



POSITION-PAPER

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BY THE CIMAC WORKING GROUP 'GAS ENGINES'

INFORMATION ABOUT THE INFLUENCE ON NO_x EMISSIONS OF AMMONIA IN THE FUEL GAS

1. Issues associated with ammonia content of gas engine fuel

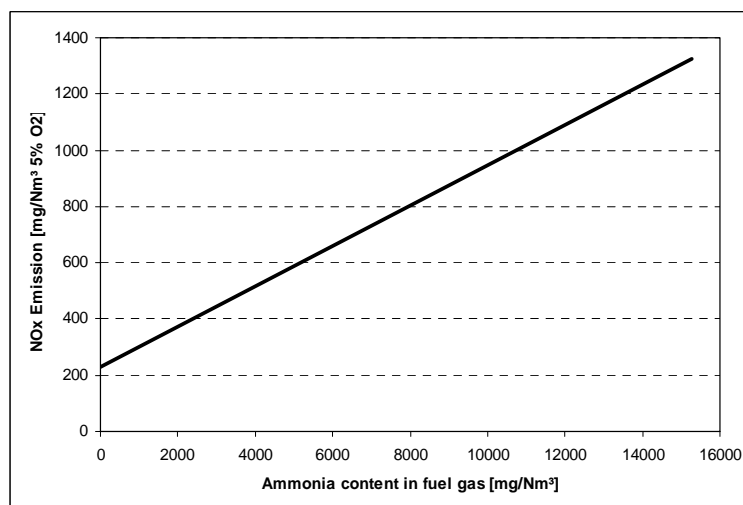
In biogas applications for stationary power generation, ammonia will normally be present in the fuel gas. The amount of ammonia varies and may be up to 2%vol of the fuel gas. In such applications it has been shown that the NO_x emissions fluctuate over time and it has further been established that the root cause of this is the variation in the ammonia content.

2. How does ammonia show up in the engine operation?

Ammonia is a strong driver in NO_x production. During combustion a high percentage of ammonia is converted to NO_x emissions. This results in additional NO_x emissions in the exhaust gas, equivalent to 2 – 3% of the ammonia in the fuel as shown in the graph below. Current engine control systems are operating without NO_x sensors, as reliable solutions for this are not yet available. In this case the engines controls are unable to detect NO_x produced from the ammonia in the fuel gas.

An ammonia vs. NO_x (in ppm) diagram is shown below. The correlation was created on a single cylinder engine with a blend of natural gas and ammonia.

Test procedure: Engine was set on a specific NO_x level and then ammonia was added with a fixed Lambda value. The result is a linear NO_x increase with increased ammonia content.



3. Some reasons for this ammonia content in the fuel gas

Biogas is produced from biomass. The quality of the biomass will determine how much ammonia is produced. The ammonia content has to be maintained below a maximum level to prevent excessive engine exhaust NO_x emissions and also to maintain an acceptable engine oil lifetime. There is a requirement for good gas cleaning or processing to limit the amount of ammonia in the fuel gas.

4. CIMAC position on the NO_x increase when a gas with high ammonia content is used as engine fuel

Currently, the CIMAC Working Group 17 'Gas Engines' is addressing the issue of fuel gas quality identification and quantification in general and including that of biogas quality variations.

- Biogas may carry a high amount of ammonia, based on the biomass source and insufficient gas cleaning.
- During combustion a high percentage of ammonia is converted to NO_x emissions.
- The extra amount of NO_x emissions is equivalent to 2 – 3% of the ammonia content in the fuel.
- If the ammonia content of the fuel gas is not kept below a specific level, the engine will have reduced oil lifetime and increased NO_x emissions.
- To ensure a stable engine operation, each engine manufacturer has defined a maximum ammonia content in the fuel gas. The recommended maximum values are in the range of 25 to 50 mg/Nm³ (based on a fuel with a LHV of 10kWh/Nm³).

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