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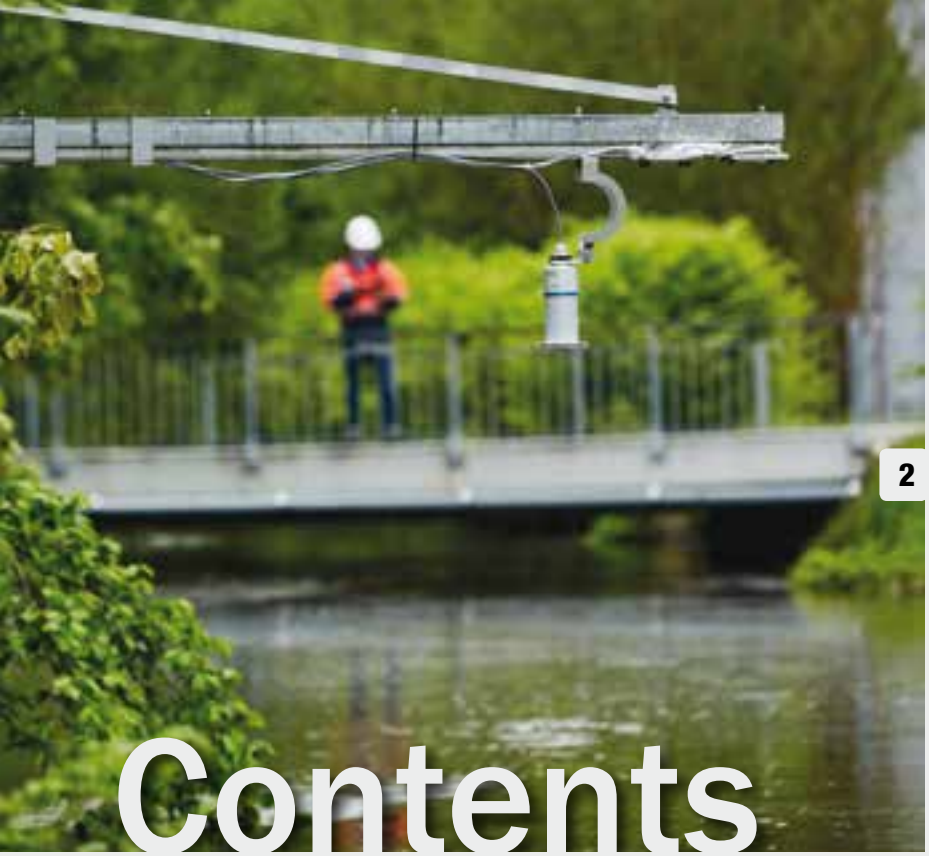

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Chemical Technology is endorsed by The South African Institution of Chemical Engineers

and the Southern African Association of Energy Efficiency

Endress+Hauser Radar steps into new dimensions

Micropilot FMR10/FMR20 – innovative and efficient

The new Micropilot FMR10 and FMR20 Endress+Hauser now offers, are perfect application-fit devices for level measurement in the water and wastewater industries and have a place as utilities in all industries.

Time-saving and innovative commissioning, operation and maintenance via app, using Bluetooth® wireless technology, are convincing benefits. An excellent price-performance-ratio, thanks to unique radar chip design, is the final plus.

Micropilot FMR10 and FMR20 belong to the first non-contact radars with Bluetooth® commissioning, operation and maintenance app. Signal curves can be shown via app on every Bluetooth®-enabled smartphone or tablet (iOS, Android). This increases plant availability due to fast access to maintenance information, and guarantees cost savings because of the usage of existing non-proprietary tool infrastructure.

Furthermore, FMR10 and FMR20 are the most compact radars in their class thanks to their unique radar chip design with integrated radio frequency components and direct emission transceiver – invented by Endress+Hauser. With their compact design, the devices also fit in limited space applications, which mean extended application scope for the radar technology.

Micropilot FMR10 and FMR20 are also providing a best price-performance ratio. For the first time radar technology is available in the price range of typical water and wastewater level devices. For this industry in particular, and for utilities in all industries, the devices meet the requisite needs. Setup is easy with just three main parameters and a remote indicator solution which result in time savings and enhanced safety.

The full PVDF body of the device resists outdoor conditions and guarantees a long sensor lifetime. Sealed wiring and fully potted electronics eliminate water ingress and allow operation under harsh environmental conditions, which means enhanced availability. In hazardous areas or places difficult to reach, safe and secure wireless remote access via Bluetooth offers many advantages. No additional tool, adapter or wiring effort is required. It is as simple as this: Connect – set – ready!

The relay of information is absolutely secure owing to the data transmission being encrypted and password-protected so that unauthorised access or manipulation is not possible.

Micropilot FMR10 and FMR20 form the beginning of a new generation of radar devices for the water and wastewater industry and utilities in all industries. Endress+Hauser as full service supplier offers a broad range of technologies to find the best fit for every application – be it ultrasonic, hydrostatic or radar.

Technical details Micropilot FMR10:

- Level measurement
- Wireless commission via *Bluetooth®* app
- 4 to 20 mA output signal
- Non Ex
- Measuring range: 5 m
- Accuracy: ± 5 mm
- Process/Ambient temperature: -40 to +60° C
- Ingress protection: IP66 / NEMA4x
- Fixed cable length: 10 m

Technical details Micropilot FMR20:

- Level and Flow (with open channels or weirs, via linearisation table)
- Commissioning via HART or optionally wireless via *Bluetooth®* app
- Optional with RIA15 remote display for commissioning
- 4 to 20 mA / HART output signal
- Gas Ex approvals
- Measuring range: 10 m or 20 m
- Accuracy: ± 2 mm
- Process/Ambient temperature: -40 to +80° C
- Ingress protection: IP66/68, NEMA4x/6P
- Cable length: up to 300 m

For further information, please visit:
http//bit.ly/20UWoxM or contact Jan Gerritsen, Product Manager Level and Pressure on email: jan.gerritsen@za.endress.com; tel: +27 11 262 8000 or Hennie Pretorius, Industry Manager – Water & Wastewater on email: hennie.pretorius@za.endress.com on tel: +27 11 262 8000 or

comment

South Africans succeeding

The Institution of Chemical Engineers (IChemE) recently announced the finalists for the IChemE Global Awards 2016. Over 120 entries from 26 countries have made it to the final stages of the Awards. Of the total of 500 entries to the competition, three South Africans have made the finals: TerraServ, H1 Holdings and Vuselela Energy, and Michelle Low, PhD, a lecturer and researcher at the University of the Witwatersrand in Johannesburg.

The winners of each of the 16 categories and the overall winner for outstanding chemical engineering project will be revealed on the 3rd of November 2016, in Manchester, UK.

These awards are significant for a number of reasons. First and foremost, the UK Institution of Chemical Engineers (IChemE) is an internationally respected membership organisation for chemical engineers having 44 000 members worldwide. It is also the only organisation which awards the internationally-recognised Chartered Chemical Engineer qualification. The IChemE Global Awards celebrate excellence, innovation and achievement in the chemical, process and biochemical industries. Successful organisations in the final stage include: Amec Foster Wheeler, BP, Chevron, Emerson, Johnson Matthey, National Nuclear Laboratory, and Shell, to name but a few.

Firstly, in the category for 'Outstanding Chemical Engineering Innovation for Resource-Poor People', aimed at technologies and products developed to impact the lives of those less fortunate, local company, TerraServ (Pty) Ltd is a finalist. In the June issue of 'Chemical Technology' we published an article about this start-up company that makes value-added consumer products from food waste. Willie Coetzee and Neels Welgemoed, have developed, piloted and perfected a process to produce natural, safe, renewable and environmentally friendly, bio-ethanol-based products from sugary food waste. In addition, the company also processes starches and other foodstuffs, to produce products such as hand sanitisers, cleaners, bio-fuels and stationery items.

Secondly, H1 Holdings and Vuselela Energy have together been selected as a finalist for the 'Sustainable Technology' Award, the sole finalist from Africa in this category. The historic abundance and low cost of power in South Africa for decades provided no incentive to develop clean energy sources, nor indeed to recycle energy in any form. It is now common knowledge that energy supplies worldwide are under severe pressure and require re-invention. Vuselela was conceived to originate and develop clean energy projects based on capturing and utilising waste heat sources and then gearing these projects through incentives available under a number of clean energy initiatives.

Thirdly, in the 'Young Researcher' Award sponsored by ExxonMobil, one of SAIChE's very own council members, Michelle Low, has been nominated as a finalist, along with students from institutions such as the University of Oxford, the University of Manchester and the University of Waikato, New Zealand.

All three finalist nominations of South African entries serve as testimony to the fact that South African engineers have what it takes to compete on a global level. Congratulations are in order for all our fine engineers and may they go from strength to strength in the years ahead.

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Beyond sensors to the Industrial Internet of Things

by Gavin Chait

Weekends are less peaceful since my wife started making beer. The equipment at the brewery is almost a century old and belongs to a farm and farmers who make their own beer, and run weddings and tours.

As she wakes up, she sends an SMS to the tour guide to ask him to have a look at the temperature gauges on the fermentation tanks. We then spend a few hours waiting for him to bother stepping out of his office and check, and send them back to her.

This is the difference between a quiet weekend, or her getting in the car to drive an hour and find out why the fermentation process has crashed.

While sensor technology has advanced significantly over the past few years, permitting an ever-expanding plethora of telemetry to be gathered and aggregated, most people working in industrial environments don't get to use it. That can be for a variety of reasons but, often, it's simply that the plant equipment is old and doesn't require replacing. The underlying technology either hasn't changed much or was built as a piece of infrastructure meant to last indefinitely.

It can be impractical to lay cable through an old smelter even as safety and efficiency could be improved through the availability of a little extra telemetry. Sterile manufacturing environments don't get much benefit from workmen traipsing through drilling holes through which to run cable. Not that engineers won't be engineers when exposed to new technology.

The first ever internet-connected device was a Coke machine at Carnegie Mellon University which was stocked and run by graduate students. In 1982, they installed micro-switches to assess the state of the machine: when it had been filled, how long individual bottles had been in the fridge, and which column was empty. The output was wired to a server and people could ping the device to get an update.

In 1992, the machine was overhauled and connected

Sensor technology and telemetry allow information to be sent from the old brewery fermentation tanks to the manager via SMS. Later on in the day the beermaker tests the resultant brew.

to the internet. Thus was the Internet of Things (IoT) born. The term itself came into use in 1999 when Kevin Ashton coined the phrase while working at Auto-ID Labs in the UK.

Effectively, IoT is a network of physical devices and objects to which sensors, actuators and network connectivity have been added. What was clever but expensive ten years ago has subsequently become both clever and cheap. More importantly, they're wireless and some are passive. For Industrial applications (known, obviously, as IIoT), this is where hype meets reality.

An 'Accenture' report from March 2016 claims that IIoT will achieve "$15 trillion of global GDP by 2030" ... 14 years from now. These claims come from wishy-washy statements like this: "Executives at Apache claim that if the global oil industry improved pump performance by even one percent, it would increase oil production by half a million barrels a day and earn the industry an additional $19 billion a year."

Nevertheless, there is scope for improving the efficiency of existing systems and products through networked telemetry. Some of the terms being thrown around are likely to trigger your gag reflex but include predictive maintenance, bridging the OT/IT gaps (Operational Technology and Information Technology), and the cognitive enterprise.

Putting aside the 'snark', a paper by Ee Lim Tan, *et al* at the Department of Biomedical Engineering, Michigan Technological University describes how inductive-capacitive resonant circuit sensor can be embedded in food packaging to monitor food quality. The planar inductor and capacitor are printed onto paper. As the paper absorbs water vapour, its capacitance changes and the sensor's resonant frequency changes accordingly. Benchmark that frequency shift against known food-quality issues and you have a way of testing food quality in situ.

Similarly, replacing manual monitoring with sensors improves productivity and removes the need for staff to enter dangerous environments just to take a pressure reading. As said in 'Plant Engineering', "In fluid power, for example, sensors can be applied for condition monitoring of injection moulding units, metal forming and fabrication equipment, conveyor systems, dispensing systems, robotic assembly, and hydraulic power units, to name a few."

These sensors are sufficiently low-cost and robust to permit a much wider range of telemetry, from temperature, to pressure and humidity.

Thing is, going from analogue or geographically bound telemetry to networked data gathering does change the way plants are managed and maintained. When live data can automatically be viewed anywhere in the world, problems at a remote plant can be diagnosed and a response prepared faster and more cost-effectively. The great thing about these sensors is that they can be added on the fly and complement existing systems without being integrated at the device itself.

The availability of all this information can be overwhelming, and — should you decide to bridge that OT/IT gap — you'll be integrating things like weather, sales orders, supply-chain-management, maintenance and whatever else strikes your fancy.

That can become extremely complex and create a whole bunch of new risks executives never had to worry about before. A recent Genpact Research Industry survey sampled 173 senior executives from manufacturing companies worldwide. The top obstacles they consider obstacles to implementing IIoT are: data security, insufficient skills amongst their technical staff, existing legacy systems, and privacy concerns.

Half of those surveyed are concerned about the potential for cyberattacks, and 13% they would never use such systems. This is not a paranoid concern.

In December 2015, Ukraine suffered severe power cuts over Christmas – the depth of the European winter – and in the midst of their conflict with ex-Soviet colonist, Russia. A computer virus, known as BlackEnergy, exploited the connection between the operational systems that controlled the power grid and the regular IT systems connected to them. Ehud Shamir at SentinelOne, a security company, described the attack to ZDNet: "When the attackers gained access to the network, they found that the operator of the power grid had been a bit sloppy and connected some of the interfaces of the power grid's industrial control system to the local LAN.

Part of the modular Black Energy malware acts as a network sniffer, and this discovered data such as user credentials that allowed the attacker to access the industrial control system and jeopardise the electricity supply."

A survey by the SANS Institute in 2015, noted that almost a third of companies have experienced some form of hack. And, while many executives recognise the risk that

their operational systems may be compromised via their IT systems, less than half have a strategy to address this.

Internet security – whether effecting industrial systems or not – is a challenge for all businesses. A company that has its billing and client management systems compromised will suffer whether the factory is offline or not. Security can be managed, and systems restored even if they are compromised, if there are good strategies in place to address them. Yes, this does make managing companies implementing IIoT much more challenging.

Enter opportunities for engineering consulting firms. GE has developed an aircraft maintenance business, expanding from their jet engine manufacturing, to monitor and predict maintenance for their clients. GE's intention is to offer their clients the ability to have no unplanned downtime on their jet engines and locomotives. They have expanded that software platform into Predix, which creates a digital cloud-based replica of your systems via the various added sensors permitting similar comprehensive management.

Michelin, similarly, is offering fleet managers to pay for tyres on a kilometres-driven basis, and using sensors to help reduce fuel consumption. Claas, a German agricultural machinery manufacturer, produces one of the most sophisticated combine harvesters in the world. Their equipment can operate automatically, with sensors that monitor crop flow and automatically optimises performance.

A company's suppliers have the potential to be integrated into the manufacturing and production process to a much greater extent than ever.

The German Federal Government has termed this next innovative wave in industry as "Industrie 4.0" and a working group was established in 2012 to develop a series of design principles to support this fourth industrial revolution.

They include:

- The ability of systems, sensors and devices to be interoperable. Given the potential for integrated systems such as those promoted by GE, such interoperability will be critical.
- Information systems must also be transparent, creating a virtual copy of a plant as a digital model derived from sensor data.
- Systems should provide technical assistance to improve decision-making and reduce the need for humans to perform boring, tiring or dangerous tasks.
- Lastly, systems must decentralise decision-making by allowing systems to run autonomously, and – should anything go wrong – inform and delegate to a higher level.

Conclusion

Certainly, there are dangers from poorly implemented systems, and going from limited telemetry to a fully-integrated system with thousands of new sensors in one step is likely to lead to companies disrupting themselves. The opportunities are also tremendous. For existing plants, there is the benefit of efficiency and safety. For innovators, there's the opportunity to create new types of services for others.

And, for me, there's the opportunity to sleep in on Saturdays if my wife can get an SMS directly from the fermentation tank only when it needs her help.

Solutions for hazardous

In an ongoing effort to provide customers with the best instrumentation equipment from around the world, leading distributor, Protea Automation Solutions, has acquired speciality explosion proof and intrinsically safe instrumentation supplier, SA EX.

Adrien De Becker is excited about his new role in Protea Automation solutions

In addition to the company's assets and world-renowned agencies, Protea also retains the skills of SA EX owner, Adrien De Becker, who is regarded by many in local circles as a leading expert in the field of intrinsically safe and explosion proof instrumentation. Simultaneously, the acquisition allows Protea to move a step closer to providing a true one-stop-shop destination for quality automation solutions.

SA EX represents a line of products that includes mobile and safety devices that have been specially designed and manufactured for hazardous environments. It also includes certified test, measurement and calibration devices such as multimeters, pressure gauges and other process control and calibration devices for hazardous environments in the petrochemical and mining industries among others.

Perfect fit

According to Jerry Smits, national sales manager for Protea Automation Solutions, the company had worked with SA EX for a number of years and always had the highest regard for the quality of products sold by the company, as well as the quality of service and expertise lent by Adrien. "When the opportunity arose recently to acquire the company we did not hesitate, as we know the value of a good company supported by a good leader.

"We believe that there is a close fit between the two companies and just like SA EX, Protea also prides itself on its ability to provide unique process solutions based on product offerings from any of its manufacturers. Our agencies currently read like the who's who of the industry and includes brands that are globally well-known in the process automation and instrumentation industry.

"Adding to this, our brag-worthy newcomer agencies therefore fit in with the existing crop of manufacturers and provides contractors and clients with all the best brands, under one roof, from a single supplier. The new brands include the likes of RKI gas detection devices, Intertec enclosures, Gönnheimer electronics and instruments, Ecom mobile devices, ESP Safety Inc. detectors and safety systems, as well as Grünewald control and measuring engineering equipment."

For more information contact Protea Automation Solutions, and speak to Jerry Smits or Adrien de Becker, Tel: +27 11 719 5700,

environments

Customers first

Speaking after the acquisition, Adrien concurred saying that the extra impetus and reach afforded to the company through the significantly more extensive network of Protea will no doubt lead to far greater exposure and will subsequently lead to dramatically increased sales across the southern African region.

"When I moved to South Africa and started SA EX in 2003 I established the business using my already vast experience of the instrumentation and automation industries. This, combined with hard work and passion, is what gave the company its start in life and what helped me to build it to the point where it became an attractive target for acquisition by a large, well respected company such as Protea Automation Solutions.

"In many ways that makes me proud of the company's achievements and the knowledge that the company has been taken over by a company whose workforce is equally passionate about quality and customer service, is reassurance that the right decisions were made. Also, to be working with a team which is equally dedicated gives me the motivation to continue serving a growing customer base under a larger umbrella."

Solutions provider

Jerry concludes, "From a customer point of view the acquisition means that they will have wider access to some of the world's best explosion proof and intrinsically safe devices and instruments. With Adrien still very much involved and with the addition of our broader product offering and additional expertise they should easily find all their requirements under a single roof – whether it be intrinsically safe, explosion proof or any other instrument or automation product.

"It may also be helpful for existing and potential customers to contact Protea Automation Solutions to establish their requirements and where necessary ensure ongoing stock holding are in place."

Intrinsically safe and explosion proof products

Protea Automation Solutions acquisition of SA EX gives contractors and clients access to some of the world's best products under a single roof. The newly acquired range includes:

- RKI gas detection devices
- Intertec enclosures
- Gönnheimer electronics and instruments
- Ecom mobile devices
- ESP Safety Inc. detectors and safety systems
- Grünewald control and measuring engineering equipment

These are among the most readily recognisable intrinsically safe and explosion proof products in the world and perfectly supplement Protea Automation Solutions' wide range of existing automation and instrumentation products.

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→ Innovative
→ API670 Compliance
→ Protection and Condition Monitoring

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- Native interface to OSI Pi
- Trending, diagnostics and Analysis
- Predictive maintenance
- 300 Channels

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- Single programmable Proximity probe which can be configured to work with any probe/cable/target-material combination.
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- One driver for all applications
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Solar Impulse proves mindset can address global challenges

In July this year, ABB alliance partner Solar Impulse completed a 'round-the-world flight' with zero fuel, showing we can run the world without consuming the earth. Solar Impulse made history by completing the first ever round-the-world flight powered only by energy from the sun. The plane landed at its starting point in Abu Dhabi at 04:05 am local time, after a final leg of 48 hours and 37 minutes from Cairo.

"This is a truly historic achievement, with tremendous symbolic significance," said ABB CEO, Ulrich Spiesshofer. "It demonstrates clearly that with pioneering spirit and clean technologies, we can run the world without consuming the earth. On behalf of everyone at ABB, congratulations to Bertrand Piccard, André Borschberg, and the rest of the Solar Impulse team. We are extremely proud to have been able to contribute to this remarkable project."

ABB forged the innovation and technology alliance with Solar Impulse because what the project has achieved in the air, ABB is doing on the ground, as a pioneer of power and automation technologies for 125 years in Switzerland.

"It's a historic first for renewable energy and clean technologies, not only for aviation," said Solar Impulse pilot, initiator and chairman, Bertrand Piccard, on arrival. "By combining their respective strengths, Solar Impulse and ABB were able to show how breakthrough innovation can be transformed into credible solutions, and how energy can be more efficiently produced, stored and used to create a cleaner world."

Solar Impulse co-founder, CEO and pilot André Borschberg confirmed the value of this partnership: "The mission would not have been possible without the expertise and support of ABB and other organisations that contributed to the project. As part of its innovation and technology alliance with Solar Impulse, ABB provided experts to support the mission, including engineers who served as embedded members of the ground crew throughout the round-the-world flight."

To attempt the round-the-world flight, Solar Impulse had to confront many of the challenges that ABB is solving on the ground for its customers, such as maximising the power yield from solar cells, integrating renewable energy into the electricity distribution systems, and improving energy efficiency.

For more information contact: Saswato Das, Antonio Ligi, Sandra Wiesner on tel: +41 43 317 65; or email 68media.relations@ch.abb.com

Liqui-Cel® degassing technology achieves high quality standards for arenas' ice

An innovative approach to high quality ice production has been adopted by the new Ice Palace in Moscow. In addition to hosting hockey matches, the arena also hosts many international events such as figure skating and short track competitions.

VTB Ice Palace, formerly known as Legends Arena, is an indoor multi-sport venue arena. The facility features three arenas all housed in the same structure. Both the large and small arenas are multi-purpose venues. VTB Ice Palace is a part of the Park of Legends big renovation project, at the territory of the former ZiL plant.

To achieve high quality standards for the ice that is used in large ice arenas, Gelios Star, a Russian OEM, has designed a 'state-of-the-art' water treatment process. This process utilises 3M Liqui-Cel® degassing technology to take gasses and bubbles out of the water used to make the ice. Gases in the water can produce a cloudy appearance in the ice which negatively impacts what the fans and TV cameras see during events held in the Ice Palace.

The overall water treatment system used in the ice palace includes the following elements that work together to improve ice production: Water pressure boosting multi-stage pump; sedimentation granular medium filtration unit with automatic back-wash; activated carbon for Cl2 (chlorine) removal; ion-exchange softening; reverse osmosis unit for 2 x 1,5 m^3/h capacity; permeate storage tanks; DI multi-stage vertical pump; two Liqui-Cel® membrane degas units 6 x 28 size; and a polishing mix-bed.

Two Liqui-Cel Membrane Degasifiers are connected in parallel and operated with a combination of air and vacuum. Carbon Dioxide and Oxygen are removed from the DI water stream, which helps to produce a crystal clear ice that looks like glass. The system can process up to 7 m^3/h. Due to the modularity of the Membrane Degasifiers and the variety of sizes available, a system to process flow rates much higher or lower can also be built.

For more information contact: 3M Industrial Business Group Membranes Business Unit on tel: +1 704 587 8888; or fax: +1 704 587 8610.

Credit for photo: https://en.wikipedia.org/wiki/VTB_Ice_Palace

Thermal imaging solution for precise measuring and documenting

The GIS measure&document app, supported by the GIS 1000 C professional thermos detector, is a one-of-a-kind package from Bosch Measuring Tools that includes a standalone thermal detector device and app that gives professional contractors the opportunity to set multiple measurement points, insert notes, add project information and get more detailed measurement information.

Bosch Measuring Tools SA brand manager Sebastian Johannes explains that the GIS measure&document app is a mobile solution for documenting temperature measurements. It allows the user to share the generated data via email or store it in the app.

"It boasts a measurement point to view all corresponding measurements, a measurements tab for number of measurements and surface temperature and a value list for importing measurements. It includes colours to indicate the status according to the measurement mode chosen on the GIS 1000 C, while the connection status at the top indicates if it is connected via Bluetooth," he says.

The tool also features a Sketch & Measure function, which allows the user to take a picture, set measurement points in the picture and add temperature measurements from the GIS 1000 C, using Bluetooth. The corresponding data, such as the dew point and ambient temperature, is then shown for each measurement point, according to the measurement mode chosen in the device.

According to Johannes, the user can share their project as a PDF document via email. "The user can create a new or open an existing project, sort and delete projects, add or edit project information, search for projects, files and notes with the search function."

In order for the wizard in the application to be connected, the user must activate Bluetooth on both devices, select the GIS 1000 C device and finally make a sample measurement." The user can create their own project, add relevant project information such as project name, customer name and contact information," he continues.

The GIS measure&document app is available free for iOS and Android smartphones and tablets. The free app is available from the Apple App Store and Google Play Store. For more information on the GIS 1000 C professional thermo detector please visit www.bosch-professional.com.

For more information contact Sebastian Johannes, on
tel: +27 11 651 9600;
email: Sebastian.Johannes@za.bosch.com

The paradox of our non-renewable resources

by Philip Lloyd, Energy Institute, Cape Peninsula University of Technology, South Africa

The Brundtland definition of sustainable development as being "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" presents problems when considering the exploitation of non-renewable resources.

Because such resources are, almost by definition, finite, any exploitation must surely limit the ability of future generations to benefit from them. However, examination of the question shows that the underlying resource of many non-renewables is huge compared to the rate at which they are being exploited.

The known reserves can actually increase faster than the rate of exploitation. In contrast, the rate of exploitation of many renewable resources is now faster than the rate of renewal. Thus it is the use of renewable rather than the use of non-renewable resources which is likely to deprive future generations.

In 1987, the UN General Assembly resolved: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (Resolution 42/187) [1]. This is known as the Brundtland definition [2]. It gives rise to a paradox, however. How can a non-renewable resource be exploited without 'compromising the ability of future generations'? Almost by definition, non-renewable resources are finite. Exploiting a finite resource must surely, therefore, leave less for future generations. Recycling may help, but 100% recycling would be difficult to achieve, and in any event the demand will grow as the population grows, so even with total recycling it will still be necessary to draw on more of the non-renewable resource.

Fifteen years later, the paradox was causing so much difficulty that the World Summit on Sustainable Development in Johannesburg resolved: "We assume a collective responsibility to advance and strengthen the interdependent and mutually reinforcing pillars of sustainable development – economic development, social development and

environmental protection – at the local, national, regional and global levels." [3]. This placed economic issues on a par with social and environmental issues. Many are unhappy that the Brundtland definition has fallen away. Does the revised formulation mean that we do not have to worry about future generations?

Of course not. But part of the conceptual problem is that many of the resources that are truly threatened are the renewable ones, not the non-renewables. Fish, large mammals, fresh water, timber, clean air – the list is endless. Many of our renewable resources are being insanely overexploited, and humanity seems incapable of agreeing rules for their protection. In contrast, many of our non-renewable reserves have become so plentiful that their prices are presently at historic lows.

Therefore, in this article I seek to enquire how it comes about that our non-renewable reserves are seemingly inexhaustible.

An example

Fears that oil will soon be exhausted have been prominent for many years [4]. During the first decade of this century, the "Peak Oil" hypothesis, that we had reached the peak of our oil production capability, was dominant [5] . The reserve and production statistics [6] tell a very different story.

Figure 1 shows the Proven Reserves of oil, the annual production of oil, and the R/P ratio (Reserves/Annual Production), ie, the number of years the oil would last if production continued at that year's rate:

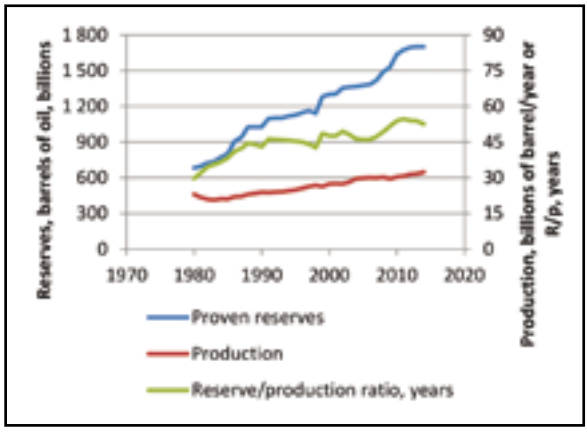


Figure 1: Oil reserves, production, and R/P ratio [6]

Back in 1980, the proven reserves were about 700 billion barrels and production was running at about 23 billion barrels per year, so there was about 30 years of oil left. By 2010, therefore, most of the 1980 oil would have been exhausted – yet by 2010, the proven reserves had grown to around 1 600 billion barrels, the consumption had increased to 30 billion barrels per annum, and there was over 50 years of oil left.

Another way of looking at this is to see how long it took to deplete the Proven Reserve in any one year. Figure 2 shows that the 1980 oil reserve was consumed by 2007, ie, it lasted 27 years; the 1985 oil lasted until 2014, 29 years; the 1990 oil will probably last until 2022, 32 years. Even though the rate of consumption is increasing, the reserve at any one time is lasting longer.

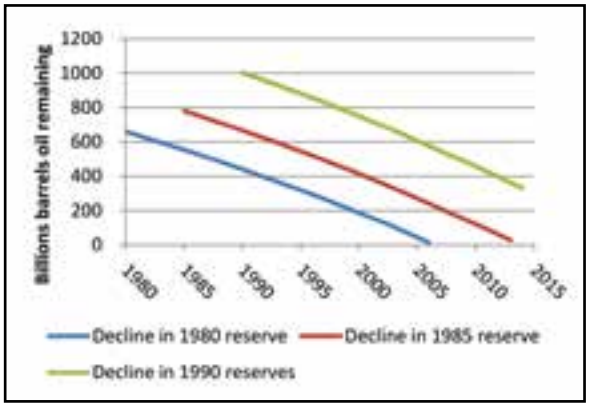


Figure 2: The use of proven reserves

Our instinct tells us that the world's resources are finite. Yet the example shows us that the reserves of oil have grown for the past 35 years even though the rate of exploitation has increased. Have our instincts let us down?

The generality of the paradox

The example of oil is not unique; many other materials are being exploited without fear of exhaustion of the reserves. For instance, Figure 3 shows how, over 50 years, the production of copper rose six-fold while the reserve/production ratio grew from 40 to nearly 80 years before dropping back to 50 years:

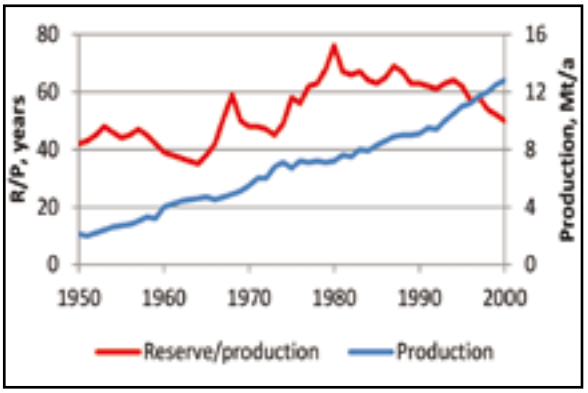


Figure 3: Production and reserve/production ratio for copper [7]

The case of copper is particularly remarkable, because copper is extensively recycled. (At present about 9 million tons of copper are recycled annually; see www.copperalliance.org.) So, a six-fold increase in what is mined is all the more significant. Moreover, consider the significance of a reserve/production ratio of 80 years.

It implies that, if you were to discover a new deposit of copper, it might mean a wait of as long as 80 years before it was worth producing the copper you had discovered. Geological exploration is not cheap. No-one likes to spend money on exploration which will only start to yield revenue after many decades.

The production volumes and the reserve/production ratio of most non-renewable resources show patterns similar to that of Figure 3. Production has increased inexorably, but the reserve has grown. Lead, mercury and asbestos are counter-examples; health concerns have reduced the demand for the resource to low levels, and the reserve/production ratio has become very large.

The resolution of the paradox

There are a number of factors underlying this paradox. The first is consideration of what constitutes a 'reserve'. Our planet has many resources; they only become reserves when someone can find a way of making use of the resource material. For instance, the crust of the Earth comprises about 8% aluminium. The lithosphere therefore contains about 70 million billion tons of aluminium. But the main reserves of aluminium are in the ore bauxite, with about 8 billion tons of aluminium, or of the order of one ten-millionth of the resource. So the reserve is a truly minute fraction of the resource, and this is true of many of the non-renewable resources. In contrast, our abuse of many renewable resources involves a significant fraction of the natural reserve.

Aluminium was more costly than gold until an efficient way of producing it from bauxite was discovered in the late 19th century. Since then the price has fallen while the volume produced has soared. This illustrates another feature of non-renewable resources – technology determines their cost, and the larger the volume, the lower the relative cost.

This can be illustrated by the case of copper [8]. In pre-industrial days, a copper resource typically contained about 5% copper, and in today's money it cost about $50/kg. By the 1900s, production was about 500 000 tons per annum, the ore contained 1-2% copper and the price was the equivalent of $40/kg. By the 1950s, production was about 2 million tons per annum, the ore contained <1% copper, and the price was about $10/kg. A new technology arrived in the 1970s, and today about one-third of all new copper is produced from very low-grade ores by dissolving the copper directly from the crushed rock, then extracting the copper from solution with a special solvent. The price fell to about $2/kg at the beginning of this century, rose sharply to over $8/kg after 2004 and is presently falling back through $4/kg.

So the grade of ore has fallen consistently over the years, and as it has fallen, new technology has been developed, and more and more of the resource has become economic – ie, converted into a reserve. Low-grade ores have required larger volumes of rock to produce the same amount of metal, so mining technology has also advanced, further reducing the cost of production.

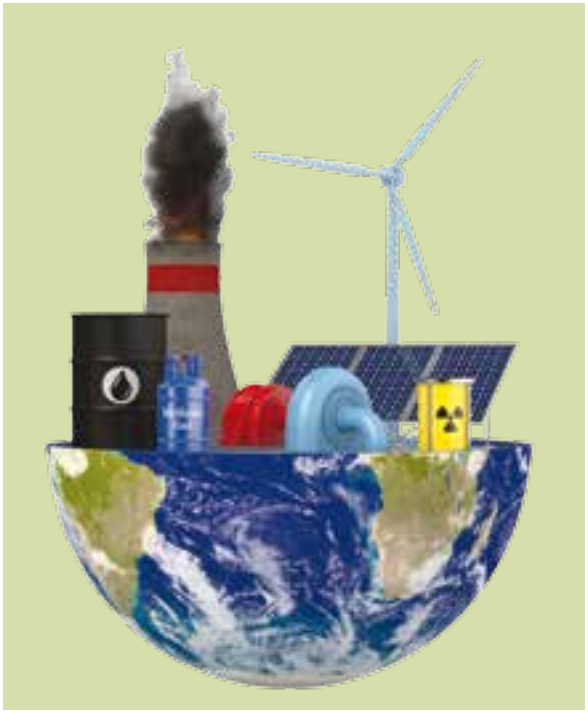
A reserve is not a static absolute. Yes, the resource is finite, but the reserve is determined by economic factors, which can vary with time and place and technology and economic environment. Moreover, the reserve is so small a fraction of the resource that by the time the reserve is consumed, time will probably have recycled the product via geological processes, and so created new ores. The reserve can ultimately be infinite.

A further factor is that the technologies of identifying a potential reserve and of quantifying its potential have evolved enormously. Geological models are continuously being improved, as more and more data are acquired. Physical techniques for identifying geological structures have evolved to a high degree of sophistication. Data processing enables three-dimensional visualisation of the underground. Drilling technology now permits precise sampling of structures hundreds of metres below surface. All these advances have reduced the time to identify a target reserve and reduced the risks inherent in deciding to exploit it.

A final factor in the inexhaustibility of non-renewable reserves is the fact that we obtain specific services from them. But other materials can possibly offer the same services at a lower price, in which case they will replace the original. For example, the Roman water distribution system relied upon lead piping. It is likely, because lead is a relatively rare metal, that were the world's plumbing systems still to rely upon lead to the same extent as the Romans, we would use a large fraction of the resource. Lead would be unaffordable. But, of course, we have learned to use other materials to provide the same service as lead at a fraction of the cost, and simultaneously avoided the health issues. The original reserve of lead may have been too small for our needs, but human ingenuity has avoided what would have seemed to the Romans an unsolvable problem.

Conclusion

The question was: "How can a non-renewable resource be exploited without compromising the ability of future generations to meet their own needs?" The resolution came down to the fact that what was exploited made up a very small fraction of the resource. Moreover, advances in the technology of both exploration and extraction meant that the economic reserve could grow, and indeed, actually grew, even while exploitation was increasing. In contrast, the



fraction of our renewable resources that are being exploited makes up a significant fraction of the total resource, to the extent that there is loss of species and future generations indeed are threatened.

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Thorium – a Safe Nuclear Fuel

by Trevor Blench, Steenkampskraal Thorium Mine, Western Cape, Souuth Africa

There is growing awareness that thorium is a safe alternative to uranium as a nuclear fuel and that its use will limit nuclear proliferation.

To meet this demand, the Steenkampskraal thorium mine in the Western Cape will begin production in about two years time. The company will mine, process and refine thorium for nuclear fuel applications. The mine has the world's highest-grade rare earth and thorium deposits, with an average rare earths grade of 14,4% and thorium of 2,14%.

HTMR100

Steenkampskraal is also designing a small, low-cost, helium-cooled thorium pebble-bed reactor known as the HTMR100. This will use thorium, mined at Steenkampskraal, as well as Steenkampskraal's locally designed thorium/uranium pebble fuel.

Steenkampskraal is designing the factory to produce the pebble fuel for the HTMR100. The fuel presents no risk of meltdown in the HTMR100 reactor compared to that experienced at Fukushima. Steenkampskraal's strategy covers four key areas: mining thorium and rare earths at Steenkampskraal, designing a safe thorium-based HTMR100 nuclear reactor; designing the thorium/uranium pebble fuel for this new reactor; and testing a safe thorium/uranium and thorium/plutonium pellet fuel for existing reactors.

The TRISO coated-particle pebble fuel for the HTMR100 reactor has been licenced, manufactured and tried and tested over many decades and is proven to be the safest nuclear fuel ever made. Large water reactors are expensive to build and require high-cost

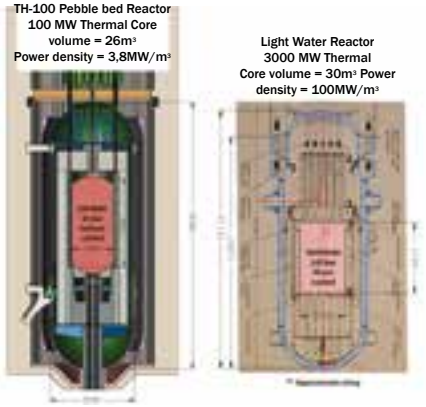


Figure 1: Triso coated-particle pebble fuel.

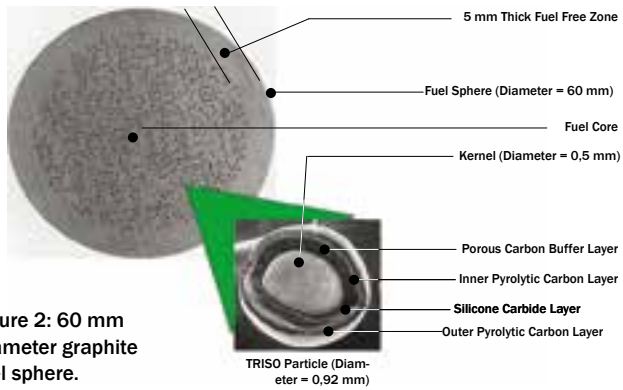


Figure 2: 60 mm Diameter graphite fuel sphere.

distribution networks to deliver the electricity to where it is needed. A small modular reactor will obviate the need to build expensive distribution networks. In addition, the HTMR100 reactor could meet other energy requirements such as desalination.

Present-day nuclear reactors are not suitable for African conditions. They can take years to build and are too large to connect to small and poorly-developed electricity grids.

Benefits

The HTMR100 reactor displays a number of benefits. Firstly, it is small. With a power output of 100 MWth, or about 35 MWe, the HTMR100 could be deployed in countries with a total installed capacity of less than 10 000 MW. It is also suitable for distributed generation. The small reactors could be built at the point where energy is needed, near towns, cities, smelters, factories or mines in remote areas.

Secondly, small HTMR100 modular reactors could be built relatively quickly. Large reactors take up to ten years to build. Small modular reactors, when the supply chain has been established, could be built in two or three years.

Thirdly, large reactors are very expensive and are beyond the financial reach of most African countries. Small modular reactors could be built, like aircrafts, in factories with efficient production capabilities and good quality control, and easily transported to the site. The production of large numbers of small modular reactors could substantially reduce their cost of production.

Tried and tested

The HTMR100 reactor technology has been tried and tested over many years and has proven its safety on many occasions. Because the HTMR100 is a helium-based, gas-cooled reactor, it does not need any water for cooling and could therefore be built away from the sea.

The HTMR100 is also versatile and capable of co-generation of several useful products. It is a high-temperature reactor with outlet temperatures of up to 750 °C. This means that it could supply high-temperature steam for industrial applications, desalinate sea water or purify contaminated water such as acidic mine water. It could also produce clean, safe and reliable base-load electricity. The HTMR100 reactor would have practically no emissions of carbon dioxide or other greenhouse gases. The combination of these factors make the design of the pebble-fuel nuclear reactor a world first. No other nuclear reactor offers a combination of these features contributing to safety, efficiency, environmentally friendly, reduced cost and the elimination of the risk of nuclear proliferation.

In addition to the pebble fuel for the HTMR100 reactor, Steenkampskraal is testing thorium/uranium pellet fuel in co-operation with its associate company in Norway, Thor Energy. This pellet fuel will be used as a supplement for uranium in existing Light Water Reactors (LWRs). Tests are being conducted at the Norwegian government-owned Halden reactor.

There is potential to use this thorium pellet fuel to supplement uranium fuel in approximately 350 existing LWRs around the world with no modifications needed to the

uranium reactor. Thor Energy is now in its fourth year of a five-year test qualification period to produce this world-first commercial thorium/uranium and thorium/plutonium pellet fuel, which will revolutionise the nuclear industry by improving safety and efficiency.

The US, France, Japan, China and South Korea have the most uranium-based nuclear reactors. These are all potential clients for the thorium/uranium pellet fuel. The Korea Atomic Research Institute (KAERI) is one of the organisations working closely with Thor Energy as part of the pellet fuel programme. South Korea has 24 uranium-based nuclear reactors, each the size of Koeberg, representing enormous potential for our pellet fuel.

Thorium fuel can use either uranium or plutonium as the fissile driver material. The by-products produced by thorium are safer than uranium-based fuel that is used in existing nuclear reactors, making thorium environmentally safer and extremely difficult to create a nuclear weapon. Plutonium is now being tested by Thor Energy as an alternative to uranium for producing thorium fuel. This on a large scale would reduce the huge plutonium stockpiles held by some of the world's largest countries.

The thorium fuel cycle is also cleaner than the uranium fuel cycle. Uranium produces plutonium and minor actinides in its waste, and plutonium can be used to manufacture nuclear weapons. The minor actinides produced in existing nuclear reactors remain radioactive for thousands of years. The thorium fuel cycle produces no plutonium and hardly any minor actinides.

The waste from the thorium fuel cycle contains mainly fission products that lose most of their radioactivity in a shorter time period. As a result, the thorium fuel cycle would substantially reduce the problems associated with the management and storage of nuclear waste.

Reactor

STL's HTMR100 (High Temperature Modular Reactor) reactor uses a once-through fuel-cycle process, meaning that the fuel passes through the reactor slower than a traditional high-temperature pebble-bed reactor.

Why is the pebble bed reactor meltdown proof? A pebble bed reactor's core power density is approximately 30 times lower than most water-cooled reactors. Power density is the amount of heat from nuclear fission typically generated in

one cubic metre in the reactor core.

Figure 1 illustrates the size and core volume of a pebble bed reactor producing 1 00 MWt compared to a typical water-cooled reactor which produces 3 000 MWt. The reactor pressure vessels are of similar size (height and diameter) and the cores (ie, the volume where the nuclear fuel is placed to produce heat from nuclear fission) are of similar physical size.

In both cases, a coolant reduces the temperature of the core during normal operation. However, the pebble bed reactor has a number of inherent safety features that ensure that the core cannot melt down when the coolant flow stops, in the case of an accident or some unforeseen event.

The strong negative temperature coefficient, together with the low power density of a pebble bed reactor, means that if the active coolant flow ceases, the reactor will automatically become sub-critical (ie, shut itself down). On the other hand, LWRs also have a negative temperature coefficient, but have a high power density and require active cooling to keep the core cooled, hence the high risk of a meltdown.

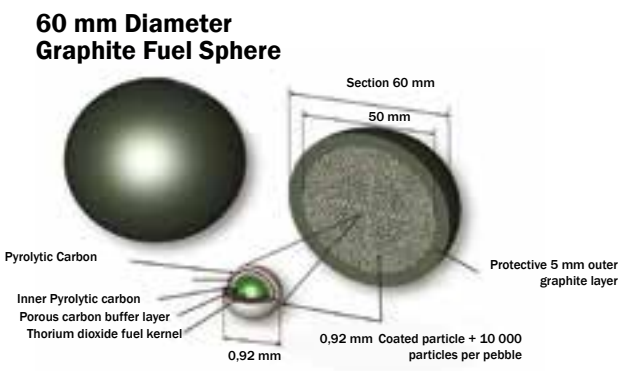


Figure 3: Comparison between Pebble and LWR reactors.

Illustration of Thorium

Conclusion

The British Government published a report in 2014 entitled 'Future Electricity Series Part 3 – Power from Nuclear' which emphasised the importance of small modular reactors and thorium as a nuclear fuel for Britain's future energy supplies.

In addition, the American Nuclear Regulatory Commission published a report in 2014 entitled 'Safety and Regulatory Issues of the Thorium Fuel Cycle' describing the qualification procedures that need to be done in order to introduce the thorium fuel cycle.

About the author

Trevor Blench has worked in financial services for most of his career as a commodity trader, stockbroker, bond trader, foreign exchange trader, financial analyst and portfolio manager. He was a member of the Johannesburg Stock Exchange for many years. He is also a director of Thor Energy AS in Norway. This company commenced a project to develop thorium as a nuclear fuel for Light Water Reactors in 2006. He has a BA Economics, MA in International Relations and an MBA Enquiries: David Boyes. Tel. +27 (0) 12 667 2141 david.boyes@thorium100.com

Pneumatic energy saving solutions

by Riaan van Eck, SMC Pneumatics, South Africa

Energy saving has become more than just a catch phrase. It is something which every business needs to consider in terms of cost and productivity.

It is estimated that a medium-sized business company loses almost 20% of energy used and it is the sum total of looking at an entire system which yields the best energy savings. During the Japan Kyoto Climate Change conference, two objectives emerged:

- More efficient use of direct oil and electricity consumption;
- To contribute to the conservation of the environment with the reduction of CO_2.

According to recent research in Europe, there are currently more than 320 000 production facilities which use compressed air systems. In total the annual estimated consumption of electricity in European industry is 400 TWh which is divided into three main categories with regards to energy: coolants – 30%, compressed air – 20% and others – 50%. The required electric energy to produce compressed air for such facilities constitutes almost 20% of this total industrial consumption.

Possible energy savings in pneumatics

- In an average facility, 70% of compressed air is used in blowing applications, 10% in actuation and the remaining 20% is lost through leaks.
- By focusing specifically on these systems, one could easily achieve energy savings of between 5 – 50%.
- The first step in conserving energy would be to look at the reduction in air for blowing processes and looking into air leaks.
- The second analysis reveals that 20% to 50% of the air consumption measured as leakage is divided into 25% for connectors/adapters, 20% for connection, 30% for hosing and 25% for other types.

If we assume that an average saving of 33% could be made thanks to using more energy-efficient compressed air systems (26 TWh), and if we take the average cost of electricity at €0,09/kWh, the total saving in electric energy which could be achieved in compressed air systems in Europe would be €2 340 M. Typical reasons for inefficiency which could be investigated are the following:

Inefficient compressor control, the compressed air pressure is too high	Poor air quality
Poor design of the pneumatic pipelines	Low quality pneumatic elements used
Incorrect sizing of the pneumatic actuators	Obstructed filters
Inefficient use of air blowing	Intermittent demand vs constant supply.
	Look for leaks in the system

It must be taken into consideration that leaks are not only produced in the case of compressed air storage but also in pneumatic systems on standby (such as static or vacuum leaks) and in pneumatic system in operation. Dynamic leaks can be detected while in use. Various methods can be used to increase efficiency, such as:

Reduce the air pressure to the minimum requirement	Adapt the size of the pneumatic components to the real performance requirements
Filter and dry the air using the correct equipment	Use only quality products
When not in use, isolate the plant by using two-way valves	Detain the air blowing when not required
Generate a vacuum by using multi-stage ejectors with vacuum switches	When replacing or installing new components, choose energy efficient options
Periodically check air consumption	Avoid and reduce air leaks

In order to generate 1 kW with compressed air we require between 7 – 8 kW of electricity. If we translate this into economic language the result is that the generation of 1Nm³ of compressed air means 1 cent of energy expense and between 2-3 cents when counting compressor maintenance. As an example, a 120 CV (88 kW) compressor is able to provide us with a flow of approximately 850 m³/h. When operating continuously over one year it will consume approximately €70 000 in electric energy (depending on the cost of the kW/h).

Efficiency = Knowing the cost/ consumption levels

To ascertain energy saving measures in pneumatics, issues such as the purchase cost and maintenance cost of the machine, how much is spent on compressed air and how much compressed air is efficiently taken advantage of, must be addressed. Only then can you decide on where and when savings are possible.

Conclusion

Save today – by reducing energy costs in the consumption of the compressed air by adopting actions which alter its generation and use. Save in the future by demanding energy efficient facilities and machines.

About the author

Riaan van Eck is the Training Manager for SMC Pneumatics South Africa. Riaan has had extensive training in Spain, UK and Germany and has been in the pneumatics industry for close to ten years working for some of the world's top pneumatic brands. He has experience in manufacturing, factory automation, process control, pneumatics and PLCs among others.

akvoFloat™ for refinery wastewater reuse – a flotation-filtration technology based on novel ceramic membranes

by Stephan Mrusek, Carles Crespo, Lucas León, all of akvola Technologies, Germany

The use of polymeric membranes (MBR, UF) as a pre-treatment before desalination has gained considerable acceptance and is generally a feasible method for refinery wastewater treatment and reuse; however, there are some important unresolved challenges.

These challenges are often in terms of increased fouling caused by oil and organics, scaling by metals and very expensive and frequent membrane replacements that significantly impair the economics of such solutions.

This article presents a full wastewater reuse project for a German refinery (250 m^3/h) and the water management study that has been carried out in order to assess the technical and economic feasibility of a solution based on akvoFloat™ – a novel water treatment technology based on ceramic membranes. The aim is to prove that this solution has the capability of avoiding the shortcomings of the above-mentioned 'state-of-the-art' technologies based on polymeric membranes with a positive ROI.

A novel technology

akvola Technologies is a water technology company that provides cost-effective and environmentally-friendly solutions based on akvoFloat™ – a proprietary flotation-filtration process – to clean hard-to-treat industrial wastewater containing high concentrations of oil (free, dispersed and emulsified) and/or suspended solids in harsh environments (pH, temperature, salinity, etc).

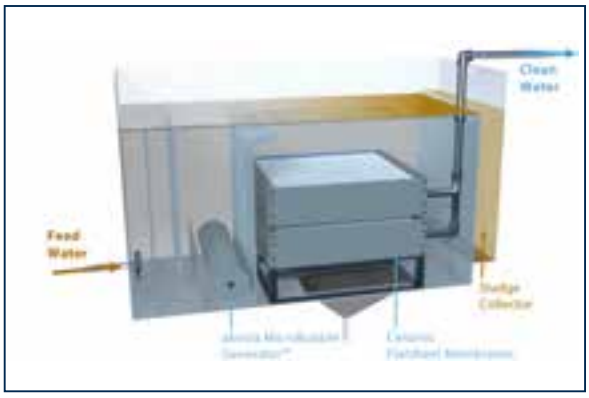


Figure 1: akvoFloat™ flotation-filtration process

akvoFloat™ is a separation technology based on a proprietary flotation-filtration process. The process leverages the akvola MicroBubble Generator™ and the company's special know-how in the design and operation of novel ceramic membranes, resulting in the most energy-efficient design on the market for oil and suspended solids removal in hard-to-treat waters.

The feed water first enters the flotation zone, where the akvola MicroBubble Generator™ induces fine gas bubbles (50-70 micron) using very little energy and equipment – without the need for a saturator or a water recycle stream, unlike DAF (Dissolved Air Flotation). These microbubbles attach to suspended matter, oils, hydrocarbons and organic flocs which are carried to the surface. The float layer that forms on the surface is skimmed off the tank at regular intervals. The partially treated water then enters the filtration zone, where submerged ceramic membranes are used as a polishing step. They provide high, constant permeate quality with very low pressure drop. (See a video here: http://vimeo.com/akvola/akvoFloat™)

The flotation in akvoFloat™ acts as a pretreatment, allowing for the submerged flat sheet ceramic membranes to be driven at high fluxes (up to 5x higher than polymerics) with very low transmembrane pressures (TMP < 0,2 bar) even in heavily polluted waters. This translates into systems with a very economical Capex/Opex balance, unlike the conventional cross-flow driven ceramic membrane systems in the market, which require more membrane surface, more equipment and have a higher energy consumption. The high chemical and mechanical robustness of ceramic membranes allow for very effective cleaning and longer lifespans that resolve the above-mentioned limitations of polymeric membranes.

Water management study: Drivers and results

The goal of the customer is to find a solution to treat 250 m^3/h wastewater effluent to be reused as boiler feed water with the following objectives:

- high resistance to influent variabilities,
- reliable, simple and cost-efficient operation and
- high recovery rate in order to minimise waste.

This project consists of a wastewater management study that includes a feasibility study (Q2 2016), a field project to validate the results obtained in the previous study (Q3-Q4 2016) and the design and implementation of a full-scale solution (2017).

Figure 2: akvoFloat™ pilot unit

Table 1: Crucial effluent parameters of existing WWTP and set RO feed quality targets

Parameter	Unit	WWTP normal operation	RO feed quality target
pH	[-]	7	-
Conductivity	[µS/cm]	1000	-
Turbidity	[NTU]	10	< 1
TSS	[mg/l]	20	-
SDI15	[-]	N/A	< 3
TOC	[mg/l]	10	< 3
COD	[mgO2/l]	35	< 6
BOD5	[mgO2/l]	< 3	< 3
CFU	[CFU/ml]	10000	< 10
O&H (Oil&Hydrocarbons)	[mg/L]	5	0.1
Nitrate	[mg/l]	45	-
Sulfate	[mg/l]	100	-
Aluminium	[mg/l]	0.07	< 0.05
Free Chlorine	[mg/l]	< 0.1	< 0.02
Iron	[mg/l]	0.5	< 0.05
Manganese	[mg/l]	0.15	< 0.05

The wastewater treatment plant (WWTP) in the oil refinery includes a flotation unit, an activated sludge process with secondary clarification and a sand filter as last treatment step to meet the current effluent limits for direct discharge to a nearby river. The favoured water reclamation option is to reuse wastewater as boiler feed water. The scope of akvoFloat™ is to treat the sand filter effluent up to RO feed quality, since an RO will be used for desalination. Comparing historical data sand filter effluent and RO feed quality requirements the wastewater impurities with the need of reduction were identified:

- Suspended solids and colloidal matter measured as Total Suspended Solids (TSS) and Turbidity

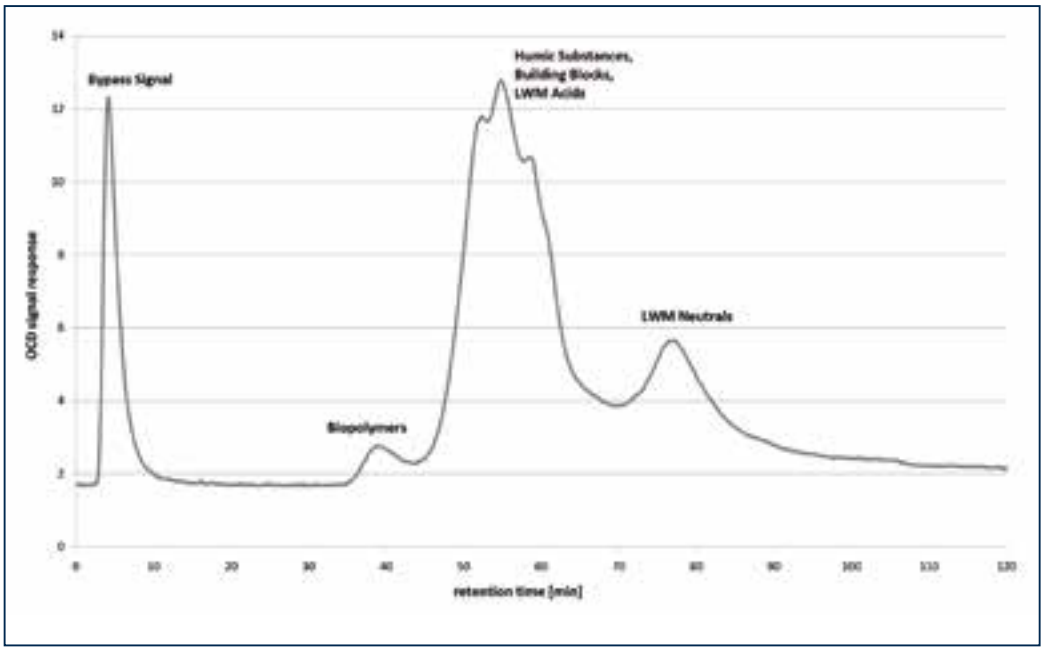


Figure 3: Results of the LC-OCD analysis to identify organic species

- Emulsified and dissolved oils measured as Oils & Hydrocarbons (O&H)
- Organics measured as Chemical Oxygen Demand (COD) and Total Organic Carbon (TOC)
- Microbes measured as Colony Forming Unit (CFU)

Other contaminants, such as metals, free chlorine, nitrates and sulfates need to be removed prior to the RO with proper chemical treatment (pH adjustment, antiscalants, and so on). Table 1 lists the crucial effluent parameters of the existing WWTP (250 m^3/h) and the set RO feed quality targets.

The removal of the organics is a challenging treatment step as the efficacy of polishing technologies is highly dependent on the exact type of organic pollutants. For this reason a Liquid Chromatography - Organic Carbon Detection (LC-OCD) analysis has been carried out to identify the organic species. The results are shown in Figure 3.

It can be seen that the organic load mainly consists of high molecular weight humic substances (humic acids, fulvic acids), building blocks (breakdown products of humic substances) and low molecular weight (LMW) acids (oxalic, formic, acetic, propionic acids). Biopolymers (polysaccharides, proteins) and LMW neutrals (alcohols, aldehydes, ketones, amino acids, sugars) are present to a lesser extent.

akvoFloat™ is chosen as the first treatment step of the treatment chain because of its high resistance against inlet quality fluctuations. In case of upsets in the WWTP's sand filter effluent, such as breakthroughs of oil or high levels of suspended solids, akvoFloat™ acts as an absolute barrier for downstream units with high sensitivity against fluctuations. Within akvoFloat™ the two sub-processes complement each other in the removal of the key contaminants:

- **Micro-flotation**: Flocculation drives the agglomeration in flocs of humic substances as well as emulsified and a part of the dissolved oils so that the micro-flotation can remove them effectively. However, building blocks are not easily agglomerated by flocculation. Preliminary flocculation + flotation lab tests with Ferric Chloride showed a COD and TOC removal of about 50% and 30% respectively.
- **Flat sheet ceramic membrane filtration**: Due to the pore size of 0,1 micron of the ceramic membranes chosen for this application of akvoFloat™, a 3-log reduction (99,9%) of bacterial count measured as CFU/ml has been achieved during the lab tests. TSS and Turbidity were reduced to below the RO feed quality limits as well as SDI15 to < 3. The remaining emulsified and flocculated dissolved oils are removed by the membrane reaching the RO feed quality limits (O&H < 0,1 mg/L).

The lab test results with akvoFloat™ show that a polishing for the COD and TOC levels is required downstream. Several RO pre-treatment technologies are available for organic load reduction including adsorption, biological activated carbon (BAC) and oxidation (ozone, UV, AOP). After careful consideration, the use of ozone was preferred with the possibility of upgrading it to an AOP by the additional dosage of hydrogen peroxide. As an additional step, Granular Activated Carbon (GAC) was chosen as the adsorption technology.

In summary, the lab test results show that the novel akvoFloat™ technology has been able to almost completely remove the bacteria, turbidity, oils and TSS, and halve the refractory organics (like humic substances). The study results conclude that adsorption on GAC and oxidation techniques with ozone are applicable downstream of akvoFloat™ in order to decrease the organic load to appropriate RO feed levels. The pilot system for the ongoing field trials includes the following treatment chain:

- an akvoFloat™ pilot unit (2-3 m^3/h),
- a polishing step (GAC and oxidation with ozone will be tested), and
- an RO pilot unit (0,5-1 m^3/h), in order to validate a stable RO operation is possible.

Conclusion

The micro-flotation pre-treatment and the properties of ceramic membranes enable this technology to overcome the limitations that polymeric membrane based technologies have shown in the past ten years – ie, increased fouling,

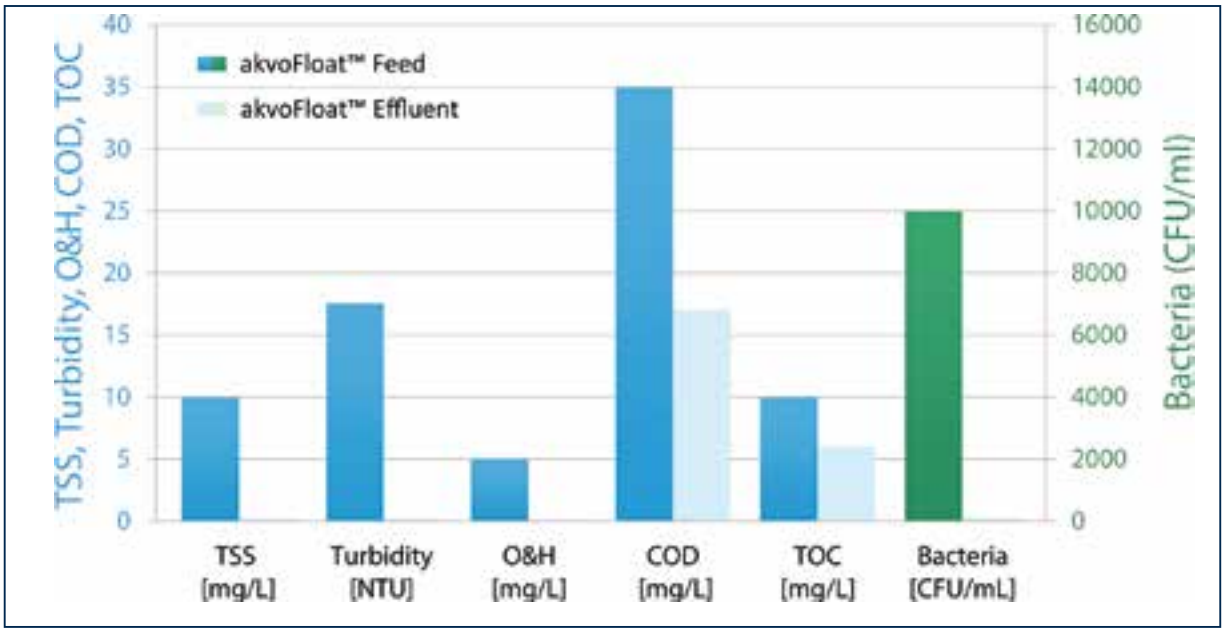


Figure 4: Lab test results of the use of akvoFloat™

frequent and costly membrane replacements.

Based on these promising results, the customer has decided to execute field trials at the refinery (ongoing). These long-term tests will reveal more about the technical and economic feasibilities of the proposed treatment trains. In particular, the operational costs of the polishing steps under consideration are a concern, due to the difficulty in the removal of the present recalcitrant organics.

Upon the successful completion of the field trials, akvola Technologies will start the design of a full-scale plant that will enable the refinery to reuse 100% of their wastewater, thereby reducing the costs of sourcing and discharging water as well as improving their environmental and water stewardship, thus meeting their internal corporate mandate expectations.

Five years of reverse osmosis membrane elements from LANXESS in Bitterfeld

"Our foray into the reverse osmosis (RO) membrane business five years ago has truly been a success story. We have almost reached the limit of our current capacity so we are going to double production capacity in the coming year," said Jean-Marc Vesselle, head of the LANXESS Liquid Purification Technologies (LPT) business unit, on the occasion of a celebration of the five-year anniversary of the Lewabrane plant operated by IAB Ionenaustauscher GmbH, a wholly owned subsidiary of the LANXESS specialty chemicals company in Germany.

"The Lewabrane brand has established a firm place for itself in the market, not least on account of its high quality and performance properties, which both we and our customers expect from 'Made in Germany' products," he added.

The market for RO membrane elements is currently projected to grow at an above-average rate of 10% annually in coming years (CAGR 2015-2020). Because the plant is already operating at almost the limit of its capacity, LANXESS has decided to double the corresponding capacity at the Bitterfeld site. The additional capacity is scheduled to come on line in the second half of 2017.

LANXESS is demonstrating its commitment to the Bitterfeld site in a number of different ways, including in Research & Development. In this regard, Vesselle said: "We are continuously conducting research in all areas of modern water treatment so that we can continue to provide our customers with the requisite expertise from a single source."

For that purpose LANXESS is cooperating with technical universities and other research facilities in the region such as the Fraunhofer Institutes for Factory Operation and Automation (IFF) in Magdeburg and for Microstructure of Materials and Systems (IMWS) in Halle.

LANXESS is one of only two companies in the world that offer know-how and products both in membrane elements and ion exchange resins. "With this comprehensive water treatment capability we can meet the requirements of customers all over the world," Vesselle remarked. The membrane element plant is the logical continuation of a tradition dating back almost 80 years in Bitterfeld-Wolfen. LANXESS operates additional production facilities for ion exchange resins in Leverkusen, Germany, and Jhagadia, India.

Because membrane and ion exchange technology frequently go hand in hand, the development and introduction of the LewaPlus integrated design software was a major contribution to optimally linking the strengths of both technologies.

Strands of different thickness are used for the novel, multifunctional feed spacers. These create space between the membrane surfaces for fast-flowing water, support the membrane in the process and cause turbulent water flow. (Photo: LANXESS AG)

For more information:
http://lpt.lanxess.com/en/home/

Andrew Murray Consulting food safety short courses 2016

Andrew Murray is a consultant food process engineer with more than 20 years experience in the design of hygienic plant for the food and beverage industries.

Cape Town: 20-21 Sept 2016; Johannesburg: 18-19 Oct 2016

For more information contact: Andrew Murray on tel: +27 028 312 3064

1.Hygienic design of food processing plants — two days

The course aims to make established and potential food processors aware of the standards that are required for modern, safe food processing installations, how to implement such standards and what documentation with regard to such standards is available locally. The course will include among other topics: Facilities, PRPs and HACCP ● Overview Regulation R962 ● Overview SABS049 (and PAS 220) ● Overview SANS 14159 ● Layout, flows and zoning ● Building structures and surface finishes ● Hazards, risks and barriers● Materials of construction ● Design of open systems ● Design of closed systems ● Pasteurisation and sterilisation systems ●

Course Fee: R4 200 plus R588 Vat = R 4 788.

2. Material and energy analysis for food processors — three days

It is now, more than ever, vital to have accurate calculations of energy requirements for any processing operation. It is also important to have a numerical understanding of the environmental issues around the use of energy. Mass and energy balances form a basis of engineering design but are equally an accounting tool that finds an important place in day-to-day plant operation.

This course aims to present methods for the use of Excel spreadsheets in the calculations of Mass (or Material) and Energy Balances and analysis.

The course covers, amongst other topics, the following: Introduction to the food industry ● Units and expressions of concentration ● Forms of energy ● Introduction to mass and energy balances ● Properties of air and water ● Heats of reaction and solution ● Pasteurisation ● Evaporation ● Dehydration ● Cooling, refrigeration and freezing ●

Course Fee: TBA

3. Introduction to layouts and hygienic design of buildings for food processing — one day

The course aims to make established and potential food-processors aware of the standards that are required for modern, safe food processing buildings, how to implement such standards and what documentation with regard to such standards is available locally.

The requirements for air handling units and other services are also considered.

The course includes among other topics: Facilities, PRPs and HACCP ● Overview Regulation R918 ● Buildings in SANS10049 and ISO 22002 ● Building structures, walls, floors and ceilings ● Layout, flows and zoning ● Surface finishes. ● Air handling systems ● Installation of services ● Checklists ●

Course Fee (2013) R2 600 plus R364 Vat = R2 964

4. Introduction to the hygienic design of equipment for food processing — one day

The course aims to make established and potential food processors aware of the standards that are required for modern, safe food processing equipment, how to implement such standards and what documentation with regard to such standards is available locally. In so far as HACCP requirements are concerned the course highlights some of the prerequisite programs that need to be put in place to allow HACCP to be implemented.

The course includes PRPs and HACCP ● Buildings and machinery in Regulation 962 and ISO 22002 ● Overview of SANS 14159 ● Hazards, risks, barriers and zoning ● Aspects of building design and surface finishes ●

Course Fee (2014) R2 600 plus R364 Vat = R 2 964.

John T Ryan Trophy winners unveiled at MineSAFE 2016

The John T Ryan Trophy for a surface-mining operation was awarded to AngloGold Ashanti's Savuka gold mine in Gauteng, while platinum producer Lonmin's 4B/1B shaft in the North West clinched the award for an underground operation at MineSAFE 2016.

The John T Ryan Trophy was presented by MSA Africa Executive Director Colin Oliver at MineSAFE 2016, the premier safety conference of the South African mining industry. MSA Africa has been involved with MineSAFE since 2011, testament to its ongoing commitment to continually improving safety records in all sectors of the South African mining industry.

An impartial panel of judges representing the Southern African Institute of Mining and Metallurgy (SAIMM), the Association of Mine Managers of South Africa (AMMSA), the South African Colliery Managers Association (SACMA) and the Metallurgical Mine Managers' Association (MMMA) determined the winners.

The John T Ryan Trophy is sculpted to represent a father safely home from work, with his arms around the shoulders of his son and daughter. "This symbolises that the mineworker is the most important commodity, and the embodiment of safety best practice in the mining industry," Oliver commented.

Established in 2009, MineSAFE advances the goal of achieving Zero Harm in the South African mining industry by bringing together mine management, the Department of Mineral Resources, the Chamber of Mines, trade unions and health and safety practitioners at all levels of industry to share best practice and strategies in this regard.

For more information contact Colin Oliver, MSA Africa Executive Director on tel: +27 11 610 2600; or email: Colin.Oliver@msasafety.com

CSIR transport infrastructure engineering expert wins JD Roberts Award

A transport infrastructure engineering expert at the Council for Scientific and Industrial Research (CSIR) was awarded the 2016 JD Roberts Award for his involvement in developing new, innovative solutions for bitumen specification and testing.

Georges Mturi, CSIR Senior Researcher and Manager of the bituminous binders' laboratory, has been selected as the recipient of the award, which is sponsored by Murray & Roberts and held in partnership with the CSIR.

Mturi leads a CSIR research project that investigates changing the current bitumen specifications from empirical-based, to more advanced performance-based methods. His expertise also includes bituminous products and technology, forensic investigations into bitumen-related road failures and the development of new additives that enhance the performance of bitumen, resulting in more durable road surfaces.

The award, which was instituted in 1980 in remembrance of Dr J D Roberts, one of Murray & Roberts' founders, encourages scientific research into technology that will enhance the quality of life of all South Africans.

Andrew Skudder, Sustainability Executive at Murray & Roberts and member of the adjudication panel, commented: "The finalists all presented work that was innovative and unique and determining a final winner was a challenging process."

The two runners-ups for the award are CSIR researchers, Drs Jeremy Gibberd and Paul Nordengen.

Gibberd's contribution to environmental sustainability, through the development of several innovative design tools that promote the design of energy- and cost-effective buildings, was also recognised. Gibberd is currently working on sustainable city projects with the United Nations Environmental Programme, the Global Environment Facility and the City of Johannesburg.

Nordengen was recognised for his work in the development of bridge, overload control and abnormal load management systems across Africa, as well as the implementation of performance-based specifications for heavy vehicles, which result in significant savings on transport costs and reduce road damage.

Paved road in Tanzania (by Leo D'lion - Tanzania Safari, CC BY-SA 2.0, https://commons.wikimedia.org/w/index.php?curid=15952608)

Dr Cornelius Ruiters, Executive Director of the CSIR, concluded, "The award is an opportunity to recognise the significant contribution made by researchers in providing competitive and environmentally sustainable solutions to infrastructure issues faced across the continent."

For more information contact: Tendani Tsedu, CSIR Media Relations Manager at 082 945 1980/+27 12 841 3417 or email: mtsedu@csir.co.za

National recognition for NCPC-SA skills development initiatives

The National Cleaner Production Centre South Africa (NCPC-SA) was announced as the winner of the 2016 Achiever Award Best Public Sector Training Programme at the recent Skills Summit in Pretoria. The award was made in recognition of the NCPC-SA's work in providing solutions to support industry's scarce and critical skills in support of the country's transition to a greener economy.

The NCPC-SA is a national programme of government that promotes the implementation of Resource Efficiency and Cleaner Production (RECP) methodologies to assist industry to lower costs through reduced energy, water and materials usage, and waste management. It is managed by the Council for Scientific and Industrial Research (CSIR) on behalf of the Department of Trade and Industry (the dti).

NCPC-SA Director, Ndivhuho Raphulu explains that the Centre established its skills development programme as part of the NCPC-SA's Industrial Energy Efficiency (IEE) Project, launched in South Africa by the United Nations Industrial Development Organization (UNIDO) in 2010, as part of the global drive towards greater energy efficiency. This was done in partnership with the Swiss Secretariat for Economic Affairs (SECO), the UK Department of International Development (UKAID/DFID), the Department of Trade and Industry (the dti) and the Department of Energy (DOE).

"As a key industrial sustainability programme of the dti, the NCPC-SA has enjoyed strong support from the Department in its efforts to introduce solutions to scarce and critical skills needs not provided for through existing qualifications," says Raphulu. A key objective of the NCPC-SA has been to ensure that its skills development initiatives have a direct and measurable impact in industry in the form of substantial financial savings, as well as a significant reduction in energy consumption, carbon emissions and waste generation.

Training offered by the NCPC-SA includes both end-user and expert-level courses in the areas of energy management systems (EnMS), RECP and energy systems optimisation (ESO). The NCPC-SA plays a leading role in the establishment of a Professional Body that will set qualification standards in the green industry that would be recognised by South African Qualifications Authority (SAQA) and will have powers and authority to assume responsibility for qualification development and quality assurance.

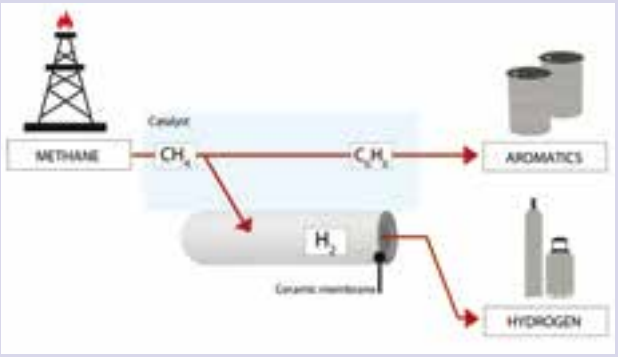
For more details contact: Julie Wells, NCPC-SA Communication and Marketing Manager Tel: 012 841 2424 Email: JWells@csir.co.za

Using natural gas as raw material for aromatic chemicals

CoorsTek Membrane Sciences, in Colorado, USA, recently announced that a team made up of some of its scientists, others from the University of Oslo (Norway), and also from the Instituto de Tecnología Química (Spain), has developed a new process to use natural gas as raw material for aromatic chemicals. The process uses a novel ceramic membrane to make the direct, non-oxidative conversion of gas to liquids possible for the first time, reducing cost, eliminating multiple process steps, and avoiding any carbon dioxide (CO_2) emissions. The resulting aromatic precursors are source chemicals for insulation materials, plastics, textiles, and jet fuel, among other valuable products.

"Consider the scale of the oil, gas, and petrochemicals industry today," said Dr Jose Serra, Professor with the Instituto de Tecnología Química. "With new ceramic membrane reactors to make fuels and chemicals from natural gas instead of crude oil, the whole hydrocarbon value chain can become significantly less expensive, cleaner, and leaner."

"By using a ceramic membrane that simultaneously removes hydrogen and injects oxygen, we have been able to make liquid hydrocarbons directly from methane in a one-step process. As a bonus, the process also generates a high-purity hydrogen stream as a byproduct," he explained.



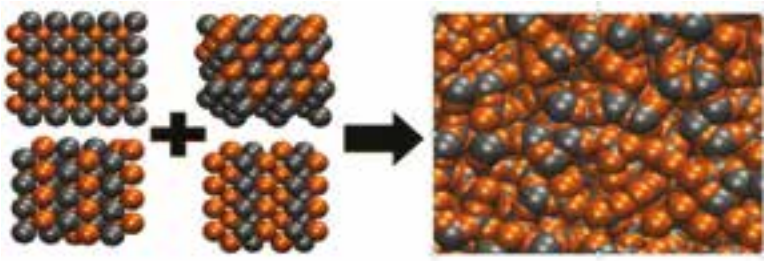
An advanced ceramic membrane converts methane (natural gas, CH_4) to aromatic chemicals and high-purity hydrogen. (Photo: CoorsTek Membrane Sciences)

"At a macro level it is really very simple – inexpensive, abundant gas in and valuable liquid out through a clean, inexpensive process. At a nanochemistry level, however, where molecules interact with catalyst and membrane at a temperature around 700° C, there were many factors to engineer and control in order to render just the specific valuable molecules needed to make the new process work."

The ceramic membranes are made from abundant materials like barium and zirconium found within large sand deposits, with the addition of thin electro-catalytic layers of plentiful metals like nickel and copper.

For more information contact Dane Bartlett at:
dbartlett@coorstek.com or
Raluca Doaga at rdoaga@keatingco.com

Crystallisation frustration predicts metallic glass formation



Researchers at Duke University at Durham, North Carolina in the USA, have discovered a way to predict which alloys will form metallic glasses. The research could pave the way for new strong, conductive materials.

Metallic glasses are sometimes formed when molten metal is cooled too fast for its atoms to arrange in a structured, crystalline order. The result is a material with numerous desirable properties. Because they are metals, metallic glasses have high hardness and toughness and good thermal conductivity. Because their structure is disorganised, they are easy to process and shape and difficult to corrode. Thanks to these characteristics, metallic glasses are used in a wide array of applications, including electrical applications, nuclear reactor engineering, medical industries, structural reinforcement and razor blades.

In a new study, researchers from Duke University, in collaboration with groups from Harvard University and Yale University, describe a method that can predict which binary alloys will form metallic glasses. Their technique involves computing and comparing the many pockets of different structures and energies that could be found within a solidified alloy.

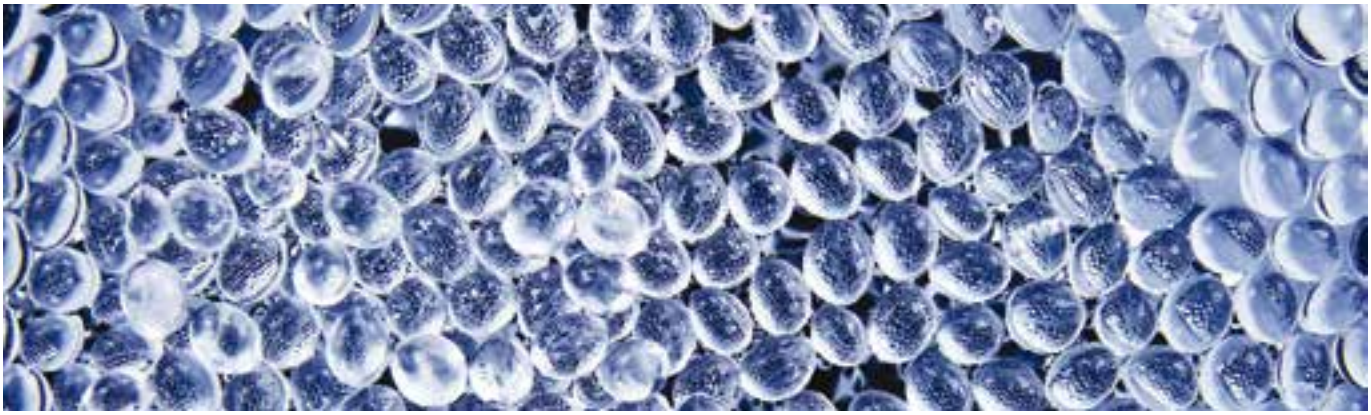
"When you get a lot of structures forming next to one another that are different but still have similar internal energies, you get a sort of frustration as the material tries to crystallise," said Eric Perim, a postdoctoral researcher at the Center for Materials Genomics at Duke. "The material can't decide which crystalline structure it wants to converge to, and a metallic glass emerges. What we created is basically a measure of that confusion."

To determine the likelihood of an alloy forming a glass, the researchers broke its chemistry down into numerous sections, each containing only a handful of atoms. They then turned to a prototype database to simulate the hundreds of structures each section could potentially take.

Called the AFLOW library, the database stores information on atomic structures that are commonly observed in nature. Using these examples, the program computes what a novel combination of elements would look like with these structures. For example, the atomic structure of sodium chloride may be used to build a potential structure for copper zirconium.

For more information contact : Ken Kingery at Ken.kingery@duke.edu
Image credit: *https://www.materialsgate.de/de/mnews/72846/Crystallization+frustration+predicts+metallic+glass+formation.html*

Significant cuts in chemical manufacturing energy use and emissions



Scientists from ExxonMobil (the largest publicly traded international oil and gas company) and the Georgia Institute of Technology in Atlanta (committed to improving the human condition through advanced science and technology) have developed a potentially revolutionary new technology that could significantly reduce the amount of energy and emissions associated with manufacturing plastics. Using a molecular-level filter, the new process employs a form of reverse osmosis to separate para-xylene, a chemical building block for polyester and plastics, from complex hydrocarbon mixtures. The current commercial-scale process used around the world relies on energy and heat to separate those molecules.

The research successfully demonstrated that para-xylene can be separated from like chemical compounds known as aromatics, by pressing them through a membrane that acts as a high-tech sieve, similar to a filter with microscopic holes.

The carbon-based membrane developed by the ExxonMobil-Georgia Tech team is about 50 times more energy efficient than the current state-of-the-art membrane separation technology. The technology still faces challenges before it can be considered for commercialisation and use at an industrial scale. The membranes used in the process will need to be tested under more challenging conditions, as industrial mixtures normally contain multiple organic compounds and may include materials that can foul membrane systems.

As global populations and living standards continue to rise, demand for products made from plastics and other petrochemicals will continue to grow. Improving industrial efficiency will help meet the world's growing need for energy, while minimising environmental impacts.

For more information, visit: www.exxonmobil.com or go to www.gatech.edu.

Source: http://www.businesswire.com/news/home/20160818005307/en/
Pic credit http://www.chemanager-online.com/sites/chemanager-online.com/files/images/special/38790167__original.jpg

Nano Towers – what would one look like and how would it work?

A Nano Tower's task is to capture and filter as much air as possible when the wind blows. The air can of course also be captured and filtered via balloons or other structures. The volume of air that blows against the Nano Tower is filtered through a braced nano sheet in order to make use of the methane and/or hydrogen contained in normal air.

At present there are wind turbines that are more than 200 m high. Tall masts based on a lattice construction are nothing new, but the Swedish company HyMeAir has calculated that it is possible to build a Nano Tower with a diameter of 300 m and a height of 470 m (or more) that is more durable, and therefore has a much longer useful life, than a wind turbine.

One possible way of building a Nano Tower could be to build, for example, 64 small individual latticed towers of the same type as modern cranes. Latticed structures do not weigh much, they require very little material and small foundations, and they are cheap and easy to build.

These 64 narrow towers could be positioned in a circle with a circumference of 942 m. The distance between the towers would then be just over ten metres. The 64 towers are joined together with lattice bars and secured by cables. This means that the towers support one another.

The external sheet, plastic or glass fibre sheet surface of the tower, to which an appropriate number of nano filters would be secured, would measure 470 m x circumference 942 m = 443 000 m^2.

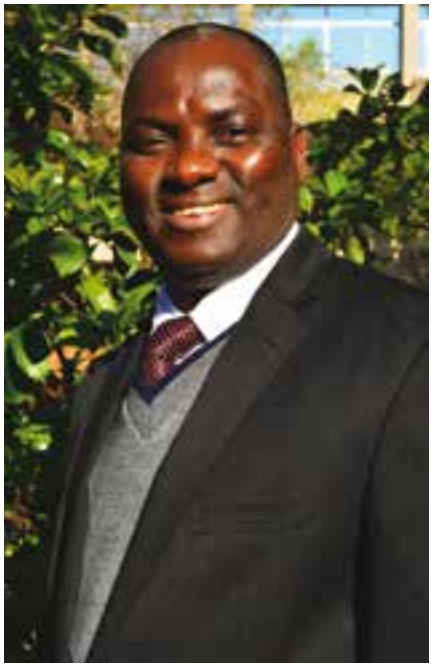
A Nano Tower is not subjected to forces from the generator and enormous rotor blades. Without these heavy moving parts, a Nano Tower should not cost any more than a wind turbine to build and operate. The useful life should also be twice as long.

In other words, the energy would be virtually free. Everything in our lives would become much cheaper. The cost of filling a large car in an environment-friendly way might fall from the current level of $60 dollars to just a couple of dollars.

If you are interested in eradicating extreme poverty in the near future, **contact**: Claes Persson of HyMeAir AB, at nomorepoor@claespersson.org

Interview with Prof Sunny Iyuke

by Michelle Low



This month we speak to Sunny Iyuke (CEng, MIChemE), a professor of Chemical Engineering at the School of Chemical & Metallurgical Engineering, University of the Witwatersrand, Johannesburg. He was recently appointed by the Minister of State for Petroleum Resources, as the Principal/ Chief Executive Officer of the Petroleum Training Institute (PTI), Effurun, Delta State, Nigeria.

ML: Tell me about where you obtained your degrees?
SI: I did my high school qualification, undergraduate (BSc) and masters (Chemical Engineering) qualifications in Nigeria. During my university career I was exposed to topics in medicine, chemistry and chemical engineering. Upon graduating I went to work in industry. When I was general manager for Sea Petroleum & Gas Company. I felt that I could do more than just routine work, and therefore decided to pursue my PhD at the National University of Malaysia.

ML: How did your research interests evolve from nanotechnology to petroleum?
SI: At my time in Malaysia, I was teaching topics in nanotechnology and fuel cell technology, and particularly carbon nanotubes, which is graphite too. Furthermore, Giem had won the Nobel prize for his work in graphene, which highlighted its application to research. That material can be used for nanotubes which can be used for various applications, ie, from drug delivery, water treatment, drilling fluids, to fuel cells which can be an alternative to fossil fuels. Seeing that nano-graphite has various research applications helped to progress my research. As for the biomedical interests, that was from my undergraduate degree, as we had exposure to dissection work, and my petroleum interests which were from my work experience.

ML: What inspired you to study and stay in chemical engineering, particularly academia?
SI: I remained in academia as it is not about routine work. Research is exciting in a sense that one can make new discoveries and add value to problems. Furthermore, I get to train students to be engineers by imparting my knowledge and interests to them. Part of the job satisfaction is that it is pleasing to see the students that I train grow into successful chemical engineers or academics.

ML: What will your new job entail?
SI: The Petroleum Training Institute (PTI) is a Parastatal of the Nigerian Ministry. As CEO, it will be in the academia environment, where I will be responsible for skills developments in the oil and gas sector for the Nigeria Petroleum industry. That includes having to train technicians to overseeing degrees. Thus training students in Nigeria for Nigerians and the global work force.

ML: Any advice for students and colleagues?
SI: We have good students, and we need to push them to be great. My advice to the students that I have taught over the years is to not be in a hurry. Take responsibility for when you work alone and when you work in a group. Remember when there is time to play, play, as that allows one to cross-pollinate ideas and therefore advance them. To my colleagues in chemical engineering, be focused in your research area, you cannot research everything. However, produce and solve problems, but do them in such a way that they are applicable. Enjoy research so that it can be seen and heard by the world. You learn a lot from people, so have an open mind when you meet them, young or old. Continue to help people (such as reviewing papers) and keep your networks from conferences. Remember, the things you do speak for you.

Connect with Professor Sunny Iyuke:
Email: sunny.iyuke@pti.edu.ng
Alternative email: sunny.iyuke@wits.ac.za

Western Cape capers at Cape Town's Faure water treatment plant

Several SAIChE-IChemE members showed up and toured the 500 Mega Litres per day City of Cape Town's Faure potable water treatment plant, one of its kind in the Southern Hemisphere.

There was a lot of enthusiasm expressed by the delegates during the tour and this led to a lively question and answer session. The event, which took place on 4 August 2016, provided an opportunity for exchanging notes and networking for Chemical Engineers.

Ronald Gunda, the Industrial Liaison for SAIChE-IChemE Western Cape member group, thanked Roland Moollan of City of Cape Town for assisting him in facilitating the event. The Western Cape member group looks forward to more similar events as delegates expressed interest in more such tours as they give wider exposure of the Process Engineering discipline.

Written by Ronald Gunda on behalf of the WC membership group.

Celebrating excellence, innovation and achievement

The IChemE Awards celebrate excellence, innovation and achievement in the chemical, biochemical and process industries.

The finalists for the IChemE global awards 2016 were announced in August.

The winners will be announced on 3 November 2016. Go to the following website for more information: http://www.icheme.org/awards

Congratulations to all of the finalists, especially the ones from South Africa; we wish you all the best for the finals:

- Award for Outstanding Chemical Engineering Innovation for Resource-poor People 2016 — *Converting food waste to valuable product,* **TerraServ (Pty) Ltd, South Africa**
- Sustainable Technology Award 2016 — *Eternity Power Thermal Harvesting™,* **Vuselela Energy (Pty) Ltd, H1 Holdings Group, South Africa**
- Young Chemical Engineer in Research Award 2016
- **Michelle Low**, *University of the Witwatersrand, Johannesburg, South Africa*

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Courses: Process Design Practices

by Cilliers Kruger

- **Date:** 7 to 11 November 2016
- **Venue:** Kopanong Hotel and Conference Centre in Benoni, Gauteng

SAIChE accredited for 5 CPD credits and now also accredited as an IChemE Approved Course with 30 hours CPD.

- **Course brochure and registration form:** RESOLVE website:

http://www.resolvekzn.co.za/index.php?option=com_content&view=article&id=49&Itemid=83

Safripol supports polymer research at the University of Pretoria

Safripol donated a Dr Collin laboratory cast film line and a Dr Collin laboratory blown film line to the Institute of Applied Materials in the Department of Chemical Engineering of Faculty of Engineering, Built Environment and Information Technology. Safripol is a major South African manufacturer of polymers and supplies polypropylene and high-density polyethylene to the converting industry for the manufacture of a wide range of packaging and industrial end products.

Prof Walter Focke, Head of the Institute of Applied Materials and well known for his applied research in the fight against malaria, is proud to partner with Safripol. These machines will be used for research projects on polymers and nanotechnology, and to train students in polymer conversion technology. Dr Collin is a renowned manufacturer of laboratory polymer processing equipment. These 'state-of-the-art' machines will enable students to transform the research they have done on paper into practical innovations. The Department is therefore very grateful for this valuable addition to their polymer processing and converting laboratory.

Prof Focke has expressed his sincere appreciation for Safripol's support of polymer-based training and research at the University of Pretoria. He said: 'In these times of economic difficulty, it is very tough to secure the funding necessary to procure such large-capital equipment. This donation provides technology that will improve the pace and accuracy of current research efforts at the Institute of Applied Materials.'

Prof Walter Focke, Head of the Institute of Applied Materials at UP.

The Dean of the Faculty, Prof Sunil Maharaj, indicated that it is a great milestone in the 60 years of engineering education at UP. He said that such a generous investment, partnership and support from Safripol will make a distinct contribution to the Faculty's goals of enhancing its internationally competitive research, teaching and learning while contributing to the economic impact that industry has in these challenging times.

SUDOKU NO 119

Complete the grid so that every row across, every column down and every 3x3 box is filled with the numbers 1 to 9. That's all there is to it! No mathematics are involved. The grid has numbers, but nothing has to add up to anything else. You solve the puzzle with reasoning and logic. For an introduction to Sudoku see http://en.wikipedia.org/wiki/Sudoku

			9			5	2	1
					8			
7		6			5			
6				4	7			
3		8	1					
	4					8		2
8	9	2						5
							8	3
							6	

Solution for SUDOKU 118

7	2	5	6	8	9	4	3	1
9	8	3	7	1	4	5	6	2
1	4	6	5	3	2	7	9	8
5	6	9	1	7	8	2	4	3
4	3	2	9	5	6	1	8	7
8	7	1	4	2	3	9	5	6
3	5	8	2	9	7	6	1	4
2	9	4	8	6	1	3	7	5
6	1	7	3	4	5	8	2	9

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