ECO PHYSICS' NOx Detectors

Nitrogen oxides in the field of burners and boilers

Nitrogen oxides (NO_x) are a by-product of nearly every combustion process. The term "nitrogen oxides" is usually used to describe two gases: nitric oxide (NO), a colourless as well as odourless gas, and nitrogen dioxide (NO_2), a reddish-brown gas with an irritating odour. Both gaseous pollutants have diverse negative effects on the environment and human health. They react with ozone molecules in the stratosphere, accounting for the destruction of the ozone layer. They also play a significant role in the formation of "unwanted ozone" (or ground level ozone) that contributes to the creation of photochemically induced smog.

NOx sources

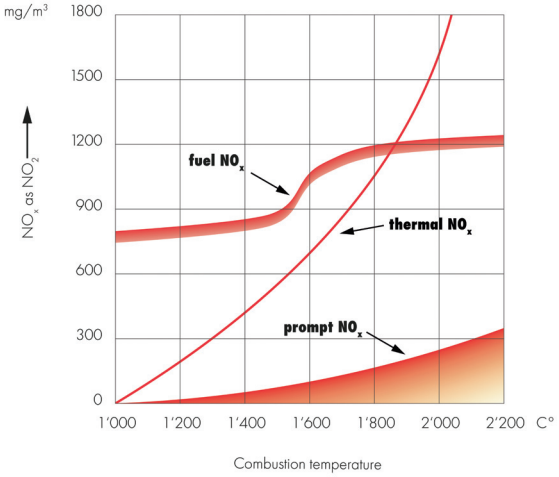
Although some of the NO_x emissions are of natural origin, a big part is generated by anthropogenic activities. The main contributors to the NO_x emissions in the EU are the transport sector and the industrial sector, of which fossil-fuelled power-plants are responsible for the highest quantity of the total NO_x emissions from stationary sources. In recent years, widespread and significant efforts were undertaken to control and reduce NO_x emissions.

NOx Formation

NO_x is formed by three different mechanisms during combustion: Thermal (Zeldovich mechanism), Prompt and Fuel-bound (European Commission 2013). A major step forward was made by industrial boiler operators in changing from coal or oil boiler fuels to natural gas. Natural gas-fired boiler burners can achieve significantly lower emissions; however, the problem is not entirely solved. While fuel bound NO_x is of no further concern with natural gas, the air used for the combustion process does not cease being a source of nitrogen oxides, because of the prevalent mechanism that supports the formation of thermal NO_x.

Ultra-low NOx solutions

Although modern systems emit less than one-third of the NO_x produced by older units, an efficient, clean-burning traditional gas burner, operating at elevated temperatures, still produces significant amounts of nitrogen oxides. In some areas, air quality compliance demands boiler emissions to be further reduced or meet "Ultra-low NO_x" (ULN) standards, which are typically less than 10-12ppm to NO_x in the flue gas.



Influence of temperature on NOx formation (Rentis, Nunge, Laforsch, Holtmann, 1999)

Future low NOx energy source

At the forefront of power research, the Aachen University of Applied Sciences conducts pioneering studies with hydrogen as a viable alternative gas turbine fuel within future low emission power generation. The most recent study 'CFD based exploration of the dry-low-NO_x hydrogen micromix combustion technology at increased energy densities' (A. Haj Ayed, K.Kusterer, H.H.-W.Funke, J.Keinz, D. Bohn, 2017) aims at analysing the influence of different geometry parameter variations on the flame structure and the NO_x emissions in order to identify the most relevant design parameters of the burner. The comprehensive goal is to push forward the maturation of this innovative combustion technology and make it applicable to real gas turbines. For the determination of NO_x levels, an ECO PHYSICS CLD 700 ELht was used.

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