Heraeus Nitro Technologies is a business unit of W.C. Heraeus, the largest company in the Heraeus Group. Heraeus Nitro Technologies is deeply rooted in the history of the company as well as in today’s operations.

It draws heavily on the expertise, manufacturing and research resources, logistics and management competence of the whole group. Manufacturing facilities are located in Europe, the United States, Central Asia and the Far East with sales offices in all major markets.

Heraeus Nitro Technologies focuses its activities on providing products and services for industrial ammonia oxidation and hydrogen cyanide production. Groundbreaking innovations, technical and commercial competence, continuous improvement and the use of the most efficient production techniques make Heraeus Nitro Technologies the worldwide technology and cost leader in its business area.

Heraeus Nitro Technologies Locations

W. C. Heraeus GmbH – Headquarters Hanau/Germany

Heraeus Metal Processing Inc., USA

Ravindra Heraeus Private Ltd., India

Heraeus Materials Technology Shanghai Ltd., P. R. China
Heraeus Nitro Technologies looks back on decades of experience in catalyst gauze manufacture. This long term experience and the focus on the science of precious metals ensures that the materials used for the manufacture of catalyst gauzes fulfil the most stringent standards in respect to their quality and purity. Over years of close monitoring of gauze performance, specific elements and substances which adversely influence either the catalytic activity or mechanical stability of the gauzes have been identified. Based on this experience, dedicated procedures have been put in place at Heraeus Nitro Technologies which guarantee an excellent performance of the gauzes.

Heraeus Nitro Technologies not only supplies catalyst gauzes but also advises customers on the best catalyst configuration, alloy and structure. Using computer programs, optimized catalyst systems can be proposed to suit individual process parameters:

- Heraeus Nitro Technologies maintains a dedicated and segregated stock of material for catalyst gauze manufacture
- The most modern material analysis techniques are used to control the material composition and level of impurities
- All substances and compounds with potentially negative influence on catalytic activity are eliminated from the manufacturing process
- All gauzes are activated by a dedicated procedure in order to ensure immediate light-off and rapid surface restructuring
More than a decade ago, Heraeus first developed and introduced a new production technique for catalyst gauzes: warp knitting. This patented production technique proved so successful that soon the majority of catalyst gauzes in use throughout the world are now manufactured using this technique. The traditional woven catalyst gauzes have almost entirely been replaced by knitted products.

The choice of the warp knitting technique was made by Heraeus after extensive comparative testing of several different gauze structures produced with varying production techniques supported by mathematical modelling and simulation of the reaction processes. The warp knitted gauze proved best due to its outstanding performance under industrial operating conditions and because of the versatility of the warp knitting production technique itself.

The Heraeus Nitro Technologies warp knitted catalyst gauzes are uniquely well suited for catalyst reactions due to their inherent features:

- high mechanical strength and form stability
- "self repairing" behaviour
- low pressure drop
- high surface area
- low platinum losses
- minimal rate of rhodium oxide formation
- high conversion rate and selectivity
- long operating cycles

The versatility of the warp knitting technique enables the manufacture of gauzes with:

- a large selection of gauze structures
- a large selection of specific catalyst weights
- a wide range of gauze diameters
- a wide range of wire diameters
- a multitude of alloy specifications
- fast production and short delivery times

Heraeus Nitro Technologies continues to offer woven products for the few remaining customers wishing to use this technology.
Heraeus Nitro Technologies has succeeded in developing a catalyst system, FTC plus, which reduces the nitrous oxide emission at source. FTC plus has been commercially available since 2000. After installation, the emissions of nitrous oxide have been reduced on average by more than 30% over extended campaign lengths in many industrial applications. FTC and FTC plus consist of a number of metallic gauze layers and can be installed in virtually any reactor. No changes to the reactor itself and no additional catalyst is required in order to operate FTC plus.

Both FTC and FTC plus catalyst systems can be delivered in the form of individual gauze layers or pads or mounted on a stretcher.

Detailed documentation and installation information as well as on-site installation support are available.

FTC, Functional Total Control, is a completely new concept for the catalytic oxidation of ammonia which has been available since 1996 solely from Heraeus Nitro Technologies. Using computer models, a fully integrated catalytic package is designed specifically for each reactor. FTC is designed to reduce total production costs: the cost savings are primarily achieved by reducing precious metal losses and reducing the precious metal weight of the installed catalyst. FTC does away with the requirement of catchment systems to be installed in the reactor.

FTCplus

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To accomplish this, FTC systems utilise specially developed, complex alloys which enable the total weight of precious metals required to be substantially reduced. When compared to conventional catalyst systems, cost reductions of up to 35% per tonne of nitric acid produced have been achieved in numerous industrial applications. This result has been achieved without sacrificing ammonia conversion efficiency or campaign length.

On the contrary, ammonia conversion efficiencies are bench marked over even extended campaigns. FTC is suitable for virtually all reactor types.
The greenhouse gas N₂O is known to have a global warming potential 310 times higher than CO₂. Annually, about 1.2 mio. tonnes of this gas are emitted by the nitric acid industry, which is equivalent to the CO₂ emissions of 80 mio. passenger cars.

On one hand, the national environmental legislation has become tighter in some countries after commencement of the Kyoto Protocol. On the other hand, the Kyoto mechanisms allow the industry to implement emission reduction projects (CDM/JI) generating carbon credits. Industries emitting huge quantities of CO₂ to the atmosphere and plants where emission reductions are only viable with very high investment have a definite demand for carbon credits.

Heraeus has developed a N₂O abatement system (HR-SC) for nitric acid plants which enables the reduction of emissions to any desired level. The catalyst consists of materials commonly used in NH₃ oxidation reactors. This ensures that no new materials are present endangering the product. The HR-SC system is made of precious metal coated ceramic pellets which are filled into steel cassettes designed to fit into the reactor.

Depending on operating conditions and the required level of emission reduction the catalyst layer thickness in medium pressure plants is typically between 20 – 60 mm causing an additional pressure drop of 1 to 40 mbar. The Heraeus N₂O reduction catalyst has been subjected to an intensive development program in small scale reactors as well as in commercial installations with an output of more than 1,000 tonnes of acid per day.

Heraeus is marketing the HR-SC system on a lease basis, charging the customer monthly based on the quantity of acid produced (in tonnes of HNO₃ 100 %). This business model has major advantages:

- **Cost transparency for the customer**
- **Technical support and trouble shooting are included in the lease fee**
- **Free of charge disposal of the spent catalyst at the Heraeus site**
Installation Modus of the N₂O Abatement Catalyst

The HR-SC is mounted directly beneath the primary catalyst (gauzes). In most cases, there are no modifications to be made prior to the installation of the Heraeus Secondary Catalyst.

On rare occasions, the basket has to be reinforced or a steel support grid has to be lowered in order to create enough space for the system. Normally, some Raschig rings equivalent to the catalyst layer will be removed.

Chronology of HR-SC installation:

1. Catalyst segments are delivered to the customer packed in a wooden box (usually one per reactor).
2. The wooden box is lifted onto the platform in the proximity of the reactor.
3. Heraeus will dispatch an application engineer, who will be present during the installation for assistance. Installation of the first HR-SC will be carried out by Heraeus engineers.
4. Part of the Raschig rings need to be removed: the layer of Raschig rings depends on the thickness of the catalyst package.
5. Raschig rings have to be levelled over the entire reactor area.
6. A fine mesh Kanthal screen is installed in the reactor to protect the surface of the Raschig rings.
7. An alumina gasket is installed at the edge of the basket.
8. The steel cassettes are installed in the reactor individually. Each segment is tagged, so it can be identified in the installation sketch provided by Heraeus.
9. The segments are connected using a special tool.
10. After having installed the HR-SC system, the reactor can be fitted with the catalyst gauzes.
Secondary Catalysts

HR-SC – Summary of Advantages

- **N₂O abatement catalyst** can be installed without major reactor modifications – no necessity for reactor redesign.
- The HR-SC system can achieve over 90% reduction in N₂O emissions and thus earns large numbers of carbon credits.
- High thermal stability.
- No mechanical abrasion of the preforms.
- No leaching of the catalyst layer.
- The system does not contain any potentially hazardous materials.
- There is no measurable effect on the oxidation efficiency.
- Catalyst stability has been proven over many months in industrial reactors.
- Low pressure drop.
- Cost optimization by combination of FTCplus-gauze systems and HR-SC.

Typical medium pressure plant

![Graph showing N₂O in tail gas (ppmv) vs. Catalyst layer thickness (mm) for FTCplus and HR-SC systems.](image)

![Graph showing N₂O in tail gas (ppmv) for Standard, Gauzes only, and Gauzes + 20 mm catalyst layer pack.](image)
Heraeus offers a number of innovative solutions based on the corrugated technology. Corrugation was originally developed for use in high pressure nitric acid plants in order to allow the installation of catchment or getter gauze technology while avoiding the problems of massive pressure drop occurring in the reactor. Heraeus has further developed this basis technology to extend its utilization into the field of catalysis as well as modifying it for application to packaged catalyst solutions.

A major leap forward is the Heraeus development of corrugation and profiling technology for medium pressure applications.

By utilizing the Heraeus MP profiling techniques, we can achieve the following advantages for operators of reactors with diameters of 2 to 7 metres:

- 20 – 30% reduction in specific load of N per unit area
- Reduced volatilization of PGMs during the production cycle
- Considerably extended campaign durations
- Higher ammonia conversion efficiency
- Easy installation and removal

Each system is individually computer designed for the reactor, the production parameters and the specific campaign. Please ask our engineers!
A revolutionary catalytic product which will eventually replace conventional gauze products is the high technology Wafer development by Heraeus.

Wafer is a highly robust, infinitely customisable catalyst package for ammonia oxidation which is wire-free! The CAD structures available with this technology and the flexible combination of varied materials integrated into the design allow plant managers to specify the ideal catalyst for each campaign. Wafer offers the following advantages over conventional catalysts:

- **Much higher porosity**, leading to faster reactions and lower propensity for side and back reactions. Lower energy requirement.
- **Greater active surface area**, allowing higher catalyst loading and reducing direct precious metal installed and indirect precious metal inventories.
- **Built-in catalytic activation**, non-geometric random forming processes result in higher catalytic activity prior to ignition. Activity remains higher over extended periods.
- **Robust and damage resistant package**, through integrated functionality a one or two piece solution is available for almost any application. The one or two piece solution also allows easy and quick installation and removal.
- **Can be supplied in corrugated and profiled forms**, suitable for all atmospheric, medium and high pressure reactors. Please consult our engineers for your customized solutions.
Stretcher

Heraeus Nitro Technologies strives to make gauze deliveries in a way which is most convenient to its customers. Detailed documentation, installation guidelines, on-time delivery and on-site installation support are all included in the service.

Gauzes can be supplied as individual sheets, as pads or using dedicated packing systems.

A speciality of Heraeus Nitro Technologies is the delivery of gauzes on the so-called Stretcher. The Stretcher is not only a transport but also a gauze installation system. The Stretcher is placed over the reactor and the gauzes are released in such a way that the gauze pack is installed in one quick and easy operation into the reactor. It is extremely well suited for reactors with diameters of 2 m and above.

Precious Metals Recovery

An inherent feature of the ammonia oxidation process is that the catalyst gauzes lose weight. Platinum is lost primarily in the form of volatile platinum oxide and to a lesser extent as particles due to mechanical losses.

Rhodium is lost in the form of rhodium oxide which is not volatile and the losses are primarily of a mechanical nature. The rate of total losses make up a linear function of the logarithm of the daily production rate per surface area of the reactor: this means that the higher the production rate per unit area of reactor the higher is the rate of material losses.

In today’s modern plant management the material lost from the catalyst cannot be regarded as material which is “lost forever”. Heraeus Nitro Technologies provides several well established methods to recover nearly ninety per cent of the precious metal primarily lost from the gauzes.

Stretcher – the upper strip and board can be removed and the catalyst opened out to lie flat on the burner
Platinum Recovery Filters

Platinum recovery filters are air phase particulate filters which are positioned downstream of the plant’s heat recovery train where gas temperatures are well below 400°C. The filters not only collect particles which are transported by the reaction gases but also facilitate the condensation of the volatile platinum oxide from the gaseous phase. The filters can be employed with or without a catchment system.

Heraeus Nitro Technologies offers:
- Supply and re-packing of Platinum Recovery Filters
- Refining of spent filters
- Recovery rates between 30 – 50%
- Low pressure drop

Plant Cleaning

In modern plants substantial amounts of precious metal catalyst are retained in the heat recovery train and large quantities of precious metals can be recovered from spent heat exchangers. Also, there are various non-destructive cleaning methods which enable the recovery of precious metals during normal plant turnarounds or stoppages, while also improving heat transfer and plant throughput.

Heraeus Nitro Technologies through our sub-contractor, 3D Recovery Europe Ltd, provides:
- Non-destructive cleaning of plants
- Non-destructive and destructive cleaning of plant components
- Recovery of precious metals from cleaning residues, PGM containing deposits and spent filters
- Increased plant performance
Technical Services offered by Heraeus

Investigation Service

Heraeus Nitro Technologies routinely uses a wide range of powerful investigation techniques for product development and customer support. The most commonly used technique is Scanning Electron Microscopy (SEM) in conjunction with Energy Dispersive X-Ray Analysis (EDXA).

With these methods the morphology of the catalyst and the composition of surface contaminants can be quickly and reliably investigated on small scale samples. In more demanding situations other techniques such as Auger Electron Spectrometry (AES) and Secondary Ion Mass Spectroscopy (SIMS) can be used for surface analysis and sub-surface profiling.

These methods are further supplemented by bulk material analysis techniques such as X-Ray Fluorescence Techniques (XRFA), Directly and Inductively Coupled Plasma Optical Emission Spectrometry (DCP and ICP-OES).

With these modern investigation methods Heraeus Nitro Technologies conducts customer related studies on the optimization of process parameters and on possible causes of operational disruptions. Catalytic poisons, carbon layers or rhodium oxide deposits, which have been caused by anomalies in temperature, pressure or gas composition during service, as well as bulk material contamination can be identified quickly and thus be avoided in future operation.

Scanning Auger spectometer

Developed catalyst structure

Rhodium oxide needles

Massive RhO$_2$ formation

Massive Fe contamination

Mechanical damage (steam leak)
Heraeus Nitro Technologies provides a trouble shooting service to customers in relation to the use of its products and services. This service includes consultations by phone or on-site and is aimed at solving any problem which may occur.

Ammonia Conversion Efficiency Measurement

The conversion rate of ammonia into nitric oxide is the decisive cost factor in the production of nitric oxide. Heraeus Nitro Technologies provides an ammonia conversion efficiency measurement service which enables the ammonia conversion rate to be precisely determined for an individual reactor. The service includes consultations, on-site measurements and training of employees.

Trouble Shooting

Heraeus Nitro Technologies provides a trouble shooting service to customers in relation to the use of its products and services.
As part of its comprehensive precious metals service Heraeus Nitro Technologies offers not only the physical precious metal cycle i.e. manufacture, processing, refining and engineering, but also a comprehensive precious metal management service.

The service includes:
- 24 hour world-wide trading and acquisition of precious metals
- Precious metal leasing
- Precious metal handling via customer metal accounts
- Local and qualitative precious metal swapping

In addition, the customers of Heraeus Nitro Technologies have a direct link to the specialists of the Heraeus Metal Trading Company who provide competent expert information and advice on the global precious metal markets.
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<th>Worldwide Production Locations</th>
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