BU Platinum Engineered Materials

Process Excellence Model

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Orlando, USA

Combining Competencies for Process Excellence

PEM Process Excellence Model

→ A unique value proposition

Umicore's business unit Platinum Engineered Materials is a fine example of how Umicore fulfills its mission to be at the leading edge of future technologies. The approach to work in closed loops and with complementary competencies provides tailor-made engineered solutions of high economic and technological value to our customers.

The main concerns of the special glass and parts of the chemical catalysis industries are the highly volatile PGM (Platinum Group Metals) prices and tremendous costs of energy that challenge these industries to keep their manufacturing processes at an ecomical scale. Besides, the end user markets do dictate a permanent increase in the quality standards of products, and also ecological drivers are considerable additional challenges for these industries.

Already several years ago we have realised how these demands do translate into our strategy and started to adapt our portfolio of products and services according to the supply chain. Meanwhile it takes far more than excellent PGM components made of sophisticated materials to increase the functionality of the PGM component. It has also become our duty to support our customers to better understand how the PGM component and its periphery do interact. Only by perfectly synchronising the boundary conditions and the PGM component a status can be reached that yields maximum efficiency, stability and security - this is what we call Process Excellence !

PEM Process Excellence Model

→ A unique value proposition

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To manage this trade-off for our customers between cost savings to remain competitive, while at the same time complying with increasingly demanding requirements from their target markets, PEM applies a total system approach to provide solutions based on innovation and technology. We have evolved from a mere PGM component supplier to the only provider of single-source solutions utilizing a sophisticated toolbox:

Spanning everything from engineering & designing, advanced materials and manufacturing technologies, as well as services like state-of-the-arts analytics, consulting and training, up to complementary non-PGM products to round off what is necessary to come up with holistic solutions. Of course, we do also close the loop in terms of material flows, and do provide recycling of both, PGM and non-PGM materials.

Our main asset – technology leadership – is our customers' main benefit: it enables our team of experts to offer specific and unique system solutions to any kind of task, being it to save PGM installation weight, to increase the lifetime of components, to reduce PGM losses or to work on an improved energy balance of the process.

PEM Process Excellence Model

→ A unique value proposition

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And what is even more important: there are hardly any one-time tasks. Our people understand that we can only be successful in case of sustainable considerations that benefit from the results and experience that we have gained in close partnerships with our customers. Consequently to manage this complexity we repeat the loop each time a campaign is finished, and restart the procedure to bring the process to the next level of excellence: Life Cycle Management.

Seeing the process form the core competence that we have built around the PGM component, and from the core competence our customers have built around making of their products is the only sustainable approach to a bright future for both, Umicore and our customers: Combining Competencies for Process Excellence !

On the following slides we provide examples of how we comply with this challenging mission in practice.

Process Excellence Model
→ Life Cycle Management

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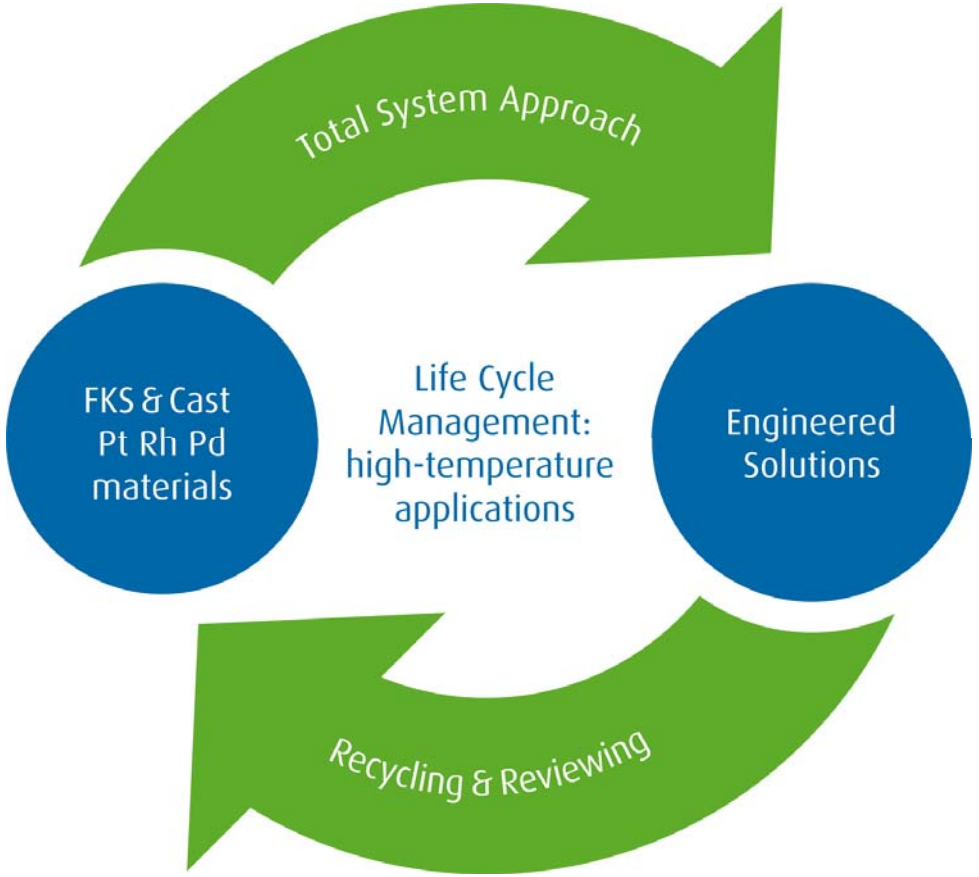
☑ Comprehensive system solutions based on engineered materials

☑ Managing complexity to save resources
- Correlation of process interfaces
- Reduction of PGM, energy, labour, ...

☑ Striving for long-term relationships enabling
- Joint development projects
- Joint learning process

☑ Focus on high added value creation by
- Innovation & technology leadership
- Closed loops & complementary competencies



Process Excellence Model
→ A unique single-source portfolio

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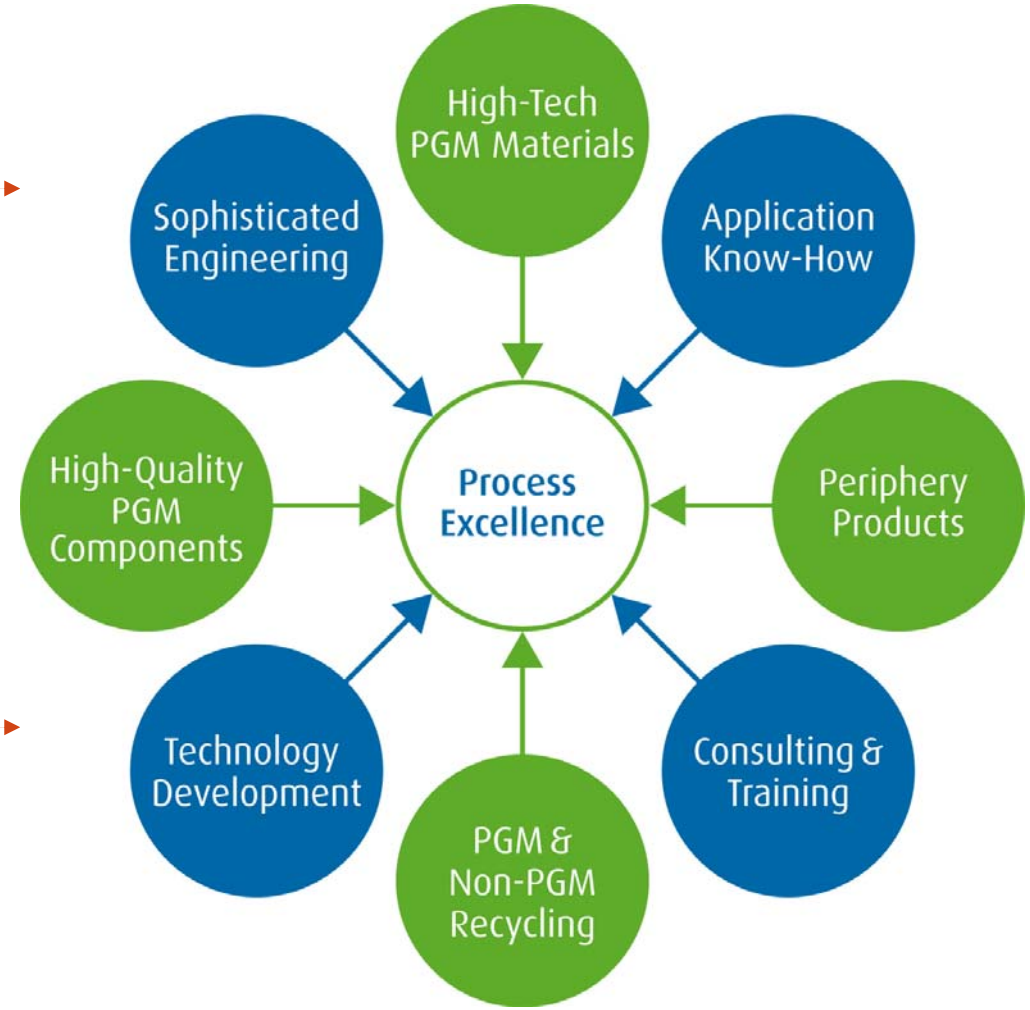
A strong team

- Some 200 experts around the globe
- Some 10 Engineering & Design experts
- Professional technical & commercial network
- State-of-the-art analyses & services

Expertise & References

- Inhouse glass & chemical industry expertise
- More than 100 years of history in treating & manufacturing of PGM alloys & compounds
- More than 35 years of experience in ODS material treatment and manufacturing
- Supplying major leading international special glass & chemical companies



Value-in-use for our customers
→ Process Excellence

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☑ Our tailor-made single-source engineered solutions are the key to optimize the functionality of our customers' PGM production equipment

- Special & fiber glass manufacturing
- Ammonia oxidation processes

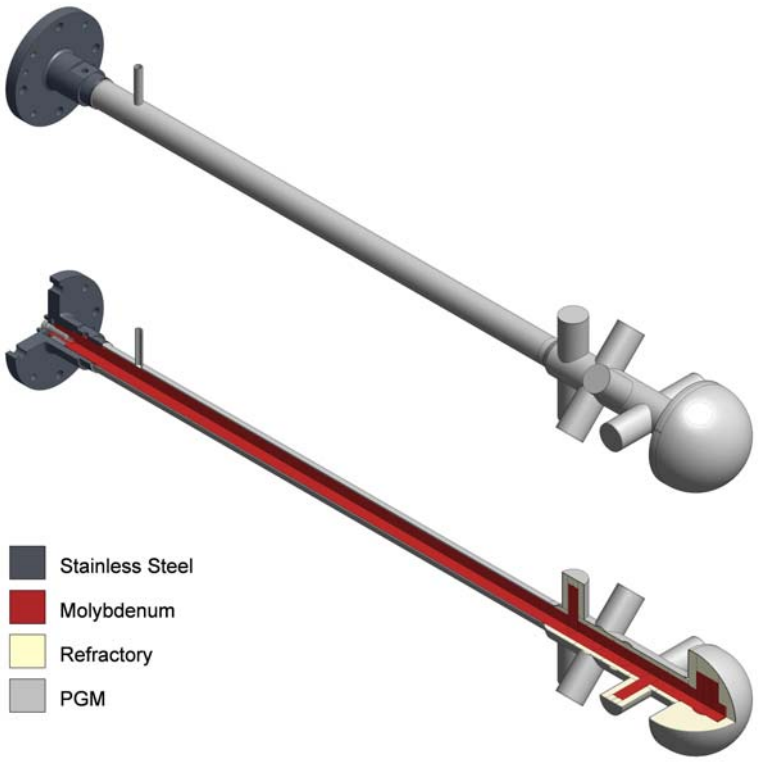
☑ We apply a holistic view of our customers' processes by including the PGM component's periphery into our solutions

☑ Our engineered solutions enable perfect synchronisation of process boundary conditions and PGM component for a maximum economic value-in-use

➔ Process Excellence translates as much into substantial total cost reduction as into efficiency, stability, and security for our customers

Glass Industry Applications

→ Example #1: Conventional Plunger design



Molybdenum core as carrier

Component design is based on cast PtRh10 alloy that requires a Molybdenum core to support the component in terms of mechanical stability.

A layer of ceramics is required to seperate the Molybdenum core from the PGM alloy to prevent intermetallic diffusion.

Necessity to have an evacuated inner core of the component.

Demanding and complicated layer structure.

Huge number of welding seams in critical areas.

Disadvantages:

Molybdenum is a potential Platinum poison that weakens the mechanical stability of the component and hence possible damages of the PGM cladding do generate a high risk of complete component failure.

Various different expansion coefficients of the respective materials generate internal mechanical friction that reduces mechanical stability of the part.

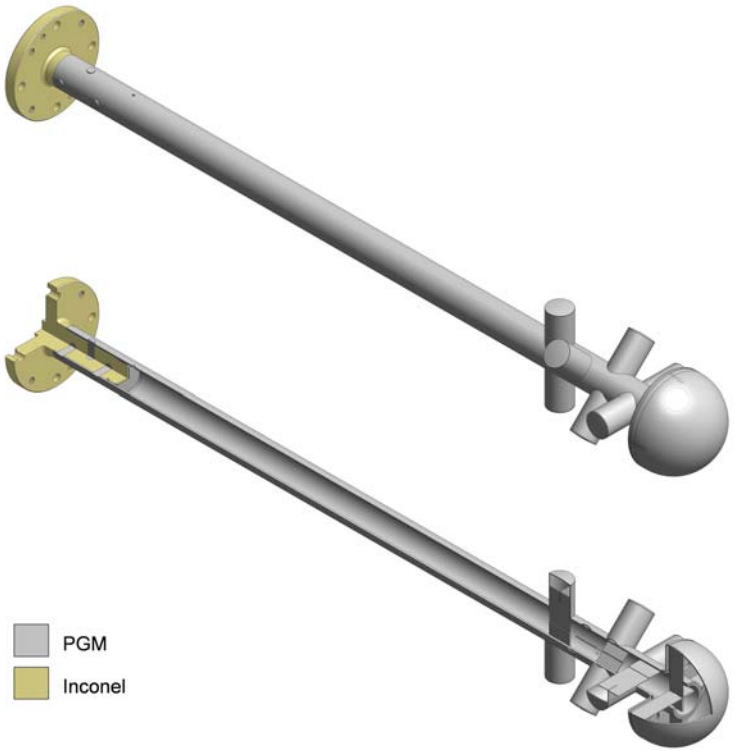
High overall PGM weight of cast alloy is required to cladd the core of the component.

High manufacturing cost due to layer structure.

Service time is limited and varies between minimum 1 and maximum 3 years.

Glass Industry Applications

→ Example #1: Umicore Plunger design



Self-supporting massive system

New design based on well-known material properties of FKS material and adjusted shaping & welding technologies.

Reduced number of welding seams and at least partially seamless shank.

Welding seams only in non-critical areas like low-stress or even better stress-free zones (sealing properties instead of supporting properties).

Unified material properties due to the fact that the entire component is made of one homogeneous material.

Achievements:

Predictable and substantially increased service time (up to 5 years).

Less overall PGM weight despite the fact that the component is made as a massive construction.

Reproducicble glass gob weight during glass forming process with very low tolerances.

Energy savings during glass forming process due to the fact that the component does extract less heat from the glass melting system.

Possibility to transfer torques of up to 100 Nm at temperatures between 1.000 and 1.500°C to the component without any mechanical damage.

Less process losses of Platinum due to decreased vapourisation tendency of FKS materials compared with cast alloys.

Simplified construction design with substantially increased functionality.

Smart Bushing Solutions

→ What does impact the performance of the process ?

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Fluid Dynamics

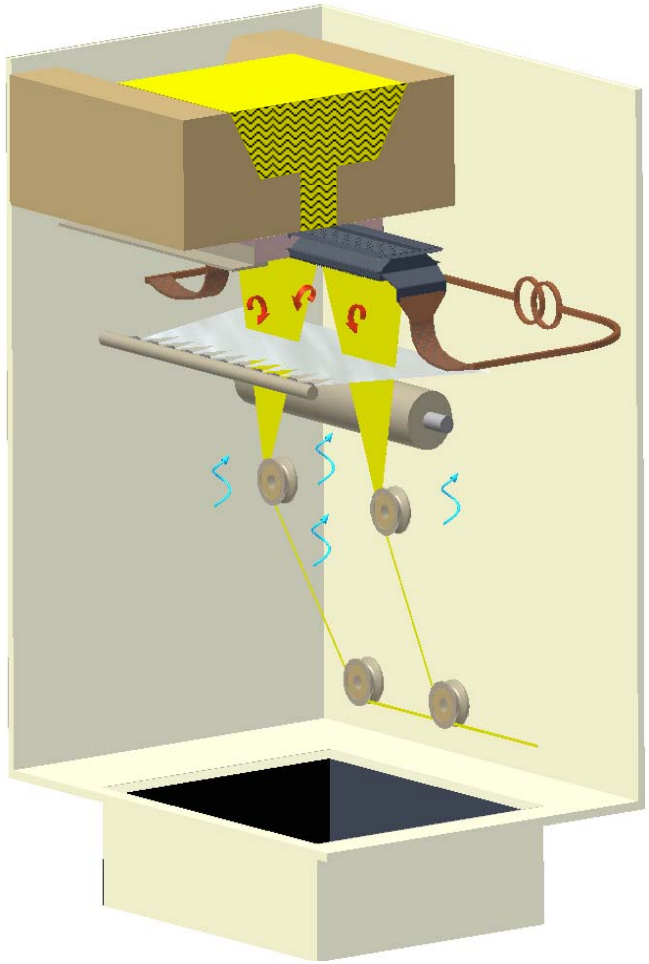
- Viscosity of glass melt
- Glass Flow Behaviour
- Wetting Behaviour
- Air circulation

Thermodynamics

- Ceramic Embedding
- Temperature Distribution
- Heat Transfers
- Heat Losses
- Emissivity
- Radiation / Convection

Electrics

- Current Density distribution
- Electrical Heating
- Power Demand



Mechanics

- Sagging & Deformation
- Tip Corrosion
- Mechanical Load
- Pull Force (rate)
- Heat Expansion
- Heating-up procedure
- Kinematics & Kinetics
- Fiber Guiding
- Bushing Dynamics
- Process Dynamics

Process Excellence

- Energy Balance
- Process Configuration
- Adjustment of process interfaces
- Bushing Lifetime
- Bushing Design

→ Cost Reduction
→ Security, Stability, Efficiency

Smart Bushing Solutions

→ Our Tools to finetune the performance of the process

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Advanced Materials

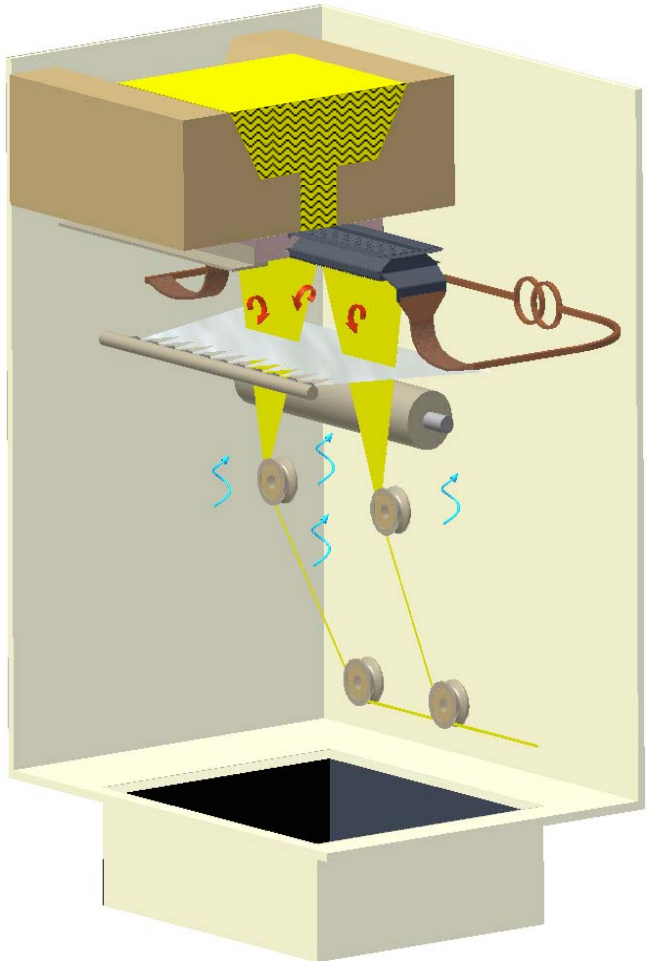
- Engineered ODS materials: FKS Pt & FKS PtRh
- Cast PtRh alloys
- Tailor-made non-PGM materials

Advanced Technologies

- Powder Metallurgy
- Laser Welding for assembly
- Automated Cutting & Welding: CAD / CAM / CNC
- Materials Technology
- Broad patent portfolio

Advanced Services

- Life Cycle Management (LCM)
- Unique mechanical testing
- Material & chemical Analysis: TEM / SEM / EDX / AAS / ICP ...
- Physical Analysis
- Glass Analysis
- Interface Analysis



Advanced Engineering

- Mathematical Simulations
- Mechanical Modelling
- Electrical Modelling
- Thermodynamic Modelling
- Fluid Dynamics Calculations
- 3D Drawings
- Light-weight systems
- Correlation of interfaces
- ReEngineering of bushings
- Own bushing designs
- Life-time Calculations

Process Excellence

1. Security, Stability, Efficiency
2. Cost Reduction:
   - Energy savings
   - PGM savings by bushing design: Rh savings / thinner sheets
   - PGM savings (less process losses)
   - Increased bushing lifetime
   - Decreased maintenance costs
   - Decreased tooling cost
   - No additional consultants needed

Smart Bushing Solutions

→ Example #2: E-Glass fiber application @ 1250°C

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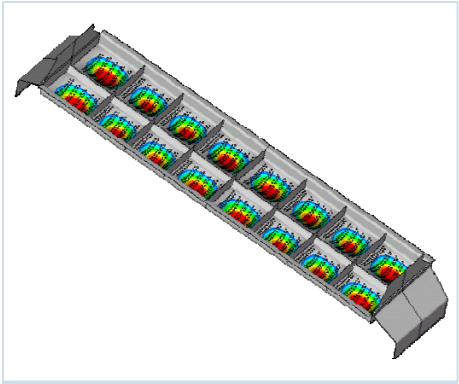
Original Bushing design

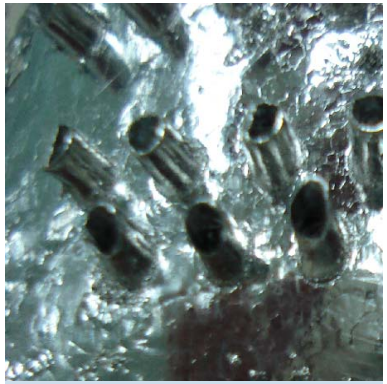
- Conventional bushing design & process view
- Service time: << 12 months
- Base-plate alloy PtRh20
- Upper structure PtRh10
- Severe problems with welding seams & sagging

Desired goals:

- Service time of 12 months
- Elimination of severe sagging problems
- Reduction of Rhodium content
- No increase of total bushing weight
- No change in boundary conditions



Simulation of status quo



Tip wear & corrosion

Coarse grains

Smart Bushing Solutions

→ Total added value for E-Glass fiber application @ 1250°C

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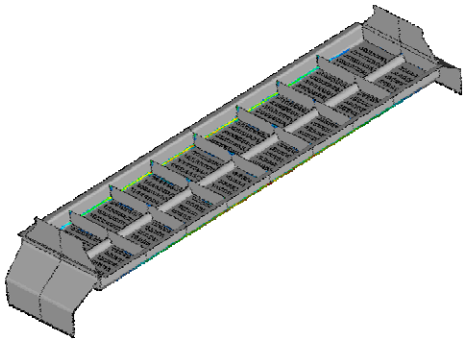
Umicore Bushing design

- Umicore LCM approach
- Design in conjunction with periphery
- Base-plate alloy FKS PtRh10
- Upper structure PtRh10
- Improved welding strategy for entire bushing
- Reduction in sheet thickness

Achievements:

- Service time of 16 months
- Stable process conditions & LCM Report
- Reduction of Rhodium content by 10%
- Sagging reduced by factor of 10
- Reduced start-up temperature & easier handling
- Total cost reduction of about 50 kEUR per bushing



Simulation of new base-plate

No tip wear

No coarse grains

Performance Catalysts

→ Our Tools to finetune the performance of the process

Advanced Engineering

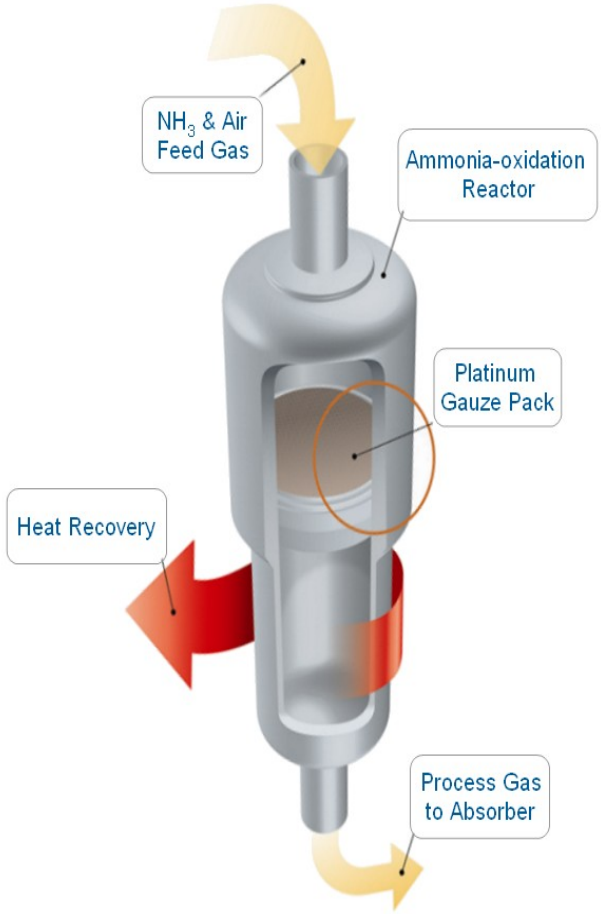
- Process Simulations
- Fluid Dynamics Calculations
- Gas flow control
- Reactor design modifications
- Correlation of interfaces
- Life-time calculations

Advanced Technologies

- Flat-bed knitting Technology
- Weaving Technolgy
- Catalyst Technology
- Getter Technology
- Emission Control

Advanced Services

- Life Cycle Management
- Cleaning of operations
- State-of-the-art analytics
- On-site support
- Commercial Services



Advanced MKS Modules

- Knitted Catalyst gauzes
  Platinit® & Multinit®
- Woven Catalyst gauzes
- Catchment gauzes
- Megapyr separator gauzes
- Ceramic Honeycombs
  MultiComb GreenLine®
  MultiComb DynamicLine

Process Excellence

1. Security, Stability, Efficiency
2. Cost Reduction:
   - Energy savings
   - PGM savings by gauze set-up
   - PGM savings (less process losses)
   - Increased campaign length
   - Increased oxidation selectivity
   - Decreased maintenance costs

Performance Catalysts

→ Our Tools to reduce nitrous oxide (N_2O) emissions

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Advanced Engineering

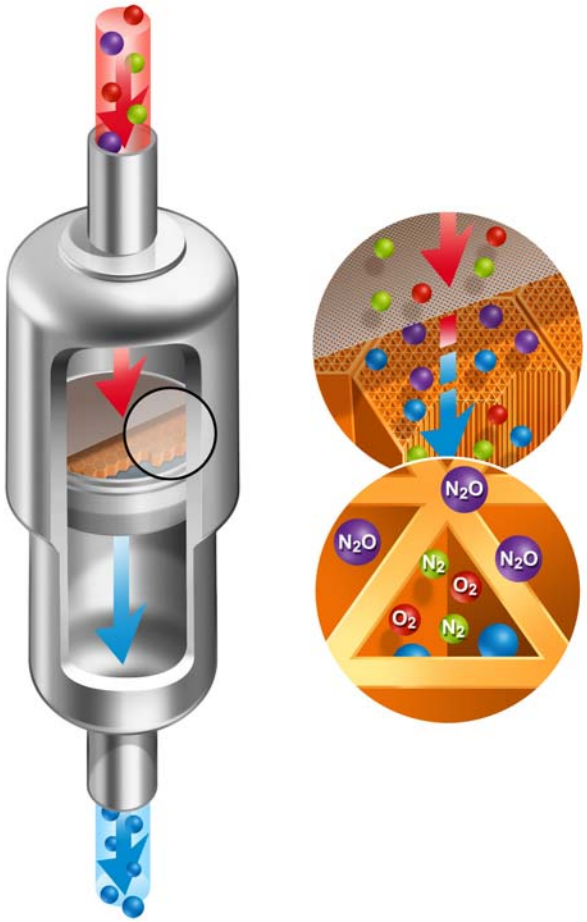
- Process Simulations
- Gas flow control
- Tailor-made adaptability for the respective types of ammonia oxidation processes

Advanced Technologies

- Sophisticated extrusion process in manufacturing of ceramic honeycomb structure

Advanced Services

- Emission measuermets
- On-site support



Advanced MKS Modules

- MultiComb GreenLine®
- Megapyr separator gauzes

in combination with all other MKS Modules

Process Excellence

1. Emission Reduction
- High selectivity of decomposition
- PGM free solution
- Easy to install
- Multi-campaign lifetime
- No negative impact on ammonia oxidation selectivity
- Bionic shape: robust & efficient
- Enables participation in global emission trade

Performance Catalysts
→ Example #3: Revealing flows in NH_3 oxidation process

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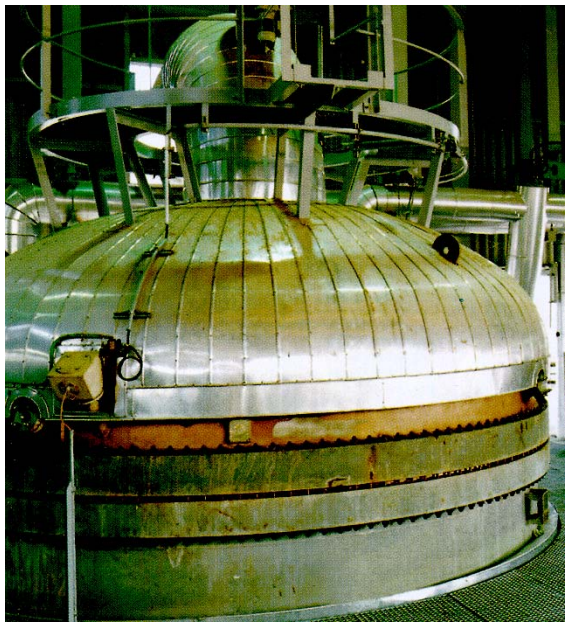
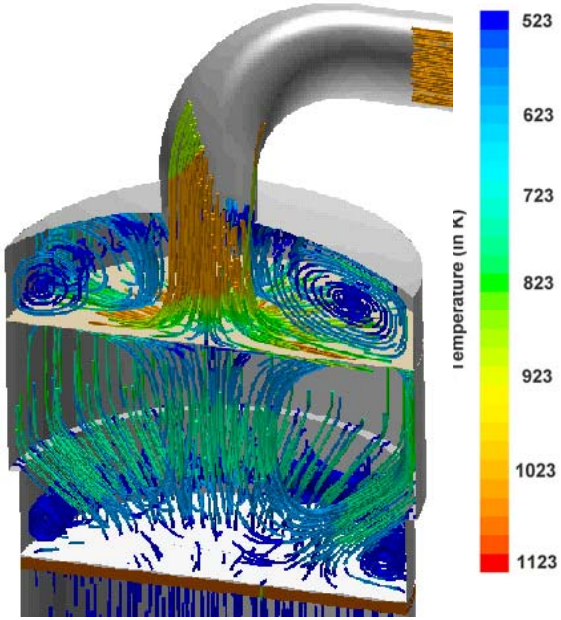
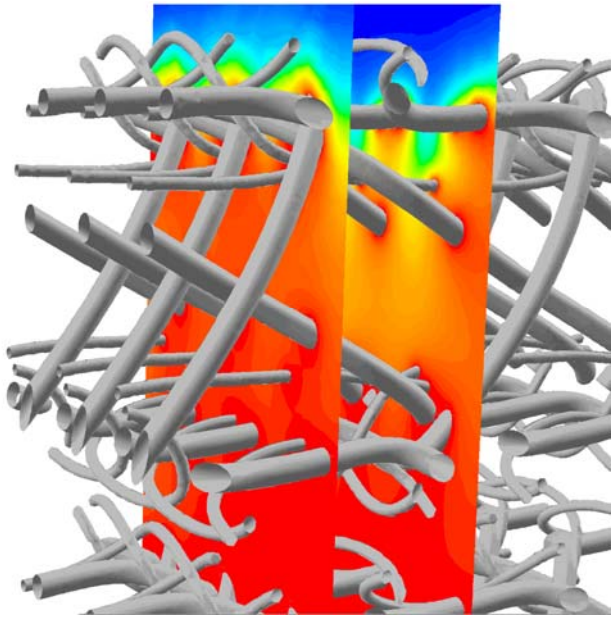
In-depth view into a medium pressure converter under operating conditions: only a perfect process understanding enables maximum catalytic performance of the gauze layers and the ceramic honeycomb catalyst for abatement of nitrous oxide as side product.







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Challenge us !

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