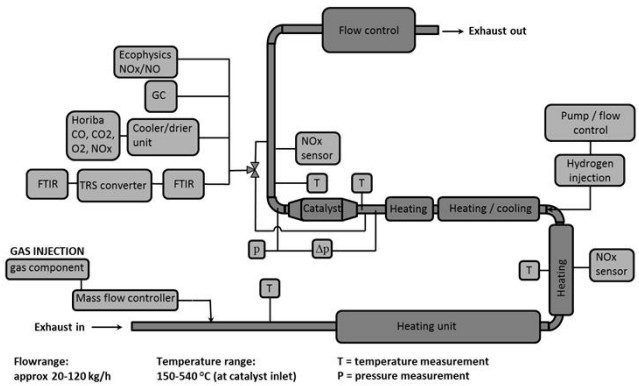
A natural gas engine research facility with a specially designed catalyst test bench has been modified to study methane emission reduction with oxidation catalyst and regeneration of the catalyst with hydrogen addition.

Introduction

The ability to produce energy by wind or solar is limited and therefore supplemental energy resources are needed. Gas engine with a flexible engine load characteristics is one relevant option. Lean burn gas engines are also known to have rather low CO_2, NO_x and PM emissions. However, the hydrocarbon emission levels can be relatively high with methane being the principal species. Since methane is a potential greenhouse gas its emissions should be minimized. One way to control the methane emissions is to utilize catalytic oxidation. However, the catalyst deactivation may form a major challenge since e.g. sulphur and water have found to inhibit the oxidation of methane. In this, we study the performance of methane oxidation catalyst and the regeneration of the catalyst with hydrogen addition.

Experimental

A lately developed research facility[1] with a small spark-ignited gas engine was utilized. For the purposes of this study, the facility was used to mimic the emissions of large (power plant) natural gas engines.



The exhaust gas temperature and flow can be independently adjusted with the research facility. The driving condition's selection was based on the emissions levels. In the selected driving mode, the engine out methane level was near 1000 ppm.

Based on laboratory studies by Dinex Ecocat, a bimetallic Pt-Pd methane oxidation catalyst (MOC) was selected for the experiment.

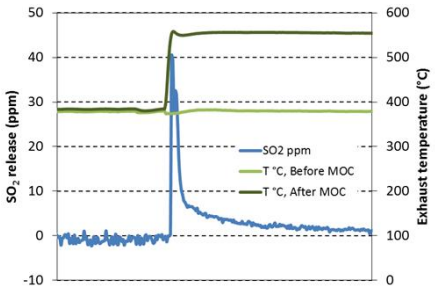
Since the natural gas (from the Nord Stream) has high methane content and only an extremely small sulphur content, additional SO_2 was utilized to result a concentration of 1-2ppm in the exhaust gas.

The experiments involved ageing periods in the selected driving mode with additional SO_2 followed by regeneration periods with hydrogen injection.

Different hydrogen concentrations and injection times were utilized based on laboratory studies (Dinex Ecocat) and literature review (University of Vaasa)

Results

The first results are from the experiments done at exhaust temperature of 380 °C. One result example shown in figure below presents the rather quick SO_2 release and temperature increase during the hydrogen injection. The effect of this on the methane conversion is under evaluation and will be published later on. The experiments will also be continued at a higher exhaust temperature.



References

[1]Murtonen T., Lehtoranta K., Korhonen S., Vesala H., Koponen P. Imitating emission matrix of large natural gas engine opens new possibilities for catalyst studies in engine laboratory. CIMAC Paper 107, 2016.