1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27

Welcome to our interactive version of Nitrogen+Syngas Issue 353

Please use either the buttons on the left or top right of the page to navigate your way around this interactive PDF

IMPORTANT INFORMATION:
Copyright – Issued six times per year, or bi-monthly. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means – electronic, mechanical, photocopying, recording or otherwise – without the prior written permission of the Copyright owner.

CONTENTS
What's in issue 353

COVER FEATURE 1
The prospects for GTL

COVER FEATURE 2
Methanol markets

COVER FEATURE 3
Innovations in steam reforming

COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

JM

Making a difference to the world around us

With years of operating experience and expertise across the syngas, petrochemical, oil and gas markets, Johnson Matthey continues to invest in technologies that improve processes whilst looking after the environment.

Our gas heated reforming technology is a proven energy efficient solution for syngas generation across multiple applications reducing both CO_2 emissions and raw water consumption, whilst maximising the opportunity to use renewable energy.

Contact us to find out how our technology can benefit your business.

Johnson Matthey
Inspiring science, enhancing life

www.jmprotech.com

Cover: photllurg/iStockPhoto.com

nitrogen+syngas

www.nitrogenandsyngas.com

NUMBER 353
MAY | JUNE 2018

CONTENTS

10 **Methanol: China in the driving seat**
Methanol has been the fastest growing syngas derivative for some years now, and will be almost ½ the size of the ammonia market by 2020. Although new capacity additions are slowing, methanol to olefins production in China continues to drive the market, while new US capacity additions will see it become a net exporter by 2019.

12 **The prospects for GTL**
Gas to liquids (GTL) technology has dropped in and out of favour in the syngas industry as oil and gas prices have moved up and down. With the withdrawal of Sasol from new GTL projects, the prospects for new GTL currently seem to rest on smaller scale, modular plants.

14 **Nitrogen+Syngas 2018**
A report on this year's Nitrogen+Syngas conference, held at the Gothia Towers in Gothenburg, Sweden in February.

17 **Full life cycle philosophies for urea plants**
Stamicarbon and Saipem discuss their philosophies for improving and supporting the life cycle of urea plants throughout the entire plant lifetime. New developments are helping to meet the challenges of the fertilizer industry, as well as providing solutions for reliable, flexible, profitable and environmentally friendly operations.

21 **Uhde® Mega UAN concept: from vision to success**
Uhde® UAN technology has proven to be versatile, flexible and reliable. In this article, E. Marcos Puertas, P. Kamermann, and J. Mathiak of thyssenkrupp Industrial Solutions AG report on the start-up and recent operating experience of two recently commissioned Mega UAN concept plants in the USA.

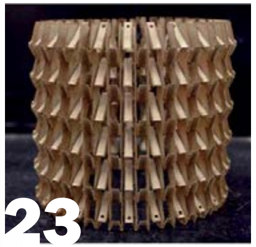
23 **Gearing up for future steam reforming**
ZoneFlow™ Reactor Technologies LLC (ZFRT) has developed proprietary, radically innovative structured catalyst solutions for steam reforming, pre-reforming and recuperative reforming. Compared to pellet catalyst, the use of ZF reactors enables significant capital and operating cost reduction in steam reforming both for new plants as well as revamps. S Ratan of ZFRT and Prof. J. De Wilde of UCL discuss the current status of the technology.

25 **Easy access to true TWT readings**
Topsoe's expert digital services for ammonia, methanol, hydrogen and syngas plants now includes TrueTemp™, a new online application to improve the accuracy and reliability of tube wall temperatures in the steam reformer.

REGULARS

3 **Editorial**
The coming war on ammonia?
4 **Price Trends**
5 **Market Outlook**
6 **Nitrogen Industry News**
8 **Syngas News**
9 **People/Calendar**
9 **Plant Manager+**
Problem No. 48: Seal systems of high pressure reciprocating pumps

12
Gas to liquids
Are small-scale modular plants the future?



23
Future steam reforming
Innovative structured catalysts for reformers.

Read this issue online at:
www.nitrogenandsyngas.com

Published by:
BCInsight

CONTENTS
What's in issue 353

COVER FEATURE 1
The prospects for GTL

COVER FEATURE 2
Methanol markets

COVER FEATURE 3
Innovations in steam reforming

COVER FEATURE 4
Full life cycle urea plants

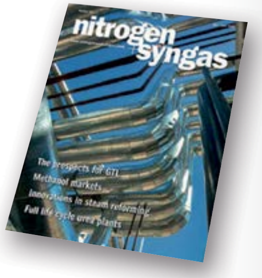
NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight

Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

The coming war on ammonia?



> Up to 10-40% of nitrogen applied as urea can be lost to the air.

Air quality has become one of the major environmental and public health issues of our time. The drive to reduce sulphur dioxide emissions has already led to the installation of scrubbers at power plants and the progressive removal of sulphur compounds from fuels that will lead in 2020 to the International Maritime Organisation's controversial regulations on sulphur in marine fuels. The fudging of NOx and particulate matter (PM) emissions from diesel cars has been an ongoing scandal in North America and Europe, and here in London we are told that by February we had already exceeded our permitted annual emissions limits on NO_2. The result could be a ban on diesel vehicles from as early as 2030.

The fertilizer industry is already well used to limits on NOx emissions, and the nitric acid industry in particular has had to focus on N_2O, and over the past decade reduced its emissions by 90%. But as Antoine Hoxha of Fertilizers Europe reminded us at this year's Nitrogen+Syngas conference in Gothenburg, ammonia may be next in the firing line, courtesy, appropriately enough, of the Gothenburg Protocol, a 1999 EU agreement on 'Long Range Trans-boundary Air Pollution'. In both the European Union and United States there is now increasing concern about ambient ammonia levels in air. There is growing evidence that ammonia is a major factor in the production of aerosols of PM2.5 in urban areas – particulate matter with a diameter of less than 2.5 micrometers – which are responsible for premature deaths from heart and lung disease and which can trigger or worsen chronic disease such as asthma, heart attack, bronchitis and other respiratory problems. A study by the UK Department for Environment, Food and Rural Affairs' Air Quality Expert Group reckoned that 50-55% of all PM2.5s in the UK were produced by ambient ammonia.

The US reckons that between 65-85% of ambient ammonia in the air comes from agriculture. The EU puts the figure at closer to 90-95%. While it is acknowledged that much of this comes from manure and slurries, and that reducing emissions from these are mainly a question of improving farming practices, fertilizer application is also a major contributor. In particular, the breakdown of urea into nitrates releases volatilised ammonia, especially in warmer, wetter climates. The US also applies ammonia directly to the soil in a solution, which is also of course a major source of volatile ammonia. EU studies have shown that nitrate fertilizers such as calcium ammonium nitrate can release 75-85% less ammonia to the air than urea, and while applying urea as a solution does not appear to help, other mitigation methods may also work, such as coating with urease inhibitors or injection of urea into the soil so that it does not lie exposed on/near the surface. In the absence of this, up to 10-40% of nitrogen applied as urea can be lost to the air.

Last year the EU finally ratified the 2012 amendments to the Gothenburg Protocol, which set national emission reduction commitments for five main air pollutants, including nitrogen oxides and ammonia, as well as fine particulate matter, by 2020 (compared to a 2005 baseline) – ratification required two thirds of member states to have individually ratified it. EU ammonia emissions have fallen since 1990, but much of this is down to a reduction in dairy farming and consequent manure spreading. While the ammonia reduction target is only 6% to 2020, the figure for 2030 is 29%, and the PM figure 59%. Member states have until the end of June 2018 to individually implement the emissions directive and take steps designed to meet their targets. What impact this will have on the fertilizer industry is hard to judge. The experience of Denmark, which reduced ammonia emissions by 40% over the 2001-10 period, suggests that it is possible to achieve such targets with only changes to farming practice, but as always with the EU, it is hard to know for sure.

In the US, there is no specific regulation as regards ambient ammonia levels as yet, but its regulation and enforcement would naturally form part of the Clean Air Act. The US Environmental Protection Agency has been wary of proposing specific legislation, admitting that there are measurement issues and that "any regulation of ammonia under the Clean Air Act must address its impact on the sustainability of domestic and global food supply". With the Trump Administration having at best considerable scepticism about the EPA and its activities, the prospect of any regulation under the current government seems remote. Still, with ammonia now clearly in the sights of regulators, this is an area to watch. ■

Richard Hands, Editor

Environmental compliance

Across a 40 years journey as licensors and contractors, we have been committing to protect the environment through the continuous improvement of proprietary technologies, providing our customers sustainability without affecting profitability.

Eurotecnica Group long lasting reputation as prime technology provider engaged in the preservation of the environment through responsible design and innovative operational techniques, is an invaluable asset for our customers, partners, employees and shareholders.

EUROMEL® Melamine
The leading technology for the production of melamine.

ET Black™ Carbon
The technology of reference for producing all ASTM grades of carbon black.

ET Sun Energy™
The thermal energy storage technology for CSP solar power stations.

Ask for more information. Visit us on www.eurotecnica.it

HIGH-END TECHNOLOGIES BY EUROTECNICA

EUROTECNICA
MAKING SUSTAINABILITY PROFITABLE

CONTENTS

What's in issue 353

COVER FEATURE 1
The prospects for GTL

COVER FEATURE 2
Methanol markets

COVER FEATURE 3
Innovations in steam reforming

COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight

Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

Price trends

MARKET INSIGHT

Alistair Wallace, Head of Fertilizer Research, Integer Research, assesses price trends and the market outlook for nitrogen.

NITROGEN

The nitrogen market remained on a bearish footing in April, despite two early Indian tenders that awarded a combined 1.7 million tonnes of urea import business (600,000 tonnes to MMTC and 1.1 million tonnes to IPL). The long winter in the Northern hemisphere has dramatically curtailed consumption in the North American and European markets, with chronic rain and frost delaying the season and reducing spring buying of urea and nitrates in Europe and the US, as well as ammonia buying for direct application in the corn belt. This meant that despite the normally positive news of a 1.1 million tonne Indian tender, prices remained flat, with Russian and North African exporters chasing Indian business and competing on price with Iranian and Arab Gulf suppliers.

The Indian Potash Ltd (IPL) tender was issued on 3rd April and closed 10th April, with IPL confirming the purchase of almost 1.1 million tonnes of urea. A quarter of the urea is expected to be supplied by Iran (who supplied 419,000 tonnes under the previous MMTC tender), a quarter from the Arab Gulf producers and the balance from Algeria and Russia/Ukraine. Prices are $259.90/tonne c.fr for the west coast and $264.90/tonne c.fr for the east coast, roughly $12/tonne lower than those paid by MMTC in March.

Global urea prices dropped during April at most major benchmarks. However, maintenance closures allowed Arab Gulf granular urea prices to find some stability with Saudi Arabia's Sabic selling 50,000 tonnes in the low $250s/tonne f.o.b. under the 3rd April Ethiopian tender. In Qatar, Qafco's Qafco V unit shut down on 23rd March for four weeks.

Chinese urea operating rates continued to increase through March and April, rising from just under 50% at the start of the year to around 65% at time of writing. The low operating rates in Q1 2018 drastically limited availability and pushed domestic prices to $310-315/t at the start of the season. Now that urea output is increasing prices have begun to ease and with thermal coal prices and anthracite slack (powder) prices falling we should continue to see operating rates increase through the remainder of Q2 2018. China's tight domestic market and poor anthracite-urea economics mean that Chinese export availability remains limited, with just 300,000 t of urea exports shipped in Q1 2018. This is unlikely to change before the Chinese season ends in June/July, unless there is a structural downwards shift in the anthracite pricing.

In other urea supply news, Petrobras announced that it would be completely divesting its loss making, Brazilian nitrogen fertilizer portfolio. This will involve the sale of the partially constructed UFN-III ammonia-urea plant in Tres Lagoas, Mato Grosso, and its Fafen-PR plant in Araucaria, Parana. The remaining production assets; Fafen-BR and Fafen-SE in Bahia and Sergipe are scheduled to be closed and mothballed by October. Combined, the two plants scheduled for closure have a urea capacity of 1.1 million t/a. However, poor production economics and aging equipment mean that Brazil's urea capacity typically operates below 75% of nameplate capacity.

In the USA, construction was completed at Dakota Gasification's urea project in Beulah, North Dakota and the company announced that the plant had reached nameplate capacity during its commissioning phase. Dakota Gasification's urea plant will add 350,000 t/a of new urea capacity in the Northern Plains region (although as it is downstream of a pre-existing ammonia plant it will lower regional ammonia availability by almost 200,000 t/a). The 660,000 t/a Socar urea project in Azerbaijan has reported that it will begin commissioning in July 2018 and should begin commercial operations in September 2018.

In the ammonia market, prices continued their downwards trajectory in March and April. The Tampa contract price fell by $35/tonne at the start of March. Then, towards the end of March, the ammonia price fell by a further $30/tonne – taking the Tampa ammonia contract price to $275/tonne c.fr. Temporary maintenance shutdowns came to an end in February, leading to a decrease in price. Weaker demand from decreased US ammonium phosphate production has also contributed to the fall in Tampa pricing. Planned maintenance in the Arab Gulf tightened supply East of Suez, lending temporary stability to the market in April, as Ma'aden Phosphate Company (MPC) idled its 1.1 million t/a facility in Saudi Arabia in late March for 35 days, and the Qafco V facility closed on 23rd March for four weeks.

Ammonia supply in the US Gulf was boosted by the restarting of Caribbean Nitrogen Company's (CNC) Trinidadian ammonia plant in April after a nine-week outage. The plant had been idled during the renegotiating of terms on a new gas-supply contract between CNC and the government's gas monopoly NGC. Yara/BASF also announced the completion of their ammonia JV in Freeport, TX. The Yara/BASF plant will add almost 700,000 t/a of ammonia availability to the US Gulf ammonia market, and is expected to increase pressure on prices in May. ■

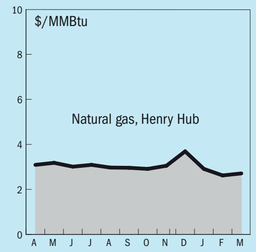
Table 1: **Price indications**

Cash equivalent	mid-Mar	mid-Jan	mid-Nov	mid-Sept
Ammonia ($/t)				
f.o.b. Caribbean	270	320	270	200
f.o.b. Arab Gulf	265-275	330-340	280-330	230-260
c.fr N.W. Europe	290-300	350-385	305-340	240-260
c.fr India	290-300	350-380	310-360	240-270
Urea ($/t)				
f.o.b. bulk Black Sea	232-238	215-225	240-250	224-234
f.o.b. bulk Arab Gulf*	253-263	242-250	259-264	227-232
f.o.b. bulk Caribbean (granular)	233-235	233-235	250-260	190-198
f.o.b. bagged China	305-315	285-295	268-272	248-255
DAP ($/t)				
f.o.b. bulk US Gulf	413-415	395	375	333-337
UAN (€/tonne)				
f.o.t. ex-tank Rouen, 30%N	158-161	160-165	159-164	141-143

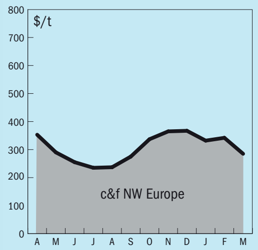
Notes: n.a. price not available at time of going to press
*n.m. no market * high-end granular*
Source: Fertilizer Week

END OF MONTH SPOT PRICES

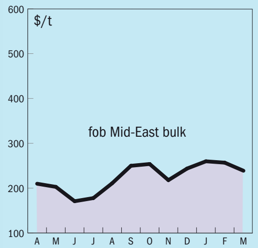
natural gas



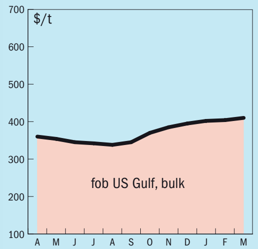
ammonia



urea



diammonium phosphate



MARKET INSIGHT

Mike Nash, Global Business Director, IHS Chemical, assesses the market for methanol.

METHANOL

Spot methanol prices fell in all regions in March, as MTO affordability remained in negative territory while global operating rates rose slightly due to restarts in the Middle East. Chinese natural gas-based production also improved and US production was more stable.

In the US, the official posted reference-prices from the major producers for April were $1.49/gal ($495/t) for both Methanex and Southern Chemical (both rollovers from March). Month-on-month weighted average spot prices in the US Gulf for March decreased by 8.34 cents/gal from February to $1.184/gal (nominal $394/t). IHS Markit Chemical's contract net transaction price for April was officially posted at $495/t.

Seasonal demand for MTBE picked up in the Americas as export demand into Europe and South America increased. Formaldehyde and acetic acid demand also improved. North American units operated at an overall rate of 84% by the end of March, up from 78% at the end of February, when there had been outages at Celanese/Mitsui and La Porte Methanol. Trinidad ran close to capacity, and Methanex's Chilean unit is estimated to have run at around 60% of capacity during March as gas availability improved. Venezuela's plants are estimated to have operated at around 63% of nameplate capacity at the start of March, declining sharply to 31% by the end of the month due to an operational issue at one unit and a turnaround at another.

In Europe, demand into formaldehyde was healthy in March, and a tight acetic acid market also prompted European units to run as hard as possible. Consumption into biodiesel improved slightly, supported by increased demand for road fuels. In terms of operations, Chemanol restarted at the beginning of March following a turnaround in February, but the one line at Sirte Oil in Libya that has been operating ran at reduced rates during March and then shut down in the same month following an explosion at the plant.

European spot prices (T2 f.o.b. Rotterdam) for March were down €24/t from their February level at €319/t over the month. Methanex posted its 2Q 2018 West European Contract Price at €380/t, f.o.b. Rotterdam T2, a rollover from the previous quarter's posted price. The ongoing suspension of duty on methanol arriving into the EU implemented by the European Commission is due to expire at the end of 2018. As yet, there is no guidance on whether the allowance will be extended or revert to previous levels.

In China, capacity utilisation rose in March compared to February to around 56% of nameplate capacity, or around 72% of effective capacity. A new 1.0 million t/a methanol unit, Hualu Hengsheng commissioned at the end of September 2017 and ran normally during March 2018. Coking gas-based methanol producers in North China ran at 41% utilisation in March on average and coal-based methanol plants in Northwest China ran at rates of 61-66% during last month, with environmental controls still in place. Some gas-based methanol plants in East China and Southwest China which were affected by seasonal natural gas restrictions restarted in March.

Methanol consumption for MTO increased in March, with operating rates averaging around 84%. Zhejiang Xingxing well following an eight-week outage in February. Several large MTO units in East China and inland China may take turnarounds in the second quarter. Formaldehyde demand improved after a lull over the Lunar New Year holiday. Operating rates for formaldehyde rose form 30% to 54% by the end of March. The formaldehyde sector typically welcomes its peak season in March. Chinese acetic acid average operating rates were assessed at 80% of total capacity with all plants running.

In Southeast Asia, there were operational issues towards the end of the month. Petronas's number two unit experienced unstable operations during the last week of March and will have a turnaround in April as well as during the 2H 2018. BMC operated normally for most of the month but then shut down at the very end of March. The unit will undergo a maintenance outage in April.

Asian prices in March traded lower by $22/t, in a weekly average low-high range of $372-383/t, c.fr, with Chinese prices in a range of $349-375/t. Methanex posted its Asia Pacific Contract Price at 460/t in April, a rollver from March. ■

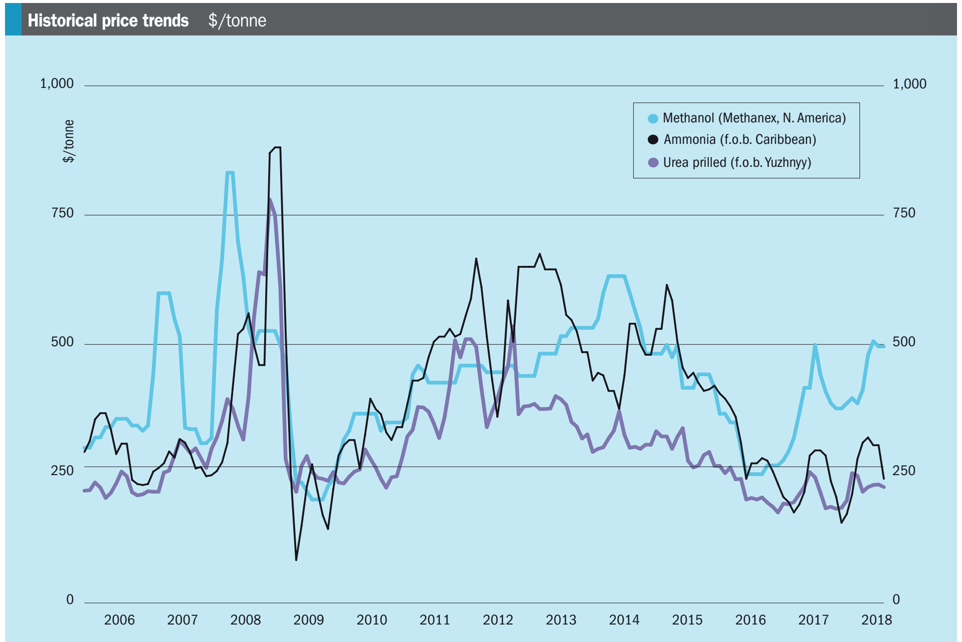
CONTENTS
What's in issue 353
COVER FEATURE 1
The prospects for GTL
COVER FEATURE 2
Methanol markets
COVER FEATURE 3
Innovations in steam reforming
COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

Market outlook



Source: BCInsight

AMMONIA

- Scheduled maintenance in the Arab Gulf, from Saudi Arabia and Qatar, limited the price drop over April. When plants restart in May the additional Arab Gulf availability will weigh on prices.
- The conclusion of the gas supply contract between CNC and NGS will add more supply to the market after the Trinidad company started ramping up production over April. Koch have been purchasing spot ammonia from Sorfert, Algeria, in the Interim as they usually lift CNC's ammonia.
- New downstream urea capacity at Koch Enid (OK), Nutrien Borger (TX) and Dakota Gas (ND) reduced anhydrous ammonia availability in Q1, however, the addition of Yara's 750,000 t/a ammonia plant will offset these losses and crate a net increase in availability this year.
- The supply/demand balance for ammonia will continue to loosen over the remainder of Q2, until demand picks up at the end of Q3 as the US begins the fill for the direct application season.
- The market is set for a bearish 2018, with the supply boost from May adding to downwards price sentiment and new Indonesian and Russian merchant capacity scheduled to start later this year.

UREA

- India's huge conclusion of 1.1 million tonnes in its second tender of 2018 did little for price sentiment of the urea market. And delays to application seasons in the US and Europe has added length to supply in the Atlantic and Mediterranean basins.
- The Chinese urea price has begun to fall and will continue to do so. Tight domestic supply means that Chinese urea has been selling at a significant premium to the major global f.o.b. benchmarks. Operating rates are expected to continue improving over the next three months.
- Capacity expansions in the US, and weak US demand, continues to be felt in the market. Dakota Gasification dispatched its first urea production in early April 2018 and US imports are expected to decrease this year.
- There is around 2.4 million t/a of new capacity still to commission this year, starting with Petrokemia Gresik's 570,000 t/a plant by June.

METHANOL

- Methanol prices continue to be at relatively high levels by historical standards, up almost 40% on a year ago, helping to push Methanex share prices to a 1-year high on expectations of a good first quarter and supported by methanol supply challenges and healthy demand, as well as low feedstock prices for natural gas.
- In Europe, the expectation of shutdowns during 2Q 2018 and typical seasonal highs in demand have helped support methanol prices, and some downstream markets such as acetic acid have seen seven year highs in pricing, keeping expectations buoyant.
- In Asia, a brief price rise looks set to be cut short by the restart of the Brunei Methanol Company facility after an unplanned outage. High inventories in China also looked to send prices lower in spite of some production outages. ■

INTRODUCING A NEW NAME IN INDUSTRIAL PROCESS SOLUTIONS

IPCO is a new name in Industrial Process solutions but a business partner with whom many in the fertilizer industry will already be familiar.

Previously operating as Sandvik Process Systems, we are now an independent company within the Wallenberg group, a business with approx. 600 000 employees and in excess of €140 billion in total sales of holdings.

We continue to develop customized solutions for the fertilizer industry, with the same people, skills and process systems – including our world-renowned Rotoform® pastillation process – but under a new name and brand.

Read more at ipco.com

ipco

CONTENTS

What's in issue 353

COVER FEATURE 1
The prospects for GTL

COVER FEATURE 2
Methanol markets

COVER FEATURE 3
Innovations in steam reforming

COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

INDIA

KBR and Toyo to develop large scale ammonia-urea complex

Toyo Engineering says that it has won a contract to build a large fertilizer plant complex at Gorakhpur in northern India as part of the Hindustan Urvarak and Rasayan Ltd (HURL) greenfield urea project. The order is valued at an estimated $753 million, and covers the construction of an ammonia plant with a capacity of 2,200 t/d and a urea plant with a capacity of 3,850 t/d. Imported liquefied natural gas will be delivered by pipeline as feedstock. Toyo Engineering will handle the design, materials procurement and construction of what will be the company's 16th urea development in India. KBR has been awarded the ammonia plant contract and will provide licensing and basic engineering design services for the ammonia section.

HURL is a joint venture comprising five large Indian public sector companies – Coal India Ltd (CIL), NTPC Ltd (NTPC) and the Indian Oil Corporation Ltd (IOCL), together with the Fertilizer Corporation of India Ltd (FCIL) and Hindustan Fertilizer Corporation Ltd (HFCL). It is hoped to become an important milestone for the Indian government towards self-sufficiency in urea production. The foundation stone of the project was laid by the Indian Prime Minister Narendra Modi in July 2016.

"We are pleased that KBR's ammonia technology has been selected for the first greenfield urea plant being set-up by HURL as part of this initiative by the government of India," said John Derbyshire, president, KBR Technology & Consulting. "This project will be an important milestone for India to meet its urea demand and KBR is honored and proud to be a part of this project."

"The HURL project at Gorakhpur shows the commitment and support of Government of India, Niti Aayog, Department of Fertilizer under Indian Ministry of Chemicals and Fertilizers and promoter companies, towards the Indian Fertilizer sector," said Arun Kumar Gupta, managing director, HURL. "We believe that with best technologies and project management practices, this project will fulfil our vision of growth, efficiency and building national self-sufficiency." ■

Matix Fertilisers aims to re-start production

Matix Fertlisers and Chemicals is hoping to re-start urea production at its plant at Panagarh in West Bengal, after the government has allowed coalbed methane producers greater flexibility in pricing and marketing of their gas. The Matix plant is able to produce 1.3 million t/a of urea at capacity, but has been idle for three years since its completion because of gas supply issues. The plant requires 2.4 million cubic metres per day of natural gas (84 million scf/d), which was to have been supplied by Essar Oil and Gas from its coalbed methane (CBM) production in the region. However, Essar has been able to produce only 0.85 million m^3/d. Another 0.15 million m^3/d can be sourced from another CBM producer, Great Easter Energy Ltd, and according to local press reports Matix is also looking at adding a propane plant which will supply a further 0.4 million m^3/d equivalent. In the meantime the plant will be able to run at 55-60% capacity. Now that a price of $8.00/MMbtu has been agreed with the CBM producers, this is expected to act as a stimulus to additional production.

UNITED KINGDOM

CF Fertilisers to revamp Billingham plant

CF Fertilisers is planning a two-year revamp programme for its Billingham ammonium nitrate (AN) plant, according to its UK subsidiary, at a total cost of £40 million ($56 million). CF Billingham site manager Keith Brudenell said that the move was a response to increased domestic demand in the UK, and would also allow the plant "to meet the challenges of the future… We are now the only company manufacturing high quality ammonium nitrate in the UK. Since CF Industries took a 100% holding in the site in 2015, demand has grown considerably and we are now developing the plant to keep pace with this and meet the challenges of the future."

The first priority is a £15.75 million ($22 million) project to upgrade and rationalise the Billingham high voltage electricity distribution network, including replacement of switchgear on the ammonia plant and upgrading those on the fertilizer production units. The new high voltage network will be 'state of the art' with a lifespan in excess of 40 years, giving the plant significant power security for future needs and making for more efficient production. The second major project is a £15.5 million ($22 million) upgrade to the ammonia plant designed to extend its life by 20 years. "This will involve replacement of the steam reforming equipment and gas transmission piping on the high temperature part of the plant and our aim is to complete the upgrade by 2020," said Brudenell. Finally, $11 million will be spent on replacing equipment items at one of Billingham's nitric acid plants.

Brudenell commented: "All in all, this is a real vote of confidence in the Billingham site and its team and for industrial chemicals on Teesside in general. It will allow us to continue the long history of ammonia and fertilizer manufacture at Billingham and make sure we are in the best shape possible to look after the needs of all our employees and customers as we approach our 100 year anniversary in 2023."

UNITED STATES

Greenfield Nitrogen looks to build 'grassroots' ammonia plant

Greenfield Nitrogen says that it plans to raise $120 million from Iowa farmers and retailers to build a regional anhydrous ammonia plant through grass-roots ownership in Garner, Iowa, which would produce about 120,000 short tons/year (109,000 metric t/a). Onsite storage will allow the company to sell and store up to 66,000 st (60,000 mt). The total cost of the plant is estimated at $220 million. A seed capital round has already raised $4.7 million. Greenfield says that the site is ready and permits are in place, with construction hoped to begin later this year and first production in 2020.

The company says that it is pursuing the development because the US continues to import more than 6 million t/a of nitrogen fertilizer, which is often shipped long distances to reach the Midwest. While there have been new domestic nitrogen plants in the US and Canada, these are now producing mainly urea or other nitrogen products such as UAN, which has left less net ammonia available. Greenfield predicts that after

CONTENTS
What's in issue 353
COVER FEATURE 1
The prospects for GTL
COVER FEATURE 2
Methanol markets
COVER FEATURE 3
Innovations in steam reforming
COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

2018, the Midwest could see a decline of up to 390,000 st/a in the domestic supply of anhydrous ammonia due to product upgrades, which the new project, located in the heart of the Corn Belt, would attempt to offset, supplying the agricultural community within a 100-mile radius. Greenfield says that the option remains open to develop downstream capacity at the site if the market changes.

Yara and BASF ammonia plant starts up at Freeport, Texas

Yara International and BASF have announced the start-up of their new joint venture world-scale ammonia plant in Freeport, Texas. The $600 million facility, Yara Freeport LLC, is 68% owned by Yara and 32% by BASF and is sited at BASF's Freeport complex. It has a capacity of 750,000 t/a of ammonia, and each partner will offtake ammonia according to their ownership share. Rather than natural gas, the plant is run on hydrogen off-gas from other nearby petrochemical plants, allowing it to avoid an expensive reforming section and considerably reducing the capital cost of the facility. A long-term supply agreement for hydrogen and nitrogen has been signed with industrial gases company Praxair, linking feedstock cost to the advantageous natural gas prices on the US Gulf coast.

BASF will use its share of ammonia to produce polyamide 6, which is commonly used in the production of carpet fibres, packaging and casings for the wire and cable markets. Polyamide 6 for injection moulding is used in high-performance engineering plastics for automotive applications. Yara will market its share of ammonia to industrial customers and the agricultural sector in North America. To support the new plant, Yara built an ammonia storage facility at Port Freeport, while BASF upgraded its existing terminal and pipeline assets.

"Together with our partners at BASF, we built a world-scale ammonia plant that not only raises the bar in terms of safety, efficiency and quality but also applies the principles of industrial symbiosis by using a by-product as feedstock for ammonia production," said Yara president and CEO, Svein Tore Holsether. "Yara Freeport strengthens our leading position in the global ammonia market and expands our production footprint in North America."

"This joint venture with Yara not only strengthens our production Verbund at the Freeport site, it demonstrates BASF's commitment to investing in North America," said Wayne T. Smith, member of the board of BASF SE and chairman and CEO of its US subsidiary. "The new plant allows us to take advantage of world-scale production economics and attractive raw material costs to strengthen the competitiveness of our customer value chain in the region."

RUSSIA

KBR to revamp Acron ammonia plant

KBR has been awarded a contract by JSC Acron subsidiary JSC Dorogobuzh to provide equipment as part of a revamp of the company's ammonia plant at Dorogobuzh in the Smolensk region of Russia. KBR previously received a contract from Dorogobuzh to license its proprietary ammonia technology to increase plant capacity to 2,100 t/d and improve efficiency. KBR is using its KBR Reforming Exchanger System (KRES™) in conjunction with a True Cold Wall Add-on Converter to achieve low project cost for the revamp at this site.

Work begins on Metafrax urea-melamine plant

Metafrax says that construction work has begun on the company's new AUM (ammonia-urea-melamine) plant at its Gubakha site. According to the company, concrete pouring of 2,000 cubic metres of concrete into the base of the urea prilling tower began on March 2nd, and on March 19th, specialists from the main engineering contractor Uralenergostroy completed erection works of the tower's base plate. The urea prilling tower will be the tallest structure of the new plant, at a height of almost 100 meters. Delivery the cast formwork for the construction of body of the tower is due to in April, and Metafrax says that its construction should be completed in July this year. Work is also under way to lay underground water and waste water systems. Overall completion is expected in 2021. Once operational, the plant will produce 300,000 t/a of ammonia, 575,000 t/a of urea and 41,000 t/a of melamine. Casale is the main project licensor and contractor.

TRINIDAD & TOBAGO

CNC reaches gas deal

The Caribbean Nitrogen Company Ltd (CNC) says that on April 1st this year it finally signed a new gas purchase agreement with the National Gas Company of Trinidad and Tobago Ltd (NGC). CNC's ammonia plant at Point Lisas has been shut down since negotiations broke down between the two companies in January over the price of gas feedstock. The previous contract had come to an end in October 2017 and after several extensions in order to reach agreement on a new contract, when none had been forthcoming by January, NGC finally turned off the gas supply.

In a joint statement issued on Easter Monday, NGC and CNC said they "have resolved all outstanding issues and reached agreement on the key commercial terms of a new gas sales contract, that are beneficial to both parties and to Trinidad and Tobago." Gas began flowing again and the plant has reportedly started up again in early April.

TANZANIA

Gas supply stalling urea plant development

The development of a greenfield urea project in East Africa has stalled because of lack of natural gas. The $1.5 billion dollar plant is to be located at the port of Mtwara on Tanzania's coast, about 300km south of the capital, Dar es Salaam. It was first mooted in 2012, and by 2016 had attracted investors and developers in the form of German companies Helm AG and Ferrostal Industries and Capital DW Fertiliser Company of Egypt. The proposed plant would produce 2,200 t/d of ammonia and 3,850 t/d of urea, and a 400 ha site has been allocated for it. However, a price for natural gas has still yet to be agreed with the Tanzania Petroleum Development Corporation. At the moment the price for gas stands at $2.60/MMBtu, but the investors deemed this too high to support the expense of developing a greenfield export site.

CANADA

Fine for UAN spill at Vancouver

A barge company has been fined $18,000 for spilling 40,000 gallons of liquid urea ammonium nitrate (UAN) into the Snake and Columbia rivers in Washington State, US and Vancouver, Canada. An investigation by the Washington Department of Ecology found that two steel tank barges owned and operated by Tidewater Barge Lines, Inc., were not properly maintained, causing the liquid fertilizer to spill into the rivers during three separate incidents in April 2017.

The first spill occurred between April 11 and 21 during transfer and storing operations at the Tidewater Snake River Terminal in Pasco. Investigators determined that 16,639 gallons of urea ammonium nitrate were released by Barge No. 78 because the storage tank was corroded. The second spill occurred between April 20 and 24 during a transfer operation as the barge transited and moored on the Columbia River near Vancouver. Investigators determined that 22,104 gallons of urea ammonium nitrate were released by Barge No. 74 because that storage tank was also corroded. The third spill was reported on April 28 and occurred in the preceding days during transporting operations on the Columbia River near Vancouver. Investigators determined that 950 gallons of urea ammonium nitrate were released by Barge No. 74 because the side shell of the tank was damaged.

"These spills were preventable through proper maintenance of the barges," says Rich Doenges, the WDE's water quality section manager. "While it dispersed rapidly in the Columbia and Snake rivers, urea ammonium nitrate fertilizer can stimulate plant and algae growth in water, which could impact fish and wildlife."

Along with the fine, the company is required to take immediate action to prevent future urea ammonium nitrate releases and submit to the WDE an annual comprehensive corrosion management plan for its barges. Detailed cleaning and inspection processes will help ensure the integrity of the steel plates and welds within the barge tanks. Tidewater Barge Lines has 30 days to pay the penalty or appeal it to the state's Pollution Control Hearings Board.

AUSTRALIA

Rock art could force AN plant move

The discovery of ancient Aboriginal rock art on the Burrup Peninsula in Western Australia has put the future of the Yara Pilbara ammonia and ammonium nitrate plants into question over the potential effects of industrial emissions on the rocks. A Federal Senate committee set up to inquire into the matter has published a report but divided along party lines in terms of its recommendations. Their inquiry arose from a claim that acid deposition limit recommended by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) was flawed because it relied on research that looked at the sensitivity of ecosystems, rather than rock, to acidic deposits. Australia's Green Party has expressed serious concern with current emissions levels and monitoring and recommended some significant steps in their own list of 15 recommendations, including moving the Pilbara AN plant to the Maitland Strategic Industrial Area and a bar on further industrial development on the Burrup Peninsula. Green senators also recommended emission levels from all industry and shipping in the area should be reduced to zero within one year, and measurements of existing emissions be established "as a matter of priority", stating that there has been "evidence of damage to the Burrup Peninsula rock art for many years." The Labour party senators recommended that the Western Australian state government work with Yara Pilbara to improve compliance, investigate how industrial emissions on the Burrup could be reduced and only approve further industrial development in the area "under strict environmental conditions". They also recommended, in conjunction with the Greens, that the site be put forward for World Heritage Site status. Senators from the Liberal-National Coalition made no recommendations, instead arguing that there was a lack of evidence to show emissions were adversely affecting rock art, and disputing the reliability of several scientific reports submitted to the committee.

CHINA

Stamicarbon licenses new urea plant

Stamicarbon has been awarded a contract to license technology and deliver proprietary equipment for a new grassroots urea plant being built by Hubei Sanning Chemical Industrial Co., Ltd. The plant, with a capacity of 2,330 t/d, will be built in Zhijiang, Hubei province, and represents Stamicarbon's second license award in China in the past year. The plant will use Stamicarbon's Ultra-Low Energy Design, which claims a 40% reduction in steam consumption in urea plants compared to conventional technologies, leading to significant reductions in energy costs and operating expenditure, whilst also reducing the carbon footprint substantially in comparison with other types of urea plants. The scope of the contract includes license, process design package and delivery of high pressure equipment and associated services for the urea plant, including a *Safurex®* pool reactor. The finishing will be prilling. Start-up of the plant is expected at the end of 2019.

Hubei Sanning Chemical Co., Ltd was founded in 1970 and since 2007 has operated as a subsidiary of Shanxi Jincheng Anthracite Mining Group Co., Ltd. ■

CONTENTS
What's in issue 353

COVER FEATURE 1
The prospects for GTL

COVER FEATURE 2
Methanol markets

COVER FEATURE 3
Innovations in steam reforming

COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight

Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

UNITED STATES

Methanex looking at new North American methanol plant

Methanex says that it is looking to build another new methanol plant in North America, and has narrowed down its options to two brownfield sites, one at Geismar in Louisiana in the United States, where the company has relocated two 1.0 million t/a methanol plants from Chile, and the other at Medicine Hat, Alberta, Canada, where Methanex also has a 600,000 t/a methanol plant which restarted in 2011. Methanex estimates the cost of building a new 1.75 million tonne/year plant at Geismar at $1.0-1.6 billion, although the option remains open of relocating a third plant from Chile, where Methanex still has an idled facility in addition to the one train still operating at Punta Arenas. Natural gas prices, the key determinant of final methanol cost, could favour the Canadian option – gas prices are actually cheaper in Alberta than they are in Louisiana as the US shale gas boom spreads north of the border. Methanex says that the cost of natural gas in Geismar is around $3.00/MMBtu, compared to around $1.70/MMBtu in Alberta. However, as the plant would probably be aimed at exporting methanol to China, the landlocked Medicine Hat site compared unfavourably to Geismar, which sits on the Mississippi River. Tax breaks offered by local authorities could also play a part in swinging the decision one way or another. However, Methanex says that no final investment decision will be made until next year, with construction potentially beginning in late 2019 and plant start-up slated for 2022-3.

Kalama methanol plant facing new EIS

The Chinese-backed Northwest Innovation Works (NWIW) methanol project at Kalama in Washington State continues to face a troubled permitting process after opposition by local environmental groups led to the state shoreline hearings reversing its decision on a development permit in September last year. The $1.8 billion, 1.65 million t/a plant (in a first phase, with a conceptual second identical phase to follow) would use cheap US shale gas to produce methanol for export to China for use in methanol to olefins (MTO) manufacture. However, the project has run into issues over its CO_2 signature. The company has relied on an innovative flowsheet from Johnson Matthey which attempts to minimise CO_2 generation during the methanol production process. NWIW also argues that by displacing Chinese coal-based methanol capacity, the facility will actually reduce global greenhouse gas emissions overall. However, the initial environmental impact statement (EIS) has been called into question, and the company is now working on a 'supplemental EIS' which will consider life cycle CO_2 costs from gas well to final plastic manufacture. A 30-day public comment period on the scope of the supplemental EIS closed on March 1st. The local environmental coalition called for the scope of this to be widened to include all manner of calculations, including how much plastic would make its way into the oceans, but as these lie outside the scope of the permitting decision, they are likely to go unheeded. While Kalama's new mayor has a platform of opposing the development, the city council and Port Authority continue to back the development, which would create 190 permanent jobs and 1,000 construction jobs, according to its original EIS.

PHOTO: NATGASOLINE

The new Natgasoline methanol plant at Beaumont, Texas.

Largest US methanol plant to start up in May

Meanwhile, in Louisiana, America's newest methanol plant is preparing for start-up. Press reports suggest that Natgasoline's 1.75 million t/a methanol plant in Beaumont, Texas will be commissioned during late April or May, around six months after its target date, after delays caused by Hurricane Harvey last year and harsher than expected winter weather. The facility will be the largest methanol plant in the United States, larger even than the projected NWIW phase 1. Natgasoline is owned jointly by Dutch fertilizer producer OCI and methanol developer G2X Energy. The Natgasoline plant will take US methanol capacity to 7.5 million t/a, up from just 2.25 million t/a in 2014.

NETHERLANDS

Waste gasification plant for Rotterdam

AkzoNobel and Enerkem are part of a consortium aiming to build a €200 million ($178 million) waste to chemicals plant at the port of Rotterdam. Other participants include Air Liquide and the Port of Rotterdam. The plant will use fluidised bed gasification to gasify 360,000 t/a of waste to produce syngas which will in turn be converted into 220,000 t/a of methanol, according to the project sponsors. The project, which will be built in the Botlek area of the Port of Rotterdam, will use Enerkem's proprietary technology, developed at their Edmonton, Canada commercial waste gasification facility. The project is also being supported by the Dutch Ministry of Economic Affairs and Climate Policy, the Province of Zuid-Holland and InnovationQuarter, the development agency for the region.

Marco Waas, director of research, development and innovation at AkzoNobel, said a recent investment agreement by the partners was an important milestone for the project. "We can convert non-recyclable waste into methanol, an essential raw material for many everyday products, including sustainable transportation fuel." He added that converting non-recyclable waste into methanol would replace fossil fuels and cut the CO_2 emissions that would otherwise be created by burning the waste.

The chief technology officer for AkzoNobel, Peter Nieuwenhuizen, said that all parties were now ready to go "full steam ahead towards a final investment decision later this year. We have made vital progress in the past months. The partners have agreed to their contributions and roles, we are very pleased with the collaboration with the Dutch government," said Nieuwenhuizen.

INDIA

Oil India takes stake in methanol project

State owned Oil India Ltd (OIL) has agreed to take a 49% equity stake in Assam Petrochemicals Ltd (APL), which is developing a methanol and formaldehyde project in Assam state. A memorandum of understanding (MoU) was signed between the state government of Assam, OIL and Assam Petrochemcials which envisages setting up of a 500 t/d methanol plant at Namrup, Assam and a 200 t/d formaldehyde plant at Boitamari in the Bongaigaon district of Assam. The total cost of this project will be $205 million. Oil India's contribution will be $37 million for its 49% equity participation in APL.

IRAN

Start-up for Kaveh

The Iranian National Petrochemcial Company says that it has begun commissioning its massive 7,000 t/d Kaveh Methanol Complex in the port city of Bandar Dayyer, Bushehr Province, has started methanol production. NPC director for projects Ali Mohammad Bosaqzadeh told local media that the complex has completed trial production, during which output reached 2,000 t/d, and that the air separation unit which provides oxygen to the plant was due to start up in a few days' time. The plant's output at full capacity of 2.3 million t/a makes it the largest methanol plant in the world.

JAPAN

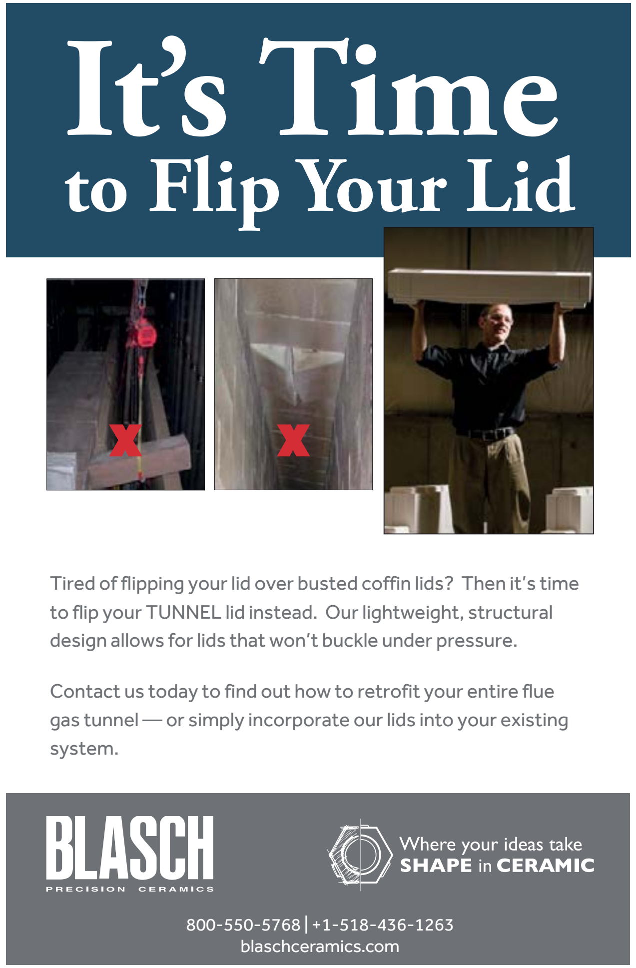
Coal gasification plant for Fukushima

Japan's Mitsubishi Hitachi Power Systems (MHPS) has begun construction work on a new coal gasification plant at Fukushima for Nakoso IGCC Power. The gasifier will form the core of the new 540 MW integrated coal gasification combined cycle (IGCC) power plant at Iwaki in Fukushima prefecture. It is due to be operational by September 2020. MHPS is assembling the components at its Nagasaki plant, which was commissioned in 2017, while shipments to the construction site are scheduled to start in June 2018. MHPS says that this will be the "world's most advanced coal-fired power plant" upon completion, contributing to the revitalisation of Fukushima prefecture following the nuclear accident in 2011. A consortium led by MHPS was awarded the turnkey lump sum construction contract in 2016 by Nakoso IGCC Power GK and Hirono IGCC Power GK to build two IGCC plants, each with a capacity of 540 MW. The two power plants are planned to be commissioned in September 2020 and September 2021, respectively. The consortium also includes Mitsubishi Heavy Industries (MHI), Mitsubishi Electric Corporation, and Mitsubishi Hitachi Power Systems Environmental Solutions.

LIBYA

Explosion shuts down methanol plant

A natural gas leak at the Sirte Oil Company's Marsa el-Brega methanol plant in Libya led to an explosion and fire in mid-March which injured one worker and caused plant operations to be suspended. The plant will remain shut until safe operations can be guaranteed, according to the Sirte Oil Company. The leak occurred in a natural gas heating unit, Libya's National Oil Corporation (NOC) said.



CONTENTS
What's in issue 353
COVER FEATURE 1
The prospects for GTL
COVER FEATURE 2
Methanol markets
COVER FEATURE 3
Innovations in steam reforming
COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

People

The Gulf Petrochemicals and Chemicals Association (GPCA) has announced the re-election of chairman **Yousef Al-Benyan**, for a new three-year term. Al-Benyan is vice chairman and chief executive officer of the Saudi Basic Industries Corporation (SABIC), and was elected as GPCA Chairman in May 2016, having previously served on GPCA's Executive Committee.

A new board of directors was also announced during GPCA's annual general assembly which took place on 5th March 2018 in Dubai. **Dr. Abdulrahman Jawahery**, president of Gulf Petrochemicals Industries Corp (GPIC), was elected as GPCA's vice chairman, effective immediately, while **Dr. Mohammed Al Mulla**, managing director and CEO of the Qatar Petroleum Corporation (QAPCO), was re-elected as treasurer, both of whom will serve on GPCA's Executive Committee.

Abdulaziz Judaimi, senior vice president, Downstream, Saudi Aramco; **Jamal Malaikah**, COO and CEO, Natpet; **Ahmad Al-Ohali**, CEO, Sipchem; and **Abdulrahman Al-Suwaidi**, CEO, QAFCO, were re-elected as members of GPCA's Board. **Said M. Bajodah**, CEO, Saudi Chevron Philips Company; and **Hazeem Al Suwaidi**, CEO, ADNOC Fertilizers, joined the board for the first time. Oman's seat continues to be represented by **Ahmed Saleh Al Jahdhami**, CEO, Orpic.

Dr. Abdulwahab Al-Sadoun, Secretary General, GPCA commented, "With nearly 30 years of experience spanning the Middle East, the Americas and the Far East, Yousef Al-Benyan has made significant contributions to the association and by extension – the regional industry – as Chairman of GPCA. I welcome his re-election and take great assurance that he will continue to lead GPCA with unmatched professionalism and dedication. I would also like to thank the outgoing Board Members for their valuable contribution to advancing GPCA's strategic vision and welcome the newly elected members to GPCA's Board. Together I am confident that we will continue to foster GPCA's key values of advocacy, networking and thought leadership."

The board of Fauji Fertilizer Company has appointed Lt Gen **Tariq Khan**, (Retd) as chief executive and managing director, with effect from March 27th. Lt Gen Khan replaces Lt Gen **Shafqaat Ahmed** (Retd). Lt Gen Khan thanked the board for by electing him and gave his appreciation for the services of Lt Gen Ahmed, praising his "outstanding standards of dedication, passion and utmost energy which infused a new spirit into the company".

Combustion systems and NOx emissions control company Fuel Tech, Inc. has appointed **Sharon L. Jones** to the company's board. Ms. Jones will serve as an independent director and her appointment increases the size of Fuel Tech's Board to six members. She previously served as Aircraft Protection Vice President and Site Lead for Orbital ATK, which designs, builds and delivers space, defence, and aviation-related systems, and before Orbital ATK's 2014 merger with Alliant Techsystems, Inc. she held a variety of senior leadership positions at Alliant, including technology vice president, manufacturing director, environmental, safety and security director, and engineering, quality assurance, and employee safety and security. Ms. Jones began her career as a research chemist at Dow Chemical Company in 1982. She holds an MBA degree from the University of St. Thomas, and a BSc in chemistry and MSc in analytical chemistry from the South Dakota School of Mines and Technology.

"Sharon's exceptional record of professional achievement in change management, operations, engineering and new product development, along with her educational background, make her an ideal addition to Fuel Tech's Board of Directors," said Vincent J. Arnone, chairman, president and chief executive officer. "We are fortunate to have her as part of the team, and expect to benefit from her counsel and informed judgement." ■

Calendar 2018

MAY

8-9
IFS Technical Conference,
PRAGUE, Czech Republic
Contact: International Fertiliser Society,
PO Box 12220, Colchester,
CO1 9PR, United Kingdom.
Tel: +44 1206 851 819
Email: secretary@fertiliser-society.org

17-18
European Conference on Sustainable Ammonia Solutions,
ROTTERDAM, the Netherlands
Contact: Stichting NH3 event Europe,
Karel Doormanweg 5,
3115 JD Schiedam, the Netherlands
Tel: +31 10 4267275
Email: nh3event@protonventures.com

JUNE

18-20
85th IFA Annual Conference,
BERLIN, Germany
Contact: IFA Conference Service,
28 rue Marbeuf, 75008 Paris, France.
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org

SEPTEMBER

16-20
63rd AIChE Annual Safety in Ammonia Plants and Related Facilities Symposium,
TORONTO, Canada
Contact: AIChE Customer Service
Tel: +1 800 242 4363/
+1 212 591 8100
Fax: +1 212 591 8888
Email: xpress@aiche.org

16-21
Ammonium Nitrate/Nitric Acid Conference,
CALGARY, Canada
Contact: Hans Reuvers, BASF
Karl Hohenwarter, Borealis
Email: johannes.reuvers@basf.com
karl.hohenwarter@borealisgroup.com
Web: www.an-na.org/2018-conference

OCTOBER

5-6
36th Annual World Methanol Conference,
VIENNA, Austria
Contact: Lynn Urban, IHS Markit
Tel: +1 303 397 2801
Email: Lynn.urban@ihsmarkit.com

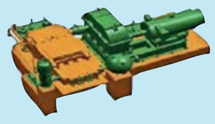
23-25
IFA Crossroads Asia-Pacific Conference,
SINGAPORE
Contact: IFA Conference Service
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org

28-30
Gasification and Syngas Technologies Meeting, COLORADO SPRINGS, USA
Contact: Gasification and Syngas Technologies Council,
3030 Clarendon Blvd. Suite 330
Arlington, VA 22201 USA.
Tel: +1 703 276 0110
Fax: +1 703 276 0141
Email: info@gasification-syngas.org
Web: www.gasification-syngas.org

Plant Manager+

Problem No. 48 Seal systems of high pressure reciprocating pumps

There is a lot of misunderstanding about the purpose and functioning of the seal systems (stuffing box) of the high pressure (HP) ammonia and HP carbamate reciprocating pumps. Some believe that lubrication is the main purpose, while others feel it is all about sealing. Both views are partly true. And for the HP ammonia pumps the objective is also to maintain the possibility to retighten the packing when ammonia starts to leak through the stuffing box. The stuffing box consists of the plunger, the casing, the high and low pressure packing assemblies, the glands and the seal system, either oil or water. This round table discussion is all about the experiences of various end users.



Pump unit KD 827.

Mr Mien Pin Chin from Asean Bintulu Fertilizer in Malaysia initiates the discussion: Can anyone tell me why our Uraca HP reciprocating carbamate pump requires two seal-water injection points for the plungers – one nearest to the plunger, which is supplied by a centrifugal pump, and another injection point nearest to the discharge, where the seal water is injected by an attached injection pump (positive displacement (PD) type)? Why can't we just use the seal water from the PD injection pump? Why add another injection point supplied by a centrifugal pump? As for the NH_3 pump plunger seal oil, why can't we use water? Will it cause corrosion problems in the discharge piping?

Mr Mahmood Rauf Zafar from Fauji Fertilizer Company in Pakistan has a similar question and explains his issues: I would also like to change the HP ammonia pumps plunger sealing to water instead of seal oil for the following reasons:

- The seal oil recovery system is large i.e. three oil tanks, one centrifugal pump, two seal oil return lines and one supply line.
- The recovery of ammonia losses from seal oil is difficult – ammonia is being vented locally. Land contamination by oil drained from vessels during plant shutdowns and during vessel handover is difficult.
- Poor performance of heat exchangers due to oil contamination.

Would anyone like to share their problems with seal water or any available literature? Which is more cost effective, oil or water?

Mr Muhammad Farooq from SABIC-Safco in Saudi Arabia replies: It needs to be considered on a case by case basis as there are questions around both carbamate pump water seal systems and ammonia pump oil seal systems:

HP ammonia pump: Many pump vendors use a water seal system for their ammonia pump (PD). Why? Will it cause corrosion? Is it is due to the quality of the water or something else? The ammonia pump oil seal system can be changed to a water seal system. It is economical and ammonia can be recovered. I would be interested to hear more about Mahmood's experiences as we don't have any ammonia losses or oil contamination issues.

HP carbamate pump: Sealing from the PD pump on the discharge line may be to counter the change of discharge pressure as the centrifugal pump cannot meet the pressure requirements because the system has a PD Uraca pump, whereas the centrifugal pump is only used to counter carbamate leakage from the plunger sealing and the pressure requirement is less as it is only a seal leak.

Mr Girish Prakash of Yara (former Tata Chemicals Ltd.) in India shares his experiences: Water sealing on ammonia pumps is now a standard feature. It has plus points in that it eliminates expensive lube oil consumption and problems of occasional oil carry-over in the process leading to faulty level gauge indications in the medium pressure absorber. Sometimes even product quality may be affected due to this. The negative aspect is a slight increase in the waste water section load due to additional ammonia water from the plungers. Periodic tightening of the plunger packing plays an important role in keeping the ammonia content in the outlet condensate under control. Only steam condensate/boiler feed water should be used for plunger sealing/flushing.

Mahmood has another question: Please share the boiler feed water flow requirement and temperature. We have Uraca ammonia pumps.

Mien also comes back with more information: For the ammonia pump, the idea of changing from seal oil to seal water is not readily accepted by some people and therefore I hope to get more clarification. My questions are:

- When you mention that water sealing is a standard feature on ammonia pumps does that mean new pumps have water sealing or were you able to modify the existing pumps by changing their seal system from oil to water?
- Are there any differences in the material for construction for pumps using seal oil compared to those using seal water?
- For the seal water, does demin water have to be used? Our desorption system is already overloaded due to a number of revamps and the idea was to use ammonia water from the ammonia water tank so that no extra water is introduced into the system.
- For those using seal water for the ammonia pump, is there any effect on the urea conversion at the reactor? (The point made by other engineers is that the more water that goes to the NH_3 water tank,the more water will be sent back to the synthesis, reducing conversion).
- Were you able to handle the extra ammonia water without pumping more to the synthesis via the carbamate pump?

Girish replies: The boiler feed water flow requirement is roughly around 0.11-0.15 m^3/h/plunger. So if you have three plungers then the total requirement is around 0.45 m^3/pump. The temperature should be around 40°C. You can modify the existing oil seal pump to a water seal pump. You should preferably use clean and cold condensate for sealing purposes.

CONTENTS
What's in issue 353
COVER FEATURE 1
The prospects for GTL
COVER FEATURE 2
Methanol markets
COVER FEATURE 3
Innovations in steam reforming
COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

Mr Mark Brouwer UreaKnowHow.com in the Netherlands shares his experiences: Most important is to use solid-free water. If it contains some ammonia it is not a problem. It is therefore better to have stainless steel lines for the water supply. The stuffing box also needs to be changed when switching from oil to water seal.

Muhammad shares his experiences:
HP carbamate pump: Judging from your information it means that your PD injection and centrifugal pump are both in service when the carbamate pump is in operation? That means that the cylinder arrangement is such that it requires sealing at both ends as one pump may not be sufficient to lubricate (water seal) the complete cylinder. Moreover, most probably there are outlets at both ends. If you want to keep one pump in service then you might need to modify the cylinder sealing arrangement (a mechanical expert can give a better opinion).

HP ammonia pump: For the HP ammonia pump many agree that a water seal is a better solution than an oil seal. We are also planning to change one of our PD ammonia pumps from oil to water seal in the near future. The water quality (steam condensate) is important. Most vendors adopted water seals in the 1990s and initially they had oil sealing. As far as material of construction is concerned we need to contact the vendor. We believe, however, it requires only stuffing box/lantern ring modifications. The provision of a filter may also be considered for seal water injection applications. The leakage rate is minimal having possibly a very minor impact on the desorption section. And since water is removed from the desorption section as process condensate, in my opinion, it is not going to affect the reactor conversion.

Mahmood provides his experiences: In my opinion, ammonia pumps with water sealing have the following advantages over oil sealing: No recycling arrangement is required (oil passing into the process cannot be eliminated), whenever you open exchangers they will be clean, no environmental problem of vessels draining, no inventory problem with water, and finally improved exchanger capacity especially in the process condensate treatment section. In my experience reducing the number of equipment items and machines is helpful for both plant operation and maintenance.

Mien replies: As regards the effect on urea conversion, the argument made was that currently we are using oil sealing so only oil gets entrained in the HP stripper, HPCC and finally the reactor. If we switch to water, water will be entrained in the synthesis instead so we will have more water in the mixture and it will reduce the urea conversion. Will this actually happen? What urea conversion is achieved in plants that are using water as their sealing water? Is there any reduction?

Mark explains the difference between water seals for ammonia and for carbamate pumps: Please be aware that there are two types of water systems. For reciprocating HP NH_3 pumps one applies a water seal system: water acts as a seal between packing rings on the process side (high pressure side) and packing rings on the atmospheric side of the plunger (low pressure side). Any water entering the process side is caused by leakage through the high pressure side packing rings, which is a minimal amount and does not visibly influence the conversion figures in the reactor. For reciprocating HP carbamate pumps a water flush system is applied: here water needs to flush along the spindle between the high pressure side and the low pressure side in order to wash away carbamate crystals. Here one can expect more but still a limited amount of water entering the process side.

Girish replies: I fully agree with you, however, in case of the ammonia feed pump, the contaminated seal water quantity theoretically is close to 0.5 m³/pump (for 3-plunger pump) but in practice (for higher packing life) it is close to 0.75-0.8 m³/pump and often compromises are also made for higher ammonia content in the seal water outlet. All water collected is processed in the waste water section and increases the ammonia load in the top section of the column. As a result, very marginal increase in process water recycle to the synthesis section is observed. Its impact on conversion is very small and cannot be measured for all practical purposes.

Mr Joseph Geronimo of Chemac Inc. in United States replies to Mien's original questions: Carbamate as we know is a difficult medium being highly corrosive and quite abrasive. As such in order to prolong packing and plunger life, Uraca has incorporated a timed flush injection in their carbamate pumps. That means the small PD pump coupled directly to the main pump crankshaft must be installed so injection occurs when the main pumps plungers are in suction stroke. When timed correctly the small PD pump injects a small amount of condensate directly on the plunger while it is retracting to BDC (bottom dead center). The small PD pump must only overcome suction pressure to inject condensate which will flush clean the plunger and also prevent carbamate from contacting the packing. This design works and packing life should be one year or more depending on how well you maintain your pump. Regarding seal oil for low pressure packing, this is an old design however many customers prefer this due to the fact that the packing will last longer sometimes up to two years or more. The seal oil must be metered such that you only overcome the suction pressure so oil can enter the chamber. Adding too much oil is a waste. If you want to eliminate the oil flush you will need new stuffing boxes designed for condensate only.

Mr Janusz Maćkowski from ZCh Police in Poland joins the discussion: We would like to change from an oil seal system to a water seal system for reciprocating HP NH_3 pumps. Which European companies are able to make such modifications and where has this already been done?

Muhammad replies: You can check with Peroni, an Italian company and they can also provide you with references for these modifications.

Janusz asks for some more information: How can we check if lubricating oil for rotating equipment (especially HP ammonia pumps) may be used in urea plants? What is the correct specification (requirements) for such lubricating oils?

Mark replies: In the past Stamicarbon had a specification for the oil quality requirements for use in urea plants. What is important here is the residue content of the oil when heated (simulation of stripper conditions). Have you had oil fouling problems? Optimised designs have been developed to avoid oil fouling in the top of the HP stripper, radar level measurements and in control valves (stuffing box).

Janusz responds: We have found oil fouling on the top of the stripper in the area of the liquid divider ferrules. I am wondering whether this contamination could have come from the CO_2 compressor by accident. ■

Methanol: China in the driving seat

Methanol has been the fastest growing syngas derivative for some years now, and will be almost 1/2 the size of the ammonia market by 2020. Although new capacity additions are slowing, methanol to olefins production in China continues to drive the market, while new US capacity additions will see it become a net exporter by 2019.

While ammonia markets have grown at an average rate of about 2% from 2011-2016, over the same period methanol markets increased by 7-9% year on year. This amazing rate of growth has seen the methanol market increase from just over 50 million t/a in 2011 to over 80 million t/a in 2017. However, virtually all of the incremental demand has come from China over that period; China has sought to monetise its huge coal reserves in order to displace imports of crude oil and various chemicals, including ammonia and methanol, beginning with fuel uses; first dimethyl ether (DME) blending into LPG, and then methanol blending into gasoline. However, methanol to olefins (MTO) for plastics production is now taking over as a massive growth area.

Chemical uses

Downstream chemical uses still represent 55% of methanol demand, but that share is falling rapidly as fuel and olefins uses come to dominate the market. This sector of the market is mature and is growing at a relatively slower rate of about 3% year on year. The backbone of the methanol industry was traditionally its use in formaldehyde production, as a route towards urea-formaldehyde and other resins for wood products (fibreboard etc) and to a lesser extent the automotive industry. In spite of some concerns about potential carcinogenic properties, growth in formaldehyde demand currently continues to roughly track GDP, and is forecast to rise at about 2.5% per year over the next five years. China is the largest single market for formaldehyde, representing about 45% of demand. A faster growing use has been acetic acid, with use mainly (90%) spread between China and industrialised Asia, the US and Western Europe. Vinyl acetate monomer (VAM) is the largest end use for acetic acid in the four regions and constitutes 30% of acetic acid, consumption, for use in adhesives and coatings. Other major uses include purified terephthalic acid (PTA) for the manufacture of resins, fibres, and films, and acetic anhydride. Chinese acetic acid consumption is rising by about 5% per year, and global consumption 3-4% per year. Finally, methyl methacrylate (MMA) is widely used in the production of resins for injection moulding and extrusion, coatings and adhesives. Growth is about 3% year on year. In 2013, China surpassed the United States as the largest MMA consumer in the world. By 2020, Chinese MMA consumption will account for about 25% of world consumption.

Fuel and olefins

While chemical uses are rising at about 3% per year, most new methanol demand has come from its increased use in fuels and olefins production, primarily in China. While DME blending into LPG has reached a mature level in China, gasoline blending of methanol at 10 or 15% (and in some cases 30, 40, 85 and 100%) currently is only licensed in 16 provinces, and a national standard has proved elusive. Nevertheless, the spread of methanol fuel blending continues, and the M85 and M100 standards are now adopted in five provinces with more planning to follow. As well as vehicle fuels, China has also begun to look at methanol as a domestic and industrial fuel, replacing coal in industrial boilers as a low pollution feed as the government asks users to switch from coal to gas for heating. In the residential sector, demand is growing, with methanol being used as a household heating fuel by some homes in North China. In the winter of 2017, some local governments required users to dismantle or change boilers using coal as fuel to reduce air pollution. At the same time the price of LNG surged, boosting demand for methanol as an alternative fuel.

Meanwhile, seeing the success of China's move towards coal-based methanol, India has also become interested in methanol and DME as fuels for vehicles and other uses. The Highways and Shipping Ministry has prepared a draft notification allowing use of M15 and M100 blends and DME as transport fuels, and anticipates legal clearance soon. Israel has also implemented a 15% (M15) methanol blending programme into fuels,while Europe and New Zealand currently blend up to 3%. Australia is also looking at methanol fuel blending.

And there continue to be new areas where methanol fuels could be used. Marine fuels have become a potential growth area due to new International Maritime Organisation (IMO) rules on sulphur content of bunker fuels and NOx and particulate emissions from ship's engines. As a clean-burning fuel (methanol reduces ship emissions by 95-99%) some companies have started to look at methanol as an alternative to liquefied natural gas (LNG), the other main alternative fuel contender.

A potential fly in the ointment is a recent decision by the IMO to halve greenhouse gas emissions from shipping by 2050 from 2008 levels. A study by the IMO in 2016 found that the 'well to propeller' lifecycle GHG emisisons of gas-derived methanol were actually higher than from other marine fuels, such as fuel oil, marine gasoil or LNG. However, it did note that for bio-methanol, the life-cycle CO_2 emissions are drastically lower compared with other fuels.

CONTENTS
What's in issue 353

COVER FEATURE 1
The prospects for GTL

COVER FEATURE 2
Methanol markets

COVER FEATURE 3
Innovations in steam reforming

COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight

Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

Methanol to olefins

Olefins production has been a massive boost to Chinese methanol consumption. As of October 2017, there were 35 methanol to olefins units operating in China, with a total capacity of 14 million t/a of olefins production (equivalent to 23 million t/a of methanol demand). About 60% of this (8 million t/a olefins, 15 million t/a methanol equivalent) was in integrated facilities where the full production cycle of coal gasification, methanol production and olefins manufacture were present, mainly in the northeast of the country; the majority of coal production lies in the northern provinces of Inner Mongolia, Shanxi and Shaanxi, responsible for over 60% of domestic supply. However, the remainder depend on 'merchant methanol', and are often in coastal locations, buying methanol either from other producers within China, or on the international market. Rising coal prices and lower oil prices have been a major headache for MTO producers, and margins have been squeezed very thin. Operating rates have dipped as low as 60% at times. Nevertheless, another three MTO plants are scheduled for start-up during 2018; Jilin Connell, Inner Mongolia Jiutai Energy and Huating Zhongxu, which will add an extra 3.3 million t/a of methanol demand over and above captive supply at these sites.

Demand increase

Figure 1 shows the estimated new demand for methanol over the next few years, according to Methanex. The boost to new demand coming from MTO and fuel uses can clearly be seen. While the rate of increase appears to be slowing, methanol demand is forecast to be more than 90 million t/a by 2020, and Methanol Market Services Asia have been even more optimistic, forecasting 120 million t/a by 2022, which would put the methanol market at almost two thirds the size of the ammonia market.

New supply

China has added most methanol capacity over the past decade, with an additional 30 million t/a of capacity in just the past five years, and there are still 30 plants under development in the country, perhaps half of which are likely to be completed. An extra 4 million t/a of new methanol capacity is due to come on-stream in China during 2018, including Anhui Haoyuan, Inner Mongolia ENN and Luxi Chemical. However, there are signs that China's methanol capacity building is slowing down, with projects being delayed and pushed back beyond the immediate time horizon. The reason for this has been a concerted government crackdown on pollution, especially of coal-burning factories close to built-up areas. There is also an attempt to tackle the country's greenhouse gas emissions by encouraging moving to natural gas for power and chemicals production. China is targeting a reduction in coal's share of energy from 68% to 60% in 2020.

Another reason has been the rising cost of coal in China. As oil prices have settled at a lower level and coal prices have risen, so there has been an incentive to turn back to naphtha as a feedstock for crackers instead of moving to MTO. Several new chemical complexes on China's east coast are now planned to be naphtha-based, and ICIS estimates that by 2021-2022, there could be 10 new naphtha crackers on-stream. In the past, these would be built by only the major companies such as PetroChina and Sinopec, but now a number of private companies are also planning these projects. Methanol production from natural gas in China has also been reduced by the government prioritising gas as a power plant fuel over the previous winter, while production from coke oven gas has been cut by pollution regulations. Overall China may see no or only a relatively small net increase in methanol supply over the coming years, and may have to rely upon increasing shipments from overseas to make up the difference. There is talk of developing methanol storage and transportation bases across China to take in overseas methanol shipments, and stabilise pricing by establishing a methanol reserve to provide a floor on pricing and a resource for heating during high-demand months.

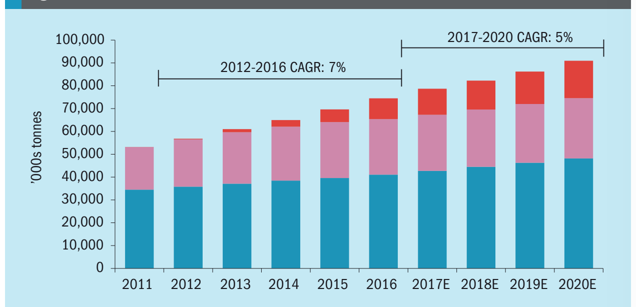
United States

Outside of China, most methanol project activity is happening in the United States, where cheap natural gas prices have encouraged the replacement of imports by domestically produced methanol from re-starts or, in the case of Methanex, relocated two 1 million t/a plants from gas-constrained Chile, and now there is large scale development of export-oriented plants, with China squarely in their sights. The new OCI Natgasoline unit in Beaumont, Texas is due to start up in the next few months, and at 1.75 million t/a will be the largest US methanol plant when it completes commissioning. It is also the first new greenfield North American methanol plant in decades.

Methanex also appears to be moving towards Geismar, location of its two relocated plants, as the site for a third 1.8 million t/a US methanol plant which it says that it intends to construct. The company has purchased land for the plant but says that it may still be a year away from making a final investment decision on whether to proceed.

Another major recent development has been the announcement by IGP Methanol that it is looking at a major methanol complex to be built at Myrtle Grove, Louisiana. The company is operating in partnership with China Cosco Shipping Energy Transportation Co., Ltd, and Jinguotou (Dalian) Development Co., Ltd (JGT), and aim to build two 1.8 million t/a methanol plants for export to China, where they will be used for MTO production at Jinguotou's complex at the port of Jinzhou. A further two trains have been discussed for the longer-term future, according to IGP. Cosco is also reportedly interested in methanol a bunker fuel. IGP has contracted engineering firm CB&I and Haldor Topsoe for preliminary design and technology work. A gas supply agreement has been agreed with Conoco. While MTO project activity in China has slowed, as noted above, the Jinzhou project is moving forward in part because of the closure of several polluting low-grade steel plants at the port, according to IGP Methanol.

Fig. 1: Methanol demand 2011-20



Source: IHS Chemical

Other major plants planned for the US Gulf include Yuhuang Chemical,which broke ground in 2015 on a 1.8 million t/a plant in St. James Parish that will cost $1.9 billion, slated to be up and running by 2020-21. G2X's 1.4 million t/a Big Lake Fuels methanol project in Lake Charles broke ground in 2016 at a cost of $1.6 billion, and also has a target of 2021 to begin production.

Other plants under development include Lake Charles Methanol, which is aiming to build a petroleum coke-based methanol plant at Lake Charles at a cost of $4 billion. The facility will include 77% carbon capture and storage – the CO_2 will be pumped to local oilfields for enhanced oil recovery. The company has secured $2 billion in loan guarantees from the US Department of Energy, but how this will stack up under a cost-cutting Trump Administration remains to be seen, and the remainder of the finance has still not yet been secured.

Other plants have also run into difficulties – Chinese-backed Northwest Innovation Works (NWIW) had originally targeted three US methanol projects: one each at the Ports of Kalama and Tacoma in Washington state, and one at St. Helens in nearby Oregon. A draft environmental impact statement (EIS) for the $1.8 billion Port of Kalama project has been rejected by local authorities and the company is now having to re-submit.

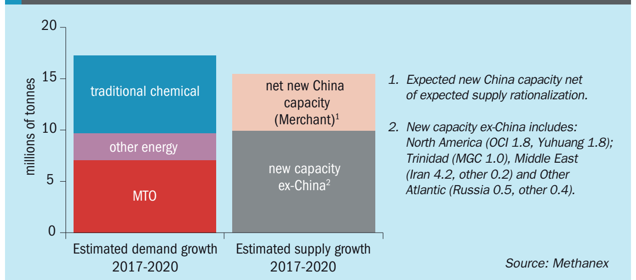
As well as these, another eight other methanol projects are under active discussion in the US, but there is no firm start date for any of them.

Iran

As we noted in our article in the previous issue, Iran also has wildly ambitious plans for expanding its methanol capacity from its current 8.9 million t/a. There is just under 10 million t/a of capacity under development, furthest advanced of which is Bushehr Olefin & Methanol at Assaluyeh, which will add 1.5 million t/a of methanol capacity later this year. The Sabalan Petrochemical Co also plans to complete a 1.65 million t/a methanol plant at Assaluyeh this year. Less advanced are the Dena and Middle East Kimiya plants, again part of the Assaluyeh complex, each again both 1.65 million t/a, and possibly complete in 2019, and the Siraf Methanol Company at Dayer, again with a 1.65 million t/a plant. Securing gas supply will be crucial for all of these projects.

As Iran has only 500,000 t/a of domestic methanol demand, these plants are all export-focused, again looking towards China. However, Iran is also looking to use methanol to olefins production as a way of generating olefins and monetising its natural gas reserves. At Chabahar, the first of these MTO complexes is planned as part of the new Mokran petrochemical hub development, associated with another new methanol plant, with an olefins capacity of 1.25 million t/a. It is understood from SPI International, the company managing the finance and engineering contracts for the Mokran petrochemical project, that the Iranian National Petrochemical Company will no longer issue new licenses for standalone methanol plants, and up to 17 MTO projects are under consideration across the country, although so far only the Mokran plant is under serious development.

Fig. 2: New methanol supply and demand, 2017-20



Source: Methanex

Other projects

Nigeria's Brass Fertilizer & Petrochemical Company has secured a $6 billion offshore facility for the offtake of its proposed methanol plant in Bayelsa State. BP Oil International Limited will take the methanol, while Brass also secured an agreement from Shell Petroleum Development Company of Nigeria for 300 million cubic feet per day of natural gas as feedstock for the plant. The project is expected to be completed in 2020, producing 1.66 million t/a of methanol.

And last year, China's Mingyuan Holdings Group Company also announced plans to set up a major methanol-to-olefins (MTO) plant alongside a giant greenfield methanol scheme at the China-Oman Industrial Park at Duqm in southern Oman, at a cost of around $2.3 billion. Development of the venture is planned in stages, with the promoters looking at a capacity of 1.8 million t/a of gas-to-methanol and methanol-to-olefins in the first phase. The foundation stone for the project was laid in April this year.

A flood of methanol?

On the face of it, the 10 million t/a of new capacity planned in Iran and 8 million t/a of capacity potentially being built in the US over the next few years looks like an enormous boost to the merchant methanol market. However, it is highly unlikely that all of this will be completed and, as Figure 2 shows, a study last year by consultancy IHS reckons that global demand increases from 2017-2020 totals an additional 17 million t/a of methanol, 7 million t/a of that coming from new Chinese MTO capacity. New methanol capacity scheduled to be completed during that timeframe includes 4 million t/a of capacity in China and about another 4 million t/a in the US, 1 million t/a in Trinidad and 4 million t/a in Iran and still falls short of anticipated demand increases.

Looking to the longer term, at last year's IMTOF conference, Mark Berggren of Methanol Market Services Asia (MMSA) projected out to 2040, by which time global methanol demand could have reached 195 million t/a. This would require 100 million t/a of new methanol capacity (assuming overall 85% availability) or 58 world-scale methanol plants, of which he could only identify 19 million t/a as currently likely to be built. This means that the methanol industry may need to build 49 new world-scale plants over the next 20 years, or 1-2 per year, simply in order to keep up with demand! This could be a good time to be in the methanol business. ■

CONTENTS

What's in issue 353
COVER FEATURE 1
The prospects for GTL
COVER FEATURE 2
Methanol markets
COVER FEATURE 3
Innovations in steam reforming
COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

First off-take of product from the new ENVIA GTL plant in Oklahoma, 2017.

PHOTO: ENVIA

Gas to liquids (GTL) technology has dropped in and out of favour in the syngas industry as oil and gas prices have moved up and down. With the withdrawal of Sasol from new GTL projects, the prospects for new GTL currently seem to rest on smaller scale, modular plants.

The prospects for GTL

In the world of syngas-based chemicals, ammonia and methanol production and, to a lesser extent hydrogen generation for refineries, predominate. However, the production of longer chain hydrocarbons by Fischer-Tropsch polymerisation has always offered the enticing possibility of being able to arbitrage cheap natural gas and high oil prices, converting from gas into to liquid fuels, and making synthetic diesel, naphtha and waxes.

Gas to liquids (GTL) production was pioneered by Sasol, who took the Fischer-Tropsch technology developed by Germany in the 1940s to produce synthetic fuels from gasified coal (to get around Germany's lack of access to world oil markets), and initially did likewise for sanctions-era South Africa, producing the huge Secunda coal to liquids (CTL) plant in the 1970s, and then moving the technology to a gas feedstock via a smaller GTL plant at Mossel Bay in the early 1990s. Shell also developed their own Shell Middle Distillate Synthesis (SMDS) technology, operating a commercial scale demonstrator plant at Bintulu in Malaysia from 1993.

With the technology proven, what was needed was a period of low gas prices and high oil prices in order to justify investment and overcome the high capital cost of the process. Unfortunately oil and gas prices moved in exactly the opposite direction during the 1990s, and interest flagged until the early 2000s, when oil prices began to rise sharply as China industrialised. A flush of new GTL projects came to life, mainly in Qatar, but also including the Escravos GTL project in Nigeria, the latter attempting to monetise associated gas from oil production which was being wastefully flared.

Sasol completed the Oryx GTL project in Qatar on time and budget, and Shell moved ahead with the far larger Pearl GTL project next door. ExxonMobil also initiated a similar sized project in Qatar. But as the commodity boom reached its peak, steel and construction costs began to mushroom. ExxonMobil pulled out of their project and Escravos in Nigeria ran into contractural difficulties and was not completed. Pearl ended up costing $20 billion, three times the initial budget. GTL also suffered from the fact that converting gas to a liquid in the form of liquefied natural gas had become an alternative for stranded gas reserves, and had become a lucrative global market that gave GTL production an opportunity cost that it often could not overcome.

But GTL was not dead – the steady fall in US natural gas prices due to shale drilling at the same time as oil and hence gasoline, diesel and naphtha prices remained at record highs kicked off the next GTL project boom. Meanwhile, LNG prices fell as the market became glutted – capacity had been built on expectation of US imports, and the US shale gas boom meant that these did not materialise. The attraction of new LNG projects began to fall and with it the opportunity cost for GTL. Now Shell was looking at a 140,000 bbl/d duplicate of Pearl GTL for the Mississippi Delta, and Sasol likewise targeted Louisiana for a 96,000 bbl/d GTL project and another similar project in Alberta, Canada. Another series of projects looked to convert inaccessible gas in Central Asia into liquid fuels, and the Escravos project in Nigeria, now without its original sponsor Chevron, finally solved its legal wrangles and was completed in 2014, albeit at a final cost of $10 billion, five times its initial estimate.

Sasol

Sasol has been the pioneer of coal to liquids (CTL) technology and to a large extent one of the major pioneers of GTL technology as well. As Table 1 shows, four of the six major GTL plants in operation have used Sasol technology. However, last year the company appeared to take a strategic decision to exit GTL projects altogether following a change in personnel at the top of the company in July 2016. New joint chief executives Bongani Nqwababa and Stephen Cornell conducted a strategic review of Sasol's operations and essentially concluded that new GTL plants were unlikely to be economically viable in unstable commodity markets, while converting coal to liquids had low returns and unacceptably high carbon dioxide emissions. In November 2017 the company finally killed its $14 billion plan to build a shale gas to liquids plant in Louisiana and divested its Canadian shale gas assets on which it had taken a $715 million write-down in 2016, along with any possibility of building a GTL plant in Canada. While there is no intention to divest its existing CTL and GTL assets, which the company said "are generating good returns and cash flows", the company said that "the value proposition for Sasol to build new GTL projects" was uneconomic "against a volatile external environment and structural shift to a low oil price environment." Plans that had been floated to convert the remaining CTL assets in South Africa to natural gas feedstock have also been quietly dropped.

Instead the company said that it is now looking to concentrate more on chemicals, and to continue to diversify its operations away from South Africa, aiming to move from generating 65% of its income in South Africa to 50%. Part of this will be through the completion of an $11 billion ethylene cracker in Louisiana, taking cheap natural gas liquids from shale gas and using them as feedstocks in chemical production, which Sasol says has a far better margin than new GTL capacity in the current oil and gas price environment. An investment in a new gas-to-liquids plant was "conceivable", Mr Cornell said in the company's last results presentation, but the projects would make sense only if the price of the gas or the products such as diesel fuel could be fixed. "Those opportunities are getting less and less. So it's going to be hard," he said.

Central Asia

One of GTL's big issues has always been opportunity cost – where a large source of natural gas has been available, LNG has often been a more profitable way of monetising it. So if GTL must compete with LNG for investment money in gas development, then perhaps the best location for it is in a landlocked country where there can be no LNG export proposal. Perhaps ideally this would be a region where pipeline export schemes have also been fraught with difficulty. This seems to be the reason for a handful of new GTL project proposals for central Asia. Many governments of the region are also reliant on Russia's Gazprom for export routes for their gas and have been looking for ways to add value to their resource-dependent economies and reduce reliance on export pipelines.

Turkmen GTL

Although not strictly a Fischer-Tropsch process, Turkmen GTL calls itself a gas to liquids producer, and will produce 15,500 bbl/d of synthetic gasoline once it comes on-stream in December this year. Owned and operated by state-owned Turkmengaz, it will use syngas generation and synthetic gasoline technology from Haldor Topsoe, based on Topsoe's TIGAS (Topsoe Improved Gasoline Synthesis) technology, which actually uses a methanol/DME intermediate step, similar to ExxonMobil's methanol to gasoline (MTG) process. Construction is a $1.7 billion collaboration between Japan's Kawasaki Heavy Industries and Turkish construction company Rönesans. Ground was broken in 2014 Ovadan-Depe near the capital of Ashgabad, and commissioning began this month of auxiliary equipment such as water treatment and air compressors. The project is backed by a soft loan granted by the Japan Bank for International Co-operation (JBIC) in 2014, which should cover 85% of total costs.

Table 1: **Global GTL projects – past and future**

Plant	Technology	Location	Capacity	Onstream
Existing				
Mossgas	Sasol	Mossel Bay, South Africa	22,000 bbl/d	1992
SMDS	Shell	Bintulu, Malaysia	14,700 bbl/d	1993
Sasolburg	Sasol	Sasolburg, South Africa	5,600 bbl/d	2004*
Oryx GTL	Sasol/Chevron	Ras Laffan, Qatar	34,000 bbl/d	2007
Pearl GTL	Shell	Ras Laffan, Qatar	140,000 bbl/d	2012
Escravos GTL	Sasol	Escravos, Nigeria	34,000 bbl/d	2014
ENVIA	Velocys	Oklahoma City, USA	250 bbl/d	2017**
Under development				
Turkmen GTL	Topsoe/KHI	Ashgabat, Turkmenistan	15,500 bbl/d	2018***
Kazoil Aktobe	Compact GTL	Aktobe, Kazakhstan	2,500 bbl/d	2018
Juniper GTL	Velocys	Lake Charles, Louisiana, USA	1,100 bbl/d	2018
Rocky Mountain	Expander	Carseland, Alberta, Canada	500 bbl/d	2019
Oltin Yol	Sasol	Shurtan, Uzbekistan	38,000 bbl/d	2021
TOPC	Not known	Turkmenbasy, Turkmenistan	13,500 bbl/d	2022?

** Built as a CTL plant but switched to gas feed in 2004. ** Waste gas from landfill. *** Strictly a methanol to gasoline process rather than Fischer-Tropsch.*

CONTENTS
What's in issue 353
COVER FEATURE 1
The prospects for GTL
COVER FEATURE 2
Methanol markets
COVER FEATURE 3
Innovations in steam reforming
COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

Turkmenistan is also planning a second, larger GTL facility near Ashgabat that will convert 3.7 bcm per year of gas into 600,000 t/a of diesel and naphtha. Financing for this $3.9 billion is not yet in place, although Turkmenaz awarded a front-end engineering design (FEED) contract to South Korea's LG and Hyundai, along with Japan's Itochu, to build the plant in 2015. Turkmen authorities reportedly held a ground-breaking ceremony for the project in 2016, but there is no report of any construction taking place as yet.

Oltin Yol

The Oltin Yol GTL project in Uzbekistan currently appears to be largest scale GTL project which is still making any serious progress. This project was itself once one of Sasol's developments, as a joint venture with Uzbekneftegaz (both companies took an initial 44.5% stake), as well as an 11% participation from Malaysia's Petronas. The project is for a 38,000 bbl/d GTL plant based on 350 million cfd of Uzbek-suppled gas, and space has been allocated at the Shurtan Gas Chemical Complex. The initial heads of agreement was signed in 2011, but funding for the project initially proved elusive, with implementation reportedly "dependent on global oil prices". Sasol progressively reduced its equity participation to 22.5% in 2014 after cost estimates had risen to $5.6 billion, and then in 2016 reduced its stake to zero, taking a $45 million write-down. The company is however still licensing its Slurry Phase Distillate technology to the project for around $100 million, but in line with Sasol's new policy will not be investing in a greenfield GTL plant. Nevertheless, the bankable feasibility study was completed at the end of 2016, and in May 2017 Uzbeknefegaz signed a $1.2 billion loan with the China Development Bank. Gazprombank and other Russian entities are also said to be interesting in financing the project. Oltin Yol has awarded Hyundai Engineering the EPC contract and licensed syngas generation technology from Haldor Topsoe for the autothermal reforming section. Construction work began in July 2017, and is currently scheduled to be completed in 2021.

Small-scale GTL

While the risk and expense of large scale GTL plants has scared away all but some state-owned Central Asian oil and gas companies, GTL may be making more progress at the other end of the spectrum, as a number of companies expend R&D effort to make smaller plants without such eye-watering costs economically viable, using microchannel reactors and modular construction. Some of these have focused on alternative feedstocks such as biomass and gasified municipal waste, but increasingly such technologies are also finding application as small scale GTL plants. Some suggest that small-scale GTL could be the 'game changer' that the industry has been waiting for, allowing producers to take advantage of gas from oilfields that might otherwise be flared or reinjected, or smaller gas fields which are not able to supply the huge volumes of gas required for LNG production or even the volumes needed for ammonia or methanol plants.

Juniper GTL

Juniper GTL was developing a $100 million natural gas to liquids plant in Southwest Louisiana, using a second hand steam reformer to generate syngas. The facility was to have become operational in the second half of 2017 and would be North America's largest commercial F-T facility, converting natural gas into 1,100 bbl/d of fuels and waxes. However, in late 2015 financial backers pulled out and construction stopped. The company went into Chapter 11 proceedings, and was about to be liquidated when York Capital Management acquired the company's assets and that of SGC Energia in Houston, developer of the Juniper plant. The asset sale has allowed construction to re-start, and York Capital says that the plant should be operational later this year. GTL technology has come in the form of a microchannel reactor developed by SGC Energia in cooperation with small-scale GTL developer Velocys.

Velocys had earlier completed a 250 bbl/d commercial demonstrator plant in Oklahoma City in 2017 using landfill gas from a nearby waste dump for ENVIA Energy. Velocys has also licensed its Fischer-Tropsch technology to Russian GTL developer Gazohim Techno, which built a 100 bbl/d demonstrator plant in 2014 at Rosenft's Angarsk petrochemical complex in Irkutsk, Siberia using its own partial oxidation process to generate syngas for the process.

Compact GTL

Small-scale GTL developer Compact GTL, chaired by ex-BP chief Tony Hayward, has also been making progress on microchannel GTL production. It has focused on Kazakhstan, for some of the reasons discussed above – the country is land locked and is far from international markets; associated gas utilisation is a major challenge and flaring is subject to tight regulation, and lack of gas utilisation options can constrain oil production. Around 75% of gas produced is re-injected or flared, equivalent to up to 40,000 bbl/d if converted to GTL. Finally, despite its large oil reserves, Kazakhstan is faced with a refined fuel shortage and imports fuel from neighbouring Russia and Azerbaijan, with transportation amounting to nearly 50% of fuel costs.

Fluor has been selected as Compact GTL's engineering partner, responsible for pre-FEED and FEED work, plus project management support during the EPC phase. The plant, not under construction in the northwestern region of Aktobe, will be a 2,500 bbl/d GTL plant and is a joint project with KazakhOil Aktobe, itself a joint oil and gas production venture between Lukoil, KazMunaiGas and China's Sinopec. KazakhOil will use associated gas from local oil fields, and by avoiding penalties for flaring the gas, the net feedstock cost will in effect be negative.

Compact GTL says it hopes it will be a showcase for potential small-scale projects elsewhere. It estimates project costs at $100,00 per installed barrel of capacity, i.e. around $250 million, with operating costs at $15-$20/bbl of diesel produced. The company also says that it has a "robust pipeline" of potential other projects and that it is "currently developing other opportunities in Kazakhstan/CIS, Southeast Asia and the Americas".

Expander Energy

Canadian-based Expander Energy is a new entrant into the small-scale GTL field, with its patented Enhanced-FT technology which recycles less valuable products from the reaction such as alcohols, naphtha, wax, etc.) to create the ideal 2:1 hydrogen:carbon monoxide feedstock for the Fischer-Tropsch reaction. The company announced in November 2017 that it was formed a subsidiary – Rocky Mountain GTL – to commercialise EFT technology, and that it has successfully completed a C$42 million private placement financing and made the final investment decision to construct Canada's first GTL plant at Carseland, Alberta. The plant will process up to 5.0 million scf/d of natural gas and natural gas liquids into a nominal 500 bbl/d of synthetic diesel and naphtha. Expander also says that the GTL plant will be "water neutral, self-sufficient in electric power, and convert significant process CO_2 into additional synthetic diesel." It has also completed a technology supply agreement with Greyrock

Energy that enables the deployment of additional plants that use Greyrock's Direct Fuel Production™ technology and GreyCat™ catalyst.

BgtL

Another new entrant is BgtL, the brainchild of Chinese technologist Dr Zhijun Jia. Last year it commissioned a 1 bbl/d demonstration unit, and the company is now seeking to commercialise its 'micro-GTL' technology, aiming it at 20-40 bbl/d production from flared gas wells, although the company has designs that go as high as 200 bbl/d.

Others

Small and micro-scale plants are not confined to these players, but others are looking at downstream ammonia or methanol rather than gas to liquids. GasTechno is pursuing several different product strands using flared gas in North Dakota. A 40 bbl/d 'methanol in a box' unit is now in operation, but the company hopes to commercialise GTL options as well using its Mini-GTL-300 and Mini-GTL-750 modular plants. Haldor Topsoe announced a partnership with Modular Plant Solutions in September 2017 to develop 'MeOH-to-go' – a small-scale (215 t/d) modular methanol unit. Primus Green Energy also have a similar 160 t/d modular methanol unit. We are clearly in an exciting time for small-scale modular reactors.

Oil price the key

Feasibility studies for other large-scale plants have cropped up in all parts of the world – wherever there is surplus, stranded gas – Algeria, Mozambique, Azerbaijan, Papua New Guinea. However, the deep pockets required to finance such ventures and the uncertainties involved mean that at the moment only Central Asia is looking at large-scale GTL developments. Nevertheless, in spite of the challenges in developing GTL projects, there are still large projects under development, while the development of cheaper, smaller-scale, modular plants which can be more easily integrated into existing facilities such as refineries and gas processing plants or take advantage of small scale, even offshore gas fields offers considerable potential for the future. And with the prospect of oil prices rising over the next few years and the LNG market slowly decoupling from oil indexed contracts, there could even be space for more large scale projects, where local conditions are favourable.

The US Energy Information Authority noted in its projection for GTL capacity last year that, aside from the Uzbekistan project, the "remaining growth in GTL output is likely to come from relatively small facilities, each with a capacity of 5,000 bbl/d or less". However, it also added that it its High Oil Price case, world crude oil prices are assumed to provide an incentive to construct new GTL plants or add capacity at existing plants, and global GTL production would continue to increase from 2025 through 2040. ■

How to save time & money

Even the best equipment is subject to wear and tear, and that means expensive plant turnarounds. As a leading high–pressure vessel manufacturer in the nitrogen sector, we can save you time and money by performing the maintenance and in situ repair of your heat exchangers and reactors in the shortest possible time. And we can provide replacements, seeing to everything from design to installation.

We have all the know–how to work with all the materials involved – and a strong international track record of successful reference projects. Our highly skilled task force have already completed a large number of in situ works abroad.

So why not ask our specialists to advise you on your next in situ project?

Schoeller-Bleckmann Nitec, Hauptstrasse 2, A-2630 Ternitz, P: +43/2630/319-0, F: +43/2630/319-19, E: sbn@christof-group.com, I: www.christof-group.com

CONTENTS
What's in issue 353

COVER FEATURE 1
The prospects for GTL

COVER FEATURE 2
Methanol markets

COVER FEATURE 3
Innovations in steam reforming

COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight

Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

Nitrogen+Syngas 2018

CRU's Nitrogen+Syngas conference headed to a snowy Gothenburg in Sweden this February, for the usual broad discussion of markets and technologies that affect the ammonia, urea, nitrates and methanol industries.

Amanada Whicher, Nitrogen Portfolio Director for CRU, introduced the conference, which has now grown to include 48 papers and several hundred delegates. Making a brief return to CRU as Senior Nitrogen Analyst was Doug Hoadley, previously CF Industries' Director of Nitrogen Analysis. His keynote nitrogen markets presentation began by looking back over the past year, in which global demand for urea actually declined in 2017, mainly due to a fall in Chinese demand, but has since returned to growth in 2018. Costs rose for Chinese urea producers in 2017 to the tune of about $20/tonne as coal prices rose, leading to issues for coal-based producers. Meanwhile, on the supply side new capacity growth is projected to peak in 2017-18 and thereafter slow, leading to increased capacity utilisation out to 2020. Over 2010-2015, urea prices have typically moved in the range of $300-500/t, but as new capacity has entered the market, so the urea price has fallen to around $180-270/t worldwide in 2016-2018.

Overall urea capacity is forecast to rise from 209 million t/a to 228 million t/a to 2022. This includes firm and probable plants, but excludes another 20 million t/a of potential speculative new capacity out to 2022 – the lead time for any new capacity development would make 2022 the time of adding greatest capacity. However, China has already closed 5-6 million t/a of capacity and could close up to another 10 million t/a. PIC Kuwait is also likely to leave the market. This would take total capacity to about 224 million t/a in 2022. Africa is seeing a series of new plants, such as Dangote in Nigeria, all of them export-oriented. Dangote is expected in 2019-20, taking Nigerian exports from 1.0 million t/a to 3.0 million t/a. New capacity in Iran will also see output rise to 6 million t/a.

The ammonia cost curve fell by about $20-40/t from 2012-16, with coal and natural gas costs falling. It has also flattened out. But in 2017 costs returned at the high end of the curve due to higher prices for natural gas and anthracite coal in China, and it is a similar picture for urea. China remains the marginal exporter, with the base cost rising to $250-270/t, but volumes have fallen dramatically from the 14 million t/a exported in 2015 to only about 4 million t/a now, and forecast closures could take that below 2 million t/a. That being the case, will China continue to set the base price for the market?

On the demand side, Chinese agricultural nitrogen consumption looks stagnant. The big factor has been corn – the support price level for corn was removed in 2015. Most of the decline is now over, and use of fertilizer for fruit and vegetable production continues to grow. There is also growth in industrial uses. Indian demand growth is falling, with the switch to neem coating and the move to 45kg instead of 50kg bags of urea leading to lower usage. Brazilian demand was up in 2017 but is expected to decline in 2018 due to inventory carryover. Overall global demand for urea is projected to rise by 2.1% year on year, from 160 million t/a in 2017 to 280 million t/a in 2022, with the greatest growth in South Asia (3.4 million t/a), East Asia (3.2 million t/a) and southeast Asia (2.0 million t/a), as well as Central and South America (2.0 million t/a).

Overall, Doug projected that new capacity and the hangover of capacity growth will outstrip demand out to 2020, with the market only beginning to balance in 2021-22. Urea prices are forecast to show modest recovery as trade recovers and the supply/demand balance starts to tighten. Key variables include the pace of India's revival of closed urea plants, adding up to 6.4 million t/a of capacity and reducing imports. Chinese coal prices could also increase further leading to more cost pressures on Chinese urea producers and leading to additional plant closures. Finally, the EU could enact regulations on urea requiring a switch to nitrates or enhanced efficiency products.

Jonas Oxgaard of Bernstein Research provided a capital markets perspective on the nitrogen industry. Investors do some things well, he said – they are clever and well informed, and many understand industries as well as companies do. They will figure out the impact of news faster than anyone else, and can use psychology, not just data. However, they are as bad at forecasting market peaks and crashes as everyone else, have a tendency to uncritically rely on consultant data, and a persistent belief that there is a connection between crop prices and nitrogen prices (there isn't – he said).

Valuing a company such as CF Industries can be done the hard way, using financial modelling, or the easy way – take the margin on their key product (in this case urea) and how much they give to investors, and this can actually provide a very close correlation with stock price movements.

Overall, Bernstein expects margins to go up due to the impact of Chinese environmental controls, which appear to be stronger and more aggressive than we might have expected, and higher energy costs forcing plant closures.

Iran

Mohammed Hassan Peivandi, chairman of TAPICO, gave a look at the fertilizer and methanol market overview from an Iranian perspective. Iran holds 10% of the world's proven oil reserves and 18% of its gas reserves. Iran's next development plan aims to take advantage of its own extensive natural gas reserves to develop olefin capacity. The rise of the US shale gas industry has led to a boom in ethane cracking from natural gas liquids in North America, and in so doing a shortage of propylene as naphtha crackers are edged out. China has addressed its own propylene shortage via coal-based methanol to olefins, and Iran is looking to make its own move into that market via gas-based MTO and MTP (methanol to propylene) capacity. Current methanol projects in Iran total 10 million t/a, as described in our article in our previous issue (*Nitrogen+Syngas* 352, March/April 2018, pp26-29), at Kaveh and Marwan, but domestic demand is only 500,000 t/a. MTO/MTP offers an opportunity to convert this excess methanol into more valuable polypropylene, as well as other downstream products such as acrylonitrile, acrylic acid, propylene oxide, ABS, acrylic fibres, cumenes, isopropanol etc and develop its own domestic petrochemical industry. While he acknowledged that it might be more economical to take the propane dehydrogenation route to propylene, Iran's government sees more benefit – especially as regards employment – from the methanol route.

Methanol

Greg Dolan of Methanol Market Services Asia (MMSA) discussed methanol's prospects with reference to its use as a shipping fuel. New IMO regulations which come into force in 2020 mean that high sulphur fuel oil will become greatly restricted as a shipping fuel. The IMO is seeking to drastically lower SOx, NOx and potentially soon also greenhouse gas emissions from marine fuels. While sulphur can be removed from fuels at the refinery level, NOx and particulate matter emissions are trickier. However, MAN have developed dual fuel engines which can run on methanol and consider it to be a mature technology, and Waartsilia also have methanol dual fuel engines which can give 99% SOx reduction, 60% NOx reduction (and water injection can reduce that further) and 95% particulate matter reduction. At the moment there are only a dozen methanol-powered ships in operation and four more on order, but there is a lot of research, development and project work going on, and meanwhile it appears that ship operators are still not investing in exhaust gas scrubbers which had been the IMO's assumption as to how the regulations would be complied with. While LNG seems a promising alternative ship fuel, methanol still seems to have good prospects, with supply available in most major ports, and a far cheaper fuelling infrastructure than LNG (possibly as low as $10,000 per installation). In India there is a move to use methanol as a marine fuel, especially for indland waterways, and China is also keen. Capturing even 5% of the world bunker fuel market would require 70 million tonnes per year of additional methanol – in effect doubling the current market. On the supply side, China plans to build 100 waste to methanol plants.

Environment

Antoine Hoxha of Fertilizers Europe gave a 'tour' of the European Union regulatory environment for fertilizers. Needless to say, this focuses heavily on the environment. New 'best available techniques' and associated emissions levels are due to be promulgated by the Joint Research Centre in Seville, including plate bank coolers, pastillation technology, combined NOx/N_2O abatement and electrostatic dedusting in ammonium nitrate units. The European Chemicals Agency in Helsinki has a proposal before it to classify nitric acid as toxic level 1 by inhalation, although there is an argument as to at what limit this should be set. DG Grow in Brussels is considering a new regulatory framework for fertilizers. However, at present it attempts to ban the use of by-products to make fertilizers. This would stop ammonium sulphate production from nylon or the use of sulphur from oil and gas, and is clearly a nonsense. Finally, DG Clima aims to reduce EU CO_2 equivalent emissions by

CONTENTS
What's in issue 353
COVER FEATURE 1
The prospects for GTL
COVER FEATURE 2
Methanol markets
COVER FEATURE 3
Innovations in steam reforming
COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

80-95% by 2050 via the Emissions Trading Scheme. Sectors like ammonia at risk of carbon leakage will get free allocation up to the benchmark, currently set at 1.62 tCO_2e per tonne for ammonia. Antoine also pointed out that nitrous oxide emissions had already been reduced by 90% compared to 2003, and so nitric acid producers should already meet the new targets.

Eystein Leren of Yara International spoke on the subject of 'green ammonia' and carbon neutral ammonia production, possibly using small scale decentralised production set up for remote locations with renewable power, with ammonia as 'energy storage'. However, as we discussed in our article in November/December (*Nitrogen+Syngas* 350), at current prices this still makes ammonia 2-3 times more expensive than gas-based ammonia even if capex prices of electrolysers come down. Could it be sold as a premium priced product? Yara conducted their own marketing experiment last year but found that while there was interest in the product, this did not translate into higher prices.

Large scale nitrogen production

The technical papers began with three presentations on Tuesday afternoon which considered large scale nitrogen production, beginning with Klaus Nolker of thyssenkrupp Industrial Solutions. The Uhde dual pressure process has allowed ammonia production at 3,300 t/d in a single train, one of which has already been revamped to 3,700 t/d. TKIS have now developed a single pressure 3,300 t/d plant, using a new design for the ammonia synthesis section. Meanwhile the dual pressure concept has been expanded to 4,700 t/d using higher front end pressure, and a larger process air compressor and more reformer tubes. This concept was described in detail in *Nitrogen+Syngas* 349, Nov/Dec 2017, pp66-71.

Svend Erik Neilson of Haldor Topsoe presented his company's SynCOR ammonia concept, which switches to an autothermal reformer followed by a two step shift configuration using a shift catalyst which can tolerate much lower steam: carbon ratios developed for use in gas to liquids production to produce hydrogen. An air separation unit feeds oxygen to the reformer and pure nitrogen to the ammonia synthesis section. In this way a single train capacity of 6,000 t/d can be achieved. This technology was covered in *Nitrogen+Syngas* 351, Jan/Feb 2018, pp48-57.

Casale have a similar technology, A6000, using an autothermal reformer but using combined reforming with an adiabatic steam pre-reformer, lowering the air separation unit size. There is a single isothermal shift converter and a two-vessel ammonia converter with axial radial beds. This technology was also detailed in *Nitrogen+Syngas* 349, Nov/Dec 2017, pp71-72. Similar technology is being used in a 7,000 t/d methanol plant due to start up in Iran this year.

Revamping

Getting more from existing plants is a topic that always finds an attentive audience, and this year was no exception. VK Arora of KPI presented a case study of an ammonia plant revamp. It had already been revamped twice from 1,100 to 1,750 t/d, and the compressors, reformer and other major equipment items were operating at their limit. The approach taken was to increase air capacity via a multi-stage integrated chilling section allowing a 120% increase in mass-flow and reducing primary load with reduced steam: carbon ratio and firing, providing energy savings per tonne of ammonia.

Peter van Buuren of Spectrasavers showed the way that Raman spectroscopy can be used in process analysis at inlets and outlets of the primary reformer and shift converters in order to assist with optimising key control parameters and hence syngas production.

Haldor Topsoe's paper, presented by Nikolai Musko, looked at ways of enhancing efficiency and reliability in a steam reformer, via a programme of assessment, calibration, maintenance and furnace manager software, tube lifetime assessment, as well as training and education of staff. He showed a case study which had allowed the plant to increase ammonia output by 3% and urea output by 6%, leading to $13 million per year of extra income.

Mahesh Gandhi of KBR described the application of NOx and CO reduction technologies for the primary reformer furnace such as fuel conditioning and injection of a reducing agent as a way of reducing emissions from ammonia plants during debottlenecking. KBR also detailed the installation of an add-on ammonia synthesis converter downstream of an existing converter to enhance per pass ammonia conversion. Such installations have faced issues of cracks and leaks due to the aggressive service environment, including high temperature syngas, so KBR have developed a True Cold Wall design which mitigates such issues. Ravishankar Subramanian of KBR also presented a case study of an installation at Chambal Fertilizers and Chemicals in India during a turnaround in April 2017.

Plant economics

The shifting cost and availability of feedstock gas often drives consideration of relocation of a used plant from one location to another where gas is cheaper or more plentiful. Dallas Robinson of BD Energy Systems looked at the costs and potential pitfalls of relocating an old plant. On the positive side the cost of relocation of a plant can be as little as 40% of the cost of building a new one, with a time frame of 2 years rather than 3. However, additional inspections are required on used equipment to provide code compliance and ensure adequate lifetime remains, and worn equipment items must be replaced.

> **"Carbon dioxide removal is an energy intensive step in the ammonia manufacturing process.**

Linde Jubail provided a case study of advanced plant control installation in a facility which generates industrial gases as well as ammonia. The reliable and flexible operation of the integrated ammonia syngas complex requires a complex control solution which enables the plant to react to changes in demand with maximised automated operation.

Massimiliano Sala of Saipem described a methodology developed by Saipem to effectively optimise investment costs by efficient integration of the different technologies, offsites and utilities, and to identify risks and constraints at the earliest stage of the project.

CO_2 removal

Carbon dioxide removal is an energy intensive step in the ammonia manufacturing process, and optimisation of CO_2 removal can significantly improve overall performance, including capacity increases and energy saving. Armin Hassanzadeh of Dow Chemical presented the results of modelling exercises used to simulate case studies with complex design configurations which were then validated against real life plant operating data. Steam consumption was reduced by as much as 80% in the one stage absorber configuration when the unit was converted from MEA to UCARSOL NH-608 formulated solvent, while a two-stage GIAP configuration was optimised to achieve a CO_2 specification of 50ppm with energy consumption of 21,000kcl/kgmol of CO_2.

In the subsequent paper, Lugi Tomasini and Walter Giacopini of Giammarco-Vetrocoke (GV) showed that the efficiency of the GV low energy regeneration process can be dramatically enhanced by adding a final third regeneration stage operating under mild vacuum. By recovering waste heat at low temperature for the solution regeneration it cuts the heat carried by the cooling water/air cooler services, and in a grassroots installation can operate without any import of low pressure steam.

Operator experiences

Venkat Pattabathulata of Dyno Nobel and Avinash Malhotra of KBR discussed the commissioning of Dyno's new 2,300 t/d ammonia plant at Waggaman in Louisiana, designed and built by KBR. In spite of some challenges caused by compromised equipment preservation and damage to process air compressors, commissioning was successfully completed in October 2016.

Nagarjuna Chemicals and Fertilizers Ltd (NCFL) shared 25 years of experiences operating their ammonia plant at Kakinada in India, including operating incidents such as milling of the catalyst in the primary reformer, reformer tube and waste heat boiler failures, as well as several revamps.

Methanol

Ammonia's 'cousin' is methanol, as both types of plants depend on the same reforming front end, and the methanol market is increasing faster than that for ammonia, as we discuss elsewhere in this issue. The conference's short methanol section began with a look by Daniel Sheldon of Johnson Matthey at the history of methanol technology, including of course the development of the ICI Low Pressure Methanol technology in the 1960s, alternative reforming schemes and the growth of autothermal reforming, and China's move to coal-based production. He noted that the start-up of the Kaveh methanol plant in Iran shows that plants of 7,000 t/d are now an economic reality.

And appropriately, the company that designed Kaveh, Casale followed this with their own presentation by Francesco Barato on the use of a partial oxidation unit in parallel to the main reformer to increase plant capacity when steam reforming lines have reached their limit. Partial oxidation is more stoichimoetrically suitable for a steam reforming plant where hydrogen is in excess.

Catalysts

The heart of any chemical plant is its catalyst, and several papers looked at this subject. Sanjiv Ratan of ZoneFlow Reactor Technologies presented his company's ZoneFlow Reactor catalyst system which uses a formed metal foil structure, described in the article elsewhere in this issue.

Clariant's Prasanth Kumar spoke together with Emanuelle Biadi of Pall EMEA on designing catalyst beds to avoid fouling and poisoning, via a variety of options such as catalytic pre-treatment, absorbents and filtration/separation technology. The need for such considerations was amply demonstrated by Sajjad Hosseininia's paper, which was given in his absence by Farham Jafarvad Giglou. Briefly, Pardis Petrochemical in Iran had experienced extreme fouling of the HT shift reactors in two ammonia plants which was traced to silica migration from ceramic catalyst balls in the HTS reactor.

Finally, Tom Davidson of Johnson Matthey showcased Matthey's Katalco 74 series of high activity ammonia synthesis catalysts which give higher efficiency and/or throughputs than conventional magnetite or wustite-based catalysts.

Urea technology

As well as familiar companies like Stamicarbon and Toyo – Toyo's paper on digital fertilizer will be carried in the next issue of *Nitrogen+Syngas* – perhaps a sign of the times is the appearance of Chinese technology companies at these events; Jinzou NEWJCM Turbomachinery described their range of compressors and turbines and detailed successful installations at the Pardis 3 urea plant, and Hengam Petrochemical and Wulan Fertilizer in China, the latter at 4,000 t/d now the world's largest single train urea plant.

For their own part, Stamicarbon, as well as describing their ultra-low energy design, considered small scale fertilizer production, using their LAUNCH MELT small scale design, as described in *Nitrogen+Syngas* 346, Mar/Apr 2017, pp46-48.

NIIK described work conducted for a customer in Russia in expanding a urea solutions section of a urea plant to achieve a significant increase in downstream UAN production – moving straight to UAN removes the need for an evaporation section, granulation and wastewater treatment section, reducing costs.

Fertilizer finishing

Since 2016 all urea sold in India must be coated in neem oil, which regulates urea hydrolysis and increases nutrient use efficiency. Mohsin Mukhtar of Engro Pakistan described his company's experience with neem coating and its potential use in the Pakistani market.

Chris Muehling of Koch Agronomic Services considered how urea producers could differentiate themselves by use of additives to make enhanced efficiency fertilizers. However, successful implementation of such technologies requires careful consideration of how the additives may affect the existing process, in terms of environmental considerations, as well as operational concerns such corrosion.

Nitric acid

The conference finished with a section on nitric acid technology, including a presentation by Heraeus on optimising catalyst gauze design to extend campaign lengths.

Start-up can be one of the trickiest times for a nitric acid plant, when emissions are at their highest, and platinum loss and catalyst ageing can be at their greatest extent. Jurgen Neumann of Hindustan Platinum showed through computer modelling that the ignition of the reaction dissolves surface atoms from the crystal lattice and causes a recrystallization of the surface leading to a considerable rise in catalyst activity and process selectivity. However, any interruption, delay or inhomogeneity in this process can lead to formation of rhodium clusters and loss of metal, and he described an improved start-up procedure to minimise the danger of this.

Jena Francois Granger of Casale presented a revamp scheme for nitric acid plants. As up to 20% of process air is used to bleach the final product, the addition of a dedicated air compressor allows all of the capacity of the main compressor to be used to feed the burner. In a duel pressure plant this increases the load of the NOx compressor, which can be overcome by diverting part of the flow from upstream to downstream of the NOx compressor. ■

CONTENTS
What's in issue 353

COVER FEATURE 1
The prospects for GTL

COVER FEATURE 2
Methanol markets

COVER FEATURE 3
Innovations in steam reforming

COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight

Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

THE CULTURE OF INNOVATION

Inspired by
The School of Athens, Raffaello Sanzio 1509-1511
Vatican Museums. Photo Scala Archives

AMMONIA
NITRATES & PHOSPHATES
UREA
MELAMINE
METHANOL
SYNGAS

A FULL RANGE OF
TECHNOLOGIES AND SERVICES

CASALE
casale.ch

CONTENTS

What's in issue 353

COVER FEATURE 1
The prospects for GTL

COVER FEATURE 2
Methanol markets

COVER FEATURE 3
Innovations in steam reforming

COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight

Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

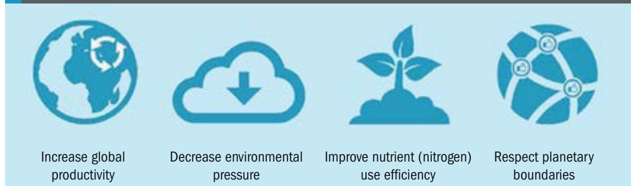
Full life cycle philosophies for urea plants

Stamicarbon and Saipem discuss their philosophies for improving and supporting the life cycle of urea plants throughout the entire plant lifetime. New developments are helping to meet the challenges of the fertilizer industry, as well as providing solutions for reliable, flexible, profitable and environmentally friendly operations.

The fertilizer industry challenge

Over the next 35 years the world population is likely to grow to over 9 billion people according to the United Nations (UN). This will put immense strain on the earth's natural resources and has an adverse impact on climate change (Fig. 1). The FAO (Food and Agriculture Organization of the UN) claims that the world would have to increase its food production by 70% – that is taking into account that 70% of the population will earn a higher income, which will lead to higher consumption. The challenge is even more severe when looking at available arable land. In 2000 the World Bank estimated the agricultural land area to be around 5 billion hectares, however, only 1.5 billion hectares were identified as arable land.

Fig. 1: **The fertilizer industry challenge**



Source: Stamicarbon

Fig. 2: **Urea from plant to plant**

Source: Stamicarbon

More people also means more air pollution. The rapid growth of industrial nations since the birth of the industrial revolution and an increase in the global use of diesel engines for transport, have had a very real impact on air quality. According to a study conducted by the Max Planck Institute for Chemistry, more than 3 million people a year are killed prematurely by air pollution – that adds up to six deaths every minute. The study states that if nothing is done to minimise air pollution the death rate will double by 2050.

How to solve it

These challenges call for expansion of arable land and/or improving crop yields on existing farmland, plus developing technologies that can improve air quality.

Feeding a growing population

Improving crop yields on existing farmland is the preferred solution when it comes to feeding a growing population, because this solution produces lower emissions of greenhouse gases than expanding arable land and doesn't involve the disruption of existing ecosystems. Yield improvement is a practical way to increase food production, not just in developed countries, but also in developing countries (Fig. 2). According to the FAO, 70% of increased cereal production can be attributed to yield improvement techniques and only 15% to the expansion of arable land.

The UN estimated that 40-60% of the world's food production is attributable to the use of commercial fertilizer and it has been claimed that over 2.4 billion people would have starved to death were it not for fertilizers. As the world population increases, so does the need for fertilizer.

Improving air quality

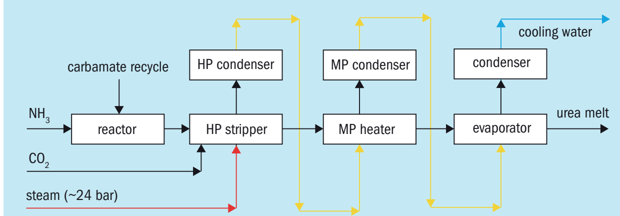
The US Environmental Protection Agency (EPA) implemented new emissions standards that required medium- and heavy-duty vehicles to significantly reduce engine emissions, particularly nitrogen oxides (NOx) and particulate matter (PM). These emissions are associated with a wide range of respiratory health problems, cardiovascular diseases and decreased lung functions.

Manufacturers developed a selective catalytic reduction (SCR) technology to meet these standards. NOx reduction fluids, with

Fig. 3: **Stamicarbon's full life cycle philosophy**

Source: Stamicarbon

Fig. 4: **Stamicarbon's N=3 concept**



Source: Stamicarbon

urea as a core component, also known as diesel exhaust fluids (DEF) or AdBlue®, are sprayed into the exhaust system and while the vehicle is running it breaks down NOx gases and converts them into nitrogen and water. Most new diesel trucks, pickups, SUVs, and vans are now equipped with the SCR technology and have a DEF tank which regularly needs to be refilled.

Stamicarbon's full life cycle philosophy

Stamicarbon, the innovation and license company of Maire Tecnimont Group, operates according to a full life cycle philosophy, in order to ensure its clients a sustainable and profitable operation throughout their plants' lifetime.

Stamicarbon has proven to be capable of dealing with the abovementioned challenges by developing and designing new urea plants equipped with future-proof technologies. Stamicarbon's philosophy is to offer continuous support to urea producers throughout the entire life cycle of their plants, no matter at which stage their plant is. This means that Stamicarbon's engagement and commitment will not stop after signing the contract and building of a plant. Tailor-made technology solutions, products and services are offered that match the needs of clients. Stamicarbon has divided its portfolio into three groups of activities that they refer to as their LAUNCH, ADVANCE and EVOLVE series (see Fig. 3). Each series caters for the specific needs of a plant at a specific phase in its life cycle.

The LAUNCH phase

A urea plant's life cycle starts with the launching of the design and proceeds through to engineering, procurement and finally the construction of the plant. Stamicarbon's LAUNCH series is a group of technologies, products and services designed to ensure effective design and optimal development of a new urea plant. It includes: project development support, feasibility studies, technology and commercial proposals, process design and basic engineering, equipment design and supply, engineering, procurement and construction, training, plant pre-commissioning and finally start-up of the plant.

When it comes to designing new fertilizer plants, Stamicarbon feels that it is important to keep on innovating and to constantly look for solutions that can make plants more efficient, more cost-effective and kinder to the environment.

For example, as the cost of energy has been increasing in recent years, Stamicarbon has once again taken on the challenge to realise a considerable reduction in steam consumption. As a result the LAUNCH MELT™ Ultra-Low Energy Design was invented. In this design the heat supplied in the form of steam is used three times. To reuse this heat two times, a medium pressure recirculation section (MP section) is required. This is achieved by making an arrangement wherein the carbamate is flashed at medium pressure and reheated using the heat of reaction and condensation. This is then further used for heat recovery by utilising it for evaporation (see Fig. 4).

The overall configuration of this design consists of a high pressure stripper, a pool reactor and a vertical reactor. The main change is that the pool reactor now contains two separate U-tube bundles in the shell. One bundle is for generating low pressure steam, as is commonly done in Stamicarbon's pool condenser/reactor design. The second bundle is used for the heat integration with the MP recirculation section.

This new process configuration, utilising the heat three times (N=3), features an incredibly low steam consumption of less than 560 kg steam tonne of urea, compared to a steam consumption of about 870 kg steam/tonne product for a typical urea process.

The technology can be effectively applied to all urea plants, irrespective of the original technology and age of the plant. Safurex® pool reactors and Safurex® pool condensers with N=3 concept can be applied to any size of plants thereby replacing the existing aging reactors. This is an effective tool for increasing the capacity of the urea plant while simultaneously reducing the specific energy consumption. This new ultra-low energy design has already been licensed to two clients in China. Their plants are expected to come on-stream in 2019.

The ADVANCE phase

After start-up, production starts and the plant enters into the next stage – the ADVANCE phase. During this phase a plant owner wants to optimise plant performance by extending its lifetime, increasing output, optimising energy efficiency, realising highest safety standards and exceeding environmental regulations.

It is of great importance to plant owners to have the assurance that they are working with reliable equipment, as this helps to prevent unsafe conditions and unscheduled plant stops. Urea plants are designed for a particular service life, usually 20 years or more. However, the corrosion properties of carbamate pose a serious threat to the integrity of urea process equipment and corrosion may reduce the service life of urea plants significantly. Therefore, Stamicarbon has developed in its ADVANCE INSPECT™ series several different plant integrity inspection services for urea equipment and/or piping to ensure optimum performance and maximum lifespan of urea process equipment (Fig. 5).

CONTENTS
What's in issue 353
COVER FEATURE 1
The prospects for GTL
COVER FEATURE 2
Methanol markets
COVER FEATURE 3
Innovations in steam reforming
COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018
BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

SUSTAINABLE UREA PLANTS

Fig. 5: **Plant and equipment inspections are vital**

PHOTO: STAMICARBON

Fig. 6: **MicroMist™ Venturi scrubbing**

PHOTO: STAMICARBON

Inspection of critical high pressure urea equipment needs to be carried out on a regular basis. Furthermore a good functioning and maintained leak detection system is of paramount importance as a last line of defence to avoid catastrophic failures.

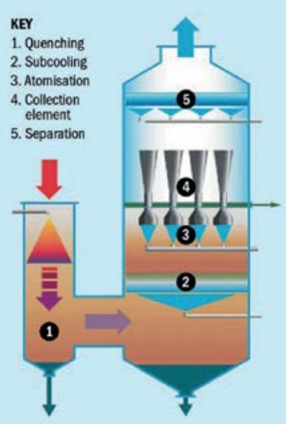
The EVOLVE phase

Although the technology of a plant may have been state-of-the-art at the time it was constructed, during its lifetime there are likely to be changes in the market and legislative environment or simply advances in technology and materials. Plants are always subjected to wear and tear which will lead to increased maintenance projects and equipment replacements. This is the moment to get a urea plant up-to-standard again. Urea plant managers may not realise it, but they could be performing several, smaller maintenance operations that are unnecessary. More than 70 years of experience has taught Stamicarbon that it is more cost-effective to have a thorough assessment and a potential revamp of the plant, instead of doing multiple quick fixes. Stamicarbon has successfully completed more than 100 revamp projects, improving plant performance and/or capacities.

Stamicarbon's EVOLVE solutions provides the means to upgrade a urea plant to the next level. This ensures that an aging plant complies with changes in legislation and stays competitive by adapting to changes in market conditions by offering solutions to increase capacities, reduce emissions, reduce energy and reduce feedstock consumption figures.

As an example of a recent successful innovation in emission reduction, Stamicarbon and EnviroCare International have developed the MicroMist™ Venturi (MMV) Scrubber, a multi-stage process for the effective and efficient scrubbing of urea particulate matter and ammonia from the granulation plant to meet the more stringent particulate matter emission regulations. During the granulation process, submicron dust is generated which is mainly responsible for the higher emission values. While older technology scrubbers easily scrub larger particles, the presence of a high degree of submicron dust requires a new capture approach and to efficiently remove ammonia, an acid solution needs to be injected. This newly introduced scrubber technology is successfully implemented and proven in other industrial applications but completely new for the urea industry (Fig. 6). The MicroMist™ Venturi (MMV) Scrubber contains six stages that progressively treat and clean the off-gas. With this technology emissions of less than 10 mg/Nm³ for dust and ammonia can be achieved.

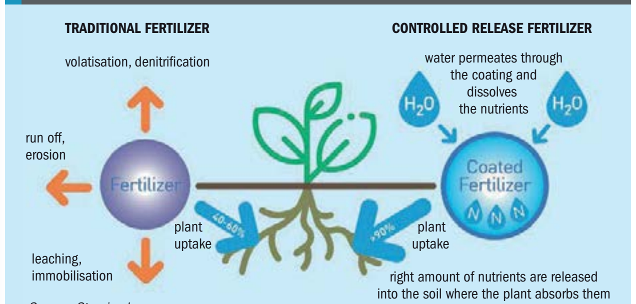
Fig. 7: **MMV scrubber phases**



Source: Stamicarbon

At the first stage, the exhaust gas is cooled down, saturated and most of the coarse particulate urea dust is collected from the gas stream (Fig. 7). Downstream of the first quench zone, a secondary quench is used. In this second quench, a dilute solution of urea is used to further cool and humidify the gas flow. This process is a very important step to assure that remaining submicron particulate is exposed to saturated gas, where particles can substantially grow in size through condensation. Inside the scrubber vessel several dual-orifice conditioning (DOI) trays can optionally be installed to further condition the gas stream. Multiple parallel venturi tubes are installed vertically on a diaphragm in the vessel. The diaphragm forces the gas flow to accelerate through the tubes. Each venturi tube includes a converging conical section (the inlet) where the gas is accelerated to throat velocity, a cylindrical throat, and the diffuser outlets of the MMV tubes are aerodynamically designed to reduce the overall pressure drop by slowing down the gas and recovering the energy. In the tubes, gases interact with the particulates and droplets twice (acceleration and deceleration). Downstream of the MMV stage, the ammonia acidic scrubbing takes place. The DOI tray is flooded from above with acidified water and the acid flow rate is controlled by a pH measurement. Typically sulphuric acid or nitric acid is used to react with ammonia, forming an ammonium salt. Remaining suspended water droplets are removed from the gas stream in the mist eliminator before the gases leave the scrubber. Fresh (clean) water is continuously sprayed on the mist eliminator to catch and wash away dirty particles. An optional wet electrostatic precipitator (WESP) can be integrated on top of the MMV scrubber to further reduce overall emissions.

Fig. 8: **Nitrogen uptake by plants**



Source: Stamicarbon

A sustainable fertilizer industry

In order to feed the growing world population in a way that is not damaging to the earth, more efficient and sustainable fertilizers are needed. That is why Stamicarbon believes that it is important to invest in innovative technologies that are futureproof and kind to the earth. These technologies can open up new value-added niche markets for fertilizer producers. Two examples are the AdBlue® design for improving air quality and the controlled release fertilizer design for improving the nutrient efficiency.

Stamicarbon's AdBlue® design to produce 32.5% urea-in-solution for NOx reduction in diesel engines ensures the production of high quality AdBlue® that conforms to ISO 22241. The AdBlue® is produced by diluting dry-flashed urea powder in deionised water. This method guarantees premium quality, zero formaldehyde and low biuret content, low production cost, free-flowing urea powder ready to be dissolved, lower emissions and, last but not least, energy saving.

The second example refers to Stamicarbon's latest development: the introduction of a smart fertilizer that is capable of releasing nutrients from the fertilizer in line with the demand from the crop. In this way the release creates a perfect balance between supply and demand of nutrients and prevents losses to the environment. This innovative smart fertilizer, developed together with US partner Pursell Agri-Tech is called Controlled-Release Fertilizer™ Design. It makes a polymer coating around the fertilizer granule, which contains the nutrients inside the membrane. It prevents valuable nutrients from leaching into the soil and volatilising into the air (Fig. 8).

The optimised recipe developed for the polymer coating results in a robust product capable of meeting the highest product and environmental requirements. Customers have full flexibility to market the products made with this technology, using their own brand name, colouring the products according their own specific colour schemes, etc. The technology further allows customers to coat nearly all fertilizer compositions at different coating conditions, allowing them to produce a broad range of controlled release fertilizer grades with a broad range of different release periods. These smart fertilizers will help farmers to improve their yields and future-proof their activities.

The future comes with many challenges, but Stamicarbon believes that by combining knowledge with smart, innovative technologies that they, can improve and support the life cycle of urea plants and with the help of the fertilizer producers, can at the end enable the world to feed itself and improve the quality of life.

Saipem's full life cycle philosophy

Saipem/Snamprogetti™ Urea Technology is a technology leader in the urea field and a major contractor for ammonia-urea complexes. Saipem has accumulated great expertise in licensing and engineering over many decades, via a learning-by-doing approach. Thanks to this background, and to the synergy it has with its manufacturers and urea plant end users, Saipem/Snamprogetti™ Urea Technology is able to offer its customers qualified services and assistance throughout the entire urea plant life cycle to maximise the performance and efficiency of urea plants, from enhancing flowsheet designs prior to construction, through optimising operating conditions, to evaluating revamp options for uprates.

Saipem/Snamprogetti is able to transfer and utilise the knowledge coming from its activity as a main contractor of ammonia-urea complexes into its proprietary urea technology features. The operation and ease of start-up of the plant are two areas which the licensor/contractor pay particular attention to in the design, based on their commissioning and start up experience.

Contractual features

The success of a project strongly depends on the collaboration between the company and the contractor(s). This collaboration is encompassed in the project contract; if one of the two parties is not confident with the contractual scheme, the project will suffer. Therefore, both company and contractor must define the most applicable strategy which takes into account the needs and the goals of all parties.

The peculiar nature of being both EPC contractor and licensor of Snamprogetti™ Urea Technology allows a continuous and seamless transfer of knowledge from technology to engineering and construction. Access to updated market information enables Saipem to carry-out detailed techno-economical evaluations to define the optimum plant configuration and to evaluate new or alternative options.

The lessons learnt from previous projects are properly managed and distributed among the various functions in order to identify in advance and eventually discard solutions that do not offer the necessary degree of confidence with respect to reliability and/or flexibility.

Recently, Saipem has undergone a major organisational change, introducing the new XSIGHT Division. The division aims

Nitrogen+Syngas 353 | May-June 2018 | www.nitrogenandsyngas.com

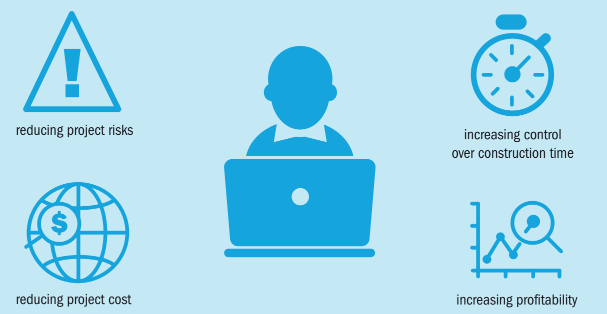
CONTENTS
What's in issue 353
COVER FEATURE 1
The prospects for GTL
COVER FEATURE 2
Methanol markets
COVER FEATURE 3
Innovations in steam reforming
COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

Fig. 9: **Saipem's xDim®, the unique platform**



Source: Saipem

Fig. 10: **Urea plant layout optimisation**

to be an efficiency accelerator, leveraging on Saipem's recognised experience as EPC contractor to support companies in the project definition with an execution-oriented approach: techno-economic feasibility studies, basic and front-end engineering, etc. XSIGHT has also embraced the technological and digitalisation challenges of the industry by focusing on the development of new collaborative design methodologies and data analysis.

An example is the new product developed by Saipem, xDim®: a unique platform for all project stakeholders to manage, control and execute the project in an integrated way during the whole project lifecycle (Fig. 9). xDim® in a single platform includes engineering information (e.g. 3D models), project control tools (scope of work, schedule, performance indicators), a database for construction and material management, historical data for operation and maintenance of the equipment, and cost reports. The platform can be accessed in real time by all the stakeholders and contractor functions (engineering, procurement and construction) from all project locations and allows both contractor and company to easily interact and promptly intervene.

Design features

Reliability is always a key feature of Saipem/Snamprogetti's urea technology worldwide. Beyond the features that constitute Snamprogetti's Urea Technology, in all the developments proposed over the past 60 years particular attention has always been paid to the concept of plant flexibility as a means to obtain reliability in operation.

A dominant factor is the capability of the process technology to attain the required performances under a wide range of operating conditions, to react to unforeseen events, avoiding unplanned shutdowns, and to maximise the on-stream factor.

Proof positive of this approach is the adoption of the flexible steam system, which was originally introduced to take care of the reduction in plant flexibility when operating under particularly tough ambient conditions, leading to high cooling water temperature and to the increase of the operating pressures of the medium and low pressure sections. The introduction of two carbamate condensers allows the constraint between the pressure of steam and condensation of high pressure gases to be removed, restoring the desired flexibility to the steam system and eventually to the whole plant.

Another characteristic peculiarity of the Snamprogetti's Urea Technology is the presence of the medium pressure section, which is not included in the process schemes of the main competing high efficiency technologies. However, in recent years Saipem has noticed that, to cope with the required flexibility and reliability for very high capacity plants, competing technologies are now providing it. In any case, thanks to ammonia separation from carbonate solution in the medium pressure section, Snamprogetti Urea Technology enjoys the advantage of being able to operate with a wide range of temperatures of ammonia from battery limits (i.e. from -33 to +40°C) and to the urea reactor. Excess ammonia and the provision of the medium pressure section improve plant flexibility and, consequently, allow for a high on stream factor and low turn down ratio, bringing benefits to plant reliability. The recycling of liquid or gas from a melamine plant is also very easy to incorporate into this section.

Lay-out

The reduction of plant elevation was made possible by the use of the carbamate ejector as a driver for high pressure loop circulation and by the adoption of the kettle type carbamate condenser. The result of this development is a horizontal lay-out (Fig. 10) with easier maintenance, which, associated with simpler operation, reduces the number of unplanned shutdowns and, consequently, improves plant reliability. Additionally, with recent plant optimisation, Saipem has reduced the plant plot area by 25%, the piping by 15% and steel structure by 30%.

Environmental

Environmental regulations are becoming particularly stringent in terms of allowable emissions as the locations of plants are increasingly sited closer to densely inhabited areas. Snamprogetti Urea Technology designers have long incorporated several features to recycle gaseous effluents containing ammonia or to improve the quality of process effluents in order to make them reusable elsewhere in the complex. They include the recovery of urea plant off-gases as flammable gas for the ammonia plant reformer or for the auxiliary boiler, the adoption of deep hydrolysis associated with ammonia distillation to obtain process condensate reusable as boiler feed water and the absorption of the off gases in an ammonia solution recycled to urea plant. Snamprogetti has started proposing the flare system to attain zero tolerance in gaseous effluent emissions. In this way no gaseous effluents are released from urea plant under any operating conditions. This flare scheme has a direct advantage for plant flexibility and reliability since it also allows the plant to cope with occasional transient process conditions which could otherwise lead to a plant shutdown. In case of clients different requirements, alternative schemes are always available , i.e. recovery of ammonia by the use of an acid solution.

Mathematical model

In order to ensure proper and reliable design features in urea process technology, a process technology licensor must own simulation and prediction tools. Snamprogetti internally developed its own mathematical model which allows thermodynamic and fluid dynamic simulation of the process conditions, enabling the plant designer to optimise equipment as well as operating conditions. The model takes into consideration two phases in one dimensional flow motion, simply connected or dispersed to simulate different flow regimes and phase bulks not in vapour-liquid and chemical equilibrium. The result of the simulation allows the characterisation of the flow regimes as well as the temperatures, compositions, and phases along the length of the equipment. The mathematical model is intended not only for process simulation but also for equipment design, and it has shown its effectiveness both for new plant design and existing plant revamping. It has been validated by application to existing plant cases.

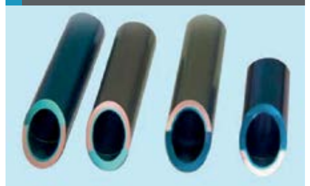
HP equipment

The urea synthesis environment represents one of the most aggressive media for materials in the chemical industry and Saipem/Snamprogetti™ Urea Technology therefore recognises the importance of always taking into consideration continuous improvements in:

- design details
- metallurgical requirements
- production solutions
- inspection and maintenance criteria.
- Optimisation of the qualification procedure

Saipem's qualification procedure for manufacturers of high pressure equipment has been optimised. The result is tight control of the manufacturer's capability in engineering, material purchasing, manufacturing and inspection from the beginning of the qualification procedure. This approach has resulted in a mandatory vendor list with high production quality, regardless of whether Saipem is the EPC contractor or the technology licensor.

Fig. 11: **Omegabond® tubes for urea stripper**



Source: Saipem

Synergy with manufacturers

This synergy with manufacturers brings a number of benefits:

- the synergy between Saipem/Snamprogetti™ Urea Technology and its qualified manufacturers increases the awareness of the crucial role of production as the main component for the final success of the technology;
- sharing with qualified manufacturers the importance of dedicating a team in terms of engineering and production also assures the continuous high quality level at the workshop;
- having a continuous presence of Saipem/Snamprogetti™ Urea Technology inspectors at the workshop drives and monitors production solutions towards optimum results.

Austenitic stainless steels for the urea plant HP section

Of major importance and an integral part of this approach on urea technology, is the verification of the actual implementation of the general specification "Austenitic stainless steels for urea plant high pressure section". Particular attention is given to:

- quality of materials;
- feedback from manufacturers;
- tube to tube sheet welds;
- laboratory feedback.

Nevertheless, the specification for the austenitic stainless steel is from time to time updated to incorporate experience, feedback and incoming market demand.

Technology developments

Material 25Cr-22Ni-2Mo is widely used in Saipem/Snamprogetti™ Urea Technology urea plants, mainly for equipment linings, because it has a higher resistance to corrosion than the previously employed 316L-UG. Material 316L-UG, on the other hand, is applied and provides good performance for piping in the high pressure section.

In addition, Saipem/Snamprogetti™ Urea Technology has developed and patented bimetallic tubes for the urea stripper. In the bimetallic tubes, the zirconium inner tubes (inserted by an extrusion process into 25Cr-22Ni-2Mo tubes) assure corrosion resistance and has made bimetallic tubes the leading design for urea strippers.

Applying the same concept of having zirconium inside the tubes, OmegaBond® material has been developed in collaboration with ATI Wah Chang for tubes of urea stripper (Fig. 11). Zirconium tubes are in this case metallurgically bonded to titanium tubes, assuring resistance to erosion. With the use of OmegaBond® tubing, the temperature in the bottom of the stripper can be higher compared to the bimetallic stripper, reducing the load on the downstream decomposition section, making it a very attractive consideration for urea plants revamping.

The needs driving the development of new solutions and construction processes can be summarised as:

- plant flexibility;
- increased output via more aggressive process conditions;
- elimination of the air passivation system for the stripper.

Duplex material has been used by Saipem/Snamprogetti™ Urea Technology for 30 years. It is currently used in the urea plant for:

- the carbamate ejector needle;
- the trim of HP urea service valves;
- the trim of PSVs (pressure safety valves).

At Saipem/Snamprogetti™ Urea Technology continuous research and development of new materials is performed to find new and competitive materials, with the aim of reducing the weight of piping and equipment and, at the same time, extending their lifetime.

The urea reactor has been upgraded. Recently a new design for reactor trays, the Snamprogetti™ SuperCups, has been developed and installed by Saipem. During the conceptual and design phases of the new trays, computational fluid dynamic studies (CFD) were carried out to analyse and optimise the mixing phenomena that take place in the reactor and to check that all internals

CONTENTS
What's in issue 353

COVER FEATURE 1
The prospects for GTL

COVER FEATURE 2
Methanol markets

COVER FEATURE 3
Innovations in steam reforming

COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight

Southbank House, Black Prince Road
London SE1 7SJ, England

Tel: +44 (0)20 7793 2567

Fax: +44 (0)20 7793 2577

Web: www.bcinsight.com
www.bcinsightsearch.com

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

are properly passivated, thus reducing the risk of corrosion (Fig. 12). CFD studies are also particularly important to verify the suitability of the new internals design for their installation in old equipment, which may have a different design (e.g. materials) from the one currently adopted.

In the design of HP equipment, Saipem/Snamprogetti™ Urea Technology takes into account the need for inspections, maintenance and repairs, on the principle that the simpler such activities are, the less time they require. The great advantage of this philosophy is that after scheduled activities urea production can be quickly restored. A leading requirement of clients is to have equipment that lasts for many years to avoid loss of production due to aging equipment and the expense of procuring new items.

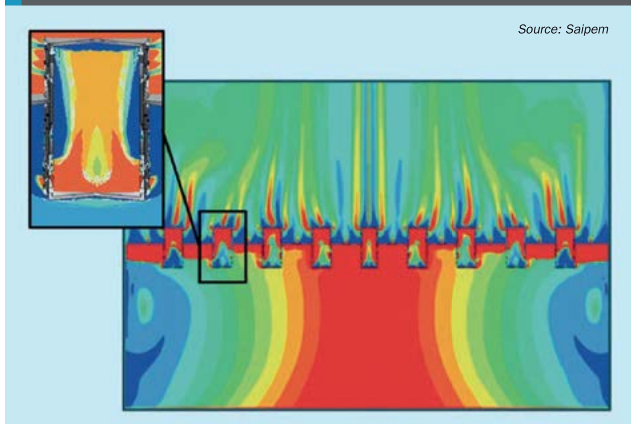
Applying this concept during equipment construction, some upgrading is always considered, for example:

- standardisation of the leakage system;
- sampling of coupons for corrosion tests;
- testing of all tube sheets, after weld overlay;
- optimisation of the welding process;
- review of the manufacturer material documentation.

Procurement

Apart from SuperCups trays, no proprietary equipment or materials are imposed by Saipem/Snamprogetti™ urea technology. Saipem's clients are free to enter the market with a competitive bid and select the vendor from Saipem's mandatory critical items vendor list.

Fig. 12: **CFD simulation for urea reactor SuperCups trays**



Nevertheless Saipem/Snamprogetti is fully involved to guarantee the soundness of HP equipment.

The typical path of Saipem's involvement in the procurement of HP equipment is:

- competitive bids;
- technical evaluation of the bids;
- review of vendor technical documentation;
- inspection during manufacturing;
- witness during key manufacturing steps;
- inspection at the tube supplier workshop;
- examination of manufacturer tests book;
- NDT witness and final inspection at the workshop.

Start-up and operation

Following the start-up of a plant, there is a dedicated department to ensure that all the relevant activities are developed according to the proper procedure. A urea plant is easy to start up, from the time of reactor feed in, production is achieved in a few hours, but proper plant preparation is a must to achieve and maintain excellent results.

After plant start-up and demonstration of the plant guarantee Saipem is always present to guide the client on all aspects relevant to the technology.

Often, after some years of operation clients ask about plant revamping in order to increase production, decrease production costs, reduce emissions or improve production quality.

A feasibility study followed by a process design package is a typical track adopted for revamping. The design efforts to enhance the plants are mainly focused on:

- improving plant economics by minimising the production cost and/or maximising production output;
- meeting market requirements in the global competition by improving the product quality or making new products (product diversification);
- reducing pollution to meet new government requests, if any;
- minimising investment cost;
- minimising utilities consumption;
- minimising the shutdown period for tie-in of new equipment;
- keeping maximum complex operability and flexibility;
- maintaining product quality and specific raw material consumption.

Plant inspection

Since maintenance and operation skills are essential components of management strategies to obtain urea plant reliability, the importance for a urea technology licensor to be able to provide the plant owner with proper services to achieve this aim is self-evident. Saipem has developed skills and expertise in equipment inspection during turnarounds that allows it to give clients suggestions for setting up preventative maintenance strategies as well as exhaustive recommendations for equipment repair and corrosion prevention. Programmes for equipment evaluation throughout their full life on the basis of NDT results are available for clients. To improve the skills of plant operators, Saipem can offer a dynamic simulator for operator training. In addition, theoretical training for improving maintenance and operational knowledge of the process is available to all clients.

As part of the after sales services, qualified personnel are dispatched to clients workshops or to the plant site to check the integrity and status of equipment through a meticulous analysis of internals, welds and whole items.

This service can be carried out at site to support the end user during the scheduled shut down of the plant or from headquarters to support and assist the end user on several aspects of the equipment manufacturing. ■

References

1. Spies C. (Stamicarbon): "Designing the future together through plant life", written for Nitrogen+Syngas (Apr 2018).
2. Carlessi L. (Saipem): "Enhancing urea plant performance throughout the life cycle", written for Nitrogen+Syngas (Apr 2018).

CONTENTS

What's in issue 353

COVER FEATURE 1
The prospects for GTL

COVER FEATURE 2
Methanol markets

COVER FEATURE 3
Innovations in steam reforming

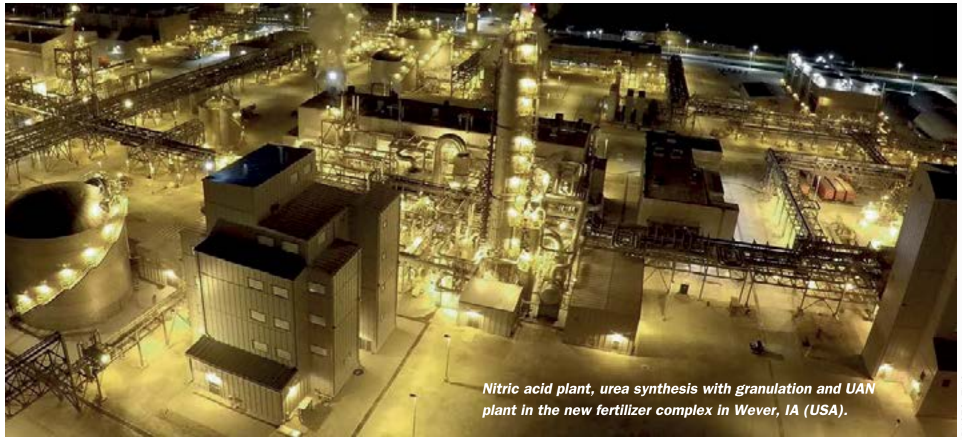
COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

Uhde® Mega UAN concept: from vision to success



Nitric acid plant, urea synthesis with granulation and UAN plant in the new fertilizer complex in Wever, IA (USA).

PHOTO: TKIS

Uhde® UAN technology has proven to be versatile, flexible and reliable. In this article, **E. Marcos Puertas**, **P. Kamermann**, and **J. Mathiak** of thyssenkrupp Industrial Solutions AG report on the start-up and recent operating experience of two recently commissioned Mega UAN concept plants in the USA.

Table 1: Typical composition of commercial UAN solutions

	UAN28	UAN32
AN	40%	45%
Urea	30%	35%
Water	30%	20%

Source: tkIS

UAN as a fertilizer

UAN is a solution of urea and ammonium nitrate in water. It is widely used as a fertilizer, mainly in North America, Western Europe and the former Soviet Union[1]. According to IFA, global UAN consumption in 2017 was 18.7 million t/d, with North America representing 70% of it.

Commonly used grades of UAN solutions contain between 28% and 32% total nitrogen and are referred to as UAN28 and UAN32 respectively.

Typical compositions of UAN28 and UAN32 are shown in Table 1.

Another important quality parameter of the UAN solution is the ammonium nitrate to urea ratio. To avoid freezing/salt-out and corrosion in UAN storage tanks, a ratio of over 1.2 and below 1.4 kg of ammonium nitrate per kilogram of urea is recommended. Most producers target a ratio of 1.28 for UAN32, keeping it between 1.26 and 1.35.

When compared to other liquid fertilizers like ammonia water, UAN solutions combine the fertilizer properties of urea and ammonium nitrate with a higher degree of safety than straight ammonium nitrate based fertilizer and a higher N-utilisation. The combination of urea and ammonium nitrate provides a readily available nitrogen source (nitrate), an intermediate action component (ammoniacal nitrogen) and a long-term/slow acting agent (amide nitrogen).

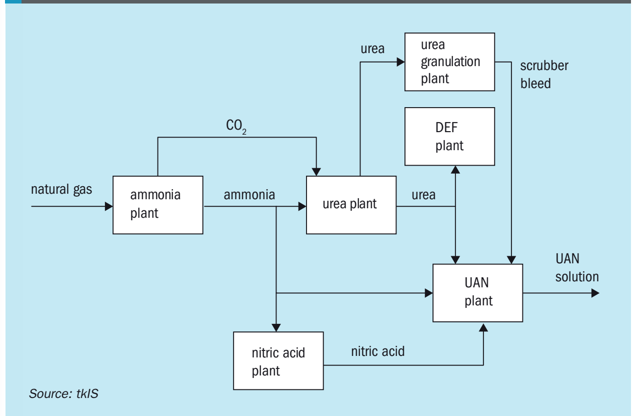
When compared to solid fertilizers, UAN solutions are easy to handle, transport and store (no caking, no dust). They can be easily distributed and uniformly applied to the field. They also have the advantage that pesticides, herbicides or other nutrients can be incorporated into the liquid solution and be applied together. This means easy distribution on the soil, requiring little effort. Water also needs to be transported and applied to the crops.

In comparison to granulated urea, UAN solutions have a higher nutrient density (e.g. UAN32 contains about 420 kgN/m³ whereas granulated urea with a bulk density of 760 kg/m³ contains 350 kgN/m³).

UAN production

UAN plants are usually large scale production units, located inside a big fertilizer complex including ammonia, urea, nitric acid and ammonium nitrate plants, offsites and utilities[2] (see Fig. 1).

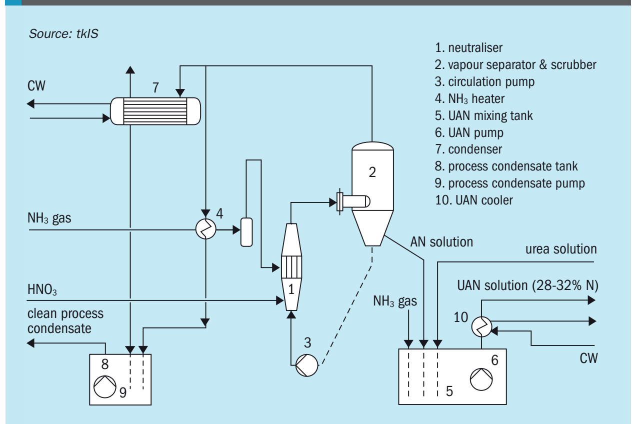
Fig. 1: Typical interconnecting diagram of a UAN fertilizer complex



Source: tkIS

Fig. 2: Typical flowsheet of a UAN unit based on Uhde® vacuum neutralisation

Source: tkIS



For these large scale facilities, tkIS (thyssenkrupp Industrial Solutions, formerly known as Uhde) developed the Mega UAN concept[1] in 2004, based on the proprietary Uhde® vacuum neutralisation process, where ammonium nitrate is produced in a forced circulation neutralisation loop (Fig. 2). The key performance features of the loop are:

- high AN concentration (up to 93 %w/w);
- very low reaction temperature (~145°C);
- no formation of AN-aerosols;
- production of very clean process condensate (~ 10 – 20 ppmw nitrogen);
- no wear and tear part;
- flexible capacity range between 40 and 110% by adapting controller set points.

To ensure stable conditions of the UAN product, uniform mixing in the UAN mixing section is critical. The proprietary UAN mixing tank from tkIS guarantees optimum mixing of the feedstocks. It combines cooling and a unique mixing section.

Recent experience of the Uhde® Mega UAN Concept

Recently, tkIS has commissioned two Mega UAN concept plants in the USA. At the beginning of 2016, a 4,300 t/d UAN complex including an ammonia plant, a nitric acid plant, urea synthesis with granulation plant and UAN plant was started up at CFI in Donaldsonville, USA (see Fig. 3). And in the spring of 2017, a 4,300 t/d UAN plant with nitric acid, urea synthesis, granulation and diesel exhaust fuel (DEF) production from tkIS, built by Orascom E&C USA, Inc. in its capacity as the EPC contractor for the entire complex, was started up for Iowa Fertilizer Company (IFCo) in Wever, USA.

Fig. 3: Mega UAN plant at CFI in Donaldsonville, USA

PHOTO: tkIS

In the following sections the start-up and operating experience of the UAN plant installed in the IFCo facility is described. Critical performance parameters are plant capacity, flexibility, quality and liquid effluents.

Plant capacity

Only a couple of hours after the initial start-up of IFCo's UAN plant, production was running at 85% capacity, exporting UAN32. Tuning it to name plate capacity took only a few hours longer.

Plant flexibility

The plant setup as shown in Fig. 1 offers the flexibility to produce several different products such as DEF, urea granules and different UAN grades. The economic success of such a facility can be maximised if the production of each product can be adapted to the daily market prices of those products. Consequently, DEF production and urea granulation were both started up and shut down on demand, and the UAN plant capacity was adapted accordingly, sometimes even on an hourly basis, without production of any off-spec product.

CONTENTS
What's in issue 353
COVER FEATURE 1
The prospects for GTL
COVER FEATURE 2
Methanol markets
COVER FEATURE 3
Innovations in steam reforming
COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27

Simultaneously, the flexibility of the UAN plant needs to be able to handle volatile ambient conditions and conditions of the upstream plants in terms of composition and flow.

An advanced UAN control philosophy is required to master transient variations.

Uhde® advanced UAN product quality control

Online instrumentation is used to control the UAN product quality. The nitrogen content, ammonium nitrate and urea concentrations, and ammonium nitrate to urea ratio of the UAN product export line are calculated based on specific gravity and refractive index. In order for these calculations to be accurate, checks against laboratory results have to be performed.

The heart of the advanced control philosophy utilises not only the UAN product properties, but also the feed composition and flows. This optimised feed-forward control of the water content of the streams being sent to the UAN mixing section (ammonium nitrate solution, urea solution and scrubber bleed from urea granulation plant) guarantees UAN production with a very stable nitrogen content and urea and ammonium nitrate concentration.

Fig. 4 shows an extract of a screenshot from the DCS system of the UAN plant while in operation. The main UAN quality parameters shown in the figure are: ammonium nitrate concentration (AYI34003A), urea concentration (AYI34003B), ammonium nitrate to urea ratio (AYI34003C) and nitrogen content (AYI34003).

An example of the UAN product quality evolution directly after one start-up is presented in the Fig. 5.

In Table 2 laboratory results of UAN product for the same timeframe are shown for comparison.

The online product quality control implemented in the IFCo facility proved to be reliable for nitrogen content, urea and ammonium nitrate concentrations. If the data downloaded from the DCS in Fig. 5 and the laboratory results shown in Table 2 are compared, it can be seen that the DCS accurately predicted the variations of ammonium nitrate and urea concentration during start-up.

After every shutdown, when the feedstocks were ready, the UAN plant was started up within minutes. Depending on the urea quality, on-spec UAN32 was achieved approximately two hours after trip reset.

Fig. 4: **UAN quality parameters shown in DCS**

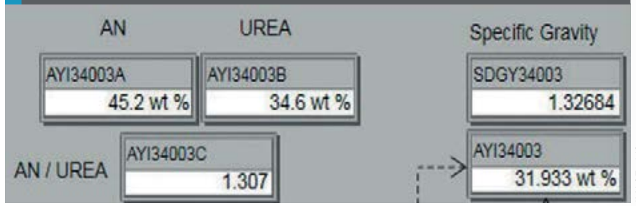
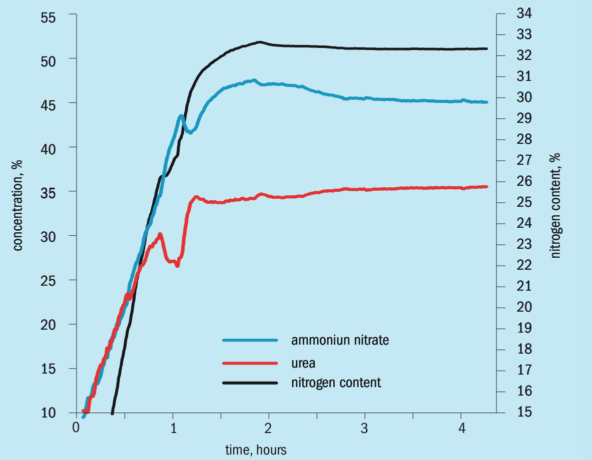


IMAGE: tkIS

Fig. 5: **UAN product quality evolution after pressing plant trip reset (data downloaded from DCS)**



Source: tkIS

The UAN plants from tkIS are fully automated and react pre-emptively against feedstock changes to avoid process deviations. One board operator and two field operators per shift were foreseen to take care of both the nitric acid and the UAN plants. If the nitric acid plant has to be started while the UAN plant is running, both board and field operators can focus on the nitric acid plant, while the UAN plant is able to run for several hours without close field or board supervision required.

Liquid effluents

Waste effluents from a fertilizer complex contain ammonia, nitric acid and/or urea, which are not easily treated inside the waste water treatment unit. The key to successful waste water management is to minimise these effluents and reuse them inside the complex as far as possible. Among these effluents process condensate from the ammonium nitrate neutralisation unit and scrubber bleed from the urea plant represent the greatest challenges. However, to target absolute zero liquid discharge, ammonia water from the ammonia evaporation section, which is usually disposed of by means of IBC container, should also be treated/handled inside the complex.

As regards process condensate from the ammonium nitrate neutralisation unit, the proprietary Uhde® vapour separator and scrubber (see Fig. 2) provide the optimum basis to produce process condensate which is so clean that it can be further used as make up water for the nitric acid absorption tower or as feed for the demineralised water plant.

Table 3 shows typical laboratory values for process condensate of the UAN plant at the IFCo facility. It can be observed that in normal operation, process condensate with below 1 ppm of nitrates and below 0.1 ppm of total ammonia was achieved, which results in a nitrogen content below 0.4 mg/l.

With regard to scrubber bleed from the urea plant, one of the limitations is the type and amount of contaminants (e.g. oil) that can be safely added to the product. Another possible limitation is the amount of water that can be added to the UAN mixing unit while still maintaining nitrogen content of 32% in the final product.

To overcome this limitation, high ammonium nitrate concentration downstream of the neutralisation unit is required. The proprietary and patented AN neutraliser as part of the Uhde® vacuum neutralisation allows this high ammonium nitrate concentration (up to 93%) without the need of additional heat sources like steam.

The UAN plants from tkIS can turn more than 5% of its nameplate capacity of waste streams into product.

To maximise the amount of water that can be added to the UAN mixing unit, very accurate online control of the product quality is required as described earlier.

The amount of ammonia water that has to be drained from the ammonia evaporation section to maintain the ammonia gas pressure often represents a challenge, both in nitric acid and ammonium nitrate plants. By adjusting the evaporation and stripping conditions of the ammonia evaporation section, the UAN plant is able to produce absolute zero liquid discharge during operation.

Once the operators had enough experience to start the neutraliser in optimised steps, the condensate was clean enough from the outset to be utilised as make-up water for the absorption tower of the nitric acid plant. Approximately three hours after every trip reset process condensate with conductivity below 50 microS/cm and below 10 mg/l of nitrogen, was also exported to battery limits as feedstock for the demineralised water plant in the utilities section of the plant.

An example of the process condensate quality evolution directly after one start-up is presented in the Fig. 6.

Table 2: **UAN product laboratory analyses for four hours after plant trip reset**

Time after trip reset	Total Nitrogen (%)	AN (%)	Urea (%)
30 min after TR	19.5	22.9	24.7
60 min after TR	29.3	38.8	33.7
90 min after TR	31.1	43.3	34.1
120 min after TR	32.7	47.2	34.7
240 min after TR	32.5	45.2	35.8

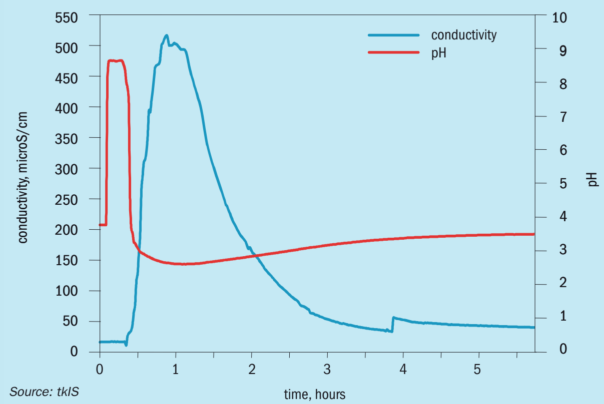
Source: tkIS

Table 3: **Process condensate laboratory analysis in normal operation**

Date	pH	Total NH_3 (ppm)	Conductivity (microS/cm)	Nitrates (ppm)
Day 1	4.1	0.1	40.34	1
Day 2	4.2	<0.1	25.3	1
Day 3	4.2	<0.1	24	<1
Day 4	4.3	<0.1	22.07	<1
Day 5	4.2	<0.1	24.42	<1

Source: tkIS

Fig. 6: **Condensate quality evolution after pressing plant trip reset (data downloaded from DCS)**



Source: tkIS

Summary

As shown in this article, the UAN plants from tkIS can be started very easily and produce on-spec product and condensate right from the start. Due to the Uhde® advanced product quality control they are easy to operate, produce zero liquid discharge in operation and are even able to reprocess waste streams produced inside the fertilizer complex, reducing the amount of waste water to be handled by the wastewater treatment plant.

References

1. Kamermann P: "Mega UAN Concept: A step ahead in the fertilizer business?" Nitrogen 2004 Conference & Exhibition, Munich, Germany, 21-24 (March 2004).
2. EFMA; "BAT Booklet 5 of 8: Production of urea and urea ammonium nitrate"; (April 2000).

CONTENTS

What's in issue 353
COVER FEATURE 1
The prospects for GTL
COVER FEATURE 2
Methanol markets
COVER FEATURE 3
Innovations in steam reforming
COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

Gearing up for future steam reforming

ZoneFlow™ Reactor Technologies LLC (ZFRT) has developed proprietary, radically innovative structured catalyst solutions for steam reforming, pre-reforming and recuperative reforming. ZoneFlow (ZF) reactors provide higher heat transfer, lower pressure drop, higher geometric surface area, more uniform flow and heat distribution, and long-term structural integrity compared to the current state-of-the-art pellet catalyst. The use of ZF reactors enables significant capital and operating cost reduction in steam reforming both for new plants as well as revamps. **S. Ratan** of ZFRT and **Prof. J. De Wilde** of UCL, Belgium discuss the current status of the technology.

The predominant technology for syngas generation over all these years has been steam reforming of light hydrocarbons, mainly natural gas commonly called steam methane reforming (SMR). This mature technology however has seen only incremental improvements in its catalyst design and its performance in conjunction with superior tube metallurgy and reformer design with the aim for better efficiency and reliability.

Current technology

The conventional "pellet" steam reforming catalysts suffer from a few inherent limitations and/or operational deficiencies. These mainly relate to a) uneven random packing voidage leading to undesired flow and temperature maldistribution, b) catalyst attrition and breakage from thermal cycling leading to increasing pressure drop and related capacity limitations and c) pore diffusion limited reaction path leading to curtailed intrinsic activity and lower resistance to carbon formation.

With the steam reformer being the heart of a syngas plant, carrying out the reactions involves heat, mass and momentum transfer and the reforming catalyst plays a critically important role in the thermal design, performance, reliability and cost-effectiveness.

Past attempts to develop structured steam reforming catalysts to overcome some of these limitations have suffered from the innate problems around differential expansion gaps leading to feed by-passing and disturbed boundary layer endotherm, as well as from the reactions being mostly realised away from the tube wall, with heat transfer limitations leading to insufficient conversion and/or hotter tubes.

Fig. 1: **ZF reactor typical casing and assembly**

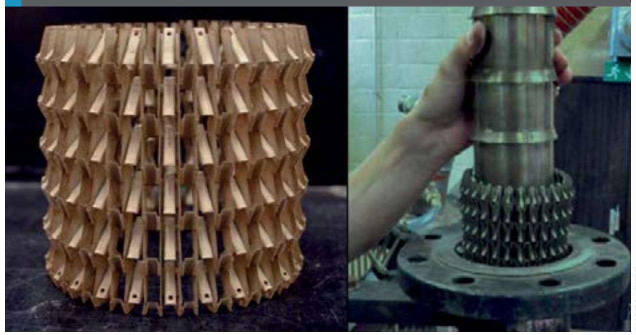


PHOTO: ZFRT

Innovative breakthrough

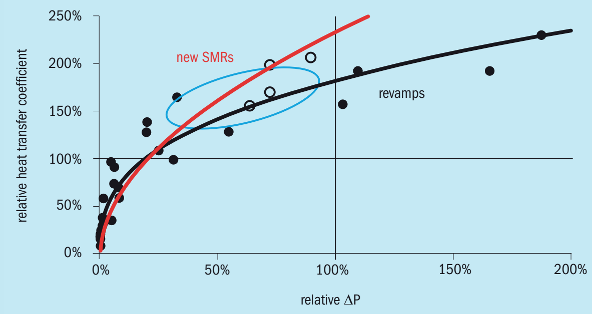
ZF reactor technology overcomes the above-mentioned deficiencies of pellet catalysts as well as providing higher heat transfer with substantially lower pressure drop. The ZF reactor's unique structure also imparts a high degree of proximal flexibility which eliminates the differential thermal expansion gaps, while carrying high (metal substrate) physical strength against breakage over its lifetime.

Its nested modules provide much more geometric surface than pellets, and take away the diffusion-limited access to the layered catalyst thus resulting in much higher catalyst effectiveness factors and increased resistance to carbon formation compared to pellets.

ZF reactors vs conventional 'pellet' catalyst

ZF Reactors are advanced engineered catalyst systems based on unique 'annular' foil casing structure (see Fig. 1) offering two primary advantages over conventional 'pellet' steam reforming catalysts:

Fig. 2: **Optimisation of heat transfer coefficient against pressure drop**



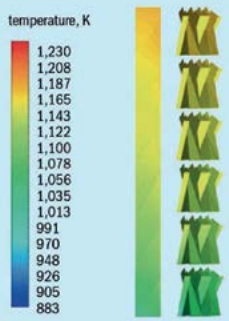
Source: ZFRT

- lower pressure drop (dP) – the ZF uses dP mainly to enhance the turbulence near the tube wall, avoiding to large extent "unutilised" dP;
- superior heat transfer – ZF annular structure directs the gas flow towards and away from the tube wall to impinge the hot surface of the tube wall which significantly enhances heat transfer lowering the tube skin temperatures or allows higher heat flux for the same tube design temperature.

Additionally, ZF reactors offer following significant advantages compared to pellets for revamping as well as new steam reformers:

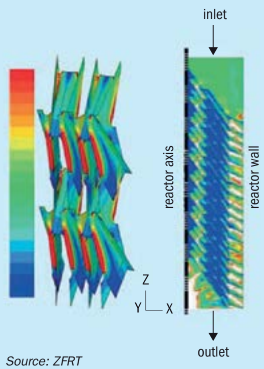
- much higher catalyst effectiveness resulting from the use of thin catalyst layers;
- uniform heat transfer and fluid flow in all the tubes against the inherent maldistribution of flow per tube with pellets (typically +/- 2-5%) and thus tube temperature non-uniformity on the same plane across the tubes, thereby also eliminating hot tubes that can restrict full-load operation while also risking shorter tube life and coke formation;
- long-term structural integrity, including mechanical features to accommodate thermal cycling, thus avoiding pressure drop build-up over time related to progressive deterioration of pellets.

Fig. 3: **CFD modelling (for upflow)**



Source: ZFRT

Fig. 4: **FEA results (for downflow)**



Source: ZFRT

ZF development and validation milestones

Various computational fluid dynamics (CFD) and finite element analysis (FEA) studies have not only confirmed these properties but also allowed greater insight into the ZF performance and design, allowing the balance between these key performance parameters to be optimised. ZF reactors can be tailored to application-specific optimum combination of higher heat transfer coefficient and lower dP compared to conventional pellet catalysts as shown in Fig. 2.

ZFRT has achieved various development and validation milestones over recent years:

- bench-scale validation at the University of California at Davis HyPaul labs;
- independent CFD reactor modelling for optimisation of the heat and mass transfer and pressure drop (Fig. 3);
- FEA to establish mechanical robustness and long-term durability (Fig. 4);
- ZF designs have been further tested and demonstrated in a commercial SMR with ZF inserted in two tubes (out of more than 200) allowing direct comparative assessment of conventional pellet catalyst under the same operating conditions, apart from verification of the ZF loading/unloading into commercial scale tubes. The results achieved the near 2-fold higher heat transfer reflected in lower tube-skin temperature by up to 60°C combined with more than 25% lower pressure drop compared to the adjacent tubes operating with pellet catalysts;
- the ZF reactor designs can be optimised and customised for required balance between heat transfer and pressure drop for the specific application, and can also be made to fit any commercial SMR tube size.

ZFRT pilot plant

ZFRT's pilot plant, installed within the Université Catholique de Louvain, Belgium (UCL), is nearing completion. It is a fully equipped and instrumented self-designed and built pilot plant with a micro-alloy tube suspended in an electric furnace. This installation will allow an extensive set of planned tests to be conducted in order to further validate the performance and physical integrity of the ZF reactor. Testing is expected to commence during 2-3Q 2018.

CONTENTS
What's in issue 353
COVER FEATURE 1
The prospects for GTL
COVER FEATURE 2
Methanol markets
COVER FEATURE 3
Innovations in steam reforming
COVER FEATURE 4
Full life cycle urea plants

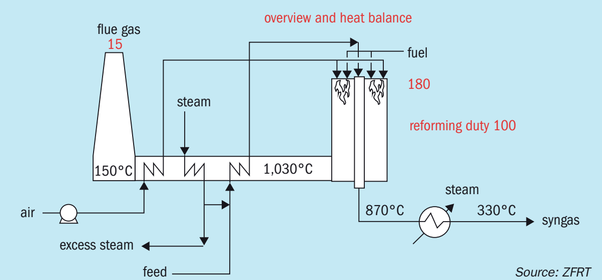
NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

Fig. 5: **Pilot plant under installation**

PHOTO: ZFRT

Fig. 6: **Steam methane reformer in a syngas plant**



Source: ZFRT

Table 1: **ZF-SP for de-bottlenecking: Case summary**

	Reference	ZF-SP
Relative capacity, %	**95 / 100**	**100 /105**
Capacity limitations	dP, TSM	removed
S/C ratio	3.0	2.8
Outlet temperature, °C	865	874
Approach to equilibrium, °C	-10	-7
CH_4 slip, dry vol-%	5.5	5.6
Radiant pressure drop (dP), bar	**2.8**	**2.5**
Relative radiant duty, %	100	104
Average heat flux, kW/m²	75	78
Bridge-wall temperature, °C	**1,008**	**1,004**
Max. tube skin temperature (TSM), °C	**940**	**938**

Source: ZFRT

Various ZF performance and integrity tests will be conducted over a wide range of operating conditions covering commercial conditions and beyond in terms of S/C ratios, pressures and temperatures. The severity levels cover S/C ratios down to 1.5, exit temperatures above 900°C and pressures up to 30 barg. Both ZF single-pass as well as ZF-Bayonet for recuperative reforming will be tested.

The UCL pilot plant (Fig. 5) consists of methane feed pretreatment and compression as needed, water demineralisation, boiler feed water pump, start-up boiler, synas boiler and steam superheater, supply of support gases (argon, nitrogen and hydrogen), steam reforming unit with electrical multi-element heated and controlled full bore tube (>6 m long), and a syngas cooling section followed by a back pressure regulator and condensate separation for safe flaring of syngas.

The plant is profusely instrumented with state-of-the-art high accuracy mass flow controllers, pressure, temperature and level controllers as well high integrity thermocouples with monitoring clusters for the necessary extensive process gas as well as tube skin temperature measurements. Excess steam produced is vented. The reformed gas composition is measured by on-line GC.

The facility has gone through scrupulous safety and operability auditing for strict compliance with all regulations, codes and standards. An uncompromising emphasis on safety has been placed during the rigorous Hazop and SIL studies as well as logics for normal and emergency shutdown.

The emissions (syngas via hot flare) and effluents (process condensate via safe disposal) have been done in full compliance of the environmental requirements and codes.

The ZF reactor designs can be optimised and customised for required balance between heat transfer and pressure drop for the specific application, and can also be made to fit any commercial SMR tube size.

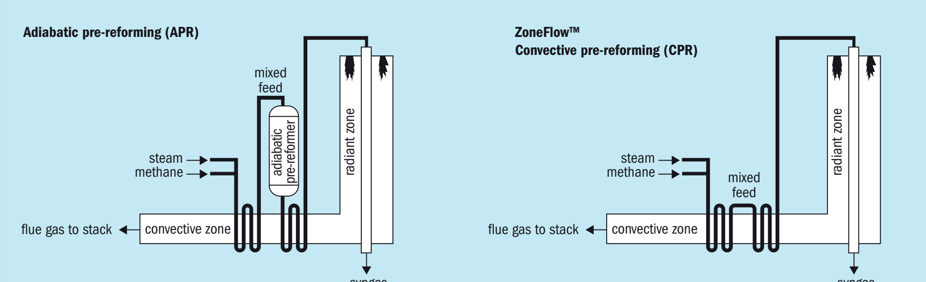
Added-value ZF Solutions for syngas SMRs

Analysis is provided for the following cases covering various ZF applications in a SMR (see Fig. 6):

ZF-single pass

- de-stressing and debottlenecking SMRs;

Fig. 7: **Convective pre-reforming for in-situ recycle of high grade heat using existing process coils**



Source: ZFRT

- higher-flux, cost-effective and more reliable new SMRs.

ZF-convective pre-reforming

- unmatched in-situ retrofit for additional capacity in existing SMRs without major modifications;
- efficient and cost-effective applications in new SMRs.

ZF-bayonet

- uniquely applicable for recuperative reforming, overcoming current barriers .

In these case analyses, the common underlying advantages from ZF's lower dP and higher heat transfer coefficient include:

- higher outlet temp without increasing maximum tube skin temperature (TSM);
- higher heat flux and/or higher outlet temp without increasing bridge-wall temperature, or related SMR firing duty;
- lower approach to equilibrium.

Destressing or debottlenecking of existing SMRs using ZF-SP reactors

For a detailed comparative summary see Table 1. Benefits include:

- additional ~ 5% capacity, while retaining or safely utilising typical design margins;
- higher average heat flux without exceeding tube design temperature;
- improved temperature uniformity;
- extended tube life and improved reliability;
- better catalyst performance and "life cycle" costs;
- optimised operation and enhanced reliability.

ZoneFlow™ convective pre-reforming (ZF-CPR)

ZFRT has also designed and engineered an ultra-low pressure drop structured catalytic reactor with high surface area/low cross section for non-adiabatic low-temperature convective pre-reforming (CPR), see Fig. 7.

It offers the following benefits (see also Table 2):

- in-situ horizontal loading in the mixed feed preheat (MFPH) coil in the convection;
- optimisation of pressure drop in combination with ZF-SP in SMR radiant tubes;
- for revamps, 8-12% additional reforming without increasing SMR firing duty;
- for new SMRs, 10-15% smaller SMR and proportionately also the steam system;
- no concerns over horizontal loading catalyst settling, attrition and related feed by-passing;
- shifts steam loads to utilities and off-sites, thus also lowering core-plant C-footprint.

ZF-bayonet (ZF-B) for recuperative reforming

ZF reactors are inherently suited for "bayonet" (tube-in-tube) recuperative reforming based on their annular casing design. The reformed process gas flows out through the centre (core) tube providing part of the

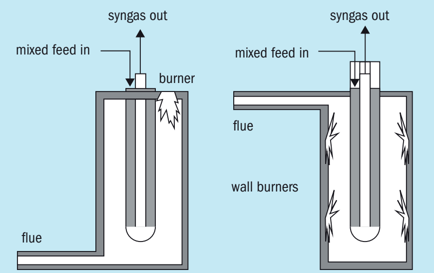
Table 2: **Summary of ZF – SP + CPR revamp application**

	Existing	ZF+CPR
Relative capacity, %	**100**	**115**
S/C ratio	**3.0**	**2.85**
SMR inlet temperature, °C	550	550/575*
SMR outlet temperature, °C	870	870/878*
Approach to equilibrium (EOR), °C	-10	-7
CH_4 slip, dry vol-%	4.8	5.1/4.8
Radiant pressure drop, bar	**2.5**	**2.3**
Average heat flux, kW/m²	80	80/82
Relative radiant duty, %	**100**	**100/103***
Bridge-wall temperature, °C	**1,020**	**1,009/1,018***
Max. tube skin temp. (TSM), °C	**950**	**938/948***

** Exploiting existing design margins*

Source: ZFRT

Fig. 8: **Bayonet application in different SMR configurations**



Source: ZFRT

CONTENTS
What's in issue 353
COVER FEATURE 1
The prospects for GTL
COVER FEATURE 2
Methanol markets
COVER FEATURE 3
Innovations in steam reforming
COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

high grade heat recovery for steam reforming, thus lowering the fired duty as well as size of the reformer by 15-20% , apart from even larger reduction in the size of the steam system. The ZF-bayonet application can be incorporated in any SMR firing configuration whether top-fired, side-fired (see Fig. 8).

ZF also overcomes the main risk of current 'pellet' catalyst crushing from differential thermal expansion as an unmatched technology based on its robust metallic substrate and flexible casing structure.

Economic benefits and applications

The merits of the ZF reactor can translate into attractive benefits ranging from relieving "stressed" reformers, extending reformer tube life and capacity revamps to lowering SMR related opex and capex. It covers the capacity span from large syngas generation plants for the refining sector (whether new or revamp of existing plants) to advanced solutions for small scale distributed hydrogen for a futuristic energy landscape. Its merits also extend to the related syngas production for methanol and GTL plants, including mini modularised units for remote gas monetisation as well as flare gas reduction.

Based on the energy costs and economic investment/IRR criteria for new plants and the level of modifications in revamping of existing plants, each application needs to be evaluated on a case-by-case basis in terms of opex and capex analysis to select the most appropriate, and economically attractive (ZF) solution. Other important case-specific conditions may include stand-alone units with no export steam, lowering of carbon footprint, SMR intensification, long term feed and product pricing, revamp project downtime as well as environmental aspects for overall optimisation of syngas generation.

Conclusions

ZF reactor technologies offer attractive applications and promising solutions and advanced options in steam reforming, thus facilitating cost-effective, efficient, reliable and attractive syngas generation.

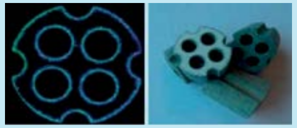
The new pilot plant designed and constructed at UCL, Belgium, as well as collaborative efforts with some of the prominent players in the syngas field, will allow further rigorous testing of ZF reactors under commercial conditions for market roll-out in steam methane reforming applications. ■

Recent innovations in steam reforming catalysts

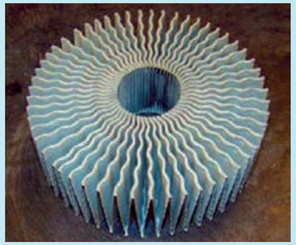
In recent years there have been several key developments in the shape and composition of nickel catalysts as well as new catalyst manufacturing methods, resulting in better products and improved performance of the steam reformer as reported in recent articles in *Nitrogen+Syngas*:

- Topsoe's most recent innovation in alkali-promoted catalysis, RK-400, provides superior protection against carbon formation in conjunction with enhanced catalyst activity and lifetime. The ingenuity of the RK-400 catalyst lies in the method by which the alkali promoters are incorporated into the catalyst carrier material to provide a reservoir of potassium promoter with the ability to replenish the surface potassium on the nickel catalyst over time (see *Nitrogen+Syngas* no. 336).
- Johnson Matthey's newest development for pellet catalyst is a nickel "eggshell" reforming catalyst, KATALCO$_{JM}$57-6Q. A new manufacturing technique developed in Billingham allows the nickel oxide to be concentrated at the surface of the pellet, where the reaction takes place, and reduces the metal content in the centre of the catalyst (see *Nitrogen+Syngas* no. 347).
- In 2014, Johnson Matthey acquired the Catacel Corporation which manufactures a range of stackable structured reactors known as CATACEL$_{JM}$ SSR™. Providing a step change in performance compared to pellet based reforming catalyst, CATACEL$_{JM}$ SSR™ is a stack of nickel catalyst coated fins which fill the reformer tube. This new technology provides significantly enhanced activity and heat transfer when compared to pellets, whilst also offering a reduced pressure drop (see *Nitrogen+Syngas* no. 337).
- Clariant has developed a new generation of reforming catalysts with a unique and optimised flower-like LDP Plus shape with eight holes. Compared to its 10-hole predecessor, the new 8-hole floral design of ReforMax® LDP Plus allows a pressure drop decrease of up to 20% (see *Nitrogen+Syngas* no. 347). ■

Topsoe's 7-hole steam refomring catalyst R-67-7H.



Cross section of KATALCO$_{JM}$57-6Q compared to traditional QUADRALOBE catalyst.



CATACEL$_{JM}$SSR individual fan.

Unique 8-hole floral design of ReforMax® LDP Plus catalyst.

Easy access to true TWT readings

Topsoe's expert digital services for ammonia, methanol, hydrogen and syngas plants now includes TrueTemp™, a new online application to improve the accuracy and reliability of tube wall temperatures (TWTs) in the steam reformer. Reformer operation can be optimised by allowing the reformer to be operated closer to design temperature and firing efficiently, while keeping the tubes safe and preventing unplanned shutdowns.

Monitoring and control of reformer tube wall temperatures (TWTs) is essential for the reformer to perform at peak efficiency and productivity under safe conditions. Operating the reformer at too low an average TWT and/or too high a temperature spread, can lead to significant production losses. On the other hand, the lifetime of the reformer tubes can suffer significantly if operated above design temperature.

TrueTemp™ digital services

Topsoe recently launched an online application named TrueTemp™ which enables plant operators and engineers to upload IR pyrometry readings and assess the reformer tube temperature profile. TrueTemp™ provides a detailed and accurate overview of key parameters in the reformer, e.g. raw and corrected TWT and burner status. TWTs are presented in an easy graphical overview. The application provides an overview that makes it easier to operate closer to tube design temperature and address non-uniform firing, and is available for both side-fired and top-fired reformers.

TrueTemp™ stores all historical operating data, enabling benchmarking of the temperature profile as well as identifying high-risk tubes being operated above design temperatures over an extended period. TrueTemp™ also guides users with various built-in warnings base on best practice and provides recommendations on how to operate the reformer in the most optimal way.

How TrueTemp™ works

When measuring TWTs, the reading on the pyrometer is incorrect because it is affected by radiant heat from the walls of the tube. Such deviations need to be corrected in order to establish the true TWT.

TrueTemp™ makes it easy to do this by applying Topsoe's in-house correction formula. This not only takes into account the TWT actually measured, but also the temperature of the furnace walls, the emissivity of the tubes and the particular type of pyrometer.

Once these temperatures have been corrected, a more accurate assessment of the reformer operation can be carried out, using the different features available in the TrueTemp™ application.

The user-friendly TrueTemp™ application interface makes it easy to get an accurate overview of how the reformer is operating, both currently and over time. It can be used to quickly assess whether the reformer is operating with a uniform temperature pattern, whether any tubes are close to (or above) design temperature, and the status of your burner operation.

The application auto-generates a performance report, along with an executive summary to provide key people with easy-to-interpret overviews of the reformer's current performance.

The application also stores the reformer operating data so that a performance data archive can be built up. This enables reformer performance to be benchmarked over an extended period, and high-risk tubes to be identified that have been operated above design temperatures. For protection against data loss, all data is backed up in storage.

Topsoe experience and best practices for safe and efficient reformer operation is now embedded in the TrueTemp™ application, providing prompt, reliable warnings and recommendations for action, which makes it easier to stay on track.

In addition to the software itself, the TrueTemp™ offering also includes "connected services", which comprise guidance and support on reformer operation from Topsoe Technical Services, as the cloud-based application allows Topsoe engineers to follow the TWT and burner status on an on-going basis.

Topsoe Furnace Manager

Topsoe Furnace Manager is the ultimate digital solution to survey TWT and burner status. It is a 24/7 real-time, furnace monitoring process safety system that can be installed on any type of steam reformer configuration. ■

CONTENTS
What's in issue 353
COVER FEATURE 1
The prospects for GTL
COVER FEATURE 2
Methanol markets
COVER FEATURE 3
Innovations in steam reforming
COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

Advertisers' index

Advertiser	Page	Website
2018 ANNA Conference	IBC	an-na.org/2018-conference/
Blasch Precision Ceramics	15	blaschceramics.com
Casale	30/31	casale.ch
Eurotecnica Contractors and Engineers	5	eurotecnica.it
Eurotecnica Contractors and Engineers	OBC	eurotecnica.it
Haldor Topsoe	11	topsoe.com
IPCO Germany GmbH	9	ipco.com/contact/de/
Integer Research	13	integer-research.com
Johnson Matthey	IFC	matthey.com/
Schoeller-Bleckmann Nitec GmbH	25	christof-group.at/en/sbn/
Stamicarbon BV	33	Stamicarbon.com

Next issue: July/August 2018

Distribution at: 63rd AIChE Annual Safety in Ammonia Plants and Related Facilities Symposium

- **Small scale ammonia plant design and applications**
- **Africa's new fertilizer plants**
- **Urea market outlook**
- **Plant data analysis**
- **The drivers for smaller scale ammonia plants**

Closing date for advertisement space booking is 21 June 2018
For further information and to book advertisement space contact:
Tina Firman, Publishing Director: tina.firman@bcinsight.com
Tel: +44 (0)20 7793 2567 Fax: +44 (0)20 7793 2577

Editor: RICHARD HANDS
richard.hands@bcinsight.com
Technical Editor: LISA CONNOCK
lisa.connock@bcinsight.com
Contributors:
ALISTAIR WALLACE
alistair.wallace@integer-research.com
MIKE NASH
mike.nash@ihs.com
Publishing Director: TINA FIRMAN
tina.firman@bcinsight.com
Subscription rates:
GBP 425; USD 850; EUR 655
Subscription claims:
Claims for non receipt of issues must be made within 3 months of the issue publication date.
Sales/Marketing/Subscriptions:
MARLENE VAZ
Tel: +44 (0)20 7793 2569
Fax: +44 (0)20 7793 2577
marlene.vaz@bcinsight.com
Cheques payable to BCInsight Ltd
Advertising enquiries:
TINA FIRMAN
tina.firman@bcinsight.com
Tel: +44 (0)20 7793 2567
Agents:
Japan: (also subscription enquiries)
KOICHI OGAWA
O.T.O. Research Corporation
Takeuchi Building
1-34-12 Takadanobaba
Shinjuku-Ku, Tokyo 169, Japan
Tel: +81 3 3208 7821
Fax: +81 3 3200 2889
Previous articles from *Nitrogen+Syngas* and *Nitrogen & Methanol* from 1996 to the present are available digitally in PDF format. To make a purchase, or for a list of available articles, please see: www.bcinsight.com
Copyright: ***Issued six times per year, or bi-monthly. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means – electronic, mechanical, photocopying, recording or otherwise – without the prior written permission of the Copyright owner.***
ISSN: 1750-6891
Design and production:
JOHN CREEK, DANI HART
Printed in England by:
Buxton Press Ltd
Palace Road, Buxton, Derbyshire, SK17 6AE
© 2018 – BCInsight Ltd
Published by: BCInsight Ltd
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

CONTENTS
What's in issue 353
COVER FEATURE 1
The prospects for GTL
COVER FEATURE 2
Methanol markets
COVER FEATURE 3
Innovations in steam reforming
COVER FEATURE 4
Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

Melamine

is a key presence in our lives.

Euromel® melamine is extensively used in the Chinese bullet trains for its superior performance. Driver's cab, switch cabinets, engine rooms, doors and sidewalls rely on melamine to feature insulation and fire resistant characteristics.

Euromel® is the trademark for melamine produced at plants licensed, engineered and implemented by Eurotecnica Group only, the leading melamine technology provider since 1978.

As many as 21 melamine plants worldwide, accounting for more than 670,000 t/y in licensed nameplate capacity, are based on Euromel® Melamine Technology. They include the production facilities of companies the likes of Qatar QAFCO, Methanol Holding Trinidad, ZAP Grupa Azoty, Xinjiang Xinlianxin (XLX) Energy Chemical Co. Ltd.

Ask for more information. Visit us on www.igoforEUROMEL.com

WE ARE MELAMINE TECHNOLOGY

EUROTECNICA

MAKING SUSTAINABILITY PROFITABLE

Don't forget the next issue of Nitrogen+Syngas July/August 2018

CONTENTS

What's in issue 353

COVER FEATURE 1

The prospects for GTL

COVER FEATURE 2

Methanol markets

COVER FEATURE 3

Innovations in steam reforming

COVER FEATURE 4

Full life cycle urea plants

NITROGEN+SYNGAS
ISSUE 353
MAY-JUNE 2018

BCInsight

Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com