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International CNG standardization on par with other automotive fuel standards, and the future diesel-like gas engine – will they come true?

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Background

The interest in alternative transport fuels is increasing. CNG is a promising candidate. However, new emission legislation contains new policies of stricter OBD demands, implementation of testing of emission performance on up to 7 years old vehicles, and testing with market fuels rather than reference fuels. For gas engine developers, this is a big challenge, when considering the wider gas quality specification of natural gas, and the current trend towards even wider ones. The biggest threat however is the sulfur levels of natural gas, almost triple compared to other automotive fuels.

Current CNG standardisation work has made evident the differences in needs regarding gas quality of the two industries involved. The NGV business is a peripheral market segment for both of these two main industrial actors, the natural gas industry and the automotive industry. With the new stricter emission regulations, the future growth of the NGV business is hinged upon the good cooperation between them. This paper aims to explain why the gas industry should make an effort to work more closely with the automotive industry regarding gas quality issues and the development of the future diesel-like gas engine.

Aim

This paper aims to

- Describe the current state of the art regarding CNG standardization, in particular the ongoing work on CEN level
- Describe the potential of the future gas powered spark-ignited Internal Combustion Engine (SI-ICE), and the importance of current development regarding on-board gas sensor technology
- Explain how the gas industry would benefit from working closer with the automotive industry regarding the issues of standardization, gas quality and support for the

future gas engine with diesel-like performance, in order to grow its future market and avoid government interference.

Methods

Methods used are

- Report from the ongoing standardization work on biomethane and CNG/LNG within CEN
- Analysis of long-term consequences of current stand of the gas business on the topics of sulfur, methane number, hydrogen and odorization
- Summary of Swedish research regarding gas engines and on-board sensor technology

Results

Current work on a new CNG standard is organised by CEN in a joint technical committee (TC408), with experts from both the gas industry and the automotive industry. The TC started working late 2011. Working drafts of the standard, divided into two parts, where issued early 2014. The first part on injection of biomethane into the grid is not discussed in this paper. The discussion regarding the second part for biomethane and CNG as automotive fuel, prEN 16723-2, is restricted to the CNG issues. Mandate M/475 from the European Commission is governing the TC408 work, and it stipulates that the parameters and limits adopted by the parallel standardization work in CEN/TC234/WG11 on natural gas quality (prEN 16726 Gas infrastructure — Quality of gas - Group H) should be taken over and referred to by TC408.

For prEN 16723-2, there will be two gaseous fuel qualities defined, reflecting the current market situation with non-grid based sourcing solutions of CNG and LNG complementing the one of the grid. The only differing parameter is methane number (MN), as defined by the MWM method (similar to the original AVL method). In local dedicated infrastructures, a more stringent minimum limit of MN 80 is adopted, while in the grid the limit implemented by prEN 16726 is adopted, MN 65.

Methane number: The majority of natural gas grids carry gas with a minimum of MN 70. According to the automotive industry, going below this level will make it in principal impossible to develop future gas engines complying with stricter emission regulations and at the same time deliver the energy-efficiency required to be a competitive choice. Certain engine technologies require even higher MN's, which is the reason for implementing a non-grid specification. The best example of such an engine is the fumigated dual-fuel engine, where natural gas is mixed in with the inlet air and ignited by a smaller portion of diesel,

acting like a liquid spark plug. It is right now the only gas engine with a fuel consumption on par with the diesel.

Sulfur: The current suggestion for a sulfur limit in the grid is 30 mg/m3, which is almost triple to the current one of other automotive fuels. The sulfur dioxide in the emissions has very deleterious effects on the catalysts of the engine after treatment systems, fouling them and leading to increasing levels of especially methane, which is the most difficult to remove. With these levels of sulfur, future stricter emission regulations will not be possible to meet. Most of the sulfur comes from the odorants added, with especially high levels added in Italy, France and Spain. Even though most grid based CNG will not contain sulfur in excess of 10 mg/m3, the grid specifications will adher to the wide specification proposed in prEN 16726, thus making it impossible to convince the automotive industry to invest wholeheartedly in this new market segment.

The diesel-like gas engine: Research performed at Lund University showed that High exhaust gas recirculation (EGR) rates combined with turbocharging is a promising way to increase the maximum load and efficiency of heavy-duty gas engines. Together with model-based control to maintain combustion stability close to the dilution limit, and variable geometry turbocharger, and high turbulence pistons, 10 % lower fuel consumption could be achieved. Further research focus on increasing the dilution limit further by implementing fuelled prechamber ignition. The first test at 10 bar IMEPg showed diesel-like performance, 47.5 %.

The promise of onboard gas quality sensing: Changes in gas quality have been shown to significantly change the heat release rate, which needs to be compensated by changing the ignition timing. If this could be done cycle to cycle in the engine, bigger variations in the engine could be allowed without compromising emissions and energy-efficiency. Two Swedish companies, one using modular near IR technology which will be affordable (5-10 EUR) when produced in high numbers, and one using advanced signal processing to gain additional information from an ion sense current lead through the sparkplug, is showing great promise.

Conclusions

It stands clear that there is a huge market potential for alternative automotive fuels that can replace diesel and petrol. Natural gas has huge potential, due to its future price prognosis, availability and the prospects of renewability by mixing in biomethane.

In order to fulfil these market prospects, it is important that the gas industry work to:

- Try to meet the vehicle industries needs for high MN spec gas by way of distributing non-grid CNG and LNG meeting the higher specification of prEN 16723-2

- Work to decrease its sulfur levels, most importantly through implementing low-sulfur or non-sulfur odorants, so the grid specifications meet the 10 ppm limit of automotive fuels

- Financially support the research work on gas engine designs with potential to reach diesel-like performance

- Financially support the work on gas quality sensors, not only when used in the grid, but also the simpler ones needed onboard vehicles