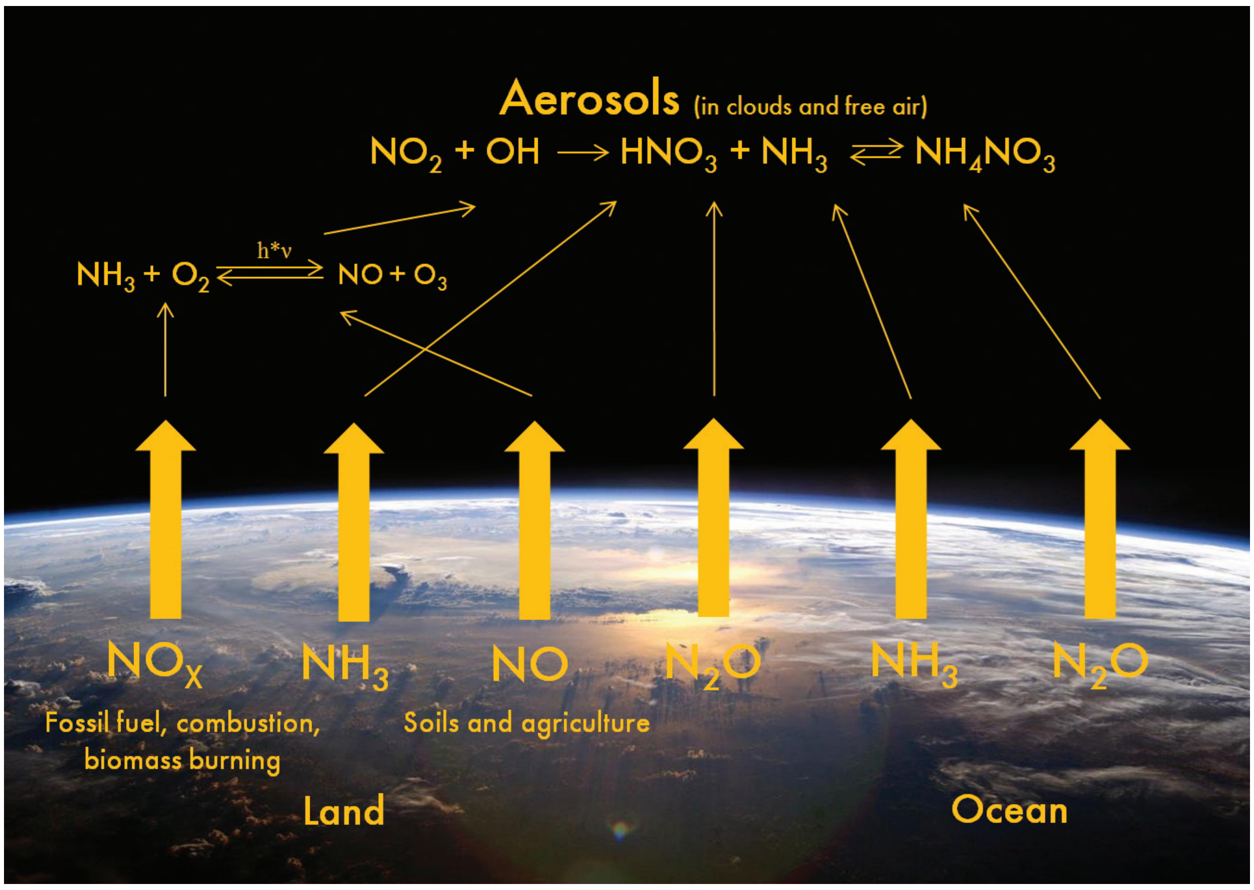
ECO PHYSICS' NO_X-DETECTORS, AN ESSENTIAL TOOL FOR STACK TESTERS IN SWEDEN

NO_X Emissions, Environmental Impact

By NO_X we define a group of gaseous compounds, based on a singular nitrogen and singular or multiple oxygen atoms. NO_X consists of approximately 95% of Nitrogen oxide (NO), less than 5% Nitrogen dioxide (NO_2) and less than 0.1% other nitrogenous trace gases. Nitrogen oxides (NO_X) are produced by the interaction of nitrogen, oxygen and hydrocarbons for instance during various forms of combustion.



Therefore NO_x is separated into:

1. Thermal NO_x (produced at very high temperatures, also supported by high pressure)
2. Fossil or combustive NO_x (bound NO_x in fossil fuels, depending on the quality of incineration)
3. Prompt NO_x (depending on the effect of hydrocarbon radicals, interacting with N_2 in the atmosphere)

Nitrogen oxides are strongly contributing to the greenhouse effect due to their absorbance and emittance of thermal and infrared radiation. The greenhouse effect consists of an equilibrium between the natural concentration of Nitrogen oxides in the atmosphere and solar radiation at 235 W/m². It maintains Earth's surface temperature at a present average of 15°C. Without this effect the temperature would be located around -18°C. This equilibrium is disturbed by Human contributions since the industrial revolution from 1750 ("Greenhouse Gases and Aerosols", IPCC reports, R.T. Watson, H. Rodhe, H. Oeschger, U. Siegenthaler). In all major cities, 50 to 75% of all emissions emerge from combustion and fossil fuels.

The emission of Nitrogen oxides (NO_x) contributes to many environmental problems. Together with Sulphur dioxide (SO_2), Nitrogen oxides are the main cause of acidification, which leads to widespread damage of flora and fauna on soil and in water habitats. Close to the ground, they participate in creating photochemical smog in summer, based on a day-night cycle presence of Ozone, where the concentration reaches its maximum in the afternoon and drops during night time.

The acidification problem in Sweden in the 1980s was the beginning of the NEC (National Emission Ceiling) directive, which had the goal to reduce the 450'000 tonnes of emitted NO_x per year (1980) to 148'000 tonnes by 2010 ("Information Facts of the Swedish Charge on Nitrogen Oxides", Naturvårdsverket/Swedish EPA, March 2006). Sweden introduced a system for NO_x-fee in 1991 where the operators monitor their emissions of NO_x and flue gas flow. The monitoring system can measure only NO in some situations and NO_2 is added as percentages of NO. Every year the monitoring systems have to be controlled by an accredited stack tester. If the monitoring system is only able to determine NO, then the operator's report uses a fixed percentage of NO_2 among total NO_x to calculate the total NO_x emission. To measure the amount of NO_2 a two-channel analyser is used to eliminate temporal variations.

Till 2013 roughly 130'000 tons of overall NO_x-emissions were achieved ("Greenhouse Emission Inventories 1990-2013", National Inventory Report Sweden 2015, Naturvårdsverket). In order to achieve such a progress, reliable, precise and regulation conform measurement instrumentation is crucial. According to the EN 14211:2012 (ambient monitoring), EN 14792:2014 (stationary sources) standard reference methods, chemiluminescence detectors are essential. They are based on the equilibrium reaction between Nitrogen oxide (NO) and Ozone (O_3), which emits light. The produced photons are multiplied and detected by a photo multiplier tube (PMT). The signal output is proportional to the NO-concentration. In order to detect other Nitrogen Oxygen based molecules in the sample (e.g. NO_x in total), they need to be converted into Nitrogen oxide (NO) to be measurable.

Vattenfall's CHP Plant

Vattenfall's power plant in Uppsala consists of various units to generate electricity and district heating for the community. As combustible materials, the power plant utilises household and industrial waste, as well as peat and wood chips. The new "waste burning unit" was completed in 2005 and is capable of burning 52 tons of waste per hour. The plant also have older waste incinerators, hot water boiler and a CHP. The "Combined Heat and Power plant" (CHP) transforms peat and wood chips into district heating and electricity.

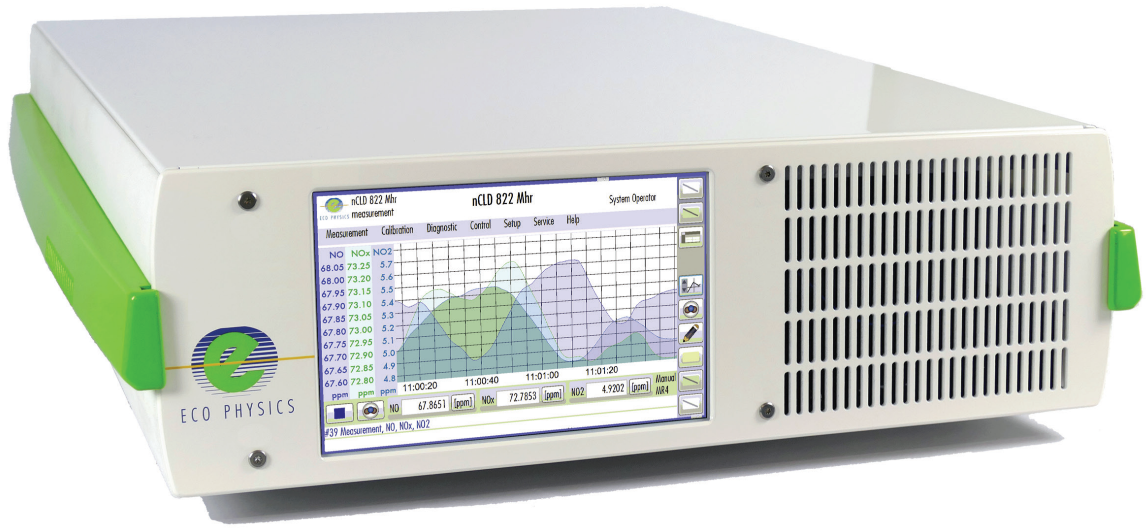
Lime is used to reduce Sulphur emissions, while electro and textile filters remove particles from the flue gas. Selective Catalytic Reduction (SCR) control systems are used for the control of NO_x-emissions in flue gas from power plants and waste incinerators. The NO_x-emission reduction requires the injection of Ammonia (NH_3) and /or urea into the flue gas, which can lead to a more than 90% NO_x reduction efficiency. According to ISO 17179:2016, the standardised measurement of NH_3 is also a strongly strived goal in the future. It will support the effective operation and maintenance of NO_x control systems in order to minimise environmental impacts due to Ammonia and NO_x. Peat will be phased out and should be replaced by 100% biomass burning in 2020. Once focused on biomass combustion, the CHP plant will deliver an output of 90 MW of heat and 50 MW of electricity.

Task of a Stack Tester

Since the 1990s, the tightening European legal emission limits demand a continuous monitoring of key parameters by a third party. These parameters comprise Nitrogen oxides (NO_x), Nitrous oxides (N_2O), Carbon dioxide (CO_2), Carbon Monoxide (CO), Sulphur dioxide (SO_2), Ozone (O_3) and Particulate Matter (PM10, PM2.5). Independent stack testers, such as METLAB, dispatch service vehicles and personnel to the CHP at Uppsala. Their equipment consists of a complete mobile emission monitoring system. The technician team is responsible for the sample collection on site at the facilities emission points, including tall stacks as well as any other exhausts exposed to environmental elements. Beyond the sample collection, the stack tester analyses and interprets the collected data, which is communicated with the facility operators and the local authorities. The data provides the direction to prevent air pollution by giving advice how to adjust the resource mixture within the incinerator. It ensures the compliance with air permits as well as with other community and state requirements. The stack tester schedule internal audit and maintain the awareness of new and revised regulations. Part of the emission monitoring system is ECO PHYSICS' two channel, chemiluminescence based, NO_x-analyser, the CLD822Mhr, which detects NO, NO_2 and NO_x at concentrations up to 5000 ppm. According to the sample conditions, an individual configuration of the instrument is necessary. For instance, a dual sample inlet, two parallel gas flow streams with heated sample lines, two reaction chambers with specialised metal converters, an internal pump and pressure regulation are installed.

A Whole New Level in Stack Testing Awaits

Based on the experience with the CLD822Mhr series among this and other industrial applications, ECO PHYSICS has developed the neoCLD800 series, which comes with a new line-up of features. It contains an internal data logger, a graphical user interface, processor controlled modular components and remote operation and control. The system operator is able to set an individual measurement- and service-management plan. Even if not present by himself, he can configure administrative rights to other users, for instance for service personnel on sight, by altering safety settings. For CHP operators and accredited stack testers, the neoCLD800 series will create a completely new perspective upon emission control management.



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