SIEMENS

Process Analytics Automotive - EURO VI

Ammonia Slip Measurement according to EURO VI standard

Optimization of Catalyst Efficiency through in-situ Laser LDS 6

Exhaust gas denitrification

Protecting the environment from harmful emissions from internal combustion engines requires an effective method either to avoid them, or to convert them into innocuous gases. Since recently any newly registered vehicle is required to meet the EURO VI emission standard. Consequently, there is a permanent requirement for engine developers to ensure the denitrification of the engine exhaust and thus reduce the amount of harmful emissions.

In gas engines this task is fulfilled mostly with a metal catalyst located straight after the engine exhaust in the hot gas zone. When it comes to diesel engines, with their intrinsically higher NO_x emissions, additives are used in a catalytic denitrification process.

In the Selective Catalytic Reduction (SCR) process, e.g. at DeNOx plants of coal fired power utilities, the removal of NO_x (nitric oxide) is done by feeding aqueous ammonia or urea solution into the exhaust gas via spray nozzles. Downstream of the injection, the NO_x is reduced on the surface of the catalyst material to nitrogen and water.

The efficiency of the denitrification process is determined by different parameters depending on the method of injection as well as the engine conditions.

Application task

The nitrogen oxides (NO_x) formed in internal combustion processes in engines are reduced to water and nitrogen by the SCR DeNOx process. Ammonia (NH_3) or urea ($CO(NH_2)_2$) is added to the exhaust gas, the reduction happens at the catalyst.

One development objective in engine labs is to increase the efficiency of the DeNOx process comprising the complete operating range of the engine. The challenge is to set the optimum dosage of NH_3 at the various load ranges of the engine. This demands accuracy at measurement and measurement dynamics of the applied equipment.

In order to optimize the catalyst efficiency a very close correlation between the measured results and the operating status must be established. The in-situ analyzer LDS 6 delivers readings with high dynamics and precision taken directly in the gas flow without delay in near real time.

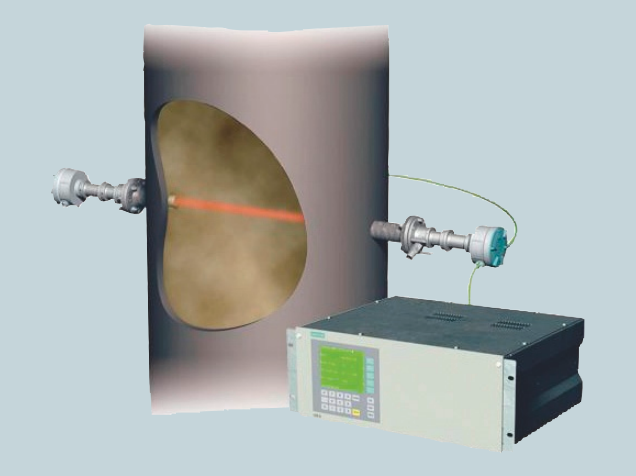

Fig. 1: LDS 6 in-situ laser gas analyzer

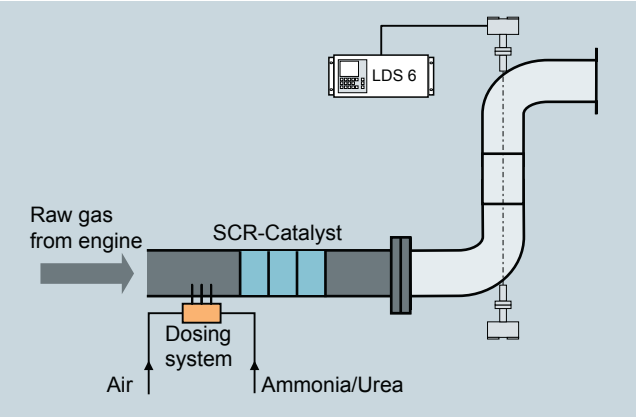

Fig. 2: LDS 6 measuring setup in engine test bed

Application solution

The EURO VI standard requires that engine manufacturers measure the ammonia slip emissions in the range from 0 ... 10 ppm. The LDS 6 has been approved for the "Laser diode spectrometer (LDS)" measurement principle according to the EURO VI standard (appendix 582/2011/EC). It is perfectly suited for the requirements of the standard, because it determines the ammonia concentration quickly and easily, while it can also be checked according to the EURO VI standard without the need to use external test gases. This eliminates the need for time-consuming and costly linearity checks by the user.

The LDS 6 sensors are mounted on the exhaust pipe directly after the SCR-catalyst (fig. 2). Since the measurements take place directly in the gas stream and in real time, the influences of the injected urea quantity level and load point on the catalyst efficiency can be monitored immediately. By measuring the NH_3 slip in every driving scenario, the dosing control systems can be optimized.

The analyzer LDS 6

LDS 6 (fig. 1) is a diode laser-based in-situ gas analyzer (TDLS = tuneable diode laser spectrometer) for measuring specific gas components directly in a process.

LDS 6 consists of a central unit and up to three pairs of cross duct sensors. The central unit is separated from the sensors by using fiber optics.

Regardless how hostile the environment is, the analyzer can always be placed outside any hazardous areas. Measurements are carried out free of spectral interferences and in real time, enabling proactive control of dynamic processes.

Key features include:

- In-situ principle, no gas sampling, results in real time
- Three measuring points simultaneously
- Fast and easy linearity checks according to EURO VI standard thanks to ten-cell test kit

LDS 6 is designed for fast and non-intrusive measurements in many industrial processes. Measuring components include: NH_3/H_2O, O_2, HF/H_2O, HCl/H_2O, CO/CO_2, ...

Flow Cell

We offer the flow cell solution in case the NH_3 analytics is intended to be available at several engine test beds with a minimum of preparation time. The flow cell is an accessory to implement measurement configurations in bypass mode.

This option is especially designed for applications where the space at the measurement site is restricted. Additionally, the carriage option allows a large measure of mobility, i. e., several measurement points can be evaluated with only one cell. Hence providing highest user flexibility. Moreover, it can be easily mounted and dismounted.

By saving time during setup changes, a very high availability of the (cost-intensive) test stand is ensured. Due to the exactly defined conditions when using the flow cell, each measurement is comparable with the results obtained at other measurement sites.

The flow cell is equipped with a standard pair of sensors. Key features include:

- Controlled heating up to 200 °C
- Wall mounting or mounting on carriage with integrated 19" frame
- Eductor pump with a delivery rate of max. 30 l/min

Linearity check

Regular linearity checks according to EURO VI are required every 12 months. These checks are made possible by an optional ten-cell test kit for easy and fast measurements in the range from 0 ... 10 ppm. The advantage of this kit is that it does not require any additional test gas. Hence complex gas handling, logistics efforts and therewith resulting costs do not apply.

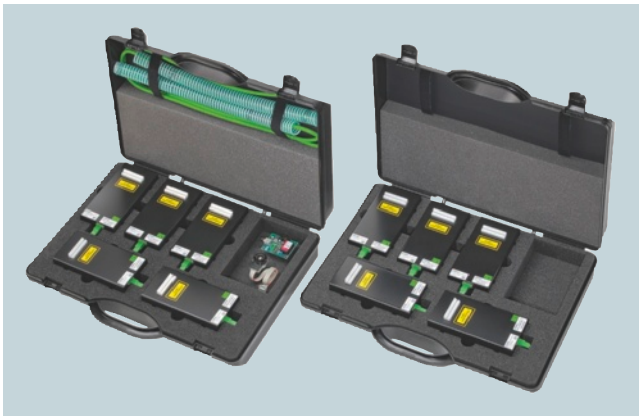

Fig. 3: Linearity verification kit

LDS 6 advantages at a glance

- Faster analysis than with extractive analytical instruments ensure most efficient optimization.
- The in-situ approach allows representative NH_3 measurements without cross interference.
- Fast and easy linearity checks according to EURO VI standard thanks to ten-cell test kit
- Up to three measurement points can be handled with only one analyzer.
- No gas sampling/conditioning is necessary, the gas is measured in situ.
- Highest reliability and lowest cost of ownership: no consumable parts, very low maintenance, no calibration necessary.
- No cross interferences due to highly specific single line absorption measurement.
- The maintenance is reduced to the cleaning of the sensor windows. No optical realignment is necessary after cleaning.

Measuring conditions

Typical measuring conditions for measurement of the NH_3 slip in the engine exhaust gas are given in the table below.

NH_3 measurement	
Min. certified NH_3 measuring range	0 ... 15 ppm
Temperature	0 ... 400 °C[1)]
Typical optical path length	1 m
Pressure	920 mbar ... 1120 mbar
Min. response time	> 1 s
EURO VI compliance	Yes, certified by the German test lab (TÜV)[2)]
MLFB application and gas code	CL, DL

[1)] Up to 1 000 °C is possible. No analyzer specification for this temperature range as NH_3 will decompose at higher temperature levels.
[2)] For use according to EU regulation No. 595/2009/EC from June 18, 2009 (EURO VI)

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