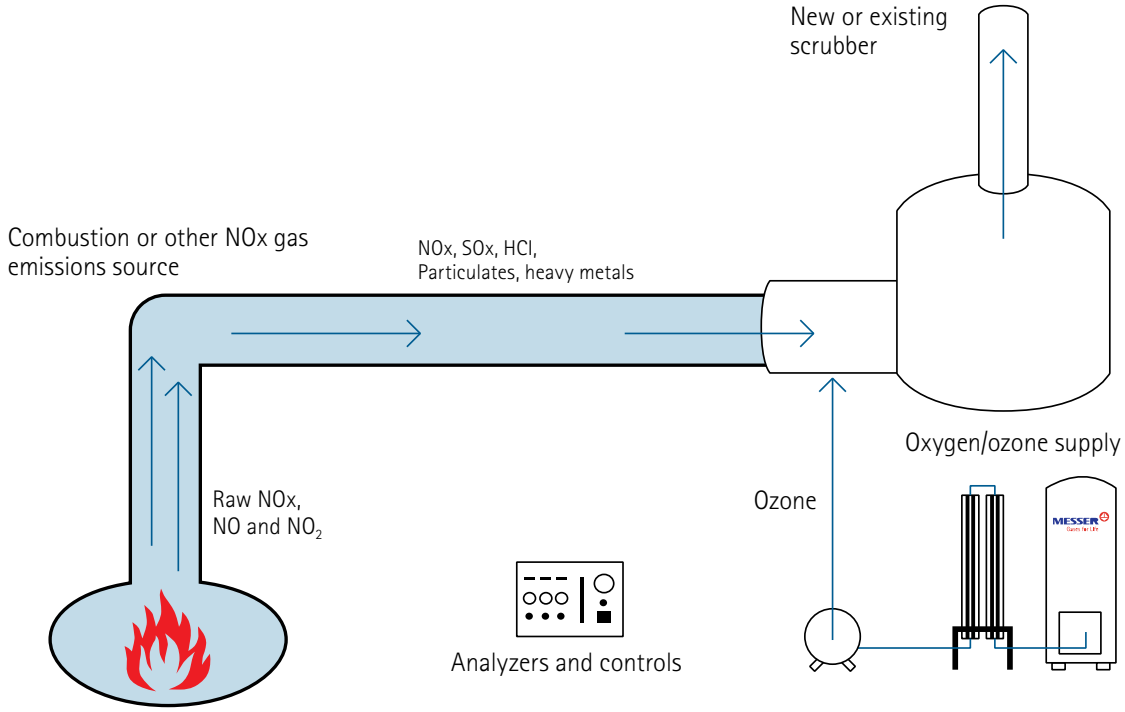
MESSER
Gases for Life

eNOx™ Gas Purification System.

Low temperature oxidation for NOx control.



Process description

The eNOx™ Low-Temperature Oxidation (LTO) process is a patented process for removal of NOx and other pollutants from waste gas streams.

Messer's eNOx gas purification technology is an end-of-pipe system that removes NOx by adding ozone to oxidize insoluble NO and NO_2 to N_2O_5 (a highly soluble species of NOx) which can be effectively removed by a variety of Air Pollution Control (APC) equipment, such as wet or semi-dry scrubbers or wet electrostatic precipitators (WESP). The eNOx technology can be used as a stand-alone treatment system, where inlet NOx levels are moderate. Additionally, it can be used cost effectively as a polishing system in conjunction with combustion modifications such as Low NOx Burners (LNB) or other post-combustion technologies such as Selective Non-Catalytic Reduction (SNCR) for NOx removal. Ozone is generated on site and on demand from oxygen and is either completely consumed in the eNOx process or residual ozone is destroyed in the scrubber system. NOx capture in wet scrubbers results in a dilute nitric acid stream which after neutralization is either sent for waste water treatment or for recovery as a valuable by-product in large industrial and utility systems. Calcium nitrate, a valuable commercial fertilizer, can be produced as a saleable product in systems using lime scrubbers. NOx capture in a dry/semi-dry scrubber results in a waste stream of nitrates mixed with other solids such as particulate matter, sulfates, chlorides, etc.

eNOx™ system chemistry

Gas phase reactions			Relative reaction rate
$NO + O_3$	$\longrightarrow$	$NO_2 + O_2$	Fast
$2NO_2 + O_3$	$\longrightarrow$	$N_2O_5 + O_2$	Fast
$CO + O_3$	$\longrightarrow$	$CO_2 + O_2$	Slow
$SO_2 + O_3$	$\longrightarrow$	$SO_3 + O_2$	Very slow
$Hg^0 + O_3$	$\longrightarrow$	$Hg^{+2} + O_2$	Fast
Liquid phase reactions			**Relative reaction rate**
$N_2O_5 + H_2O$	$\longrightarrow$	$2HNO_3$	Very fast

- Ozone is highly selective for NOx relative to other combustion products
- NOx is rapidly converted to water soluble species
- The resulting N_2O_5 is readily absorbed by aqueous scrubbing solutions or adsorbed by dry/semi-dry scrubber adsorbents

Overall benefits

- Lowest achievable level of NOx emissions
- Easily tuned for variable loads
- Low temperature operation
- Fully automated
- No secondary gaseous pollutants generated
- Consistent reliable performance regardless of fuel type
- No effect of particulate matter on NOx removal
- Simultaneous oxidation of Hg and other contaminants
- Easily integrated with existing wet scrubbers

Applications

- Utility boilers (coal, petcoke, lignite fired)
- Industrial boilers (gas, coal, No. 6 oil)
- Kilns, furnaces and ovens (lead, iron ore, zinc/copper, glass, cement)
- Waste combustors (bio-waste, tires, industrial wastes)
- Acid gas streams (exhaust from pickling and chemical processes)
- FCC off gas (Belco® Clean Air Technologies)
- Incinerators (municipal, industrial)

Commercial application

Systems using the patented LTO process have been installed in a number of challenging applications where waste gas streams laden with particles and metals have had to be treated to very low NOx levels to meet national or local air quality requirements. In addition to gas, coal and petcoke fired boilers, full scale commercial systems have been installed across a range of different market segments, including in a metals furnace, a stainless steel pickling plant, sulfuric acid plants, and multiple FCC regenerator off-gas treatment plants. Flue gas volumes treated range from 0.2 to 22 MMscf/hr. Inlet NOx levels range from 30 to 3000ppm (more typically 50 to 300ppm) with typical outlet NOx levels required in the range from 10 to 50ppm. Under design conditions, a total of over 250 MMscf/h of polluted air is treated in the systems resulting in the removal of more than 16,500 tons of NOx each year.

Messer modular ozone and oxygen supply systems enable quick and easy retrofit of the eNOx gas purification process into existing APC systems without significant changes or additional major process equipment. The small, modular system footprint allows flexibility of the equipment layout to meet unique spatial requirements for a variety of applications and industries. Custom-designed eNOx systems are commercially used in treating large gas streams containing NOx and have demonstrated consistent performance to remove NOx on combustion systems fueled by natural gas, oil, and coal. The NOx removal performance does not deteriorate with respect to time in spite of heavy dust loading and the presence of other contaminants. The on-site generation of ozone to treat NOx results in a highly responsive control system for treatment of single point sources with variable loads or fuels, or even multiple point sources combined into a single treatment system.

The eNOx apparatus PSO

- Feasibility study and demonstration
- Process license
- Basic engineering package, detailed engineering support, startup and troubleshooting with and without process guarantees
- Oxygen and/or ozone (gas) sales
- Complete turn-key eNOx system along with co-operation partner

Demonstration

Messer has developed an eNOx system that has been successfully used to demonstrate the performance of LTO on customer processes, as well as develop detailed process and operating data for use in designing full scale installations.

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