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CONTACTLESS MEASUREMENTS

- the future of gas sensing

NEO Monitors / *PERFORMANCE YOU CAN TRUST*

Combustion: *Essentials* – For Decision Makers

Combustion processes are used in most industries to provide heat and power for operation. For this purpose, boilers, heaters, and furnaces are burning fuels such as natural or bio gas, or waste. When deciding on a new combustion control system, in addition to capital expenditures (CAPEX) and operational expenditures (OPEX), potential fuel savings, maximization of heater throughput and minimization of pollutants like nitrogen oxides (NOx) are important considerations as well.

A look at the combustion theory shows that the ideal operating point is in the slightly lean regime, i.e. with an excess of air. A lean combustion ensures that fuel is burnt completely under all conditions and thus the potential of high carbon monoxide (CO) concentrations and unburnt fuel in the flue gas is minimized. Otherwise, fuel would be wasted and unsafe combustion conditions could potentially occur.

Originally only oxygen (O2) was used as control signal and the operating point was typically between 5 % and 10 % excess air, which means that efficiency was low and NOx generation was high. More recently, additional CO measurements are used to provide a feedback on the O2-set point as well as being used to monitor CO breakthroughs to avoid fuel rich operations. With such an additional measurement, the operating point can be reduced to a range between 3 % to 6 %.

As an example, let's take a typical ethylene cracker with 200 MBTUs per hour and heater. By lowering the operating point from 7 % excess air to 4 % at a firing rate of 85 % to 100 %, the annual fuel savings is about $80,000 per heater (assuming $2.33/MTBU).

That means that for an ethylene cracker with six heaters, the combined annual fuel savings are nearly $500,000. At the same time, NOx production is reduced by around 33 % due to the lower excess air (Figure 1).

Several different technologies were developed over time to perform combustion optimization. Most of them are point type sensors (probes) that have to be in physical contact with the process gas. Zirconium oxide probes and catalytic combustible sensors are currently the most popular. These sensors, however, suffer from fast degradation due to harsh conditions, catalyst poisoning or inhibiting if exposed to reducing gases (e.g., Sulphur). Combustible sensors (COe) are not CO-specific but measure the sum of all combustible gases, i.e. besides CO also hydrogen (H2) and hydrocarbons are contributing to the concentration readings.

Tunable Diode Laser Absorption Spectroscopy (TDLAS), on the other hand, is based on a contactless measurement principle, the interaction of laser light and gas molecules. The measurements can be carried out directly in the process (in-situ) across the combustion chamber so that results are representing the whole chamber and not just single points close to the wall.

A consequence of the contactless measuring principle is that the instruments are not exposed to corrosive gases and high temperatures, and complex and maintenance-intensive extraction systems are generally not required. In contrast to zirconium oxide probes, which require a monthly recalibration due to degradation, TDLAS analyzers are only validated once a year.

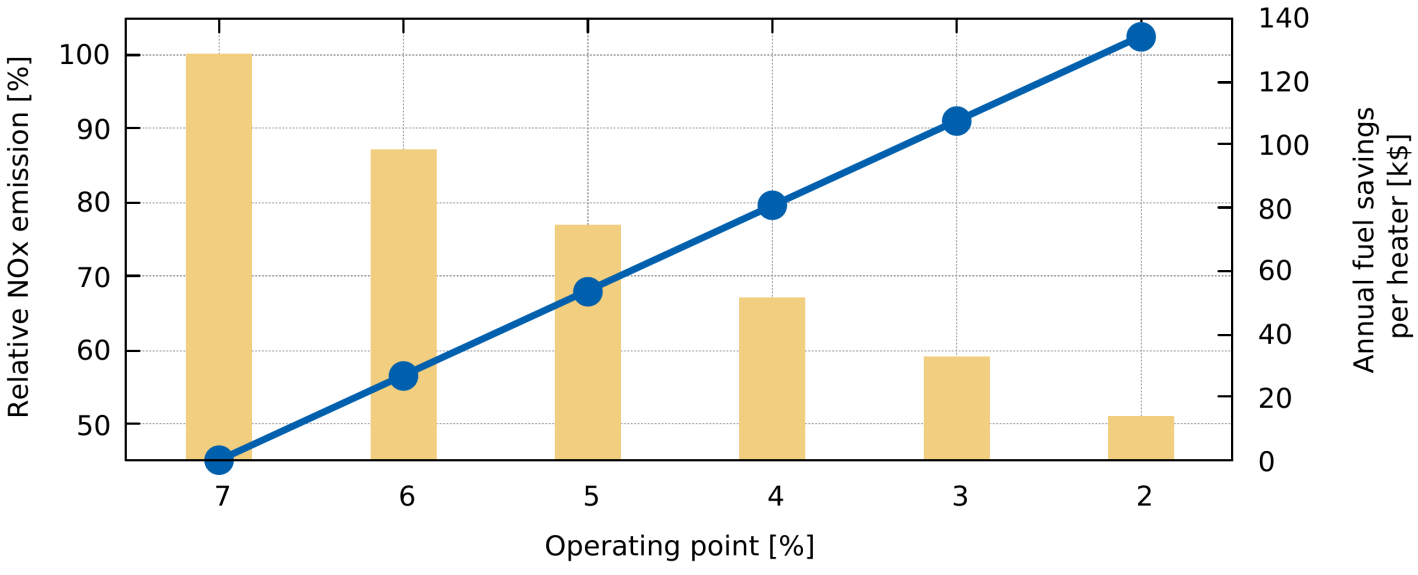

Figure 1: Annual fuel savings per heater in k$ (blue; right axis) and reduction in NOx emissions in % (yellow; left axis) for various operating points in relation to an operating point of 7 %.

The elimination of an extraction system and a much lower maintenance effort lead to a drastic reduction in the OPEX for the TDLAS analyzer compared to other technologies. Furthermore, TDLAS is highly sensitive and selective so that very low detection limits are achieved without interference from other gases in the process. This means that, in contrast to COe measurements, TDLAS can measure the true CO value, which leads to better optimization of the operating point.

NEO Monitors' duo for a complete combustion analysis consists of two in-situ LaserGas™ III analyzers: one for O2 and process temperature measurements and one for the measurement of CO, methane (CH4) and water vapor (H2O).

Each analyzer consists of a transmitter and a receiver unit that are mounted on diametrically opposite sides of a combustion chamber. While the investment costs for such transmitter-receiver configurations are somewhat higher than that for point type sensors, the significantly lower maintenance costs and better combustion optimization compensate for this after a short period of operation.

Now, if we look again at the fuel savings calculation above and also factor in the difference in CAPEX and OPEX between point type sensors and TDLAS analyzers, we get the total TDLAS benefits per heater for the first five years of operation (Figure 2).
For an ethylene cracker with six heaters, the benefits after five years of operation are over $2.7 million.

With a LaserGas™ iQ2, the dedicated combustion analyzer from NEO Monitors, CAPEX costs can be further reduced. It combines transmitter and receiver units of the above described analyzer duo in a single transceiver setup. In this case, a retro-reflector is used to send the beam back to the transceiver so that the beam is passing the investigated gas sample twice. Together with a probe solution (LaserGas™ iQ2 Vulcan) especially designed for retro-fit applications, only a single flange is required, which reduces investment costs to a minimum and all other advantages of in-situ measurements are retained.

And there are even more advantages using LaserGas™ analyzers for combustion control.
As mentioned above, the analyzers can also measure CH4, H2O and process temperature. Especially during the start-up of a combustion information about CH4 concentrations are essential for safety purposes.
H2O measurements can be used for wet-dry conversion of gas measurements and thus ensures compatibility with typical extractive solutions.
And finally, a TDLAS-based process temperature measurement is the best information for proper temperature compensation of the concentration readings.

In a nutshell: Contactless measurements are the future of gas sensing.

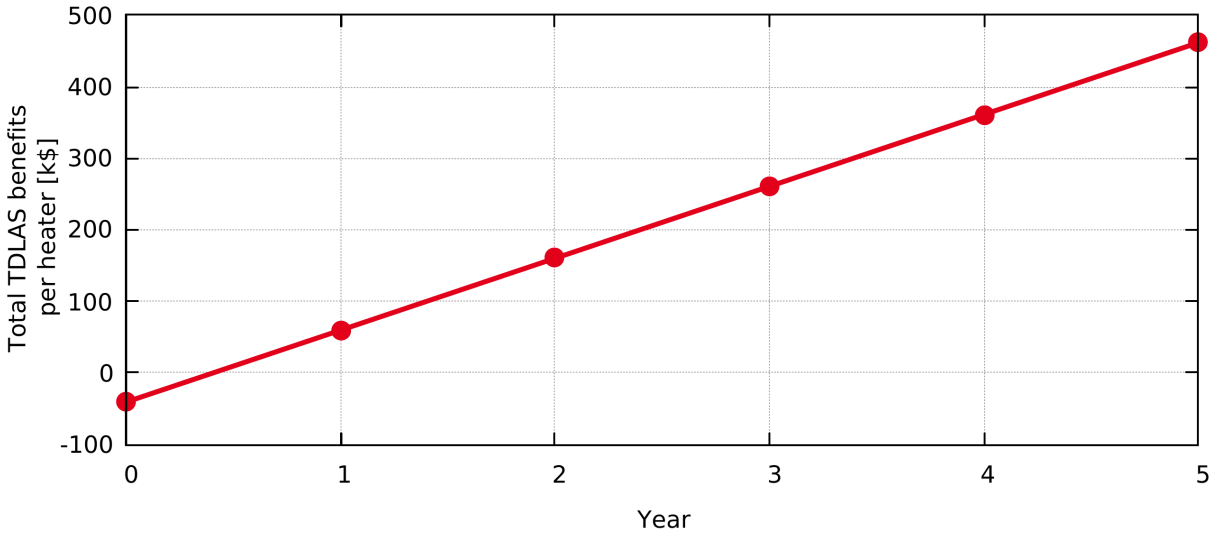

Figure 2: Total TDLAS benefits in k$ per heater for the first five years of operation.

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About us

NEO Monitors AS was founded in 2003 as a commercial part of Norsk Elektro Optikk AS (NEO). Today, NEO Monitors is a leading manufacturer and supplier of TDLAS gas and dust analyzers, based on over 30 years of high-risk research and development in electro-optics and laser technology.

NEO Monitors develops and supplies tailored solutions (LaserGas™ and LaserDust™) for measuring gas and dust in all types of industries worldwide.

The analyzers are typically used for:

1. Process optimization,
2. Continuous emission monitoring,
3. Safety applications.

The analyzers can measure more than 40 gases and their combinations. They are used in numerous applications in all kinds of industries such as cement, chemical / petrochemical, oil and gas, energy, pulp and paper, environment, fertilizer and many more.

NEO Monitors has more than 40 distributors spread across all continents. It is the fastest growing European company in this niche, with over 18 000 analyzers installed (2020).
The analyzers meet different requirements in the industry, from monitoring gas in stacks, pipes, ducts and process chambers to monitoring the safety of workers and environmental functions.

NEO Monitors AS was acquired by the Nederman Group in 2017 and we are proud to represent the same values:

"We protect people, planet and production from harmful effects of industrial processes, contributing to sustainable production, environmental benefits and a safe workplace."

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Our Distributors

NEO Monitors' solutions and expertise are available from a global distributor network. Our partners ensure that resellers and customers all around the world have access to our solutions, help them with the implementation and offer service, training and support.

To view all of our Global Distributors, please scan the QR code

Our Offices

Norway

NEO Monitors AS
Prost Stabels vei 22
N-2019 Skedsmokorset, Norway

Switchboard +47 67 97 47 00
Sales and application +47 400 01 613
neosales@neomonitors.com
www.neomonitors.com

China

NEO Monitors AS Beijing Representative Office
Room 16C4, Tower 2, Xihuan Plaza 1,
Xizhimenwai Avenue, Xicheng District
Beijing 100044, China

Phone +86(10) 5830 2877
info@neomonitors.com.cn
www.neomonitors.com.cn

USA

NEO Monitors Corp.
11200 Westheimer Rd, Suite 500
Houston, TX 77042

us@neomonitors.com
www.neomonitors.com