IN BRIEF
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GAS PROCESSORS ASSOCIATION EUROPE

Affordable Blue Hydrogen Production

By Nan Liu, Licensing Technology Manager Gasification and Blue Hydrogen

Low-carbon hydrogen is "essential to support the EU's commitment to reach carbon neutrality by 2050 and for the global effort to implement the Paris Agreement while working towards zero pollution".[i] Without it, decarbonising heavy industry will be difficult. But today's hydrogen production is a major source of carbon dioxide (CO_2) emissions. "Green hydrogen (from the electrolysis of water using renewable power) is likely to be the long-term solution. However, it is predicted to be double the cost of "blue" hydrogen, which is produced from natural gas with carbon capture utilisation and storage (CCUS), in 2030 (Figure 1) and may not achieve cost parity until about 2045.[ii]

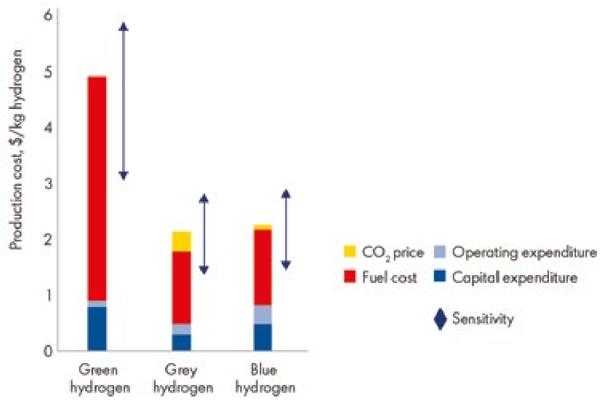

Figure 1. Hydrogen production costs in 2030 based on $25-35/t CO_2 costs and SMR blue hydrogen production.

Green and blue hydrogen production have similar efficiencies (80% and 78% respectively), but the levelised cost of production is significantly higher for electrolysis at €66/MWh compared with €47/MWh for steam methane reforming (SMR) with CCUS.[iii]

Currently, there is insufficient renewable energy available to support large-scale green hydrogen production. Indeed, meeting today's hydrogen demand through electrolysis would require more than the EU's annual electricity use.[iv] In addition, using the current EU electricity mix would produce "grey" hydrogen from electrolysis with 2.2 times the greenhouse gas emissions of producing grey hydrogen from natural gas.[v] This is because nearly half (45.5%) of the net electricity generated in the EU comes from burning natural gas, coal and oil.[vi]

If hydrogen is to contribute to carbon neutrality, blue hydrogen production needs to be scaled up rapidly until large-scale green hydrogen production becomes economic. The cost of CO_2 already makes blue hydrogen via SMR competitive against grey, and the Shell Blue Hydrogen Process (SBHP), which is based on proven Shell gas partial oxidation (SGP) and Shell ADIP* ULTRA technologies, significantly improves blue hydrogen economics.

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Comparing greenfield technology options

Three technology options for greenfield blue hydrogen projects are considered: SMR, autothermal reforming (ATR) and SGP technology (Figure 2).

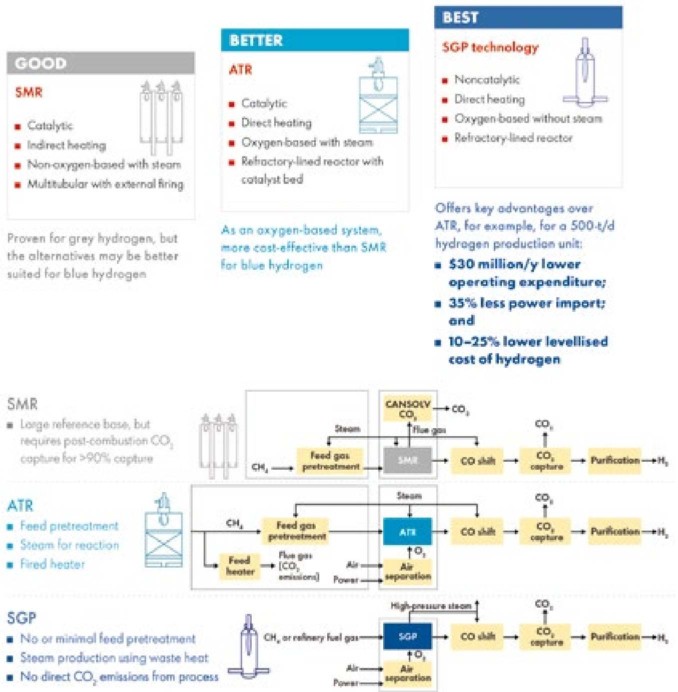

Figure 2. Blue hydrogen technologies and process line-ups.

SMR

SMR is the most common hydrogen production technology. It uses steam in a multitubular reactor with external firing for indirect heating. Post-combustion carbon capture such as the Shell CANSOLV* CO_2 Capture System, which can capture nearly all the CO_2 (99%) from low-pressure, post-combustion flue gas, can be retrofitted to convert grey hydrogen production to blue. However, for greenfield blue hydrogen applications, oxygen-based systems such as ATR and gas SGP technologies are more cost-effective (Figure 3), a conclusion backed by numerous studies and reports.[vii] This advantage increases with scale because the relative cost of the air separation unit decreases with increasing capacity. Another advantage of SGP is that more than 99.9% of the CO_2 can be captured using the lower-cost, pre-combustion Shell ADIP ULTRA technology.

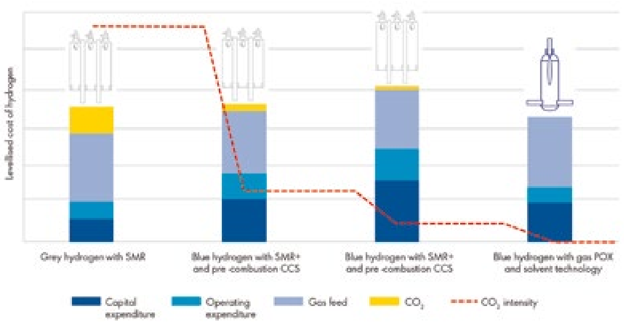

Figure 3. Relative CO_2 intensity and cost of grey and blue hydrogen via SMR with pre- and post-combustion capture, and blue hydrogen via the SBHP, which integrates SGP and Shell ADIP ULTRA technologies. Note that the cost of CO_2 makes grey hydrogen via SMR more expensive than blue hydrogen from SGP technology.

ATR

ATR uses oxygen and steam with direct firing in a refractory-lined reactor with a catalyst bed. It can be combined with pre-combustion carbon capture technology to convert grey hydrogen production to blue. Although it is more cost-effective than SMR, ATR requires a substantial feed gas pretreatment investment and the fired heater produces CO_2 emissions (Figure. 2) that either reduce the total CO_2 captured or require an expensive post-combustion capture system.

SGP technology

SGP technology is also an oxygen-based system with direct firing in a refractory-lined reactor, but it is a noncatalytic process that does not consume steam and has no direct CO_2 emissions. The SBHP integrates it with the Shell ADIP ULTRA pre-combustion carbon capture technology to produce blue hydrogen. Compared with SMR, SGP technology saves money by maximising carbon-capture efficiency and simplifying the process line-up, both of which offset the oxygen production costs (Figure 4).

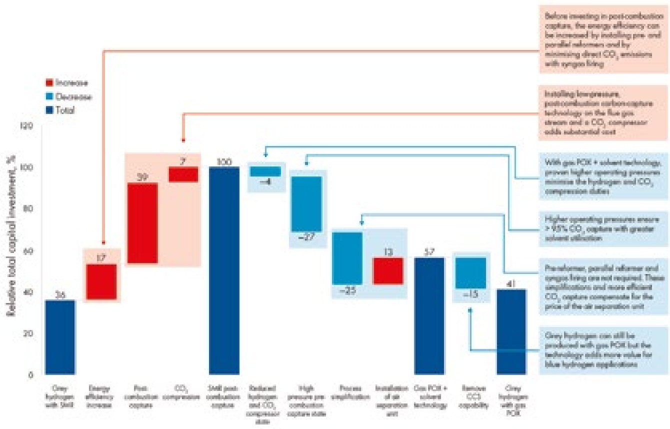

Figure 4. Relative capital investment comparison between grey and blue hydrogen via SMR and SGP technologies.

Advantages of SGP technology over ATR

For greenfield blue hydrogen production, oxygen-based systems offer clear benefits over SMR, and SGP technology has significant advantages over ATR, including:

- generating high-pressure steam using waste heat from the reaction, which can satisfy the steam consumption of the blue hydrogen process and some internal power consumers, whereas ATR requires steam as a reactant;
- operating at higher pressure, which results in less compression duty on hydrogen products and CO_2 for CCS; and
- being a noncatalytic, direct-fired system that is robust against feed contaminants such as sulphur with a far simpler process line-up than ATR (Figure 2); thereby accommodating a large range of natural gas quality and giving refiners greater feed flexibility to decarbonise refinery fuel gas.

These advantages result in a 22% lower levelised cost of hydrogen (Figure 5). This saving comes from a 17% lower capital expenditure because the potential for a higher operating pressure leads to smaller hydrogen compressor (single-stage compression), CO_2 capture and CO_2 compressor units, and a 34% lower operating expenditure (excluding the natural gas feedstock price) from reduced compression duties and more steam generation for internal power. SGP technology consumes 6% more natural gas, but this is offset by the power generation from the excess steam.

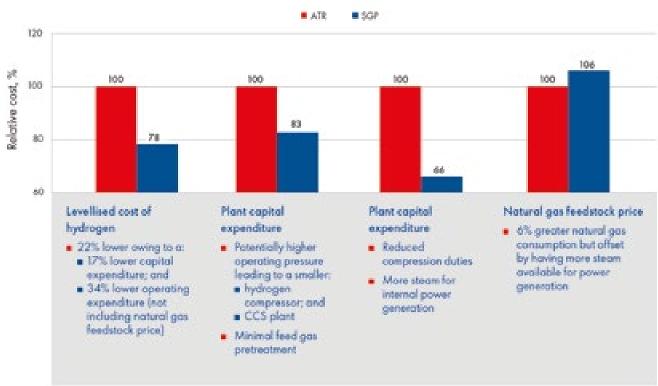

Fig. 5. The relative costs of SGP and ATR (with gas reheat reformer) technologies.

The SBHP is an end-to-end line-up that maximises the integration of SGP and ADIP ULTRA technologies. Compared with an ATR unit, modelling shows that a line-up producing 500 t/d of pure hydrogen would have:

- $30 million/y lower operating expenditure;
- 35% less power import;
- >99% CO_2 capture; and
- a 10–25% lower levelised cost of hydrogen.

The results demonstrate the advantages of the SBHP over ATR for large-scale blue hydrogen projects. Further efficiencies can be achieved by integrating it with other Shell and open-source technologies (Figure 6).

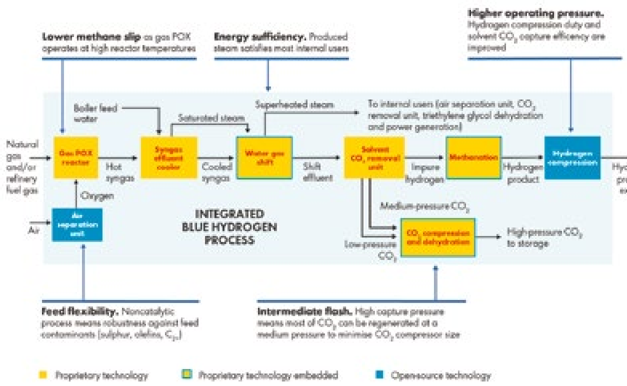

Figure 6. The advantages of integrating the SBHP with other technologies, with Shell as the master licensor.

The choice between a methanator or a pressure-swing absorption unit for the hydrogen purification step depends on the required hydrogen purity. For example, a pressure-swing absorption unit is necessary to achieve the >99.97% purity required for the hydrogen used in fuel cells. The off-gas is predominantly hydrogen with trace contaminants such as carbon monoxide, CO_2 and nitrogen. In the ATR process, this off-gas is typically burned to preheat the natural gas, which produces direct CO_2 emissions.

In a methanator, the purity of the final hydrogen is lower (>98%, depending on the feed gas properties). However, it avoids the direct CO_2 emissions from burning the pressure-swing absorption off-gas. The main advantage of choosing a methanator is that hydrogen is not lost via the pressure-swing absorption off-gas. Consequently, it reduces natural gas consumption for the same hydrogen production. In addition, a methanator is commonly applied in industry, as it satisfies the hydrogen purity requirements of most industrial consumers.

SBHP history

The technologies integrated in the SBHP are newly available to third parties but have a long history of use within Shell.

SGP technology is mature (TRL9) and "low-carbon", which makes it eligible for government funding. Research into oil gasification was being conducted in Amsterdam, the Netherlands, in 1956 and the technology has been continuously improved since.

Today, SGP technology has over 30 active residue and gas gasification licensees, and there are more than 100 gasifiers using the technology worldwide. For instance:

- since 2011, the Pearl gas-to-liquids plant in Qatar has operated 18 trains, each with an equivalent pure hydrogen production capacity of 500 t/d. This is defined as pure hydrogen production, i.e., not including any inerts, methane, CO_2, or carbon monoxide, which will also be present, depending on the final purification step.
- from 1997, Pernis refinery, the Netherlands, has used SGP technology to operate a 1-Mt/y CO_2 capture capacity; the CO_2 is used in local greenhouses.

The SBHP enhances the economics of hydrogen production and carbon capture, but without sequestering the CO_2 directly or through enhanced oil recovery, the hydrogen produced remains grey. Consequently, in addition to carbon capture, blue hydrogen projects rely on CO_2 compression, transportation and use or storage expertise. Shell has gained this valuable expertise and experience through its direct involvement in CCUS projects at various stages throughout the world. For example, since 2015, the Shell Quest facility, Canada, has captured and stored more than 5 Mt of CO_2.

Key takeaways

Scaling up blue hydrogen production is vital if heavy industry is to be decarbonised to help meet the EU's commitment to reach carbon neutrality by 2050 and for the global effort to implement the Paris Agreement. For greenfield blue hydrogen applications, SMR is inefficient owing to poor CO_2 recovery and scalability. Oxygen-based systems offer better value and the SBHP, which integrates SGP and Shell ADIP ULTRA technologies, offers key advantages over ATR, including a 10–25% lower levelised cost of hydrogen, a 20% lower capital expenditure, a 35% lower operating expenditure (excluding natural gas feedstock price), >99% CO_2 captured and overall process simplicity. The process, which is now available to third-party refiners, is proven at the 500-t/d scale.

About the author

Nan Liu, Licensing Technology Manager Gasification, Shell Catalysts & Technologies, has fulfilled roles throughout the project life cycle, from initial feasibility and front-end development to project execution and plant operations, on major capital projects around the globe. These include the start-up of the gasification unit at the Fujian refinery and ethylene project in China, and performance optimisation at the gasification and hydrogen plant at Shell's Pernis refinery in the Netherlands. Nan has a strong commercial mindset and is a keen advocate of gasification as a value-adding investment.

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A Virtual World

Gary Bowerbank, Chairperson - GPA Europe

This is my first editorial piece for *InBrief*, and while the "View from the Top" does not sit so well with me, I do welcome the opportunity to engage with our members and happy to share a few thoughts and reflections.

While writing this we are all still dealing with the direct and indirect impacts of the COVID-19 pandemic, with most of us still working from home – where the lines between work and non-work become ever more blurred. We all need to manage this in our own way, take time outs in the day, have fixed end of the day, etc. I do hope we all manage to take some small positives away from the forced period of home working; at the very least avoiding the commute.

However, while there are signs of light at the end of the tunnel here in Europe, I am sure we all have friends, family and/or colleagues in other parts of the world where there are still significant challenges to overcome. I wish them success and that we can all come out of this stronger.

Due to the pandemic we of course could not hold our usual face to face sessions (YP event, conferences, or AGM) in 2020, which has also been the case for this year. The resulted in two firsts for GPA Europe:

1. Virtual Event Series
2. Virtual Conference

Let me first reflect on the Virtual Event Series. These short sessions, typically over a lunchtime provided us the opportunity to cover a wide range of themes; Future Energy (including Blue H2), Digitalisation, Unit Processes (such as Filtration, Gas Sweetening). We also used some of these sessions as Young Professional (YP) training events. They were provided to our members for free, and are available to members via **https://gpaeurope.com/category/presentations.**

Over the sessions we had 373 participants, with approximately 106 per session. I would personally like to thank everyone who attended for making them a success, but most of all I would like to show my appreciation for the various speakers.

Moving on to the recent Virtual Conference, which based on the messages shared directly with me was seen as a real success. And while nothing can replace a face to face event for networking and more innovative discussions, I feel the virtual event still managed to bring together some excellent papers and an extremely well-informed audience. This combination, together with the highly relevant themes of Hydrogen, Carbon Capture Utilisation and Storage (CCUS) and Biogas, resulted in some really engaging question and answer sessions; as well as some though provoking keynote addresses – most notably the one by our very own David Simmonds (which may be viewed via **https://gpaeurope.com/category/presentations).**

We also conducted a workshop exploring the same themes, where 30 participants worked through some preassigned challenges in a workshop format. I would like to thank Helen (GPA Europe Executive Administrator), the Technical Committee, members of the Energy Vectors KSI (more on these later), presenters and keynote speakers; as well as our Gold Sponsors (Comprimo, Petrofac, Shell Catalysts & Technologies and Parker Hannifin) – without them we could not have put on such an event. In the next In Brief there will be much more feedback on the event, but my key takeaway was the need for collaboration across sectors and between all parts of the value chain (regulators, governments operators, technology providers, etc.), and that the knowledge within the gas processing industry will remain relevant for many years to come.

Speaking of years to come, this is a good time to give you some updates on the Key Strategic Initiates that have been set up to support the overall GPA Europe Vision, Goal and Strategy (introduced in 2019 AGM). Within this edition of *In Brief* there will be much more on the people involved and what they have been doing, but let me first thanks them all for giving up their own free time and helping us make some good progress.

Value Proposition Tool	The team have developed to tool, which we hope is helpful in demonstrating the value of being a GPA Europe Member to their companies. **https://gpaeurope.com/**
Marketing	Increased LinkedIn following Monthly Chairman posting Targeted marketing
Future Energies	Set up Energy Champion Teams along the Hydrogen, Carbon Capture Utilisation and Storage (CCUS) and Biogas, which seek to link GPA Europe to those new sectors and bring back knowledge to our members.
Training	Inventorying available training form existing material, with a view to make learning videos available to members.

Looking ahead to the rest of the year. It seems unlikely that we would be able to have any face to face events, but that does not mean we will not be busy. We will still have much to do supporting the overall GPA Europe Vision, Goal and Strategy, the AGM and we will be exploring what other virtual events we could offer, so do check the monthly Newsletter and connect with us on LinkedIn, follow us on Twitter or join us on Facebook.

Stay safe, have fun and hope to see you all at a future event (even if virtual) very soon.

Gary Bowerbank
Chairperson - GPA Europe

SEPTEMBER 2020 – APRIL 2021

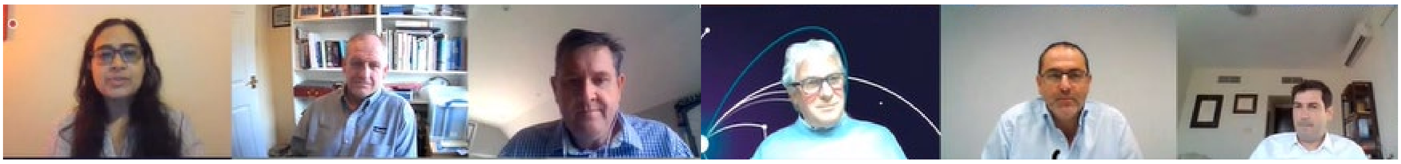
PANEL DISCUSSION

24 September 2020

Moderated by Sumedha Sharma, Technical Editor, Hydrocarbon Processing

With a special thank you to our Event Sponsors, Fluor Ltd and Linde GmbH.

During a time when we were all dealing with ambiguity, rapid change, and a new set of expectations, we had 90 minutes in the company of representatives from Fluor Ltd, BASF SE and Siemens, where we got answers on What will COVID-19 mean for our industry now and in the next 18 months? We had four panellists, Gerd Modes and Jay Habayeb both from BASF SE, Graham Mason of Fluor and Keiren Lake from Siemens. The panellists all gave extremely interesting insights into how the industry and world could change in the aftermath of COVID. The panel session was moderated by Sumedha Sharma from Hydrocarbon Processing who did an excellent job.



Speakers in order of appearance: Sumedha Sharma, Martin Copp, Graham Mason, Kieren Lake, Gerd Modes and Jay Habayeb

08 OCTOBER 2020

YOUNG PROFESSIONAL SESSION "CARBON CAPTURE, UTILISATION AND STORAGE"

Moderated by Joseph Fisher, Genesis Oil & Gas and Myrian Schenk, TechnipFMC

Our first Virtual Young Professional Training Session kicked off with two presentations on a topic selected by our Young Professional Committee, on carbon capture. A look into possible engineering solutions to combat climate challenge from Dr Nejat Rahmanian; and examples of separating CO_2 from other gases, including a look at Europe's first Bioenergy with Carbon Capture and Storage (BECCS) demonstration project with Drax Power at Selby from Professor Chris Rayner.

Dr Nejet Rahamanian

Our first presentation was by Dr Nejat Rahmanian of the University of Bradford.

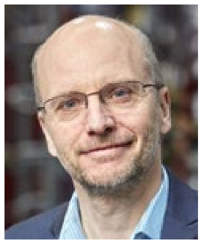
Global Warming and Climate Change: Hoax or reality?

Climate change is perhaps the most controversial global challenge that has emerged in the last decades and is a top agenda item in terms of its social, economic, political and technical impacts. The Paris Agreement articulates the most recent international effort, negotiated by 196 countries, to combat climate change.

The agreement aims to keep global warming to well below 2°C above pre-industrial levels and to pursue efforts to limit it to 1.5°C. The latest UN report published in October 2018 confirmed that atmospheric concentration of carbon dioxide is an increasing concern as it may cause global temperature rises to occur faster than it was previously expected.

Historical meteorological data also shows that the average temperature of the earth has risen since the industrial revolution and the rise in global temperature is positively with unprecedented increases in greenhouse gas emissions and in particular carbon dioxide. However, there remains controversy over whether climate change is really occurring, how much has occurred, if greenhouse gases caused it, if any actions should be taken and, if so, what remedial actions should be and what is its economic impact. This is in spite of the fact that in the scientific literature there is a strong consensus that global surface temperatures have increased.

This presentation addressed the above, focussing on the UK and worldwide and presented a number of possible engineering solutions to combat climate challenge.



Chris Rayner

Our second presentation was by Professor Chris Rayner of the University of Leeds.

CO_2 Capture using alternatives to amine-based capture agents and comparative studies

This presentation covered the work carried out by C-capture Ltd, a university start-up which specialises in the development and application of highly efficient CO_2 separation processes. C-capture recently developed a fundamentally new solvent-based approach for separating CO_2 from other gases. This technology is found to significantly reduce energy requirements for the separation process, allowing for the use of inexpensive materials of construction, and provides a substantially reduced environmental profile compared to current methods. Separation of CO_2 from other gases is a key part of a low carbon economy, and examples were discussed; ranging from biomethane production by biogas upgrading; hydrogen production; and Europe's first Bioenergy with Carbon Capture and Storage (BECCS) demonstration project with Drax Power at Selby.

GPA EUROPE VIRTUAL EVENT SERIES
22 OCTOBER 2020

TECHNICAL SESSION "GREEN ENERGY/ ENERGY TRANSITION"

Moderated by Tony Wimpenny, Orbital Gas Systems

Our first Virtual Technical Session kicked off with two presentations on the topic of Green Energy/Energy Transition. The energy transition is of course about finding alternatives to fossil fuels to find more sustainable energy. This is a crucial time for the gas industry. Gas has the opportunity to bridge the gap between where we are now and to a greener future. We all have a valuable role to play.

Adam Jones

Our first presentation was by Adam Jones of Costain.

The Acorn Carbon Capture and Storage Project

Adam's presentation discussed the Acorn CCS project which is part of Costain's decarbonisation project. The Acorn CCS project is a low-cost, low-risk, scalable, carbon capture and storage scheme that will not only enable the cost-efficient carbon capture and storage of current carbon emissions from the onshore gas facilities at St Fergus but is also a key enabler for the Acorn Hydrogen project where North Sea natural gas will be reformed into clean hydrogen. It is designed to be built quickly, taking advantage of existing oil and gas infrastructure and a well understood offshore CO_2 storage site. The system is designed to be an enabler of other capture and storage projects including provision of CO_2 shipping facilities in Peterhead Port and repurposing the existing Feeder 10 pipeline to enable capture of CO_2 from wider regions. The project is led by Pale Blue Dot Energy Ltd supported by study partners Shell, Total and Chrysaor with Costain providing onshore and offshore facilities engineering and consultancy services.

Marine Juge

Our second presentation was Marine Juge of ENGIE.

GERG (the European Gas Research Group) completes first stage of flagship biomethane project for CEN and the European Commission

GERG announced the successful completion of the first phase of the European Commission funded project on removing barriers to biomethane injection in the natural gas grid and use as a vehicle fuel.

There is huge potential for biomethane transported in the gas network to play a significant part in decarbonisation of our energy system. As a substitute for natural gas, it allows use of existing infrastructure, while complementing intermittent renewable energy sources. However, some contaminants, inherent to the biomethane production processes, can be present in biomethane at a trace level. Depending on their concentration, these trace components (not present in natural gas) can interact with the gas chain infrastructure, and engines and boilers,

Two standards regarding biomethane have been published:

- EN 16723-1: specifications for biomethane for injection in the natural gas network;
- EN 16723-2: automotive fuels specifications.

Limit concentration values are however lacking real-world data. This can be a barrier for the development of biomethane in Europe as limits can be over prescriptive. For this reason, GERG and CEN launched a project in 2016 with the aim to identify the associated acceptable threshold for gas appliances and infrastructure. This presentation by Marine demonstrated the results of the project.

GPA EUROPE VIRTUAL EVENT SERIES
19 NOVEMBER 2020

TECHNICAL SESSION

Moderated by Sandy Dunlop, Dunlop Presentations Ltd.

Our November Virtual Technical Session covered two very different subjects but each of significant importance to natural gas process plant design. These presentations were followed by our Annual General Meeting.

The first presenters of the session were Mounir Mossolly and Celine Belbol of TechnipFMC.

Turbomachinery Configuration for LNG Projects - Conceptual Selection

Mounir Mossolly

Celine Belbol

Mounir and Celine's presentation described the important stages required in assessing the required duty and arrangement of the gas turbine drivers. Given that the selection of these enormous machines impacts significantly on their contribution to the overall cost and success of any LNG project, the work begins at the very earliest stages of project development. In the earliest LNG facilities, steam turbine drivers were used but after 1975, heavy duty gas turbines became the dominant drivers. Whilst electric drivers have been considered, the latest largest LNG facilities are now using aero derivative gas turbines.

The selection process for gas turbine drivers has to consider the fact that they are available only in discrete power outputs making the selection of the best unit for the require conditions. The decision on selection of the machinery is made by the plant owner based on input from specialist turbomachinery and process engineers with the validation of the process licensor at the pre-FEED stage. During FEED analysis of the turbine operation is carried out to ensure the project objectives can be achieved and will generally allow procurement to proceed before EPC to avoid delivery impact on project schedule. Turbomachinery engineers continue to manage interfaces during the EPC phase.

The initial selection needs to consider owners' willingness to consider innovative processes to improve efficiency and often political considerations have to be taken into account. The selection of the most appropriate machine will consider the capacity of the plant and the number of refrigeration trains required and thus the number of gas turbine shaft-lines that are required. This can then be matched against the available power of different manufacturers machines under the local operating conditions. Ambient conditions can have a significant effect with atmospheric temperature having a significant effect – gas turbine capacity rated at 15°C can be reduced by 18% if running at 35°C. Other factors to be considered include potential fouling and aging of the turbine blades which might lead to 7% reduction in power output. This assessment of effect on capacity is referred to as derating.

Arrangements of compressors have developed from a single shaft design to arrangements with two or three parallel shafts operating to allow more flexibility in turndown and start-up operations. The arrangement of compressors and turbines on a single shaft has become quite complicated in modern design with multiple turbines and helper motors and compressors on a single shaft line with some shaft lines now up to 50 meters in length.

There are two distinct types of gas turbine, the Heavy-Duty and Aero-Derivative. The Heavy-Duty machines are heavier than the Aero-Derivative but are more robust requiring lower fuel gas pressure and are lower cost. Aero-Derivatives however are more efficient and are multi-speed with a wider speed range.

Deliberate derating of the turbine to match the compressor power demand is possible if necessary, to maintain optimum efficiency e.g. by adding waster heat recovery on the turbine for steam generation or equally if demand exceeds the rated power rating, inlet air chilling can increase to power output.

Finally, an important aspect of the selection process is the identification and validation of any novelty design. In these cases, a thorough qualification plan is undertaken to go through all aspects of the novelty and provide assurance that the proposed improvement is valid and will not detract for the overall objective of the concept.

Taking all these factors into account will enable a number of combinations of options to meet a certain configuration, but the final selection is of considerable importance when one considers that the compressor system value may run into several hundred million dollars. The techniques undertaken provide solid assurance that the final decision, when made, will be the right one for the particular application.

The second presenter was Dr Nejat Rahmanian of the University of Bradford.

An industrial and experimental case studies on hydrate prediction and inhibition

Dr Nejat Rahmanian of the University of Bradford reported on the outcome of studies associated with hydrate formation and prediction for the South Pars project in Iran particularly focusing on a comparison of the efficacy of Aspen's HYSYS and HydraFlash. The presentation began with a general review of hydrates and the condition under which they can form and thus the mechanisms for mitigation including operation and the use of inhibitors, such as methanol and mono ethylene glycol (MEG).

For comparison between HYSYS and HydraFlash used the Peng-Robinson equation and glycol fluid package and while it has been generally felt that HYSYS is accurate to within ± 0.8°C in cases, this is not necessarily the case with complicated compositions and high-water and salt content.

The study compared the prediction of hydrate formation temperature by the simulation programmes with the experimental results of Deaton and Frost (1946) and showed a good prediction of the hydrate curve of the experimental results using a NaCl/Ethylene glycol inhibitor as reported by Masoudi et al. (2004). However, when the curves were

Nejat Rahmanian

predicted using Methanol or MEG inhibition, the predicted results from each simulator started to diverge at higher pressures.

The next step was to apply the findings to a specific industrial case – the processing of gas from the South Pars field offshore Iran. The Iranian South Pars and Qatari North Dome gas fields are joined with around a quarter of the 1260 TCF Recoverable Gas in Place in both Iranian and Qatari sectors. Gas arriving at shore enters a slug catcher and then, liquids removed are processed to recover MEG which is recycled to the platform. Gas flow for the design conditions was 28.2 MMSCMD per each phase. The feed gas to the onshore plant contains around 83% methane and a long tail of hydrocarbons with carbon numbers of 9 and higher and around 0.58% water, thus necessitating hydrate inhibition. The major challenge was that the presence of salts in the water tended to result in the salt deposition, MEG loss and thus fouling and corrosion potential. Nejat described a few processes that might be used to handle the salt content.

South Pars offshore field, Iran

The design basis considered by Bradford was to process all the glycolated water to produce a product of 70% MEG/30% water with MEG in the sour water limited to 150 ppm. Salt removal of 250 kg/h and pH control were also to be included. The key issue was that the hydrate line of the gas in the subsea pipeline was around 25°C and in the event of a shutdown, the temperature in the pipeline would fall below 25°C with consequent hydrate production and blockage of the pipeline.

Analysis of the HYSIS and HydraFlash simulations for the design gas composition showed that predicted hydrate line was comparable up to around 150 bar, but above this pressure, the HydraFlash Software suggested a lower hydrate production temperature than HYSYS. When inhibitors were introduced (10% and 20% Methanol or MEG) the difference was emphasised with HYSYS again overpredicting the Hydration temperature. Introduction of salts to the prediction simulation was then considered. Comparing with experimental data HYSYS failed to match the experimental data particularly at low pressure and further analysis of the data of Mohammadi et al. (2008) (which considered pressures up to 30 bar) showed that HydraFlash almost exactly fitted the experimental data. Nejat attributed this to the fact that whilst HYSYS considered NaCl, HydraFlash covers over 18 different salts in their simulations.

Nejat concluded that during the feasibility study a solid knowledge of hydrate prediction and inhibition is required to prevent unnecessary investment and additional costs to the clients for hydrate prevention. HYSYS was good for prediction of hydrate formation in simple hydrocarbon systems, but for more complex systems, particularly those with different types of salts, HydraFlash is a more accurate predictor than HYSYS.

GPA Europe Chairperson's Annual Report 2020

By Martin Copp, Chairperson, GPA Europe

We started the year being co-hosts of the GPA GCC Chapter 28th Annual Technical Conference and Workshops. This event took place in Kuwait and...oh wait. Something happened and it didn't go ahead.

We followed this up with the 2020 Spring Conference in Paris, co-hosted by Total in their Paris headquarters. This was attended by... zero attendees.

I suppose I could finish my report there as due to COVID-19, we were not able to hold any of our normal events. However, to end my report there would not do justice to the hard work that the Management Committee and members of GPA Europe have put in over 2020, mostly in their own time.

So, what did we achieve?

It took some time for us to respond to the global pandemic, but when we did, I believe, and I'd like to think our members also agree that we did so in an extremely effective manner.

We launched a series of webinars, the first time that we've ever done this. Thanks must go to the TechComm and Helen for organising this and getting the IT in place to allow these to happen.

Even though there is a light on the horizon with the very promising vaccine news, the TechComm has already committed to organising another four dates in March, April and May of 2021. No decision about a 2021 conference has yet been made and we're sure that you'll understand that these decisions cannot be made in the current climate. I'd personally like to think that there is a possibility that a physical conference could happen in late 2021 but obviously this decision can only be made when there is more certainty in the world about COVID being under control.

From the numbers of people who have participated in the webinars so far, it's fair to say that member participation in our events in 2020 has been high than have attended our physical conferences at least in the last ten years but probably also in the entire history of GPA Europe.

Personally, I'd like to think that in the future we'll continue to run online webinars, in addition to physical conferences so that GPA Europe continues to provide even more value to our member companies.

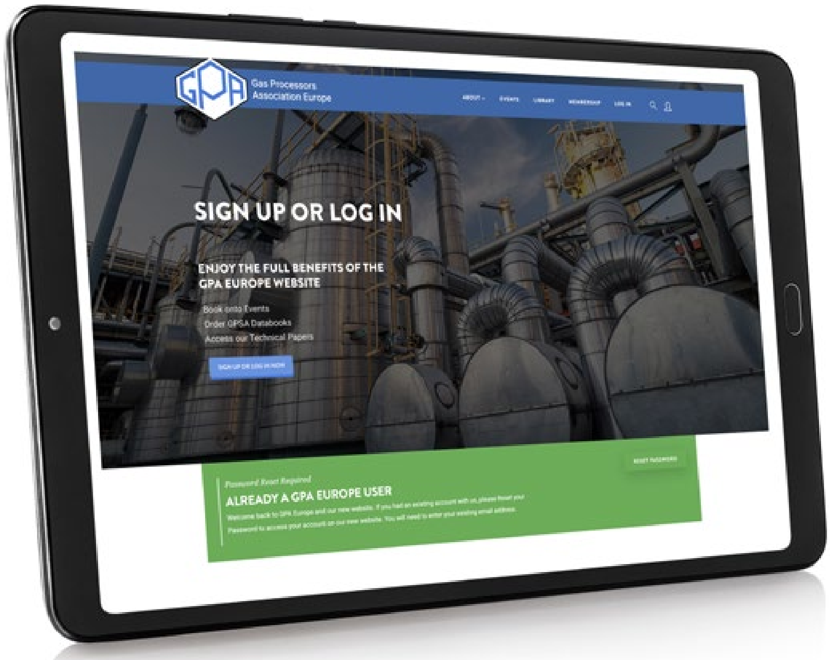
I'd like to remind you all that all of the webinars are recorded and are available in the members area of the website for you to view.

GPA Europe - Vision, Goal and Strategy

Vision	Shaping the future of sustainable energy by facilitating innovation, knowledge sharing and collaboration			
Goal	• Membership increase of 20% by 2025 • Annual Conference attendance increase of 100% by 2025	• Increase diversity of the organisation* • YP attendance at Annual Conference of 15% by 2025		
Scope	To provide high quality technical information from experts in our industry through multiple channels offering networking and learning opportunities			
Competitive Advantages	• Quality of Papers & Historical Information • Free Training for Young Professionals • Breadth of Knowledge	• Intimate F2F Networking Opportunities • Access to High Technical Expertise • European		
Primary Focus Markets	Producers / Operators	Contractors	Equipment Suppliers	Licensors / Consultants
Strategic Key Initiatives	• Develop a value proposition tool adaptable to all members • Develop targeted marketing strategy and support with relevant tools • Develop a plan to address future energy/gas markets • Develop a training strategy to address members development needs			

Roadmaps have been created and actions started to be implemented. I would like to thank, on behalf of all GPA members, the members of these teams for the drive and energy that they have imparted into this exercise. This has all been done in their own private time and will result in huge benefits for GPA Europe membership moving forward. We're always looking for more member involvement so if you feel that you can contribute to these teams in the future, please don't hesitate to reach out to Helen.

Martin Copp



www.gpaeurope.com

Our new website

We also launched our new website. We were able to do this based upon the boost to the GPA Europe accounts as a result of the successful Amsterdam 2019 conference. I'm sure you will all agree that the new website is a major improvement on our old one with better features and significantly improved search functionality. A huge thank you to the website team that worked on this.

One of the areas that GPA Europe has been working hard on over the last 12 months is the Key Strategic Initiatives that are part of the GPA Europe Vision, Goal and Strategy that we presented at last year's AGM.

In the Vision, Goal and Strategy, we highlighted four Key Strategic Initiatives that would drive GPA Europe forward. These are:

- Develop a value proposition tool adaptable to all members
- Develop a targeted marketing strategy and support with relevant tools
- Develop a plan to address future energy/gas markets
- Develop a training strategy to address members development needs

Following the call at the 2019 AGM for members to volunteer for these teams, we had 17 people volunteer to work on these initiatives.

I'd like to finish of this report with several thank yous.

Today is my final day as Chairperson of GPA Europe and I'll be handing over this privilege to Gary Bowerbank of Shell Global Solutions.

I'm not going to thank everyone by name as this would take too long, but I am going to collectively thank the Officers and ManComm of GPA Europe. Without these people volunteering their time and passion, GPA Europe would not exist to provide GPA Europe members with the excellent technical conferences, papers, and resources that I believe we deliver. Thank you ManComm.

I'd also like to thank GPA Europe member companies for their continued support. Without this support, our association would not exist. If there was no GPA Europe, the energy and gas market would lose a valuable source of innovation and knowledge that it will surely need given the challenges with the changes that will occur in these markets over the coming years. Now more than ever, the world is going to need expertise in delivering technical solutions for gas processing and energy production whether that's Natural Gas, Hydrogen, Ammonia. We know that companies will come under increasing pressure to cut costs but where else are companies going to get the wealth of knowledge, experience, networking etc. that GPA Europe provides for only £700 or €805 per year for the highest level of membership.

And finally, it's been an honour and privilege to serve as Chairperson of GPA Europe. Thank you.

GPA EUROPE VIRTUAL EVENT SERIES

10 DECEMBER 2020

TECHNICAL SESSION "FUTURE ENERGY"

Moderated by Koos Overwater, TechnipFMC

Our December Virtual Technical Session focused on two presentations on the topic of Future Energy with a focus on hydrogen. This session was sponsored and hosted by TechnipFMC.

Our first presentation was by Christian Bladanet of TechnipFMC.

Christian Bladanet

Energy transition: threat or opportunities?

For decades, the natural gas industry has been working towards improving the wellbeing of societies, by providing safe, affordable and abundant energy. During this journey, our industry has continuously developed technologies improving the efficiency and emissions of the gas processing facilities.

Today, clean, carbon free, green energies make all the talk. Is it the bell tolls of the natural gas industry?

This presentation presented emerging ways to produce, store and transport carbon free or carbon neutral energies and how members of GPA Europe (producers, contractors and suppliers) can contribute to this movement, by building on our industry know-how and experiences.

Our second presentation was by Matt Mardell of Shell Global Solutions.

Matt Mardell

The Shell Blue Hydrogen Process

To meet net-zero-emission ambitions, low-carbon hydrogen production must increase rapidly. Matt's presentation covered why hydrogen and blue hydrogen matter, how to manufacture blue hydrogen, Shell's blue hydrogen technologies, and internal studies which compare green and blue hydrogen.

Blue hydrogen production from natural gas along with carbon capture, utilisation and storage (CCUS) is necessary to bridge the gap until large-scale hydrogen production using renewable energy becomes economic. The cost of carbon dioxide (CO_2) already makes blue hydrogen via steam methane reforming (SMR) competitive against grey (without CCUS), and the Shell Blue Hydrogen Process (SBHP) further increases the affordability of blue hydrogen for greenfield projects.

14 JANUARY 2021

YOUNG PROFESSIONAL SESSION "DIGITALISATION"

Moderated by Ilhem Kouaiche, TechnipFMC and Paul Martial, TOTAL, both members of our Young Professional Committee.

Our first Virtual Young Professional Session of 2021 was under the theme Digitalisation.

Our first presentation was by Dr. Ralf Notz of BASF SE.

Boost your engineering workflow: Digitalisation in the design and optimisation of acid gas removal units

The main focus of this presentation was to illustrate how the engineering workflow can be improved by CAPE-OPEN. The CAPE-OPEN standard defines rules and an interface to allow communication between Computer Aided Process Engineering (CAPE) applications such as between a PME and a so-called process modelling component (PMC), which can be e.g. a thermodynamic model or the model of a unit operation. The implementation of the CAPE-OPEN interface as unit operation will be described for the example of BASF's simulation tool OASE® connect for the OASE® gas treatment technology. As result, the full OASE® connect simulation can be embedded as unit operation into any CAPE-OPEN compatible PME. This implementation of the CAPE-OPEN interface is unique in the sense that the OASE® connect calculation is not carried out on the same computer or server as the PME, but on a BASF server. This approach allows for the protection of intellectual property of proprietary simulation tools.

Ralf Notz

The embedding via the CAPE-OPEN interface allows data to flow seamlessly between a PME and a PMC, so that the user can always produce a consistent heat and material balance. In the unavoidable case of changes in operating conditions or design parameters, such as the gas throughput or the feed gas composition, the updated simulation results are automatically reflected in all connected downstream documents, further enhancing efficiency.

As a result the application of the CAPE-OPEN interface allows savings in time and effort and facilitates effective work-sharing between offices worldwide.

GPA EUROPE VIRTUAL EVENT SERIES

14 JANUARY 2021

YOUNG PROFESSIONAL SESSION "DIGITALISATION"

Moderated by Ilhem Kouaiche, TechnipFMC and Paul Martial, TOTAL, both members of our Young Professional Committee.

Our second presentation was by Fabrice Rey of Technip France.

Field operator and management training using Virtual Reality and a reactive digital twin

With more complex plants in remote locations, operating companies have the challenge of finding new ways to train field operators that are less costly and more efficient. The offer of an introduction to plant operations and the acquisition of new operation skills without leaving the office is a personal development opportunity much appreciated by today's personnel including managers and millennials.

As an illustration of the digital transformation of the oil & gas industry, this presentation described new technologies that makes it possible to consider Immersive Training Simulators (ITS) using 3D models to produce training solutions, reducing costs and schedule and improving safety.

Fabrice Rey

21 JANUARY 2021

TROUBLESHOOTING POORLY PERFORMING FILTERS/COALESCERS

Martin Copp

Our first Virtual Technical Session of 2021 was a slightly different format to our previous sessions; we had a 90-minute interactive seminar looking at the types of filters and coalescers commonly employed, operational issues that might be encountered and ways to identify what is causing the operational issues.

Our interactive session was by Martin Copp of Parker Hannifin. Troubleshooting poorly performing filters/coalescers

Filters and coalescers are used in all walks of life where we produce, utilise or consume fluids that are processed or used. Our cars (at least those with internal combustion engines) are only able to provide the reliable, economic and ever lower emissions that we expect as a result of the fuel, lube and air filters they use. We are able to turn on the tap and safely drink fresh water as a result of the filtration and purification processes that the water goes through. Planes can fly at high elevation and temperatures well below freezing point due to the filters and coalescers used in the fuelling procedure. Milk, beer, wine and carbonated drinks are safe for us to consume due to harmful bacteria being removed via filtration.

Filtration and coalescing technologies are also widely used in every processing environment. The economics of hydrocarbon processing is heavily affected by the effectiveness of the filters and coalescers utilised. Plants are only able to produce on spec products and operate at the highest energy efficiency, highest throughput, highest reliability and lowest maintenance costs if the correct filtration and coalescing technology is installed and correctly maintained. Even when the correct filtration solutions are installed, operational issues can occur which affects the performance of this critical equipment.

GPA EUROPE VIRTUAL EVENT SERIES

19 FEBRUARY 2021

TECHNICAL SESSION "GAS SWEETENING TECHNOLOGIES"

Moderated by Myrian Schenk, Technip Energies

Our February Virtual Technical Session focused on two presentations on the topic of Gas Sweetening Technologies.

Our first presentation was by Hiroaki Hasegawa of JGC Corporation.

Hiroaki Hasegawa

DDR-type Zeolite Membrane: A practical solution for CO_2 separation in the oil and gas industry

JGC Corporation (JGC) and NGK Insulators, Ltd. (NGK) are jointly developing the DDR-type zeolite membrane system for CO_2 recovery from associated gas and natural gas. This nano porous zeolite membrane prepared on an alumina substrate has advantages such as high CO_2/CH4 selectivity compared to conventional membranes, high durability and no restriction on the partial pressure of CO_2 for operation. The DDR-type zeolite membrane system can therefore be applied at high pressure and with high CO_2 concentration in gas production where conventional polymeric membranes can be significantly plasticised and lose their performance.

Our second presentation was by Patrick Schiffmann of Linde GmbH.

Patrick Schiffmann,

Membrane requirements for efficient natural gas sweetening

Natural gas (NG) has become an increasingly important resource for power production and as feedstock for the chemical industry. But as the worldwide availability of CO_2 lean NG decreases, unconventional NG sources with high CO_2 concentrations and considerable contents of heavy hydrocarbons (HHC) must be used. Removing CO_2 from NG with membranes is a proven technology but, in many cases, conventional membranes lack stability against plasticised and degradation at high CO_2 and HHC partial pressures, which increases the frequency of membrane exchanges and reduces the methane recovery.

To treat such gases more efficiently, a highly selective and under NG process conditions stable membrane is essential. Such a membrane has been developed in close cooperation between Evonik and Linde. Extensive laboratory experiments and field data showed an excellent separation performance, HHC resistance and plasticised stability. In various commercial applications, a selectivity of approximately twice the value of conventional membranes has been proven. CO_2 could be removed with considerably less hydrocarbon losses and reduced energy requirements. Additionally, the extended long-term stability of this membrane allows an extended replacement cycle and thus reduces downtime and associated costs.

GPA EUROPE VIRTUAL EVENT SERIES

25 MARCH 2021

TECHNICAL SESSION "MAINTENANCE / INSPECTION"

Moderated by Javier Alfonzo, Petrofac

Our March Virtual Technical Session focused on two presentations on the topic of Maintenance/Inspection.

Our first presentation was by Paul Stockwell of Process Vision.

Development of a Robotic System for Inspection and Maintenance Tasks in High-pressure Vessels


Paul Stockwell

This presentation by Paul detailed Process Vision's development of a new snake robot system to undertake inspections and maintenance tasks while the process is at high pressure. With the proof of principle stage completed, it included a description of the interactive hydraulic and servo motor systems required to enable a manoeuvrable snake robot that is tethered to the tapping point through which it enters the high-pressure vessel. It also described using a Material Extraction Line (MEL) to remove fouling when it is located.

Paul provided a demonstration of the system showing the device entering a high-pressure vessel, locating and removing liquids and recovering the robot without loss of containment.

Follow the demonstration, applications for the technology were discussed that include, gas processing tower inspection to improve foam management, separator inspection to aid diagnosis of problems and 3D modelling of temperature, pressure and flow in a process vessel while in service.

Our second presentation was by Dr Mike Lewis of Xodus Group.

Investigation of Internals Failure on a Low Temperature Separator


Dr Mike Lewis

Mike's presentation highlighted a root cause analysis of the failure of internals within a low temperature separator. During inspection of a separation train, damaged internals were found inside a low temperature separator. Subsequent inspection showed similar failures on other trains.

The study used detailed CFD and FEA, highlights the failure mechanisms and provides permanent resolutions to eliminate further failures.

15 APRIL 2021

YOUNG PROFESSIONAL SESSION "CARBON CAPTURE, UTILISATION AND STORAGE"

Moderated by Gerald Vorberg, BASF SE.

Our next Virtual Young Professional Session was a 60-minute session under the theme Carbon Capture, Utilisation and Storage.

This presentation was by Michiel Baerends of Fluor.

Carbon Capture – Why, Who, What & How

Michiel's presentation covered the key topics in Carbon Capture:

- Why should clients be interested in capturing carbon?
- Who is already practicing carbon capture, and where?
- Where is all the captured CO2 going to go?
- What technical options are available, how does the process work?
- How much is it all going to cost – and how to lower this cost?
- What to do next?

One element we learnt was the 'Why' - CO_2 capture does not just have a focus on the environmental aspect but also pushed my legislators for economic reasons. CO_2 increased rapidly with wealth and energy demand around the world and the reverse cannot happen overnight.

Michiel Baerends

GPA EUROPE VIRTUAL EVENT SERIES
22 APRIL 2021

Petrofac

Axens

TECHNICAL SESSION "FUTURE ENERGY"

Moderated by Alex Haynes, Petrofac

Our final session in our Virtual Series concentrated on two presentations on the topic of Future Energy with a focus on hydrogen and carbon capture. This session was sponsored and hosted by Petrofac; Axens were also bronze sponsors of the event.

Our first presentation was by Chet Biliyok of Petrofac.

The Challenges of Delivering a Large-Scale Green Hydrogen Project

Chet Biliyok

In an emissions-constrained world, hydrogen will play a significant role in decarbonising hard-to-abate sectors, residential heating, transportation, and flexible power generation. Thus, green hydrogen generation via water electrolysis using renewable energy will need to be rapidly scaled up and deployed.

In Q1 2021, Petrofac delivered front end engineering design for the Arrowsmith Hydrogen Plant, a 25 tonnes/day green hydrogen production facility, the first phase of a staged development by Infinite Blue Energy Group.

Several challenges were encountered that are specific to hydrogen projects – the intermittency of the renewable energy, the selection of the appropriate hydrogen production technology, feed and wastewater management, large scale hydrogen storage, equipment supply chain limitations and HSE challenges. These challenges are not the typical engineering problems faced in designing gas processing facilities, and were addressed by a combination of a systems design approach, the unorthodox use of equipment, and good engineering practices that remain valid no matter the process or the industry under consideration.

With hydrogen on the ascendency, and similar projects expected to proliferate over the next few years, it is concluded that location of the plant will be a primary enabler for projects. In this particular case, Western Australia possesses abundant renewable resources that facilitates reliable and cheap renewable power generation, which then results in competitive green hydrogen prices. Presently, such conditions are not accessible in all regions around the world, therefore financial viability of green hydrogen deployment needs to be considered on a case-by-case basis.

Our second presentation was by Clément Salais of Axens.

Optimized CO_2 capture with DMX™ process

Clement Salais

CO_2 capture and storage is foreseen as a necessity to limit global warming, as indicated by the recent reports from International Energy Agency. Major initiatives have to be initiated in a near future with concrete actions to get efficient results in limiting global warming. DMX™ process is foreseen as a key driver to initiate such transition in the industrial world. This process is based on a second-generation amine solvent, allowing to drastically reducing CO_2 capture cost in comparison to more conventional solvent such as MEA and others available solvents.

Based on the actual knowledge, techno-economic studies have been performed for three study cases and show significant advantage of DMX™ technology relatively to MEA: up to 30% reduction in OPEX can be obtained for lower or similar CAPEX, depending on the condition.

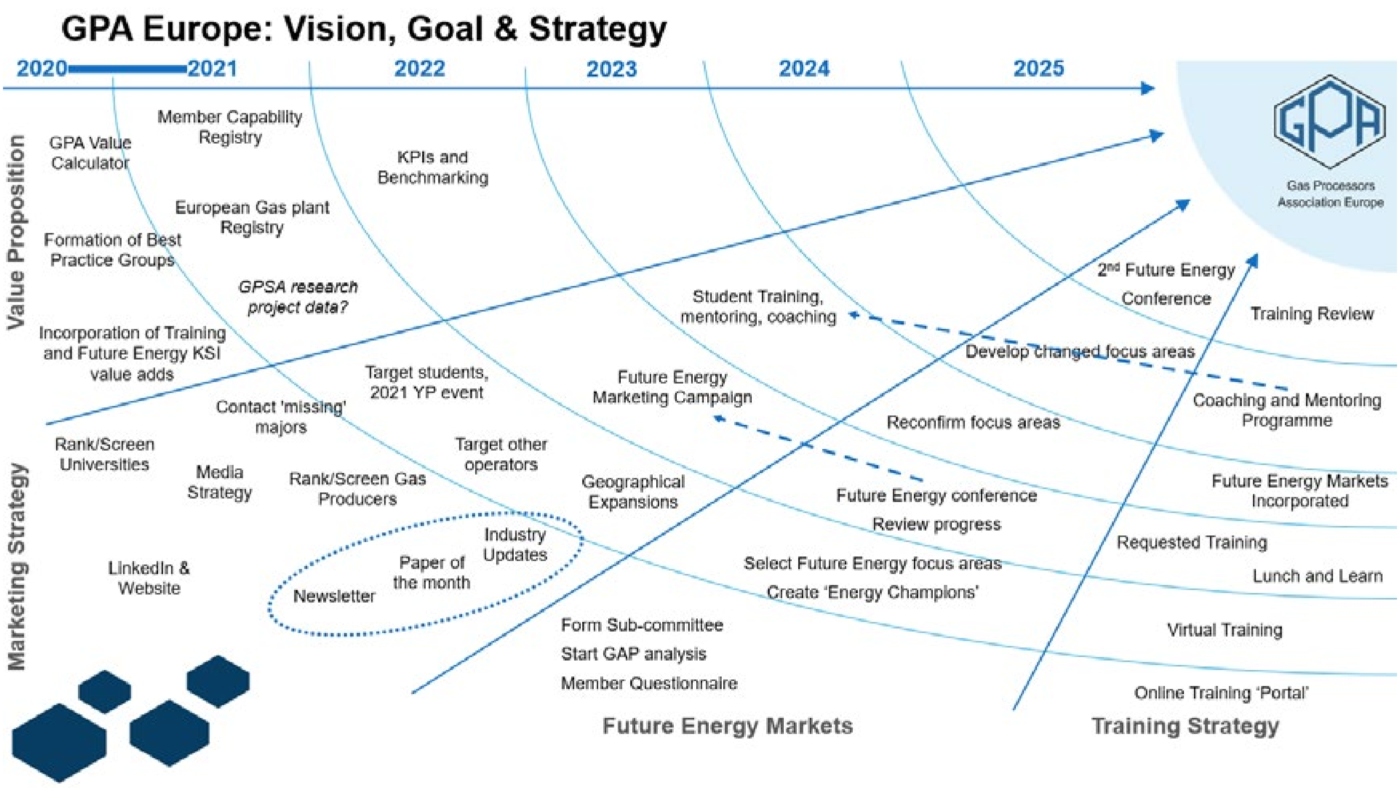
Such performance would be demonstrated within the H2020 3D Project, based on pilot test on real industrial gas from ArcelorMittal steel mill plant in Dunkirk (France). The H2020 3D Project could also study the whole value chain for an industrial CCS application linking ArcelorMittal plant in Dunkirk to potential storages in the North Sea. The 3D Project coordinated by IFPEN involves 11 companies and academic partners from Europe.

GPA Europe Key Strategic Initiative Groups

During our Annual General Meeting on 14 November 2019, Martin Copp presented the work that has been carried out to date, looking at the future of GPA Europe.

We reached out to our members to support with actioning out our Key Strategic Initiatives:

1. Develop a value proposition tool adaptable to all members
2. Develop targeted marketing strategy and support with relevant tools
3. Develop a plan to address future energy/gas markets
4. Develop a training strategy to address members development needs



Continued on page 18

Meet the Team - **Future Energy**

Team Lead: David Simmonds

Fluor
Hamish Blackwood

BP
Boris Ertl

Advisian Group
Stephen Lamport

Amine Experts
Philip Le Grange

Fluor
Samantha Nicholson

McDermott
Philip Walsh

Orbital Gas Systems
Tony Wimpenny

Meet the Team - **Marketing**

Kelvion UK
Team Lead: Paul Hopkinson

Shell Global Solutions
Gary Bowerbank

Dow Europe GmbH
Adriano Gentilucci

Orbital Gas Systems
Tony Wimpenny

Petrogenium
Alex Woldhuis

Meet the Team - **Training**

Worley
Team Lead: Fiona George

Kelvion UK
Paul Hopkinson

Amine Experts
Philip Le Grange

Equinor
Sigbjørn Svenes

Orbital Gas Systems
Tony Wimpenny

Meet the Team - **Value Proposition**

Amine Experts
Team Lead: Philip Le Grange

Parker Hannifin
Martin Copp

Technip Energies
Gauthier Perdu

Equinor
Sigbjørn Svenes

Orbital Gas Systems
Tony Wimpenny

Petrogenium
Alex Woldhuis

Continued on page 20

In each future edition of *InBrief* we will you bring you an update from one KSI team.
For regular updates please see our website where we will be creating a new area for all details on the KSI teams' work. We will post details on LinkedIn and our newsletter over the coming months

KSI Team Update: **Future Energy Champion Updates**

Following last year's strategic review GPA Europe has formalised workgroups looking at Future Energy. These workgroups are looking at green energy solutions designed to reduce carbon emissions in all aspects of our lives including Industry. Over recent years GPA Europe has been supporting the greater utilisation of natural gas which has inherently reduced carbon emissions per unit of energy delivered, replacing much coal and oil use. GPA Europe recognises that further work is needed and therefore has initiated workgroups looking at Hydrogen and Ammonia, Carbon Capture and Bio-Fuels.

As members are aware great strides have also been made with reducing cost of renewable energy, utilising wind turbines and solar. Electric vehicle and heat pump technologies are also fast becoming commonplace and offer high levels of efficiency, but longer term they have their constraints, and it is very likely that we will see a mix of energy vectors to meet our future energy needs. GPA Europe believes its members have significant skills and experience to bring to the table and has a key role to play to promote the benefits of gaseous energy vectors. In turn this approach will provide members with longer term job opportunities.

Hydrogen/Ammonia

Hydrogen is being pursued by a number of countries as part of their future energy mix and will particularly be required for heavy transport, industry, and building heating. Renewable energy can be used to produce green hydrogen, and this will become commonplace when we produce power surplus to requirements. However, we are still a way off that point, and, today, the costs of producing green hydrogen remain high.

Blue hydrogen, produced from the steam reforming of coal or natural gas with the recovery and disposal of carbon dioxide, is viewed by many as a less than green solution. However, the technology is available, and it can be scaled quickly to provide a rapid roll out replacing much natural gas. Long distance transportation of hydrogen is also feasible, though pipeline transmission and/or transport of liquefied gas will be less efficient than today's transport of natural gas. Naturally, hydrogen costs will be higher than the equivalent natural gas, but it is anticipated that unit energy costs will still be lower than that derived from renewable energy.

Conversion of hydrogen to Ammonia or the utilisation of Liquid Organic Hydrogen Carriers (LOHCs) may enhance the transportability of hydrogen and work is also progressing with these future options.

> “Gas Processors Association Europe believes its members have significant skills and experience to bring to the table and has a key role to play to promote the benefits of gaseous energy vectors. In turn this approach will provide members with longer term job opportunities.”

Carbon Capture and Storage

Achieving the greenhouse gas emission reduction objective set out in the Paris Agreement will require a considerable adjustment in how energy is sourced. Europe's energy mix is ~75% fossil fuel based. Many countries see carbon capture and storage (CCS) to be a vital stepping stone to decarbonise their existing energy infrastructure to meet emission reduction goals.

Past CCS projects have focused on enhanced oil recovery as the incentive, but new government policies and grants are catalysing the development of CCS hubs across Europe. These hubs leverage the economies of scale of the industrial clusters and CAPEX savings can made utilising existing pipeline infrastructure to sequester CO2 in underground geological storage sites.

As the energy mix becomes less reliant on fossil fuels CCS will continue to play an important role tackling hard to abate industrial sectors such as cement, iron and steel, and chemicals. Combining CCS with either a bio-mass power plant or Direct Air Capture (DAC) technology can provide negative emissions.

Bio-Fuels

GPA Europe role

- Promote a balanced way forward, highlighting many of the advantages of gaseous energy vectors
- Highlight the need for a realisable energy transition plan to Net Zero 2050, through development of Biofuels and 'Green' *blue* hydrogen with efficient CCS
- Assist Members through the transition from natural gas
- Support collaboration opportunities and development of strong safety standards for new fuels

CORPORATE MEMBERS

This listing of current Corporate Members represents the status at 1 May 2021.

Level 1 Members

Air Liquide Global E&C Solutions Germany GmbH
Aker Solutions Ltd
Amines & Plasticizers Ltd
Atlas Copco Energas GmbH
Axens
BASF SE
Bechtel Ltd.
BP Exploration Operating Co. Ltd.
Cameron Flow Control Technology (UK) Limited
CB&I Ltd
Celdes s.r.l. fob Saipem
Costain
Dow Chemical Co. Ltd
ENGIE - CRIGEN
Equinor
Fives Cryo
Fjords Processing France SAS
Fluor Ltd.
Gassco AS
Genesis Oil and Gas Consultants Limited
GL Industrial Services UK Ltd
Grace GmbH
Iron Mountain Slovakia s.r.o
Johnson Matthey
Kellogg Brown & Root
Oil & Gas Corrosion
Pall Europe
Parker Hannifin - PECO
Petrofac Facilities Management Ltd.
Schlumberger Purification Solutions
Shell Global Solutions International BV
SIME
Technip France SAS
Tecnimont S.p.A
TOTAL SE
Uniper Technologies GmbH
William Blythe Limited
Wintershall Dea GmbH
Wood Group UK Limited
Worley

Level 2 Members

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Axiom Angewandte Prozesstechnik GmbH
BASF Catalysts Germany GmbH
CDB Engineering SpA
Chart Energy
Hatch
Iv-Oil and Gas
KBC Process Technology Ltd.
Kelvion Ltd.
Liquid Gas Equipment Ltd
Merichem Company
Oil & Gas Systems Limited
Orbital Gas Systems Ltd
Process Vision Ltd.
Rotor-Tech, Inc.
SBM Schiedam
Sulzer Chemtech Ltd.
Technip E & C Ltd
Teesside Gas & Liquids
TGE Gas Engineering GmbH UK Branch
Tranter
Vahterus Oy
VTU Engineering GmbH
Zeochem AG

Level 3 Members

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Gas Liquids Engineering Ltd
Gasconsult Ltd
Kirk Process Solutions
MPR Services
Optimized Gas Treating
Petrogenium
Phillip Townsend Associates Ltd.
SDS Separation Technology B.V.
Sulphur Experts
Thermasep
Upstream Concept Engineering

Academic Members

Hydrocarbon Processing
University of Bradford
University of Surrey

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