TRI-NO_X

3 Alternatives for Efficient NOx Control:

1. Dry removal with the unique **UltraCat catalyst filters** for gas temperatures greater than 350°F. This technology provides NOx control at temperatures lower than conventional Selective Catalyst Reduction (SCR), while capturing particulate, and offers the option of removing acid gases, mercury, and dioxins. Please view the NOx Control page for more information.

2. Standard dry removal stand-alone Ultra SCR, both low temp (starting at 350°F) and high temp (up to 1100°F). Please see the Low Temperature SCR page for more information.

3. Wet scrubbing with the Tri-NOx for applications under 350°F with special requirements. See below.

Tri-Mer's field-proven Tri-NO_X system handles any oxide of nitrogen, from any source. It is highly effective in controlling both NO and NO_2.

The ratio of NO to NO_2 in the gas stream is a critical factor in system engineering: the ratio determines, among other things, the stages required. Processes such as those related to combustion produce constant gas ratios and constant volume inputs (cfm.) Other processes, including metal finishing, nitrations and refining, generate variable NO/NO_2 ratios and variable volumes. Either can be handled efficiently, and with minimal operator attention, by Tri-NO_X.

It's important to determine, prior to system design, the local output restrictions for each component. Some regions require total NO_X ($NO+NO_2$) reduction to specific ppm limits, generally under 100 ppm, and sometimes below 25 ppm, expressed as total NO_2.

Other regions require the reduction of NO_X expressed as NO_2 only. This standard eliminates the yellow-brown plume produced by high NO_2 loads and can't be equated with total NO_X control. Tri-NO_X processes are applicable for both requirements.

The chart documents the performance of the Tri-NO_X process under continuous duty loading, over a 6-hour period. (This system controls total NO_X.)

Performance

Tri-Mer Tri-NO_X scrubber systems are engineered to meet specific ppm outlet values under continuous duty. These values are expressed in ppm or lbs./hr. NO_X, depending on local permit requirements. **Tri-NO_X systems provide exceptional reliability and service life.**

Control Requirements

Oxides of nitrogen generate two forms of gas phase emission: NO (primarily invisible) and NO_2 (visible as yellow-brown gas.) Combustion source generators of oxides of nitrogen produce an invisible NO_X gas constituent. The ratio of NO to NO_2 in a combustion source is primarily above 90%/10%, NO to NO_2. These sources usually produce lower NO_X inlet concentrations expressed as ppm – generally less than 1500. However, they produce this load continuously.

Some direct-fired combustion, including high-temperature ovens, direct-fired rotary kilns, direct-fired calcinators and other processes that use heat to drive off nitrates, also produce NO_2 in the visible spectrum. NO_X-producing processes such as metals refining and chemical nitrations are done in enclosed, steam-heated kettles and generate extraordinarily high ppm loads of NO_X. These sources always generate a visible NO_2 plume. Other sources, such as aluminum anodizing, metal finishing and nitric etching, also produce high NO_2 loads in the visible spectrum.

While these sources produce significant NO_2 constituents, they also produce a large quantity of NO. Consideration must be given to total NO load when designing a system; simply containing the NO_2 portion of the gas stream will not guarantee the system will perform as required. The engineering expertise applied to each Tri-NO_X system assures the process will always operate within specified parameters.

Tri-NO_X multi-stage

High temperature "gas inlet"

Tri-NO_X process adapted to calcinator and rotary kiln system.

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TRI-NO_X

AnoVent

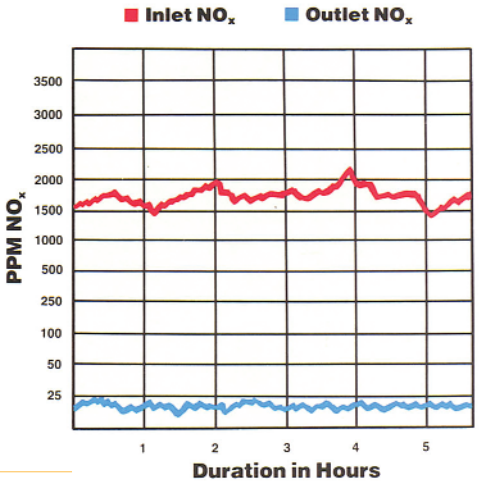
AnoVent incorporates Tri-Mer's patented Tri-NO_X technology for total control over NO_X (nitrogen oxide) generation. The system handles fumes from nitric acid, bright dip operations, sulfuric acid, sodium hydroxide and other anodizing solutions.

AnoVent is engineered to customer requirements and meets or exceeds local codes for emissions to the outside, and OSHA standards applicable indoors.

Capacities are 500 CFM to 250,000 CFM; standard construction is stainless steel, polypropylene or PVC. Higher alloys are available.

System design includes interior ventilation hood and ducting. PVC ventilation ducts carry the corrosive fume/gas combinations to the scrubber.

The chart depicts a Tri-NO_X process during 6 hours of operation. Note the constant outlet below 25 ppm.



Staged Concept

The physical and chemical properties of gas streams containing oxides of nitrogen necessitate multiple stages to achieve the reactions needed to destroy the input load.

Some processes require five or more stages; others can operate with fewer. Two-stage processes may be appropriate for light loads requiring only NO_2 control.

A 60,000 CFM AnoVent system venting a bright dip operation.

Tri-NO_X® Multi-Chem™

Some process gas streams require multiple chemical treatments to reduce ppm output to concentrations of 50 ppm and lower. These processes require 4-6 stages and use Tri-Mer's Multi-Chem technology. Sources generating continuous NO_X loads with high NO_2 content may benefit from an acid recovery module; the schematic at the end of this PDF shows an example.

Design and Construction

Consideration is given to system use, likely future use, input concentrations, temperature and gas stream residuals. Polypropylene and 316 stainless steel are standard materials; options include fiberglass, PVC and high alloy metals.

80% of systems on-line today are constructed of UV-stabilized polypropylene. This cost-effective and reliable material is suitable for virtually all NO_X systems and is compatible with the aggressive chemical environments of NO_X scrubbing.

Where processes involve high temperatures, stainless steel gas pre-quenchers are used to reduce inlet temperatures to below 230°F. Heat exchangers and cooling towers are options for systems with saturated gas streams.

Tri-Mer design engineers evaluate all operating parameters and analyze each application in-detail before recommending a plan for construction.

Tri-NO_X Multi-Stage Multi-Chem system with acid recovery.

Dry Sump

The dry sump packed column is an important engineering feature of the Tri-NO_X system. Each column incorporates an independent recirculation system as a unit separate from the packed tower. This allows accessibility to instrumentation, sensors, level controls, mixers and tank accessories while the scrubber is in operation, and with no interruption of production.

Tri-Packs® Tower Packing

Tri-Packs is the media of choice for NO_X scrubbing. Tri-Packs represents a significant breakthrough in scrubber tower packings. A spherical design provides maximum surface contact between gas and scrubbing liquid by facilitating continuous formation of droplets throughout the packed bed. This produces extraordinarily high scrubbing efficiency.

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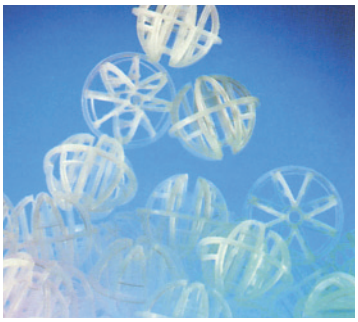
Tri-Packs® Tower Packing, Cont.

Tri-Packs tower packing prevents clogging because there are no flat surfaces or minute openings to harbor particulates. Puddling is prevented because there are no corners or valleys, and wasteful liquid flow down the wall surfaces is minimized. Tri-Packs does not allow dry spots or compression interlock to occur.

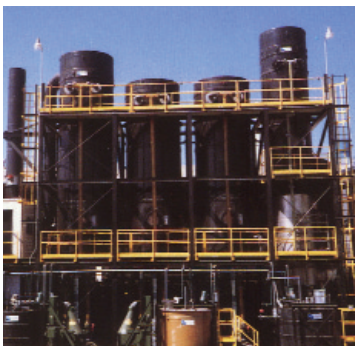
Tri-Packs develops a very low static pressure per ft. of depth. It can often reduce both the size of the tower and the quantity of scrubbing liquid required.



Tri-Packs advanced technology tower packing

Instrumentation

Tri-NO_X systems are generally supplied with fully-automated process control packages that interface easily with a wider controls configuration or plant-wide system. Included are control panels and process instrumentation, as well as monitoring equipment specified by the customer. Typical options include devices for measuring process air flow, static pressure, gas stream temperature and chemical consumption, or for automatic chemical feed or report generation.



Tri-NO_X Multi-Chem vertical system applied to nitrating oven.

Operation and Maintenance

Tri-NO_X and Multi-Chem systems operate with minimal oversight. Unique to the Tri-NO_X system is the ability to override the process for service or other reasons. The modular design of each stage allows maintenance during operation.

Daily maintenance is limited to the addition of process chemicals (where non-automated) and inspection of instrumentation.

Multi-stage horizontal NO_X scrubber applied to steel pickling line.

Design Alternatives

Most Tri-NO_X installations have a vertical packed bed format. This design maximizes the contact between gas and liquid within the counter-current dry sump packed column.

Applications with elevation and other restrictions precluding vertical configurations can achieve equal scrubber performance with a horizontal system.

NOx Stack Monitoring

Many regions, and all non-attainment zones, now require continuous NO_X monitoring. Tri-Mer provides precise, continuous NO_X stack monitoring in conjunction with the process controller, assuring the system never exceeds permit level loads. Real-time hard-copy graphing can be generated in formats most useful to the customer. Systems can monitor NO and NO_2 separately and outlet simultaneously with inlet.

Tri-NO_X scrubber through-the-roof installation.

Effluent

The Tri-NO_X system is chemically safe: waste generated by the system can be handled by the most basic wastewater treatment systems. Overflow is pre-treated in the Tri-NO_X tank farm and pH balanced before discharge. Blow-down rates from the process are extremely low per pound of NO_X destroyed. Consult Tri-Mer for specifics related to waste characterization.

Scrubbing Residual Inorganics

A major advantage of Tri-NO_X is concurrent scrubbing of residual inorganic compounds found in NO_X gas streams, including sulphur dioxide, hydrofluoric acid, sulphuric acid, hydrochloric acid. For most users, the advantages of operating a single scrubber for a multi-phase inlet problem are significant.

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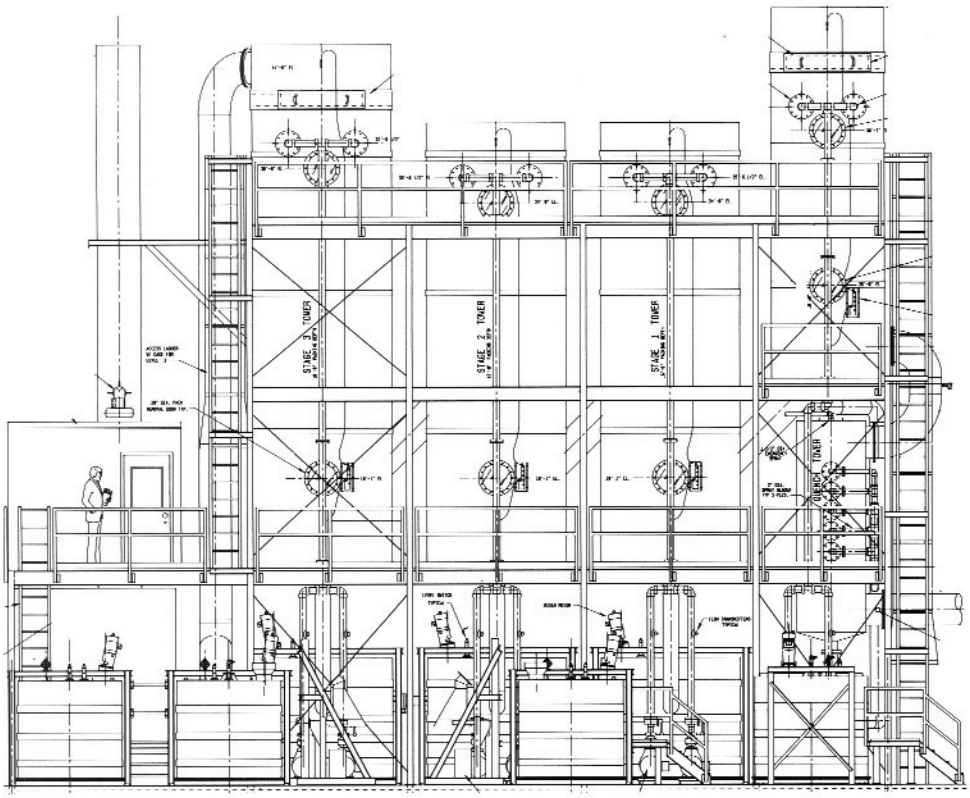
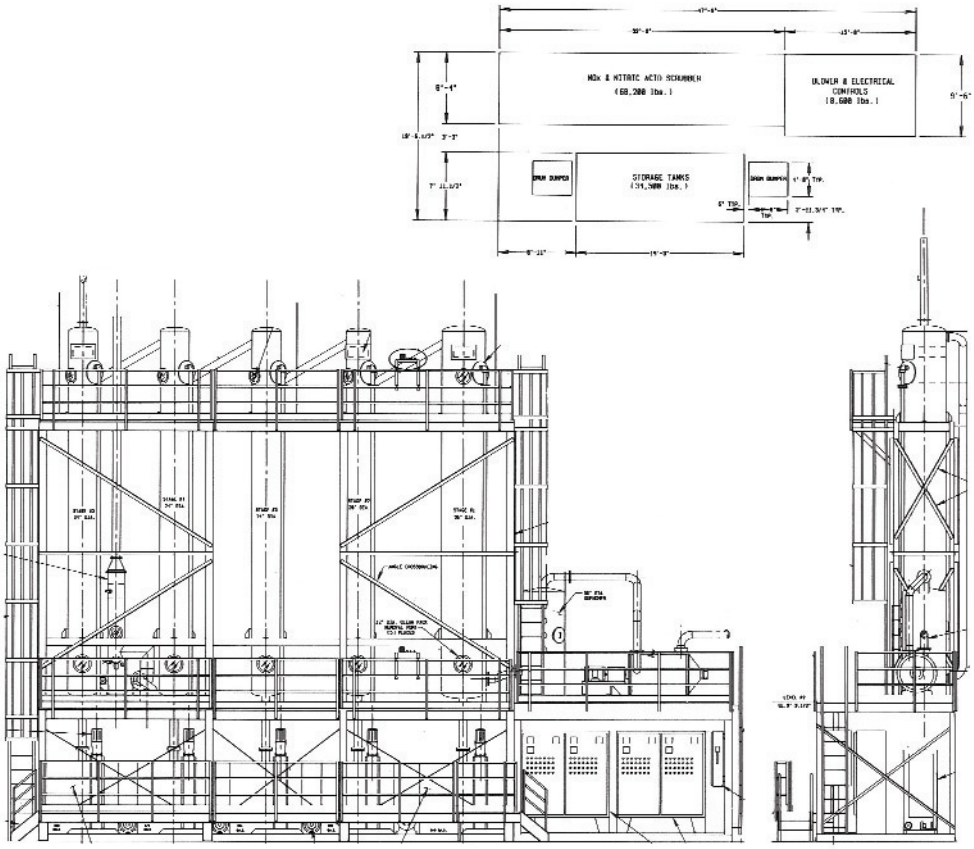


Multi-Stage NO_x Scrubber

Typical front elevation, five (5) stage unit including gas quencher.



Multi-Stage High Load NO_x Scrubber with Acid Recovery Stage

(Elevation views)

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