Nitrogen and Syngas Technical Programme

1. **Plant Reliability and Troubleshooting**

**Engro Fertilizers** - Cracking the code: a decade-long journey to enhance plant reliability

The surging incidents represented a critical operational challenge, leading to production losses and indicating a need for deeper analysis. Comprehensive troubleshooting and collaboration with OEMs and third parties led to identifying the root causes and implementing corrective measures to mitigate surging, improving overall operational reliability.

This presentation focuses on combination of multiple troubleshooting efforts and innovative rectification strategies demonstrated a novel approach to addressing a complex operational issue, leading to improved compressor performance and plant stability.

Yara Safety Department – MOC - Management of change

Despite huge improvements in company's procedures and attention to control the management of change in the various Yara plants and sites, the company still face incidents and near misses that are in essence due to failures in managing the risks generated by changes to either installations, way of operating or procedures.

The presentation will highlight how training, sharing of lessons learnt, continuous improvement, and the help of a common tool are being used at Yara to reduce the probability of failure due to improperly managed MOC.

**Fauji Fertilizer Company Limited** - Investigating syngas piping failure - a root cause analysis

The presentation will delve deep in the operational risk of syngas leakages due to in-service carbonate SCC and its management through temporary repairs with full encirclement type B sleeves, ensuring safe operation until the affected piping could be permanently replaced. FFC will discuss long-term solutions and practical recommendation in replacing affected piping with stress-relieved carbon steel or stainless steel and to keep track of pH levels and carbonate ion concentrations.

In summary, the presentation will illustrate failure analysis and how to effectively address a major operational issue by blending historical experience with modern analysis techniques to resolve and prevent plant technical issues in the future.

1. **Novel Green Ammonia Technologies**

**Linde GmbH** - PEM electrolyser for green NH3 industrial pilot - Experience and requirements for technology development for full scale applications

Pilot project of “Skrei” at Herøya Industrial Site in Porsgrunn, Norway

At the COP 21 summit in Paris on 12 December 2015, UNFCCC member nations reached a historic agreement to combat climate change by committing to a sustainable, low-carbon future. The Paris Agreement requires all countries to submit their "nationally determined contributions" (NDCs) and to enhance their efforts over time. Norway is fully committed to these goals and supports the project described by this presentation.

This presentation will cover key operational aspects including characteristic data on performance and hydrogen output. It will also address technical challenges in scaling PEM electrolysis for green ammonia production, such as equipment scale, material selection, and integration with ammonia synthesis. Furthermore, cost-reduction strategies, including advancements in system integration and modularisation, along with novel technical solutions and essential lessons learned from the pilot phase.

**Casale SA -** Impact of pressure and temperature variation due to intermittent renewable energy on pressure components in green ammonia facilities

The growing importance of green ammonia as a versatile and eco-friendly energy carrier and storage in the global pursuit of sustainable energy sources has raised interest in the development of ammonia plants based on renewable sources.

The intermittent nature of renewable sources of energy poses a unique challenge to the operability and mechanical reliability of ammonia plants requiring a deep rethinking of the established design based on steady feedstock.

The presentation will focus on integrated approach between process, equipment, and piping design paving the way for the successful and sustainable implementation of novel green ammonia technologies.

**Thyssenkrupp Uhde GmbH** - Beyond the trend: challenges in green ammonia economy

Can simple, clear, colourless gases hold the key to a sustainable energy future? While green hydrogen and green ammonia promise to be a clean energy carrier, there are significant challenges to overcome in production, storage and transport but also in financially realizing the projects.

The presentation will charter the right path for developing and delivering green hydrogen and ammonia projects through standardised modularisation, which allows both faster and cost-effective engineering.

1. **Nitric Acid: catalyst and equipment**

**Umicore AG & Co. KG -** How to achieve higher gauze efficiency and lower costs in nitric acid plants: a practical guide

The Ostwald process is the predominant method for producing nitric acid, and it is crucial to have customised catalyst solutions for each plant due to the intricate nature of the reaction process and distinct characteristics of ammonia oxidation reactors. In the presentation, Umicore will focus on how we can increase, in collaboration with plant operators, the individual plant performance. By examining relevant campaign and plant parameters, identify specific opportunities for improvement are identified. Current industrial examples are used to demonstrate how this novel approach leads to success through technical improvements and precise analytical results.

**NobelClad** - Explosion welded applications in nitric acid equipment realise superior safety and reliability levels

Many critical failures occur in amongst others the cooler condenser in nitric acid plants. Alternating wet-dry zones (condensation and re-evaporation) of nitric acid initiate the formation of di-chromic acid leading to high corrosion rates and consequential failures. The assurance of the integrity of the several important heat exchangers in nitric acid plants is a critical pre-condition for the safe and reliable operation of any nitric acid plant.

The presentation will focus on developments in explosion welded products with an interlayer, as a new state-of-the-art solution to obtain the highest safety and reliability levels in any nitric acid plant against limited additional costs.

**Johnson Matthey** - Getting the most out of your gauze

Platinum gauzes have been used as ammonia oxidation catalysts for well over a century and much has been written on their efficacy and optimisation. Earlier discussions focussed on conversion efficiency and metal loss. More recently, environmental considerations are of ever-increasing importance.

Fundamental understanding allows gauze designs to be optimised to maximise yields, minimise metal inventory and reduce losses and reduce N2O (nitrous oxide) formation.

The presentation will dive deep in operational experience and R&D to both improve nitric acid plant productivity and to reduce emissions to environment. It also addresses benefits that can be achieved through good operational practices and potential pitfalls associated with less good operational practices. It concludes with reflections on likely future improvements which will be realised over the next few years.

1. **Urea Plant Design**

**Casale SA -** Self-stripping plant revamping with HYPER-U

HYPER-U is a novel urea synthesis process recently developed by Casale to address the ever-growing demand of sustainable fertilizer production. Based on the conventional self-stripping technology, it features innovative concepts which allows a drastic reduction of the consumption of MP steam and cooling water. Namely, a thorough heat recovery strategy is implemented to maximise the re-use of the thermal energy supplied via MP steam to the HP Stripper which in fact is used five times.

**Stamicarbon** - Ultra-low energy plant and mechanical design pool condenser/pool reactor

Ultra-Low Energy Design (ULE) is the state-of-art of Stamicarbon urea technology. This design has achieved great reduction on steam consumption, cooling water consumption and at the same time good product quality. For an ULE melt plant with prilled product the steam consumption is less than 567 kg steam/ton of urea (23 bara, 330 °C), remarkable decrease compared to former design, as proven in multiple plants in operation since 2021 designed with 2334 MTD capacity.

ULE technology takes advantage of several features such as the use of special dual-bundle pool reactor up to 3000 MTD and dual-bundle pool condenser for larger capacity plants, allowing a direct heat integration between synthesis section (HP) and medium pressure section (MP), and more heat integration downstream the plant.

There are further advancements in mechanical design of dual-bundle ULE pool condenser/pool reactor considering the large capacity urea plants in construction, where dual bundles are located outside the vessel, directly attached to the front-side of the tube sheet.

ULE technology is key innovation in urea technology providing a drastic OPEX reduction without compromising the CAPEX of the urea plant. ULE technology has been licensed 9 times in a relatively short time, with 5 plants already in operation.

**Mitsubishi Heavy Industries, Ltd -** Enhancement of urea production through utilisation of an energy-efficient post combustion carbon capture process for reformer flue gas, and installation of a bulk flow cooler in a new fertilizer plant in Bangladesh

- Largest fertilizer plant, 2,800 tons of urea per day in Bangladesh

- CO2 recovery process from reformer flue gas has been installed to integrate

- Low energy consumption by installing bulk flow cooler in granulation plant

- Digital safety measures have been implemented for plant entry and work processes

In MHI's ongoing efforts to reduce environmental impact and optimize efficiency in large-scale plants, they have constructed the Ghorasal Polash Urea Fertilizer in Bangladesh with a low carbon footprint. The project, which was completed and received final acceptance in March 2024, now stands as the largest fertilizer complex in Bangladesh, boasting a production capacity of 2,800 tons of urea per day and 1,600 tons of ammonia per day.

This project showcases three major technological and safety advancements. Firstly, it employs high-efficiency CO2 recovery technology to address the scarcity of CO2 resulting from the use of lean natural gas. This technology greatly enhances the overall efficiency of the plant. Secondly, energy-saving equipment is utilized in Granulation plant, further contributing to energy efficiency. And lastly, digital safety measures have been implemented for plant entry and work processes.

1. **GHG Emissions Reduction**

**Air Products -** Membrane-based ammonia purge gas hydrogen recovery units: a fresh look at an established technology

Legacy grey hydrogen supply is rapidly being replaced with blue and green hydrogen to support sustainability and decarbonisation efforts. The transition to low (or no) carbon hydrogen has not been without consequence, as hydrogen prices have been on the rise. With increasing hydrogen prices impacting the cost to produce ammonia, producers are re-looking at hydrogen recovery technology.

Air Products Membrane Solutions has been helping Steam Methane Reformer (SMR) based ammonia plants recover hydrogen since the 1980’s with membrane-based purge gas hydrogen recovery units (PGRUs). In total more than X(1) [tons/ncm] of hydrogen have been recovered through these systems. These PGRUs have consistently provided great value to our customers by recovering valuable hydrogen, saving natural gas, and avoiding X(2) millions of tons of CO2e emissions.  Technology has continued to evolve since the introduction of PGRUs and with the increased value of hydrogen, operators of SMR based ammonia plants would be well served to ensure their PGRUs are optimized for performance.

This presentation will cover the fundamentals of membrane separation, PGRU options and operation, optimization of legacy PGRUs, and the economic and GHG avoidance benefits for the Ammonia industry.

**Heraeus Precious Metals GmbH & Co. KG -** Plant and process conditions for effective reduction of N₂O emissions from nitric acid production

During production of nitric acid, nitrous oxide is released into the atmosphere as a by-product. N2O is a powerful greenhouse gas with roughly 273 times the potential global warming effect of carbon dioxide, making it a major contributor to climate change. It is therefore mandatory to reduce the N2O emissions of nitric acid plants.

More than 60 million tons of nitric acid are produced around the world annually, with an estimated 500,000 tons of nitrous oxide generated as a byproduct – equivalent to the carbon dioxide emissions from over 60 million mid-sized cars.

Highly efficient catalysts from Heraeus can significantly reduce nitrous oxide emissions up to 95%. Heraeus offers the possibility to reduce N2O emissions due to our well-known FTC Flex-technology by primary abatement. Therefore, the system helps our customers to meet the latest abatement requirements in the demanding N2O emission markets in combination with secondary or tertiary solutions. Besides catalytic gauzes, Heraeus offers Secondary Catalyst Systems for further N2O emission reduction.

**Linde -** The optimum carbon capture rate in H2 & NH3 plants: it is not 99%

EPC execution & operational experience of Linde for large scale H2 plants including experience in CO2 capture show, that extreme capture rates will impact operational performance, e.g. wrt. efficiency, on-stream time, economics, and life cycle emissions.

There is a significant drive to achieve high carbon capture rates for new and existing plants. This approach is environmentally driven, and the intention is to minimise the impact of new plants, which produce NH3 based on fossil feedstock, e.g. natural gas. Many projects target extremely high capture rates and some of these advertised approaches are going beyond 99%.

There is no doubt, that extremely high capture rates can be achieved with already available technology.  However, to focus on the capture rate only is a limited perspective. It is clear, that the higher the target capture rate is, the more the design needs to focus on this task. Above certain carbon capture rates more catalyst, more compression, more equipment, etc. are required which can fail and impact the reliability of the ammonia production.

The presentation will explain by a study for a world-scale ammonia production that there is a ‘sweet spot’ for a good level of carbon capture rate. Such a ‘sweet spot’ is not only defined by the plant’s carbon capture rate, which covers the direct emissions only. Capital investment, plant availability, plant energy efficiency, constructability, and OSBL impacts are having an important influence on the reasonable carbon capture rate.

A holistic approach on rating the life cycle emissions and operational reliability will help to find the optimum capture without too much focus on the single value of carbon capture rate.

**BASF Process Catalysts -** Sustainable methanol production powered by novel BASF SYNSPIRE™ Methanol catalysts

Ammonia is considered one of the most promising energy vectors in the future green hydrogen value chain. Green hydrogen will be produced by electrolysis in regions with abundant renewable electrical energy and directly converted to ammonia on-site. This ammonia is shipped to other regions where green hydrogen is required. At the point of destination, ammonia is catalytically reformed to produce hydrogen and nitrogen at elevated temperatures, and ideally at the desired high pressures of a specific target application.

Industrial processes for the reforming of ammonia are currently in a design phase, and first industrial plants are expected to start operation in 2026. A typical process design consists of an adiabatic pre-reformer and a fired tubular reformer, both covering a broad range of operating temperatures from 350 to 800°C to obtain thermodynamic equilibrium with high conversion at industrial pressure levels that can range from 20 to 50 bar.

BASF Process Catalysts offers a holistic, tailormade portfolio of innovative catalysts specifically designed for the ammonia reforming application. Their brand, BASF SYNSPIRE™ ARC (Ammonia Reforming Catalysts), provides unique solutions and value propositions to customers in this field. These catalysts have been optimised for various temperature ranges and are based on different active components, promoters, and high-performance carriers. The commercial SYNSPIRE™ ARC catalyst family is also supported by kinetic models based on full scale particle screening and empirical aging models, which were determined using realistic ammonia feedstocks containing relevant amounts of water (which is always present in technical grade ammonia).

One notable advantage of BASF SYNSPIRE™ ARC catalysts is their compatibility with BASF’s proprietary structured (layered) catalyst bed concepts. This enables the combination of various catalysts in a single reactor to boost the overall energy efficiency while minimizing CAPEX and OPEX. and enhances the flexibility in the design of optimal processes for specific use cases.

1. **Ammonia, Methanol and Urea Operations**

**PT Pupuk Sriwidjaja Palembang -** Optimising ammonia plant operations: Chemical injection for fouling control to address elevated vacuum pressure. A case study of efficiency improvement from ammonia PSP-2B condenser 103-JTC

Ammonia Plant 2B at PT Pupuk Sriwidjaja Palembang has a production capacity of 2,000 MTPD and an efficiency of 32 MMBTU/ton NH3, making it the largest and most efficient ammonia plant within PUSRI. The presence of Plant PSP-2B significantly impacts the reduction in the cost of ammonia production at a corporate level. Consequently, operational disruptions at Ammonia PSP-2B can lead to substantial decreases in production and efficiency, thereby affecting the company’s profitability.

In 2021, the Ammonia Plant PSP-2B encountered issues that resulted in an increase in steam imports.

The presentation addresses operational challenges in ammonia plant operations, with a specific focus on elevated vacuum pressure and fouling in a condenser. Using a comprehensive case study of the Ammonia PSP-2B Condenser 103-JTC, it examines the implementation of chemical injection as a strategic solution to fouling issues. The analysis highlights how these actions enhance operational efficiency and stability, providing actionable insights and recommendations for optimising plant performance and addressing similar challenges in industrial environments.

**OQ Salalah Cluster -** Challenges & Solutions: ammonia and methanol plants operating beyond full capacity - How we achieved this milestone

OQ Salalah Cluster manages a plant complex producing ammonia and methanol with integrated front end (common feed purification, reforming and syngas compression). Methanol production design capacity is 3000 MeT/D, whereas ammonia plant capacity is 1000 MeT/D. Both plants are currently running above their full capacity.

Installation of ammonia production unit at the back end of a methanol plant has many advantages. Especially if the raw material for that methanol plant is natural gas. The stoichiometric ratio of the syngas required for methanol plant is 2, whereas syngas generated from NG has this ratio [(CO+CO2)/(H2-CO2)] around 3, thus creating a large amount of excess hydrogen. Although hydrogen today proves to be a leading commodity, producing ammonia proves to be one of the most profitable options. Burning it in the reformer as fuel is the worst use of this valuable gas as it is being done in most of the methanol units around the world.

Consequently, the overall energy and carbon intensity of the production complex has improved and proves to be better than any of the world's independent ammonia / methanol plant with similar capacities.

It presents us a great opportunity to recover CO2 from reformer flue gases for urea production in future.

The ammonia plant can easily be converted to green ammonia producer with the availability of renewable energy resources reaching the OQ goals to be carbon free by 2040.

**Helwan Fertilizers Company -** Employing simulation for urea plant to improve operational conditions and reduce utility usage (water, energy, and others) to achieve sustainability goals

Several case studies will be presented which showcase the workflow used in assessing and improving plant asset performance. In the synthesis section, key decisions regarding heat exchanger cleaning were taken, by comparing plant performance against model results and quantifying the loss in terms of increased energy consumption. In the granulation section, a series of evaluations were done for solid handling equipment, like granulators, crushers and model results compared to design. Key operating variables were identified resulting in corrective action and leading to significant energy and material savings.

The simulation of the two sections of the urea plant (synthesis and granulation) was a powerful and useful tool to assist with decisions related to the production process. These decisions led to saving a financial loss of around $ 372K/year because of a decrease in consumption, as well as the identification of variables causing changes in the sequence of the production process. This simulation also helped improve equipment efficiency, reduce emissions, and preserve the environment

**Quest Integrity -** Lifecycle integrity management of outlet pigtails

The presentation provides a general overview of the damage mechanisms for outlet pigtails, particularly metallurgical changes that occur due to operation at elevated temperatures and the effects of in-service loading. These factors are unlikely to have been accounted for during the design stage and will affect outlet pigtails in an aging plant.

The presentation also provides insights into some of Methanex’s operational experience with respect to the integrity management of outlet pigtails, including problems that have occurred for the outlet pigtails during operation and learnings gained from these incidents. Methanex’s application of suitable specifications during design and procurement and asset management strategies for monitoring damage during operation are intended to demonstrate an example of a lifecycle integrity management approach and the methods and solutions used to appropriately manage the risk of in-service outlet pigtail damage described above.

1. **Urea Plant Safety Technology**

**Stamicarbon -** The first successful installation of mechanical plugs in a pool condenser

The first Safurex® mechanical plugs are installed in an aging pool condenser in operation since 1994 in a Stamicarbon urea plant. The integrity and reliability of the X2CrNiMo25-22-2 U-bundle is compromised due to mechanical damages at the baffles; i.e. so-called baffle hammering. To extend the lifetime of the vessel around 40 U-tubes needed to be plugged.

The presentation describes the successful installation of over 80 mechanical plugs in the above-mentioned pool condenser as well as the successful accelerated corrosion tests conducted in the autoclave. The Safurex® plugs can be installed reliably not only in Safurex® but also in austenitic heat exchanger tubes such as X2CrNiMo25-2-2 or X2CrNiMo18-14-3.

The Stamicarbon Safurex® mechanical plugs are now available for plugging high pressure  urea equipment, not only in pool condensers but also other heat exchangers such a HP stripper. HP carbamate condenser or HP scrubber.

**MPC2 e.U –** Corrosion Ray, EC-Pen, portable metallography & microscopy: a smart combination of different non-destructive test methods allows quick and reliable on-site assessment of critical process equipment at the manufacturer's workshop and the end-user's plan

MPC²'s proprietary "Corrosion Ray" technology was continuously developed further in 2024, resulting in additional application options. Curved component surfaces such as pipes can now be assessed quickly and reliably in terms of their corrosion properties, as can weld seam surfaces. In addition, a special fixation device has been developed to enable precise positioning of the measuring equipment. The user-friendliness of the device has also been improved.

In addition to the Corrosion Ray, the compact EC-Pen is the tool of choice for areas that are very difficult to access, for instance fillet welds in confined spaces. The targeted application of portable metallography & microscopy provides high-resolution images of the investigated surfaces and thus allows immediate conclusions to be drawn regarding sensitization, grain size, phase fraction and texture.

**Helwan Fertilizers Company -** Standard Operating Procedures (SOPs) in a dynamic visual environment on control panels

This paper presents a novel approach to improving process safety using real- time, dynamic visualisation of Standard Operating Procedures (SOPs) integrated into control room panels. This dynamic SOP displays include the procedures ordered by priority accompanied by the real- time values, alongside the targeted reference values. By comparing the actual values to the target values, it is possible to assess the progress in executing procedures and quickly identify any deviations.

Additionally, the displaying screens also include verification indicators to ensure correct execution of the procedures, as well as alternative actions in case the required indicators are not met. The system facilitates the oversight of the trip system’s operation through displaying the dedicated icons, guaranteeing their operational status when necessary and safeguarding both staff and equipment from any potential risks. The panels include startup, shutdown, and emergency operating procedures, with an interface allowing the operator to select the appropriate panel according to the situation.

The presentation will concentrate on case studies illustrating the benefits and improvements in process safety and efficiency resulting from the use of the screens.

1. **Nitric Acid and Ammonium Nitrate Technology and Plant Reliability**

**Casale SA -** Cutting-edge approaches in fertilizer technology: CASALE's expanded product portfolio

The presentation focuses on developing new plants licensed by Casale in the field of nitric acid and ammonium nitrate.

In recent years, CASALE has strengthened its position as a leading licensor of fertilizer plants by delivering innovative and high-efficiency solutions worldwide. Among its most notable achievements are a stand-alone Ammonium Nitrate Solution (ANS) plant, a high-performance Weak Nitric Acid (WNA) plant, and a complex for solid fertilizer production. These projects benefit from CASALE’s state-of-the-art technologies, offering high energy export, reduced emissions, and simplified effluent management.

With a strong commitment to innovation, CASALE continues to be a trusted and forward-thinking partner in the global fertilizer.

**Abu Qir Fertilizers Company -** Lesson learned of changing the defected carrying beams for the granulator of an ammonium nitrate plant at Abu-Qir Fertilizers Company , Alexandria, Egypt

The presentation will address a real life case of operational issues and their solutions.

Operational issues:

* Tight time constraints
* Stress Corrosion Cracks
* Risk of Unit Collapse
* Unknown Exact Weight of the Granulator

Solutions:

* 3-D Simulation: To visualise and plan the replacement process
* Temporary Steel Structure: To support the granulator during the transition
* Operational Continuity: Planning to install parts of the new structure while the unit was still operational demonstrated a balance between maintenance and ongoing production needs
* Our ability to identify these problems and implement effective solutions underscores our technical competence and strategic thinking

The project introduces novel approaches to engineering challenges. The use of 3-D simulation for planning and designing a temporary steel structure to support the granulator while parts of the new structure were installed demonstrates innovation. The creativity in designing solutions that accommodate the operational constraints, such as the compact area and the necessity to keep the unit functional, highlights our ability to think outside the box and implement new techniques in problem-solving.

**PT. Pupuk Kaltim -** Optimisation of labyrinth seal design in Turbo Train 3-in-1 air compressor to address high thrust bearing temperature issues in ammonium nitrate and nitric acid plants

The presentation will delve in real-life experience during the commissioning phase of an ammonium nitrate project in Bontang, Indonesia. The experience highlights how operational issues, such as thrust bearing temperatures exceeding the maximum design limit of 100°C, were successfully addressed. The presentation will highlight that the innovative solution of modifying the compressor was carried out for the first time within the company and the vendor, demonstrating the importance of better updating operational standards.

The modification of the labyrinth seal design and the piston balance channel were new innovations that had not previously been implemented, either within the company or by the manufacturer (vendor). This innovation became a key solution that allowed the compressor to function in accordance with design standards, reflecting an important contribution to improving production and maintenance processes.

**Siemens AG -** High-Fidelity operator training simulator for greenfield green fertilizer plants

Operator Training Simulators (OTS) are critical for new nitric acid production plants to ensure that personnel are prepared to manage complex processes safely and efficiently. OTS systems enhance operator competency, reduce risks during plant operations, and ensure rapid response to non-standard conditions, which is especially important for chemical plants handling hazardous materials

This talk focuses on the development of a high-fidelity Operator Training Simulator (OTS) for new greenfield green fertilizer plants, integrating Siemens gPROMS and SIMIT technologies. Today’s customers require a Distributed Control System (DCS) with advanced simulation and optimization capabilities, alongside an OTS to train operators under conditions of plant uncertainty.

The proposed solution utilises Siemens gPROMS’ equation-oriented process modeling platform to simulate complex process dynamics, supported by its mathematical and physical properties libraries. This high-fidelity model is combined with Siemens SIMIT for control system emulation and real-time operator training, creating a digital twin of the plant. gPROMS enables accurate, large-scale simulations, including dynamic scenarios for process units such as hydrogen production, ammonia synthesis, nitric acid processing, and ammonium nitrate production. It is designed to handle changing process conditions efficiently, offering robust tools for both steady-state and transient simulations.

1. **Sustainable Fertilizer Production**

**Stamicarbon -** Pioneering sustainable nitrogen technology: from green ammonia to integrated fertilizer plant

Stamicarbon is a world-renowned licensor of urea plants, as well as nitric acid plants. In an effort to contribute to a more sustainable future Stamicarbon launched its green ammonia technology, to help reduce the climate impact of fertilizer production.

A significant development effort has been made, and is ongoing, to integrate the various plants required in a fertilizer production complex as much as possible, both decreasing environmental impact and increasing efficiency.

This presentation will give an overview of the technical developments in relation to green ammonium nitrate-based fertilizer plants, circular urea plants as well as fully integrated fertilizer complexes making ammonia, nitrates and urea.

Attention will also be given to integration with upstream units, such as various types of electrolysers, or other methods of generating sustainable hydrogen and nitrogen generation plants. Specific attention has also been given to processing of waste streams to minimise emissions and thus maximise productivity as much as technically feasible.

All this enables Stamicarbon to stay true to its moto to ‘help the world feed itself’.

**Fauji Fertilzer Company -** Overcoming hurdles in transitioning to sustainable and clean fertilizer manufacturing: challenges and opportunities

The presentation directly relates to operational experience by focusing on the real challenges that fertilizer producers face when transitioning from traditional systems to more sustainable technologies. The speaker will delve in firsthand experiences of the difficulties in modernising older plants, especially dealing with the high costs of new technologies and the lack of retrofit solutions for existing equipment. These challenges are common across the industry, and the presentation will reflect this practical experience.

The presentation also highlights key operational issues like the financial strains of adopting sustainable technologies without immediate economic returns, the challenge of rising product prices in absence of control mechanism and their impact on farmers buying power. Furthermore, the speaker will explore the difficulty of finding scalable, proven technologies that can be integrated into older systems.

**Abu Qir Fertilizers & Chemical Industries -** AFC Environmental sustainability roadmap

Abu Qir Fertilizers & Chemical Industries Company (AFC) is a leading company in the production and marketing of nitrogenous fertilizers in the local and international markets in accordance with EU standards. Currently, the most important challenge at present is the climate change, and in this context, AFC is passionate to meet the CBAM Standards for fertilizers containing ammonia such as urea and ammonium nitrate.

This presentation will outline AFC's efforts to align with international standards, particularly the Carbon Border Adjustment Mechanism (CBAM), and reduce CO2 emissions through various initiatives. AFC's projects include the installation of an ENVINOx unit, solar units, and upgrading ammonia converters to enhance energy efficiency and reduce carbon footprint.

The company also aims to decrease emissions by implementing strategic plans such as connecting CO2 networks between plants, supplying CO2 to liquefaction companies, and revamping urea plants to utilize emitted CO2. By adhering to CBAM regulations, AFC seeks to ensure compliance with EU standards and support Egypt’s national decarbonisation roadmap for fertilizers sector.

**Solex Thermal -** Optimising fertilizer processing: comparative analysis of cooling technologies for enhanced operational efficiency

The selection of the right cooling technology is crucial in the fertilizer producing process, particularly given its importance in the packing, storage and transportation stages. Proper cooling ensures product stability, prevents caking and reduces the risk of thermal degradation, which is essential for maintaining the quality and safety of the fertilizer during these subsequent stages.

This presentation will provide a comprehensive comparison of three primary cooling technologies used in the industry:

Fluid beds

Rotary drums

Plate-based moving bed heat exchangers

Each technology will be examined in terms of its operational efficiency, cost-effectiveness, energy consumption and impact on product quality. Other considerations to be examined include:

Scalability

Environmental impact

Adaptability to various fertilizer types

The presentation will conclude with examples of how these technologies are performing in real-world operations, showcasing successful implementations and addressing any technical challenges that have arisen.

1. **CO2 Removal and Carbon Capture and Utilisation**

**BASF -** Optimisation potential for existing CO₂ removal unit of ammonia plants with BASF’s OASE® white low-low pressure (LLP) flash configuration

Most of CO2 removal units in ammonia plants with BASF’s OASE white process come with two-stage absorption configuration i.e. Absorber + High pressure (HP) flash + Low pressure (LP) flash and Stripper. The presentation will focus on the operation of low-low pressure (LLP) flash and relevant modifications. With the addition of LLP flash, it improves the regeneration of semi-lean solution. Design with CAPEX or OPEX optimization for existing plants are possible even with as-built column dimensions and reboiler duty.

The presentation will discuss an innovative solution that can increase the capacity or revamp the existing ammonia plants by introducing a new vessel as a second stage of regeneration and utilizing pressure release.

This implemented change with AGRU LLP flash is projected to secure an energy consumption margin of 15 to 20%. Furthermore, it will effectively manage the flow rate of lean and semi-lean amine.

We believe this innovation could significantly improve ammonia plant's efficiency and operational capacity.

**Optimised Gas Treating Inc. -** Effect of maldistribution on CO₂ absorber performance

Liquid maldistribution is an operational problem known to seriously degrade packed tower performance yet quantitative information about its effect is scarce.  Uneven gas distribution can so severely affect the performance of large diameter trayed and packed columns that a special mechanical device is sometimes used to provide more uniform gas distribution.  Gas maldistribution has the same potential to cause serious performance loss as liquid maldistribution. In fact, both occur together.

It is not possible to predict the true extent of maldistribution. This is a complex hydraulics problem needing detailed information on such things as distributor out-of-levelness and the results of a computational fluid mechanics study of the flows in the tower sump and vapour entry region.  However, if maldistribution is suspected, thermal imaging of the column from several positions around its periphery can provide an estimate of where liquid flow is excessive and, by inference, where gas flow is abnormally high. This kind of information, combined with accurate simulation of a rough hydraulic representation of the tower with maldistribution in mind, can be useful in troubleshooting this challenging situation.  This is discussed further via a commercial example in the context of a poorly performing carbon dioxide removal unit in an ammonia production plant.  Both piperazine-promoted MDEA and DEA promoted hot potassium carbonate solvents are considered and absorber performance using these solvents is shown to respond quite differently to maldistribution.

**NextChem Tech S.p.A. -** Carbon capture energy balance. Can heat pumps solve the equation?

The presentation concentrates on NextChem experience in adapting Carbon Capture Units to different industries and qualifies the technological solutions that can be implemented to overcome the critical integration of such energy demanding plant in facilities that cannot comply with its utilities needs.

The novel approach is not in the solution per se, but in the specific topological configuration and in its implementation that described through cases studies of real plant applications can provide a roadmap to solve the current industrial constraints that limit Carbon Capture adoption in the hard to abate sectors.

**KBR -** Carbon capture and green methanol production potential in the pulp and paper industry

The presentation discusses a novel process layout, based on proven underlying technologies.

If we look only at Europe, the pulp and paper industry could be a source of a quarter of the biogenic carbon available in the region for making low carbon intensity methanol. Tiis is important since Europe will the first mover to use methanol as fuel for ships.

Therefore, a study on the process and costs for producing methanol from the emissions of pulp industry is quite interesting.

We use high-quality in-house data which gives more value to the results presented. We will report the base assumptions so attendees can verify the results if needed.

1. **Digitalisation: technology and innovation**

**Clariant -** Clariant´s PLUS series and Clarity – Drop-in solutions and digital catalyst insights to enhance the profitability and sustainability of existing syngas assets

Clariant successfully launched its new "Plus" series of syngas catalysts designed to enhance the economics and reduce emissions of syngas plants for hydrogen, methanol and ammonia production. Over the past five years, Clariant upgraded three key catalysts in its syngas portfolio:

ReforMax LDP Plus

ShiftMax 217 Plus

AmoMax 10 Plus

Clarity

The presentation will detail commercial references for each catalyst from all business areas globally and feature case studies of how Clarity was used to provide faster support and troubleshooting.

**Stamicarbon -** Elevate your plant operations: The future of process monitoring

Stamicarbon, a leader in Nitrogen fertilizers technology, continuously innovates to enhance plant longevity, reduce emissions, and lower energy consumption. One of our standout digital innovations is the Process Monitor (PM), a powerful online tool designed to not only optimise plant operational efficiency but also contribute to sustainability.

The Process Monitor (PM) utilises real-time data, a first principles-based process model, and machine learning models to generate meticulously chosen and process-tailored Key Performance Indicators (KPIs) and Key Variables (KVs). With the valuable insights provided by the Process Monitor, operators can adjust the set points of critical process parameters accordingly.

The Process Monitor is web-based and offers a secure cyber environment through its state-of-the-art cloud-based deployment. It is available 24/7 for day-to-day process monitoring, plant analysis, and corrective actions.

The successful implementation of the process monitor in urea plants, leading to a 3-4 % increase in productivity and a 3-4 % reduction in specific steam consumption, is a testament to its effectiveness.

**Toyo Engineering Corporation -** Advancements in TOYO’s DX-PLANT®

TOYO’s presentation for the Nitrogen + Syngas 2025 will highlight novelty of digital solution service applied extensively to plant engineering, and operation support.

(DX-PLANT® is a registered trademark of Toyo Engineering Corporation in Japan (Registered Number 6132604).)

Toyo Engineering Corporation (TOYO), a global leading engineering contractor and urea process licensor, has developed a system for the digital transformation of plants (DX-PLANT®) aimed at maximizing client revenue and minimising costs by leveraging TOYO’s engineering expertise in chemical process technology and operations for industrial plants. Through DX-PLANT®, TOYO creates a “digital twin”, a virtual plant synchronised with an actual plant based on big data collected from industrial plants.

As a recent achievement, in August 2024, TOYO signed a two-year paid contract to provide technical advisory services utilizing DX-PLANT®. Additionally, TOYO has begun initiatives to utilise data through generative AI, aiming to further enhance our services. This article presents the evolved services of DX-PLANT®

**Topsoe A/S -** Access the wealth of knowledge through Topsoe's new digital learning solution

The evolving demographics of our society present a significant challenge for organisations. As senior operators, who belong to the baby boomer generation, retire, they take with them a wealth of operational knowledge and hands-on experience. This creates a noticeable knowledge gap within our workforce, making it difficult for newer operators to acquire the same level of expertise without proper guidance and mentorship.

To tackle this issue head-on, we have developed Topsoe Academy On-demand, a comprehensive solution that acts as a vital bridge. By providing instant access to over 80 years of Topsoe knowledge and recommendations, our platform effectively addresses the knowledge gap. It offers a range of benefits, including flexibility, accessibility, personalisation, and interactivity, ensuring that every member of our workforce receives the necessary training to excel in their roles.

With Topsoe Academy On-demand, we are committed to empowering our workforce and equipping them with the skills and knowledge they need to thrive in their respective positions. By bridging the gap between retiring senior operators and newer employees, we can foster a seamless transfer of expertise and maintain a high level of operational excellence within our organisation.

1. **Fertilizer Finishing**

**UreaKnowHow -** Production technologies for urea + AS/sulphur fertilizers

Sulphur deficiency occurs widely in many parts of the world and is caused because of less use of Single Super Phosphate which contains gypsum (CaSO4) and more sulphur is removed from fields due to increasing yields and declining soil reserves due to erosion and leaching. Also, emissions of sulphur dioxide from burning fossil fuels have provided a large sulphur input to soil, as both rain and deposition of dust. With reduced emissions, deficiencies are increasing. Fertilizers enriched with sulphur are now more and more commonly used to correct sulphur deficiencies.

A  better  Sulphur  supplier  may be  Ammonium  Sulphate (AS),  which makes  the  Sulphur  available  in a  form  that  can  be  directly  taken  up  by  plants.  By   itself,  Ammonium  Sulphate  is

less  attractive as a  fertilizer  for  fertilizing purposes  by  reason of its relatively low nitrogen   content (21%) and its high sulphur  content, but by combining  ammonium  sulphate  with  urea  in  various  ratios, it is possible to produce fertilizers  with nitrogen and  sulphur concentrations  suited  to  specific  requirements  of  crops.

Thus,  for  example, by combining  the components  in a  Urea / Ammonium  Sulphate  weight  ratio  of  about  4/1, a fertilizer can  be  obtained  which  contains  about  40%  N and about 5% S, and is very suitable for many  fertilizing  purposes.

Urea fertilizer is characterised by significant loss (up to 70%) due to the high mobility in the environment. The main problems associated with low Nutrient Use Efficiency have a significant impact on climate change and possible environmental toxicity, eutrophication and nitrate pollution, ozone and air quality degradation, and emissions of greenhouse gases.

A N+S fertilizer can possibly enhance the utilization rate of nitrogen due to their well-known synergy. Plants need sufficient levels of sulphur to be able to utilise nitrogen efficiently. Together, nitrogen and sulphur are vital building blocks for protein, so N and S should be applied at the same time.

The challenge when adding AS to urea melt is its limited the solubility and thus for high N/S ratios a slurry needs to be handled. With S the challenge is different but not easier.

This presentation will describe which production technologies have been developed to produce these high value N+S fertilizers and which references are already available for each one.

**Stamicarbon -** Stamicarbon granulation technology: from urea to UAS

Stamicarbon has over 21 years of experience in licensing urea granulation plants, and has built its reputation in the business with its unparalleled fluidised bed granulation technology. This technology is well known for its longer granulator running times, lower dust formation and lower formaldehyde consumption, bringing economic and environmental value to its customers. Nowadays, due to a strong demand from the market to have a more diverse product portfolio, Stamicarbon has developed technologies which enable the addition of the nutrient of sulphur into a urea granule, through the ammonium sulphate (AS) salt.

Due to the increasingly stricter ammonia emissions’ regulations which the industry is globally facing, many clients are requesting to have applied ammonia scrubbers in their urea plants. The by-product of the scrubbed ammonia with sulphuric acid is the AS salt which typically has no value for the end-user, thus is considered as a waste stream and needs to be properly disposed. However, Stamicarbon has developed it is recycle evaporation system which allows the end-user to upgrade the AS waste stream and incorporate it into the urea final product. This results in a urea granule with a small percentage of AS. Currently, there are already two plants utilising such concept and another two plants of 4000 MTPD each which are in the construction phase.

In case the customers want to further increase their AS content, Stamicarbon has developed a granulation process which allows the end-user to produce urea-AS (UAS) granules up to a maximum of 32.5wt% of AS, allowing the end-user to have the flexibility to choose its final product AS concentration. This latest development is already licensed in a 600 MTPD plant which was started-up in 2018. In the meantime, new developments were made in this process which allow Stamicarbon to license new UAS plants for larger capacities.

**A.W.S. Corporation SRL -** HDAN prill tower gas combined treatment, with WESP finishing implementation to Agropolychim unit in Bulgaria

INCRO, the licensing company belonging to FERTIBERIA, is a key player on licensing own technologies for DAP/MAP/NPKs and Ammonium nitrate manufacture, both for fertilizer and explosives field. The gradual increase on environmental legislation requirement, forces licensors to look for better scrubbing technologies linked to their processes, still keeping reasonable cost.

One typical difficult application is scrubbing exhaust gases from prilling towers. Ammonium nitrate solution prilling at high temperatures generates a micronic particles mist of difficult separation. The large air volume and dust characteristics requires costly abatement systems, like candles, high pressure drop scrubbers, wet electrostatic separators..., but the cost of such fine polishing systems is sometimes unbearable for end users.

This paper describes one real application for a former INCRO’s technologies customer, AGROPOLYCHIM, which operates a HDAN prill tower in Devnya- Bulgaria. HDAN prilling tower handles a very large volume of gases, containing very small quantities of ammonia and AN dust, but in the form of a visible mist of difficult recovery.

INCRO, using its own expertise in FERTIBERIA units with the cooperation of AWS-Italy, a firm specialized in Wet Electrostatic precipitators (WESP), designed a scrubber arrangement in which most of the exhaust gases are dry and wet recycled to prilling tower, just purging a small portion that goes through a very efficient WESP, still maintaining, or improving prilling conditions. WESP captures micronic particles, significantly reduces mist and complies with the new strict environmental limit with a contained CAPEX / OPEX compared with other alternatives, thanks to the installation of WESP just for the purged portion. WESP very low pressure drop compared with other alternatives also results on lower power consumption.

Other side advantages of this full arrangement are WESP absence of plugging, low maintenance, long life and the prill tower conditions stabilization year-round, regardless of season, or ambient conditions

**Casale SA -** AN / CAN & enhanced urea finishing technologies

During the decades of activity in the fertilizer market, Casale SA has built a complete portfolio of finishing technologies, partly through technology development and partly by well-grounded acquisition. Casale offers technologies for the production of traditional fertilizers as well as green fertilizers. In many cases, as licensor, Casale SA can offer the Client the choice between different technologies from its portfolio in the different stages of the production process.

Papers will describe Casale flexible solutions to produce fertilizer grade urea, DEF-grade granular urea, cattle feed grade urea or enhanced urea grades such as urea with ammonium sulphate (UAS), sulphurised urea (US), or urea with micronutrients (Urea+).

Nitrates based fertilizers production can be achieved thanks to Fluidised Bed granulation or Drum Granulation technology as finishing stage as well as prilling bucket device. Both the available technologies can be adopted in high density ammonium nitrate HDAN or in CAN grades, but they can also be designed to enable production of both grades in the same flexible unit.

Finishing section can be fitted with an extremely performant “double temperature” scrubbing technology for tail gas treatment installed as a complete tailor-made system or as a modular setup, providing add-ons for different applications.

1. **Urea Plant Safety and Integrity**

**Misr Fertilizers Production Co. MOPCO -** Operational problems and their solutions - A rupture in high-pressure drainage line for HP scrubber, leakage of high-pressure urea solution and ammonium carbamate

Case study.

A rupture in the high-pressure line (drainage line for HP scrubber) caused leakage of high-pressure urea solution and ammonium carbamate to the atmosphere which resulted in emergency shutdown of the plant, dangers for the working stuff and losses in production.

By evaluating the Inspection results we can define this failure as chloride stress corrosion crack, REF.(API 571), marine environment or other sources caused by chloride contamination to the line and the adjacent structure which transferred to the defected spool by washing water or by rains and penetrated under insulation affecting the pipe surface.

The case will include: all inspection results and inspection activities, as well as the remedy action recommendations.

**Fauji Fertilizer Company -** Syn turbine casing integrity and operational continuity: addressing cracks in a high-pressure turbine

After seven years of service, cracks were discovered in the high-pressure zones of the turbine's outer casing, indicating the challenges faced in maintaining such critical equipment under high-pressure and high-temperature conditions. The extended service life of the repaired casing (22 years) reflects a deep understanding of the turbine's operational limits, and the maintenance strategies required to ensure continuity.

The presentation will delve in the **comprehensive repair methodology** and the **predictive maintenance techniques** used. Assessing critical crack length and continual condition monitoring helped predict crack propagation and avoid catastrophic failure. Additionally, the challenges of integrating new and aged components during the replacement of the outer casing highlight novel technical solutions in turbine repair.

**Yara Belgium SA/NV -** Thermowell design and Inspection

Yara is continuously updating its own technical specifications under the steering system documentation in all product business lines under the governance of Operational Excellence (OPEX) team. In the field of Urea, the core team recently updated one of these standards. It was needed to better define the minimum design requirements for materials, fabrication and inspection for thermowell used to monitor and control the temperature in high pressure piping loop.

During a recent turnaround in an Indian Yara facility, upon piping inspection, serious corrosion was found in one thermowell located in the pipeline that connect the HP Urea Reactor to the HP Urea Stripper. Although, this piping system was assessed based on the risk-based inspection program defined under the reliability frame in Yara, the inspection of these temperature sensitive elements was not considered, even if subjected to the same damage mechanisms defined for the piping itself.

This presentation will introduce the near miss occurred in the Indian Yara Urea Plant, briefly and subsequently will cover the possible solution Yara is aware of in the market as well as the preferred solutions by Yara, in view to have a system which is reliable, safe, and easy to inspect. Being the HP system working at very high pressure, any leakage would potentially be catastrophic in case the scenario of break before leak occurs.

The presentation will also discuss the inspection technique used to monitor the degradation of the thermowell as well as the piping including alternative non-intrusive solution under testing in other Yara facilities.

1. **Urea Production: Materials of Construction**

**Saipem S.P.A. -** Boosting the lifetime of urea HP equipment

Replacement of high-pressure equipment is sometimes undertaken by end-users to extend the lifetime of their urea plants. Equipment design, synergies with manufacturers, materials and plant performances are the key features to put in place the right strategy to avoid replacement. Solutions can be implemented either at design phase or in existing facilities during operation and maintenance.

The adoption of materials with minimal corrosion rates is at the basis of a prolonged equipment life, that is why Saipem and Tubacex have jointly introduced SATURN31, the new Super Duplex material developed for the highly corrosive environment of the HP section in urea.

The installation of SuperCups in the urea synthesis reactor allows in design phase to optimise the equipment size and in the operating plants to increase the reactor efficiency and offload the urea stripper and the downstream sections with benefits on mechanical and process performances.

The AMMO LASER Leak Detection System, by UreaKnowHow.com and Key-Tech Engineering, has been technically approved by Saipem as it allows for the prompt and reliable detection of a leak and for its subsequent management, saving time from routine visual checks and eliminating the risk of human errors.

The involvement at every turnaround of licensor’s specialists for inspecting the HP equipment and assessing its conditions allows the end-users to exploit the experience acquired by Saipem over a long time in many urea plants, with possibility to implement lessons learnt gained worldwide in operating plants.

This presentation will deliver an objective analysis on the implications of urea HP equipment replacement and will describe Saipem’s pillars for the implementation of the above strategy, based on its longstanding experience as acquired by assisting end-users worldwide in operation and maintenance.

**Alleima Tube AB -** Advanced material solutions for optimised urea production - A portfolio overview

The production of urea requires advanced materials for equipment, particularly in the high-pressure section, due to the highly corrosive environment. Alleima, a renowned manufacturer of advanced stainless steels and special alloys, has been developing corrosion-resistant alloys and products tailored for the urea industry since the 1970s.

The presentation will introduce key products such as Alleima® 3R60 Urea Grade (UNS S31603), Alleima® 2RE69 (UNS S31050), SAF™ 2906 (UNS S32906), and Bimetallic tubing (2RE69 with Zirconium 702), which have been specifically designed to withstand the most aggressive conditions in the urea industry.

The urea production industry faces challenges due to the highly corrosive nature of the process environment. Equipment failure due to corrosion can lead to costly downtime and maintenance. Therefore, the selection of appropriate materials is crucial for ensuring the longevity and efficiency of urea production plants. Alleima's extensive experience and broad portfolio of tailored material solutions for urea plants enable effective corrosion mitigation, regardless of process design and material preferences. The material portfolio not only addresses the current challenges in urea production but also provides a robust foundation for future advancements in the industry. By staying at the forefront of material science, Alleima aims to support the urea industry in achieving higher efficiency, safety, and sustainability in its operations.

**Mannesmann Stainless Tubes GmbH -** Weldability of high performance super-duplex seamless tube material used in classic & modern urea process units

In the world of Fertilizer production reliable and easy installable materials are key. The industry is calling for cost improved material solutions with positive influence on the total cost of ownership and easy supply chains. As a global seamless stainless tube manufacturer, Mannesmann Stainless Tubes stands for its technology driven customer orientated precision and quality.

Understanding the needs of Designer/Manufacturer and Operator of Chemical Process Plants, our quality approach is linked to the tube itself, and on the further processing steps which our products have to overcome. One of those is the installation of our Fertilizer tubes by welding.

Therefore, MST started a test program for having a deeper look in the microstructure, mechanical and corrosion resistance behaviour of the tube weld. The investigated super duplex material is designed to perform under harsh environments occurring during the Ammonia/ Urea production. Especially under high temperatures and pressures combined with high corrosive requirements under low oxygen access, the material performance is an added value for the industry.

The test program will present details from the welding procedure, the tube and weld investigations and the results from mechanical, micrography and corrosion tests.

1. **Decarbonising Urea Production**

**Stamicarbon -** Valorisation of excess LP steam for reduced carbon footprint of urea plants

Traditional urea plants produce an excess of low pressure (LP) steam, available at relatively low temperature (less than 150 °C), as usually not the whole energy generated by the exothermic reaction of carbamate formation is reused inside the process. This steam is typically considered as an unwanted product with a relatively low value due to the temperature limitation. The excess steam might even have to be vented off and this represents a waste of energy.

The aim of this presentation is to explore avenues to achieve carbon footprint reduction and re-utilisation of what it traditionally considered a “waste” stream. Several methods are industrially available; this presentation will outline two case studies for potential re-utilisation of excess LP steam: a) reuse of LP steam as motive fluid of turbine drivers – being common practice in a urea plant, b) mechanical vapor recompression (MVR) of LP steam as heat exchange medium.

This facilitates a transition from traditional carbon-based steam boilers to renewable electricity sources by leveraging the exothermic energy from the urea synthesis process.

**thyssenkrupp Uhde GmbH -** Technical solutions to decarbonise urea plants

One problem of all existing urea plants is their CO2 foodprint. The technical solutions which will be discussed contribute to reduce the CO2 footprint of new and existing urea plants.

Any urea stripping process has one single real steam consumer, e.g. in a CO2 stripping process it is the high-pressure heat exchanger, also called high-pressure stripper. All other downstream equipment use lower pressure steam. The steam provided to the high-pressure heat exchanger is typically sourced from boilers, which consume gas to generate steam, and partly also from the upstream grey ammonia plant. If the heat source for the high-pressure heat exchanger can be replaced by renewable energy, a great reduction of CO2 emissions from urea production is achieved.

The presentation will discuss how this can be achieved by clever heat-integration and boosting thermal energy to a higher level. The savings and benefits will be demonstrated at the example of a world-scale urea plant.

The proposed solutions can be operated on renewable sources and thus provide technical solutions to decarbonise urea production.

**TOYO Engineering Corporation -** TOYO decarbonises urea production for modern and vintage urea plants, and next-gen g-Urea® plants

TOYO’s presentation at the 38th CRU Nitrogen + Syngas Expoconference 2025 will highlight the **novelty** of TOYO’s decarbonisation technology. This includes Toyo’s latest urea synthesis technology ACES21-LP®, which has been awarded its first project application; further studies focused on energy flows and economic analysis of next-gen g-Urea®; and improvement of vintage urea plants through replacing the old reactor with the new reactor equipped with TOYO's proprietary high-efficiency crossflow baffle plates and DP28WTM linings without modifying rest of the plants.

1. **From Green Ammonia to Green Hydrogen – the Journey**

**Plug Power -** Safe, sustainable and profitable ammonia production

Green Ammonia production is currently only taking place on experimental basis, but at the same time is one of the hottest topics in the industry. Operating data from industrial scale electrolysis units will be at the heart of the presentation.

All methods and concepts are introduced and described fully, objectively and are equally applicable to all types of technologies available on the market. Examples are presented on how Plug Power is implementing these concepts and methods in practice.

The presentation will discuss how ExPSR (Explosion Pressure Shock Resistant) equipment rating can be achieved at reasonable cost by doing appropriate experimental work instead of excessive theoretical calculations.

**Saipem S.p.A. -** Ammonia terminal on gravity-based structure: a key asset for the energy transition

To satisfy a higher demand for “green” and “blue” ammonia in the fertilizer industry and the energy sector, the supply and distribution of ammonia is significantly increasing and is expected to constantly accelerate in the next decade.

In this perspective, new ammonia terminals will be required and shall be designed considering social and environmental challenges, as well as local permitting and safety regulations.

Saipem has developed a wide range of solutions to tackle those challenges by offering large-scale Liquid NH3 (LNH3) storage and import/export terminal facilities supported on Gravity Based Structure (GBS).

The GBS concept can allow the entire integration of the LNH3 storage system inside a single concrete hull, fully enclosed in multiple barriers of concrete structure, implying inherently safer solutions when compared to conventional onshore systems.

In case of a need to produce clean hydrogen, an ammonia cracking facility characterized by zero CO2 emissions can be installed on the topside of the GBS, thus serving at once as an import terminal of clean ammonia and an export terminal of clean hydrogen.

This solution is highly effective, particularly in Europe, considering the expected increase of ammonia import and the rising demand for clean hydrogen to meet the ambitious decarbonization targets.

The presentation includes relevant projects on which Saipem has capitalised to enrich its EPC expertise in the design and construction of large-scale GBS solutions with storage system for refrigerated liquefied gases, such as LNG and LNH3.

**Air Liquide -** Cracking it back: the most promising technology on the horizon to produce hydrogen from ammonia

Hydrogen carriers have a great potential connecting regions with an abundance of renewable energy with the European Union and other parts of the world. The advantages of ammonia as a hydrogen carrier are recognized as it allows transporting hydrogen while avoiding cryogenic conditions and high pressure with a superior volumetric hydrogen density. While the infrastructure for ammonia production and shipment is available today, there are no industrial size units in operation to crack ammonia back to hydrogen. Air Liquide took on this challenge by developing the most mature and de-risked ammonia cracking technology.

To achieve a quick time to market, Air Liquide invested in a pilot plant for ammonia cracking and combustion with some key components at commercial size. This will allow for de-risked scale-up towards the first commercial project. The pilot plant, located in Antwerp, is aiming for start-up in  2024 as a final step of the technology validation. Therefore, for the first time ever, operational results of an ammonia cracker at pilot scale will be presented.

As part of ADVANCE, its 2025 strategic plan, Air Liquide is deeply committed to creating a positive impact on both the environment and society. The group supports the decarbonisation of industry and the advent of a low-carbon society, in which hydrogen plays a decisive role. By developing unique and innovative technologies for the design of industrial scale ammonia cracking units, we are ready to provide our customers with safe, efficient and reliable solutions and to contribute to a sustainable future.

1. **Ammonia and Methanol Plant Operations and Optimisation**

**PT Petrokimia Gresik -** Accelerating ammonia plant cold start-up by optimising the primary reformer heating path - A case study

The case study is based on real-world operational experience at PT Petrokimia Gresik’s ammonia plant. It details the cold start-up process of the primary reformer, and the challenges faced, providing practical insights into the plant’s operations.

The study introduces a novel approach to optimising the nitrogen circulation path during the cold start-up process. By utilizing the previously unused 173-J line for low-temperature shift (LTS) heating, the modification represents an innovative solution that significantly reduces heating time.

The speaker will present objective data, including the average heating times before and after the modification, and will quantify the improvement with a 37% decrease in heating time. This data-driven approach ensures the findings are based on measurable outcomes.

The study identifies the extended nitrogen circulation path as a key operational problem and provides a detailed solution. By reconfiguring the heating path and installing a permanent line with additional block valves, the modification effectively addresses the issue, leading to enhanced operational efficiency.

**OQbi** - How OQ has improved the reliability of methanol steam methane reformer tubes

OQ-Methanol plant with a name plate capacity of 3000 MTPD was commissioned in 2010 in Salalah, Oman. Steam methane reformer (primary) is the most critical equipment for production of Syn gas from natural gas & steam reforming. Reformer tubes often experience integrity issues related to fuel quality and operation upsets. Mostly, plants undergo shutdown for tubes/pigtail replacement prior to accomplish the design operating hours, ex, 100,000 operating hours (as standard practice). OQ-Methanol plant also suffered series of operating issues with reformer operation ranging from hot-spots, high No'x emissions mainly due to uneven fuel balance & optimisation. Reformer tubes have completed 100,000 hours in 2020 and there is a plan to be replace in TA-2028.

The presentation will focus on tubes integrity improvement by adopting initiatives both supporting and enhancing Opex & Capex.

**Engro Fertilizers Limited -** Successful decommissioning, inspection and recommissioning of ammonia storage tank - a record breaking feat

The successful decommissioning, inspection, and recommissioning of the Ammonia Storage Tank (T-3001) highlights Engro Fertilizers' extensive operational experience. Ammonia storage tanks are installed worldwide, and its decommissioning and inspection has been a challenging task. In this presentation Engro Fertilizers will share their experience how the company managed to complete the whole process in just less than 50 days.

The project’s success was quantified through clear metrics, such as the record timeline of 46 days, zero incidents or environmental concerns, and strict adherence to vendor and global best practices. This demonstrates an objective approach in executing and evaluating the project's success, rooted in measurable outcomes and adherence to industry standards.

The presentation will also address several operational challenges, such as managing thermal stress, preventing stress corrosion cracking, and mitigating risks of over-pressurisation or vacuum collapse. By applying rigorous risk assessments, benchmarking, and innovative engineering solutions, these operational problems were effectively resolved, ensuring the tank's integrity and operational readiness post-inspection.

**Casale SA -** Successful start-up of a European ammonia plant following replacement of obsolete bayonet and fire-tube boilers with Casale-Arvos double-tube design

An European ammonia plant, has successfully restarted following a revamp of the process gas cooling section. Casale replaced the outdated 101-CA/B and 102-C boilers located downstream of the secondary reformer with three new double-tube type boilers supplied by Arvos.

The presentation details the installation of the new Casale-Arvos boilers and the plant’s successful start-up after the steam generation system upgrade. The new boilers were installed in the same location as the previous ones, minimising investment costs and plant modifications. The more robust and reliable design of the Casale-Arvos boilers has resulted in enhanced overall performance and reliability of the ammonia plant.

1. **Ammonia Plant Operations**

**Engro Fertilizers -** Drying out for success: Engro’s experience of effective HTSC dry-out and resuming ammonia production

Sudden failure of Waste Heat Boiler is akin to a heart attack at ammonia plant. The presentation elaborates steps taken to handle emergency ensuring smooth and safe shutdown of the plant. It discusses the novel approach taken to quickly cool down the reforming section for vessel entry without exposing the wet HTSC catalyst to hot nitrogen. Similar strategy was then utilised to carry out controlled dry-out of the HTSC catalyst in parallel to the repairs for minimising plant startup time and production loss.

Detailed SOP was developed with Topsoe and KPIs were continuously monitored resulting in successful dry-out of the bed. Lastly, the presentation touches on the performance of the catalyst post dry-out, impact of excessive BFW ingress on the catalyst bed, and steps taken to sustain operation for the next 2 years.

**Indorama Eleme Fertilizers and Chemicals -** Excellence in catalyst performance monitoring: Indorama's digital transformation with CLARITY™ prime

The presentation discusses the operational experience and benefits achieved by Indorama Eleme Fertilizer & Chemicals after implementing Clariant's CLARITY™ Prime digital service for their ammonia production facility. It highlights how the service enabled predictive maintenance, improved catalyst performance insights, and advanced technical support, contributing to more reliable and efficient plant operations.

The presentation introduces CLARITY™ Prime as Clariant's advanced digital service for syngas plants, offering real-time plant performance data visualisation, automated catalyst health alerts, and cutting-edge machine learning-based models for catalyst performance projections. This service represents a novel approach to digitalisation and catalyst management in the ammonia industry.

**Pupuk Sriwidjaja Palembang -** N2C - circulating nitrogen to reduce cooling time of secondary reformer catalyst replacement using LTS start-up-blower (173-J) on KBR Purifier ammonia Plant Pusri 2B, Pupuk Sriwidjaja Palembang

Pupuk Sriwidjaja (Pusri) has been established since December 24, 1959. Pusri is one of the of petrochemical factories in Indonesia with a production of 1.7 million tons of ammonia per year. Pusri operates 4 Ammonia Factories including Pusri-1B, Pusri-2B, Pusri-III and Pusri-IV. Pusri 2B, the newest ammonia plant in Pusri, used natural gas, raw water, and air as the main raw materials with KBR-Purifier technology.

The presentation discusses efforts to reduce cooling time of the catalyst secondary reformer before unloading. This is an important part of the plant’s operational excellence as reducing the duration of cooling down increases the opportunity for more production and reduces CO2 emissions caused by conventional cooling using dry ice.

1. **Energy Transition and Future Fuels**

**BASF SE -** Designing a sustainable aviation fuel (SAF) production process from methanol: towards a greener future in the aviation sector

Join us for a presentation on the future of sustainable aviation fuel (SAF) production! The European Union has set an ambitious target of sourcing 70% of jet fuel from renewable sources by 2050, with nearly half of it coming from renewable electricity. This target will be achieved through the ReFuelEU Aviation initiative, which mandates suppliers to blend SAF with fossil kerosene in increasing amounts from 2025 onwards, and a sub-mandate on synthetic fuels (eSAF) will be implemented as of 2030.

To achieve this goal, entirely new catalysts and advanced process technology will be required, and we are leading the industry with the development of the dedicated M2SAF process, a collaboration between Uhde and BASF. Our innovative methanol-based process is set to transform SAF production by improving flexibility, cost-effectiveness and sustainability. Refiners and fuel producers will be able to efficiently transform renewable methanol, a globally traded commodity, to high-quality sustainable jet fuel at production sites irrespective of the local availability of green power. By utilizing CO2 and renewable electricity more efficiently, we are enabling a green aviation sector.

The M2SAF project is partly funded by the Federal Ministry for Digital and Transport as part of the Funding Programme Renewable Fuels (01.09.2022-31.01.2025). The funding guideline for the development of renewable fuels is coordinated by NOW GmbH and supported by the project management agencies VDI/VDE Innovation + Technik GmbH and Fachagentur Nachwachsende Rohstoffe e. V. (Agency for Renewable Resources).

**Topsoe -** Unleashing the power of blue hydrogen: Topsoe's innovations for a clean energy future

Hydrogen plays a crucial role in achieving a clean energy future, as electricity alone cannot decarbonise all sectors effectively. The Hydrogen Council predicts a sevenfold increase in global hydrogen demand by 2050, driven by ambitious decarbonisation targets worldwide.
To fully unlock hydrogen's potential in reducing CO2 emissions, it is necessary to supplement green hydrogen with other clean sources, known as "blue hydrogen," which have a low carbon intensity.

Topsoe will demonstrate how blue hydrogen can be produced by combining traditional production methods with innovative clean technologies. This can be achieved by revamping existing grey hydrogen plants or constructing new blue hydrogen plants.

Topsoe's SynCORTM technology is particularly suitable for mega-scale production of deep blue hydrogen, characterised by ultra-low carbon intensity and full integration of CO2 capture technology. Furthermore, Topsoe introduces the eReactTM, the latest addition to their reforming portfolio. This electrified reformer not only produces hydrogen but does so with ultra-low carbon intensity, further contributing to the clean energy transition.

**Casale -** Blue H2: ROX, HyPOX, HyPure

The presentation delves into the  technologies and solutions that Casale-Technip strategical alliance offers to operators for low carbon hydrogen production on a large scale.

Casale and Technip Energies provide a full range of solutions for low-carbon hydrogen production: Recuperative & oxidative reforming or auto-thermal reforming technology for medium to large production with ROX & Hypure and partial oxidation-based process for small to medium size with HyPOX.

Casale and Technip Energies technologies are combined to optimise hydrogen production, achieving, at the same time, very low carbon intensity (up to 99% carbon capture rate).

1. **Low Carbon Hydrogen Production**

**thyssenkrupp Uhde GmbH -** Challenges of hybrid ammonia plants – innovative ways to close the nitrogen gap and cope with fluctuating green hydrogen profiles

The decarbonisation of the fertilizer industry is a widely discussed topic because of cost increase by carbon taxes or other regulatory instruments in many countries. The possibilities of major energy efficiency improvements of existing assets are limited and are associated with high investments. However, the replacement of part of natural gas feed or fuel by injection of green hydrogen from renewable energy is a measure to significantly decarbonise existing ammonia plants. Besides the benefit of saving natural gas and possible carbon taxes, the green share of the end product of this hybrid fertilizer complex can be also promoted with a premium price.

thyssenkrupp Uhde has been engaged in several projects to investigate the plant modification and the resulting operational impact required by green hydrogen injection for the purpose of natural gas replacement as well as of production increase. This presentatuion describes the boundary conditions (e.g. less heat recovery for steam production and a nitrogen gap due to reduced process air flow) of hybrid plants by decarbonisation of an ammonia/urea-complex and possible solutions. One highlight is a comparison of different innovative ways to furnish the necessary nitrogen supply into the ammonia process.

**NextChem Tech S.p.A -** Key performance indicators of CPO, SMR and ATR in low carbon hydrogen production

Hydrogen is industrially generated from fossil feedstock by using steam methane reforming (SMR), autothermal reforming (ATR), catalytic (CPO) and not catalytic (POx) partial oxidation processes. The aim of the presentation is to compare the performance of these technologies, evaluating feedstock consumption, carbon emissions and overall costs at industrial scale.

The presentation provides a comprehensive analysis on the critical KPIs that affect the technology selection when defining the optimum option for hydrogen production. The novel analysis is describing the key elements that affect this selection and highlights the importance of the decarbonisation target as a parameter that can deeply influence the decision and the future consumptions of the plant.

The speaker will also focus on the advantages of the Catalytic Partial Oxidation, as a viable alternative to the most commonly implemented technologies, therefore highlighting when and why its peculiar characteristics might be attractive in the new market scenarios with a high demand of low carbon hydrogen.

**Air Liquide Global E & C Solutions Germany GmbH -** Flexible decarbonisation: navigating energy transition with hydrogen and ammonia

As the energy transition accelerates, a growing demand for low carbon energy vectors is intensely perceived. Incumbent policies, local tax credits, subsidies, transportation, logistics and at the same time international collaboration are visibly leading to a new trend where a H2 molecule-based product flexibility is sought by the industry.

Thus, a new low-carbon ecosystem is in the need to be conceptualised where a central production facility can offer a flexible product diversification with the two most popular decarbonised molecules, H2 itself and NH3 at a scale that satisfies extensive decarbonisation targets. Air Liquide Engineering & Construction has developed an innovative plant configuration solution to meet this need, combining oxygen-blown Lurgi™ autothermal reforming (ATR) technology coupled with Cryocap™ H2 CO2 capture technology.

**UNICAT Catalyst Technologies, LLC –** Ammonia cracking catalyst: what is in your tubes? Optimising fundamentals of ammonia cracking catalyst starting from the suppor

Green ammonia production and subsequent disassociation is the most significant industry topic for a generation. In terms of ammonia cracking, much thought is given to prospective flowschemes, with catalyst-packed, tubular reactors inside fired heaters at the heart. Optimal active metal(s) for the catalyst is a hotly debated subject.

UNICAT is taking an alternative approach. Although potential active metals are screened and tested at UNICAT’s European R&D centre, and proprietary kinetic models have been developed by industry-renowned experts, a critical understanding is required of how catalyst supports play a pivotal role in thermally efficient and economically viable ammonia crackers.

UNICAT will present to the audience how Magcat®-ACTS can be deployed in any ammonia cracking reactor design, and will describe benefits of spherical, textured catalyst in ammonia disassociation reactions. Detailed information and new key understandings derived from UNICAT’s ammonia disassociation kinetic model will be provided.

In addition, UNICAT will discuss similar textured sphere catalyst technology for ammonia disassociation adiabatic ‘pre-crackers’ as well as providing information on PSA systems for reactant separation based on expertise in PSA adsorbents and PLC optimisation. With ‘best technology @ best value’ for three major process blocks, along with industrial catalyst and engineering knowledge to back it up, this presentation from UNICAT provides detailed understanding on 'software' requirements for viable, world-scale ammonia disassociation plants.

1. **Asset Integrity**

**Quest Integrity and SK Energy** - Application of Level 3 fitness-for-service assessment for understanding hot collector integrity

The presentation concentrates on asset operational problems and their solutions. SK Energy identified reliability concerns with their reformer outlet system and worked with Quest Integrity to better understand the cause of the integrity issues and how to better manage operating scenarios to extend asset life. This was enabled through complex stress analysis/fracture mechanics assessments, coupled with destructive testing and metallurgical assessments.

**ENGEMASA Engenharia e Materials Ltda -** Catalyst tubes after 10 years in service: correlation between operating history and remaining lifetime

The presentation was developed in partnership with an experienced tube manufacturer and a final user of a well-known refinery. It is based on a real case assessment of equipment running 10 years in true condition service. The conclusions can be used as guidelines for operational staff to increase the asset's lifetime and avoid undesirable failures.

The presenter will share a novel model that correlates the metallurgical damage accumulated by the material and the operating history of the equipment (i.e. temperature, pressure, and others) showing to be a useful tool for supporting the decision-making related to asset reliability and safety.

**IGS Europe -** Increasing process efficiency and service life of syngas reformers, amine and Benfield vessels - Four case studies

The presentation highlights four detailed case studies that demonstrate IGS Technologies and Services' extensive operational experience in improving the efficiency and extending the service life of syngas reformers and pressure vessels. The collaborative efforts between IGS and its clients underscore practical, hands-on experience in addressing and overcoming operational challenges in real-world settings.

The engineering recommendations and solutions presented are based on detailed Efficiency Audits conducted by IGS. The systematic approach, including benefit analysis, price, payback period, scope, and timeline, ensures that the solutions are objective and tailored to meet the specific needs of each client. Additionally, the post-turnaround project analysis provides an unbiased validation of the solution's performance.

The case studies illustrate various operational problems, such as heavy fouling in the reformer convection section, firing duty limitations, hot spots on the reformer shell, and corrosion in the CO2-capture Amine system. Each problem is addressed with a specific solution, such as the use of Remote Operated Vehicles (ROV) for cleaning, high emissivity coatings for efficiency improvement, safe in-situ repairs, and alloy upgrades to mitigate corrosion. These solutions effectively resolve the operational issues, enhance reliability, and prevent unplanned shutdowns.