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CONTENTS

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WORDS from the EDITOR

Green roofs and walls are becoming increasingly popular in Australasia. It makes sense to me as they can look spectacular while improving the environment — if they are designed, built and maintained correctly. However, if this doesn't happen, they can become an eyesore resulting in an outcome that is the opposite of what was intended.

In late 2022, the Australasian Green Infrastructure Network (AGIN) was established to help facilitate the scalable adoption of green infrastructure such as green roofs, walls and facades in Australia and New Zealand. In this issue, we talk to one of the co-founders about how the organisation is working to help prevent those eyesores, which can result from poorly designed, installed or maintained green wall structures.

We also discover how plants are providing inspiration on a different level — to scientists trying to recover millions of tonnes of valuable resources from wastewater across the globe. The new techniques to harvest, recycle and reuse valuable minerals, metals and nutrients from resource-rich wastewater have been developed by adapting plant 'membrane separation mechanisms' for use in wastewater plants. The technology could benefit a range of industries such as agriculture, aquaculture, desalination, battery recycling and mining.

There are many more technologies being developed to solve sustainability issues. From water filtration and cleaning up to resource recovery and fuel cell efficiency, this issue has it covered.

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Green paradise for Australasia

*Ben Nicholson, Co-Founder, Australasian Green Infrastructure Network**

In her song 'Big Yellow Taxi', Joni Mitchell laments the destruction of paradise to make way for a parking lot. Over the 50-plus years since the penning of her song, paradise's footprint has shrunk ever further as our cities grow bigger and urban populations increase. On the upside, many cities, including some in Australasia, are bringing paradise back by clothing the exterior (and interior) of buildings in greenery.

Junglefy Roof at Roche, Sydney, NSW. Image credit: Junglefy, ©Remy Brand.

As the uptake of green roofs and walls increases, so does the demand for excellence in their design, installation and maintenance. We have all lamented the demise of a favoured pot plant and wondered what went wrong. When greenery covering an entire building is poorly designed, installed or maintained it will eventually fail, become an eyesore and get pulled down — an outcome that is the opposite of sustainable urban design.

For the most part, the challenges and benefits of transforming cities into greener places are now well understood. An increasing number of buildings in Australia and Aoteroa New Zealand are being clothed with plants. However, the synergy of people and ideas across government, research and the 'green infrastructure' sector in Australasia is still limited.

Australian author, journalist and broadcaster Tracey Spicer AM has observed that "sometimes challenges seem enormous, but if you can connect with others working towards the same goal, it becomes more achievable".

To this end, my colleague Gail Hall and I co-founded a Community of Practice in 2021 to build a network of people across government, academia and industry with a common interest in green infrastructure. In late 2022, we incorporated the Australasian Green Infrastructure Network (AGIN) and along with a core group of volunteers, we have launched a webpage and are preparing for our inaugural annual general meeting.

In addition to growing AGIN over the next 12 months, our volunteers will support the creation of an online knowledge hub. We will make representations to government on the need for better policy supporting the uptake of well-maintained green infrastructure and we will organise an online seminar with international presenters in the second half of 2023.

There are a range of climate-resilient solutions that work hand in hand with green infrastructure. In the Feb–March 2022 edition of *Sustainability Matters*, the article 'Cool roofs' noted the increasing rate of heat-related deaths across more than 500 cities globally due to the 'urban heat island' effect. In the article, Professor Mattheos (Mat) Santamouris, of the University of New South Wales, cited a study of 'super cool' roofing materials that reduced the surface temperature of a trial roof to just 25°C on a day where the ambient temperature was 42°C.

Junglefy Breathing Walls at Manly Vale Car Park, Manly Vale, NSW. Image credit: Junglefy, ©Remy Brand.

In some circumstances, a building structure is not capable of supporting a green roof or wall and in those circumstances, super cool roofs provide excellent opportunities to reduce the urban heat island effect. For buildings that can support green roofs and walls, a suite of benefits can be provided in addition to cooling our cities.

Green roofs can also absorb stormwater when it rains, and green roofs and walls provide habitat 'stepping stones' for migratory birds as well as for local birds and insects. When green roofs are combined with solar panels, the 'bio-solar' combination improves energy-generating efficiency by 3% on average, and the solar panels provide shade for plants. Green roofs have been shown to improve health and wellbeing of people by filtering air and providing pleasant views.

The cities of tomorrow can look and feel like paradise — we just have to connect with each other in better ways to make it happen.

**Ben Nicholson, together with Gail Hall, is co-founder of the Australasian Green Infrastructure Network (AGIN) — a new peak body formed to bring government, industry and researchers together to facilitate the scalable adoption of green infrastructure such as green roofs, walls and facades in Australia and New Zealand.*

Australasian Green Infrastructure Network
www.agin.org.au

Inspiration from plants

Sorting out the jumble of valuable resources in wastewater

It's estimated global wastewater contains three million metric tonnes of phosphorus, 16.6 million metric tonnes of nitrogen and 6.3 million metric tonnes of potassium. The recovery of these nutrients from wastewater could offset 13.4% of global agricultural demand for these resources.

Scientists from The Australian National University (ANU) are drawing inspiration from plants to develop new techniques to separate and extract valuable minerals, metals and nutrients from resource-rich wastewater.

The ANU researchers are adapting plant 'membrane separation mechanisms' so they can be embedded in new wastewater recycling technologies. This approach can provide a way to harvest, recycle and reuse valuable metal, mineral and nutrient resources from liquid wastes.

The technology could benefit a range of industries such as agriculture, aquaculture, desalination, battery recycling and mining. It could also help companies rethink their approach to how they deal with waste by creating a way to extract value from wastewater. The research also has implications for flood- and drought-prone areas across Australia.

The ammonia and hydrogen molecules, among others, that are embedded in wastewater could provide electricity to power around 158 million households.

"The world's wastewater contains a jumbled mess of resources that are incredibly valuable, but only in their pure form. A big challenge researchers face is figuring out how to efficiently extract these valuable minerals, metals and nutrients while

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"The world's wastewater contains a jumbled mess of resources that are incredibly valuable, but only in their pure form. A big challenge researchers face is figuring out how to efficiently extract these valuable minerals, metals and nutrients while retaining their purity.


Image credit: Nic Vevers/ANU

retaining their purity," ANU plant scientist Associate Professor Caitlin Byrt said.

"The Australian mining industry for example creates more than 500 million tonnes of waste per year, and these wastes are rich in resources like copper, lithium and iron. But at the moment the liquid waste is just a problem; it can't be dumped and it can't be used. It's just waste unless each resource can be separated out in a pure form.

"This is particularly the case in the battery recycling space; you have this huge, rich source of lithium inside dead batteries, but we can't yet extract or reuse it efficiently. Harvesting resources from industrial and urban waste is a key step towards transitioning to a circular green economy and building a sustainable future, as well as reducing our carbon footprint."

The researchers investigated the specialised molecular mechanisms that help plants recognise and separate different metal, mineral and nutrient molecules contained in soil, allowing them to sort the good from the bad — an essential biological process necessary for their growth and development.

"Resources such as boron, iron, lithium and phosphorus are used in battery technologies and plants are masters at separating these types of resources," Byrt said.

Ammonia, a compound used to create fertiliser and an essential material in crop production, is another key resource scientists are looking to extract from liquid waste solutions.

"Fertiliser costs are going through the roof, which puts a lot of pressure on Australian farmers to be able to afford these higher prices and yet we're wasting huge proportions of these molecules and that's causing environmental problems," Byrt said.

"Ammonia is also a critical storage molecule for hydrogen fuels. So, as we continue to develop hydrogen fuel industries, there will be an increase in demand for ammonia for use as a storage molecule, because that's how the hydrogen fuel industry will be able to transport the stored hydrogen around and ultimately use it as a potential fuel source for fuelling cars and other technologies."

Byrt said advances in precision separation technology could also offer security to flood- and drought-prone communities across Australia by providing them with portable, secure and reliable access to clean drinking water in the face of worsening weather events as a result of climate change.

"Clean water and the security of nutrient resources underpin agricultural productivity. Development of technologies to sustainably manage these resources is essential for food security in Australia and globally," she said.

The research has been published in *New Phytologist*.

Using AI to improve water filtration

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Researchers in the journal *ACS Central Science* have reported that artificial intelligence (AI) could speed up the development of promising materials that can be used to improve water filter systems. In a proof-of-concept study, the researchers simulated different patterns of water-attracting and water-repelling groups lining a filter's porous membrane and found arrangements that could let water through and slow down contaminants.

Filter systems, ranging from faucets to industrial systems, clean up water for drinking and other uses. Current filtration membranes struggle with water that is extremely dirty or has small, neutral molecules such as boric acid. Synthetic porous materials are generally limited to sorting compounds by either size or charge whereas biological membranes have pores made of proteins, such as aquaporin, that can separate water from other molecules by both size and charge. This is because of the different types of functional groups, or collections of atoms, lining the channels.

In the study, M. Scott Shell and colleagues wanted to use computers to design the inside of a carbon nanotube pore that can filter water containing boric acid.

The researchers simulated a carbon nanotube channel with hydroxyl (water-attracting) and/or methyl (water-repelling) groups tethered to the atoms on the inner wall. They designed and tested thousands of functional group patterns with algorithms and machine learning, a type of AI, to assess the speed of water and boric acid moving through the pore. They found that:

- The optimal patterns had one or two rows of hydroxyl groups sandwiched between methyl groups, forming rings around the midsection of the pore.
- In these simulations, water went through the pore nearly twice as fast as boric acid.
- Another series of simulations showed that the optimised carbon nanotube designs could also separate other neutral solutes, including phenol, benzene and isopropanol from water.

According to the researchers, the study demonstrates AI's usefulness toward developing water purification membranes with novel properties and could form the basis of a new type of filter system. The approach could also be adapted to design surfaces that have unique interactions with water or other molecules, such as coatings that resist fouling.

The study was supported with funding from the US Department of Energy (via the Centre for Materials for Water and Energy Systems (M-WET), an Energy Frontier Research Centre) as well as additional support from the US National Science Foundation, the California NanoSystems Institute, the Materials Research Science and Engineering Centre (MRSEC) and a National Science Foundation Graduate Research Fellowship.

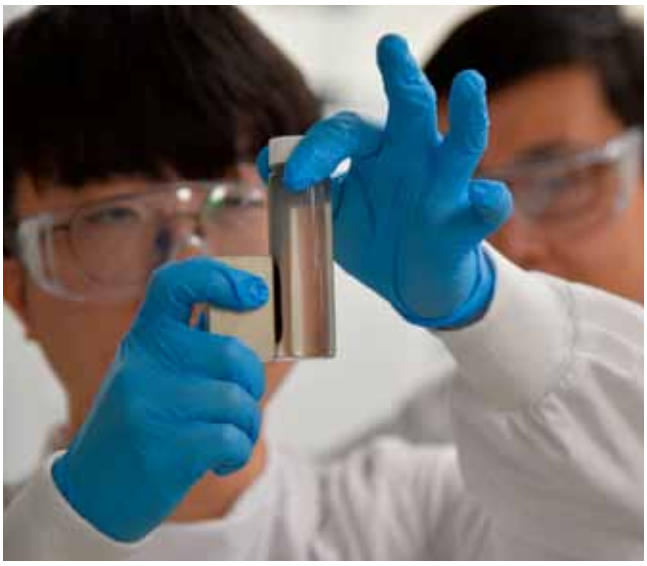
Magnetic method for cleaning water

Researchers from the Australian Institute for Bioengineering and Nanotechnology (AIBN), based at The University of Queensland, say they have pioneered a simple, fast and effective technique to remove per- and polyfluoroalkyl substances (PFAS) chemicals from water.

PFAS are synthetic compounds used in industry and consumer products since the 1950s, but they persist in the environment, potentially leading to human health problems. As noted by AIBN polymer chemist Dr Cheng Zhang, "Removing PFAS chemicals from contaminated waters is urgently needed to safeguard public and environmental health — but existing methods require machinery like pumps, take a lot of time and need their own power source."

Zhang and PhD candidate Xiao Tan teamed up to develop their own PFAS removal technique that involves treating contaminated water with a new solution, called a magnetic fluorinated polymer sorbent. As explained by Zhang, "This solution that we developed coats the PFAS particles and then we can use a magnet to attract, isolate and remove them."

Zhang and Tan used their method to clear 95% of PFAS from a small amount of contaminated water in under a minute, with their results published in the journal *Angewandte Chemie*. Zhang said the technique is faster, cheaper and cleaner than existing methods, as it does not require electricity — making it suitable for remote and off-grid communities — and can be reused up to 10 times.



PhD candidate Xiao Tan holds a magnet attracting PFAS particles to the side of a vial of contaminated water, supervised by Dr Cheng Zhang.

"Our team will now scale up the testing and we hope to have a commercially available product ready in the next three years," he said.

Moving a step closer to recyclable phone batteries

Engineers at RMIT University have developed an innovation that could see mobile phone batteries with a lifetime up to three times longer than today's technology.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By using high-frequency sound waves to remove rust that inhibits battery performance, batteries could be recyclable and last up to nine years instead of the typical two or three years.

In Australia, only 10% of used handheld batteries, including for mobile phones, are collected for recycling. The remaining 90% of batteries go to landfill or are disposed of incorrectly, which can cause damage to the environment.

A major barrier to these items being reused is the high cost of recycling lithium, but that challenge could be addressed by the team's research. They are working with a nanomaterial called MXene, a class of materials that may be used as an alternative to lithium for batteries in the future.

Leslie Yeo, Professor of Chemical Engineering and lead senior researcher, said MXene was similar to graphene with high electrical conductivity.

"Unlike graphene, MXenes are highly tailorable and open up a whole range of possible technological applications in the future," Yeo said.

A challenge with using MXene was that it rusted easily, inhibiting electrical conductivity and rendering it unusable. The researchers overcame this by using sound waves at a certain frequency to remove rust and restore it to close to its original state.

"The ability to prolong the shelf life of MXene is critical to ensuring its potential to be used for commercially viable electronic parts," Yeo said.

Hossein Alijani and Dr Amgad Rezk with the new rust-busting device. Image credit: RMIT University

How the innovation works

Co-lead author Hossein Alijani, a PhD candidate, said the rust that forms on the surface on MXene in a humid environment or when suspended in watery solutions was its greatest challenge.

"Surface oxide, which is rust, is difficult to remove especially on this material, which is much, much thinner than a human hair," Alijani said.

He said current methods used to reduce oxidisation rely on chemical coating of the material, which limits its use.

"In this work, we show that exposing an oxidised MXene film to high-frequency vibrations for just a minute removes the rust on the film. This simple procedure allows its electrical and electrochemical performance to be recovered," he said.

Potential applications

The team's method of removing rust from MXene opens the door for the nanomaterial to be used in applications in energy storage, sensors, wireless transmission and environmental remediation.

Associate Professor Amgad Rezk, one of the lead senior researchers, said, "Materials used in electronics, including batteries, generally suffer deterioration after two or three years of use due to rust forming. With our method, we can potentially extend the lifetime of battery components by up to three times."

Next steps

While the innovation is promising, the team needs to work with industry to integrate its acoustics device into existing manufacturing systems and processes.

The team is also exploring the use of their invention to remove oxide layers from other materials for applications in sensing and renewable energy.

"We are keen to collaborate with industry partners so that our method of rust removal can be scaled up," Yeo said.

The research paper 'Recovery of Oxidized Two-Dimensional Titanium Carbide Ti3C2Tz MXene Films Through High Frequency Nanoscale Electromechanical Vibration' was published in *Nature Communications*.

RMIT University

www.rmit.edu.au

NON-CONTACTING RADAR TRANSMITTERS

Emerson has introduced the Rosemount 1208 Level and Flow Transmitter Series non-contacting radar transmitters. The product is an alternative to ultrasonic and hydrostatic devices for water monitoring applications, featuring 80 GHz fast-sweep frequency modulated continuous wave (FMCW) technology on a single electronic chip, which delivers measurements within a compact device suitable for applications with space constraints or compliance requirements, such as water applications.

The measurement accuracy of the line is unaffected by most process conditions, including condensation and variations in pressure, temperature and density. The transmitter collects information with fast-sweep FMCW technology and advanced algorithms. This provides level measurement accuracy of 2 mm at a range of 15 m, helping organisations optimise processes and comply with environmental requirements. In addition, the non-contacting design has no moving parts or calibration requirements, creating a virtually maintenance-free device that minimises manual procedures and delivers long-term performance.

The transmitter is available in two models, offering different communication protocols and approvals. It is designed specifically for water and process industry utility applications and offers IO-Link connectivity as part of its hybrid communication options that also include three-wire 4–20 mA and switch outputs. IO-Link connectivity reduces installation complexity, enables simple integration into high-level automation networks and provides access to process insights that can enhance operational performance. It further reduces complexity by enabling remote configuration and monitoring.

The product offers two-wire 4–20 mA and HART communication options, providing access to advanced diagnostics. This supports predictive maintenance and more effective troubleshooting, leading to reduced downtime and improved operational efficiency. Hazardous area approval enables use in areas where an explosive gas atmosphere could occur during normal operation.

Emerson
www.emerson.com

MACHINE VISION CAMERA

The pco.pixelfly 1.3 SWIR from PCO.Tech is a machine vision camera with an InGaAs image sensor that is IMX990-sensitive in the shortwave infrared, near infrared and visible range of the electromagnetic spectrum.

The camera is suitable for use in a variety of applications, including waste sorting, smart farming and food processing quality control, pharmaceutical and other product packaging industries.

The camera shows a good high sensitivity in the whole spectral range, with up to 90% in the shortwave infrared part. The small pixels enable the use of small magnification optics in microscopy and a low dark current for even longer exposure times. As a result, it shows high sensitivity across the entire spectral range with more than 90% in shortwave infrared.

Features include VIS & SWIR sensitivity, 400 to 1700 nm, 1280 x 1024 resolution, long exposure times due to low dark current and peak QE of 90%. The camera's small 5 x 5 μm pixels enable the use of small magnification optics in microscopy. It measures 7 x 7 x 11.5 cm and uses a USB 3.1 Gen 1 interface.

SciTech Pty Ltd
www.scitech.com.au

LEAK DETECTING NOISE LOGGER

WaterGroup has launched the SmartEAR, a SebaKMT IoT noise logger built to detect leaks in water networks.

Thanks to the advances in modern IoT technologies, the product is designed to make it much easier to monitor critical or troublesome water mains. Instead of requiring two or even three devices to detect a leak, record it and send it to the cloud, this product is designed to do it all in one.

The device allows recording up to 10s noise files at configurable times and intervals, using a revised cloud-based monitoring platform: Poseyedon.

With a battery life of up to nine years, it can be accommodated in below-ground hydrant compartments, valve boxes and other tight spaces.

The SmartEAR-GO! app displays data and lets utilities install and manage the devices with a guided installation routine.

Another feature is the antenna test. Open and close the lid, and it will measure the current signal strength and quality in 1 s intervals. If required, the signal can be boosted by various external antenna solutions.

The device comes pre-programmed to enable quick leak detection. Thanks to the built-in NB-IoT/CAT-M1 combi module and its magnetic attachment, it is a simple plug-and-play installation.

Once in operation, the device can determine the probability of leakage in the water network each day.

WaterGroup Pty Ltd
www.watergroup.com.au

TO STANDARDS FOR VOC MONITORING

Volatile organic compounds (VOCs) are common groundwater contaminants that can include a variety of chemicals and may be emitted as gases from certain solids or liquids.

TO 14, 15, 17 standards for VOC monitoring and soil sampling are available from CAC GAS in all configurations 39, 41, 62 or subset component mixtures. Gas mixtures for all VOCs, including BTEX mixtures, Isobutylene and other organic vapours, are available.

The gas mixtures are available in a variety of cylinder sizes including: 14DS (14L steel), 48AL (48L aluminium), 58DAL (58L aluminium), 74DAL (74L aluminium), and 98RAL (110L aluminium).

CAC Gas & Instrumentation
www.cacgas.com.au

PROTECTIVE PACKAGING SOLUTION

ExpandOS is a protective void fill that is fully certified biodegradable, compostable and also holds SFI certification in the US. It has been used in the packaging industry for over 15 years in the US and Europe, and now has a growing presence in Australia and NZ. ExpandOS can be branded by product owners to help with environmental marketing.

The 40 x 40 x 36 mm triangular structure is made from 400 GSM recycled kraft board with notches on the edges to facilitate interlocking with each other. The result is a rigid mass that is designed to stop product movement in the carton. If a carton is accidentally dropped by freight couriers, the packaging solution can help to absorb the energy from the fall, protecting the product and reducing breakage significantly. For example, it has been used to reduce breakage of flat screen TVs by placing another box around the TV and filling the void with ExpandOS.

Designed to not only reduce breakage in transit but also reduce carbon footprint, the packaging solution is suitable for products such as ceramics, crystal and glass, electronics, commercial parts and equipment, general manufacturing and even in aerospace markets.

The Ribbon Supply Co.
www.ribbonsupply.com.au

POWER-TO-GAS —
ADMIXTURE OF HYDROGEN FROM RENEWABLE ENERGIES INTO THE NATURAL GAS GRID AND THE ASSOCIATED SUITABILITY OF SICK ULTRASONIC GAS METERS

Daniel Heinig, Strategic Product Manager, SICK Engineering GmbH in Ottendorf-Okrilla/Germany

Introduction

In addition to the requirements for a secure, reliable and affordable power supply, the idea of sustainability within the context of the energy revolution is coming into focus. Renewable energy sources such as wind, water or solar have an important role to play in this energy mix. Since the electricity generated from these upcoming but highly fluctuating energy sources cannot be transported or consumed in a way that allows for grid compensation, it must be stored. One possibility is to store the energy as gas in the existing natural gas network. For years, there have been developments towards converting electrical energy into storable gases such as hydrogen (H_2) or synthetic natural gas. The process of converting electricity into gas by electrolysis is known as power-to-gas (also PtG or P2G). The hydrogen produced can be fed into the existing natural gas network, stored there, transported and consumed as required. In numerous countries of the European Union, research projects have been running since about 2010 looking at the question of how much hydrogen the existing natural gas network is able to absorb without the gas consumption points being negatively affected. In industry, very different limit values for the admixture of H_2 with natural gas are currently mentioned. Values typically range from 5 to 25% by volume. However, what seems clear is that the proportion will increase steadily over the coming years. How quickly this happens will certainly depend on the speed of investment and the progress made with developing power-to-gas technologies. The question of what effects the admixture of hydrogen into natural gas has on the infrastructure installed today is of increasing concern to the industry.

Technical Guideline G19 (TR G 19)

In December 2014, the Physikalisch Technische Bundesanstalt (PTB) issued the Technical Guideline TR G 191, which regulates “feeding hydrogen into the natural gas network” for “measuring instruments for gas.” The Guideline declares the use of gas measurement devices “of any technologies” shall be safe, provided that the hydrogen content of the natural gas is less than 5% by volume. The use of meters is permitted for a proportion between 5 and 10% by volume of hydrogen, provided the manufacturer explicitly permits this. For the use of meters with natural gas containing > 10% hydrogen by volume,

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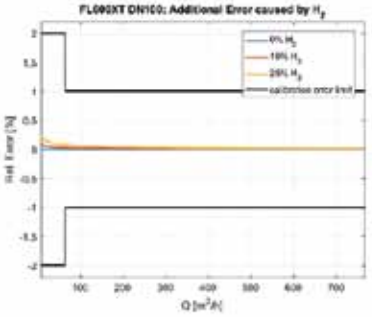

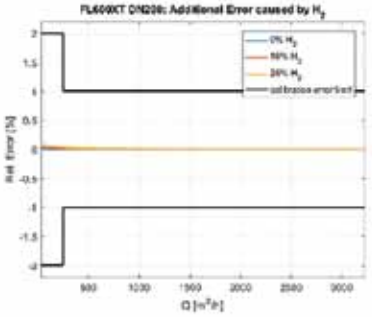

Fig.1 (left): Influence of the H_2 content on the measurement error of a DN100 FLOWSIC600-XT after application of the linearisation correction, on the basis of pure natural gas data.
Fig 2 (right): Influence of the H2 content on the measurement error of a DN200 FLOWSIC600-XT after application of the linearisation correction, on the basis of pure natural gas data.

a manufacturer's declaration as well as a PTB declaration of clearance must be submitted in addition to the manufacturer's declaration. The FLOWSIC600 and FLOWSIC600-XT gas meters installed today can be used in applications with up to 10% hydrogen by volume in natural gas; this is possible within the calibration error limits and without the need for a new metrological test. SICK has published a corresponding manufacturer's declaration in accordance with TR G 19.2.

Effect of the admixture of hydrogen on measuring capability

The addition of hydrogen has an effect on the characteristic curve behavior and thus on the measuring uncertainty of the devices. A measuring capability does not amount to the same thing as an unchanged measurement accuracy. The latest test results of an ultrasonic gas meter calibrated with natural gas show the relative error (measurement deviation) on the measurement result (Fig. 1 and Fig. 2) caused by a hydrogen admixture of 10% and 25% by volume, respectively.

The relative error is about 0.1% with a proportion of 10% hydrogen by volume in the natural gas in the lower flow rate range (Qmin). This error lies far within the transport error limits for natural gas measurements subject to calibration. Similar data was published in a technical report by gwf-Gas in May 2013. A FLOWSIC600 DN80 was used for the investigations. The report concludes, "Up to 10% H2 content by volume, no influence on the ultrasonic gas meter can be detected if the hydrogen is well mixed with the natural gas". SICK ultrasonic gas meters are able to measure natural gas containing hydrogen. A recalibration is not necessary if up to 10% by volume of hydrogen is fed in.

Effect of the admixture of hydrogen on material compatibility

The Federal Institute for Materials Research and Testing (BAM), in its report entitled *Resilience assessments of metallic container materials and polymeric sealing/coating and lining materials* of January 2015, examined the material resilience of certain materials for use with natural gas containing hydrogen. This shows that the gas flow meters made of the usual material alloys (steels) and all other parts in contact with the medium, such as ultrasonic probes and sealing rings, are resistant to natural gas containing hydrogen.

Effect of the admixture of hydrogen on explosion protection

Hydrogen has a different specific ignition capability from that of natural gas. Taking account of purely hydrogen flow rate measurements, the applicable explosion group under explosion protection regulations is IIC. This defines higher requirements for the equipment with regard to ignition gap dimensions and energy inputs than for natural gas. Explosion group IIA is sufficient for a natural gas measurement. In September 2016, the Federal Institute for Materials Research and Testing (BAM) published its report which shows that the explosion pressure changes only slightly up to an H2 proportion of 25% by volume. Likewise, a 10% by volume admixture of hydrogen has no significant influence on the standard gap width for the gas group IIA (Fig. 3). The results lead to the conclusion that a 25% admixture of hydrogen by volume, in all likelihood, does not inadmissibly reduce the standard gap width for the gas group IIA.

Conclusion

Gas flow meters of the SICK FLOWSIC600 and FLOWSIC600-XT families, due to their ultrasonic technology, are suitable today for measuring natural gases containing proportions of hydrogen up to 10% by volume within the scope transport according to the laws of calibration. The reliability and quality of the measurement results are not affected by changes in density, flow velocity or speed of sound.

SICK
Sensor Intelligence.

SICK Pty Ltd
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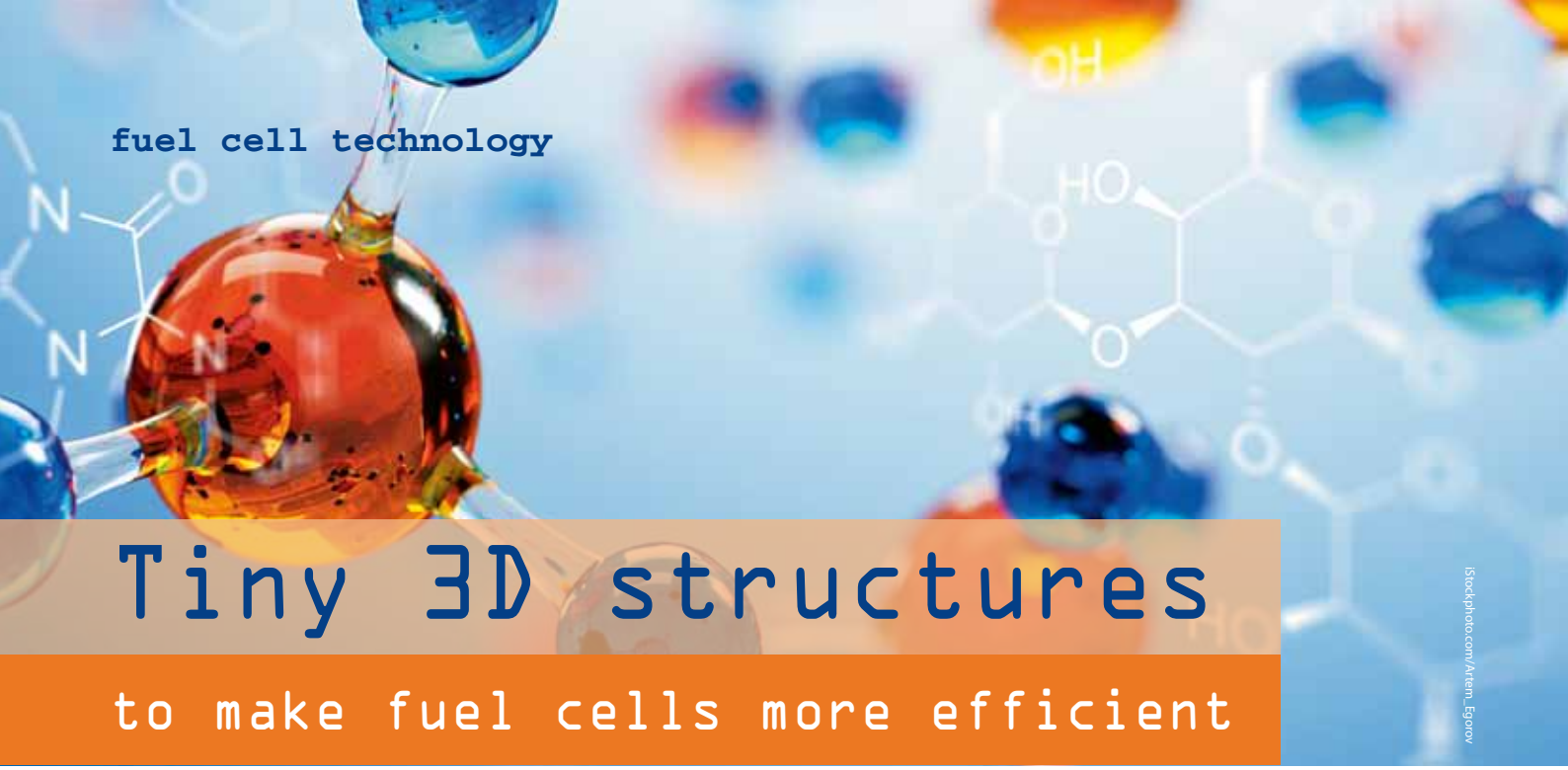

Tiny 3D structures

to make fuel cells more efficient

In a study published in *Science Advances*, researchers from the School of Chemistry at the University of New South Wales (UNSW) demonstrated a novel technique for creating 3D materials that could eventually make hydrogen batteries and other fuel cells more sustainable.

The study showed it is possible to sequentially 'grow' interconnected hierarchical structures in 3D at the nanoscale, creating unique chemical and physical properties to support energy conversion reactions.

Hierarchical structures are configurations of units like molecules within an organisation of other units that themselves may be ordered. In the natural world, similar phenomena can be seen in flower petals and tree branches. These structures have extraordinary potential at a level beyond the visibility of the human eye — at the nanoscale.

Scientists found it challenging to replicate these 3D structures with metal components on the nanoscale using conventional methods. Each of these materials must be small enough to measure in nanometres, and there are 1,000,000 nm in a mm.

"To date, scientists have been able to assemble hierarchical-type structures on the micrometre or molecular scale," said Prof Richard Tilley, Director of the Electron Microscope Unit at UNSW and senior author of the study. "But to get the level of precision needed to assemble on the nanoscale, we needed to develop an entirely new bottom-up methodology."

The researchers were able to use chemical synthesis to grow hexagonal crystal-structured nickel branches on cubic crystal-structured cores to create 3D hierarchical structures with dimensions of around 10–20 nanometres.

The resulting 3D nanostructure has a high surface area, high conductivity due to the direct connection of a metallic core and branches and surfaces that can be chemically modified. These properties make it a suitable electrocatalyst support, helping to speed up the rate of reactions in the oxygen evolution reaction, which is a crucial process in energy conversion. Its properties were examined using electrochemical analysis from electron microscopes provided by the Electron Microscope Unit.

"Growing the material step by step is a contrast to what we do assembling structures at the micrometre level, which is starting with bulk material and etching it down," said Dr Lucy Gloag, lead author of the study and Postdoctoral Fellow at the School of Chemistry, UNSW Science. "This new method allows us to have excellent control over the conditions, which lets us keep all of the components ultrasmall — on the nanoscale — where the unique catalytic properties exist."

In conventional catalysts, which are often spherical, most atoms remain stuck in the middle of the sphere and very few on the surface, meaning most material would be wasted as it cannot take part in the reaction environment. The new 3D nanostructures are engineered to expose more atoms to the reaction environment, which, according to Tilley, may facilitate more efficient and effective catalysis for energy conversion.

Authors of the study, Professor Richard Tilley and Dr Lucy Gloag. Photo: UNSW.

"If this is used in a fuel cell or battery, having a higher surface area for the catalyst means the reaction will be more efficient when converting hydrogen into electricity," Tilley said.

Gloag said it means that less of the material needs to be used for the reaction.

"It will eventually decrease the costs as well, making energy production more sustainable and ultimately shifting our dependence further away from fossil fuels."

In the next research stage, the scientists will aim to modify the surface of the material with platinum, which, though more expensive, is a superior catalytic metal.

"These exceptionally high surface areas would support a material like platinum to be layered on in individual atoms, so we have the absolute best use of these expensive metals in a reaction environment," Tilley said.

University of New South Wales

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Council installs solution to solve a pumping problem

Located North of Adelaide in South Australia, the Light Regional Council is responsible for the wastewater treatment systems in its location. The Waste Operations Coordinator, Adam Broadbent, and his team were having ongoing problems with their submersible pumps at the Kapunda CWMS treatment plant.

Broadbent advised Hydro Innovations that his team struggled to perform maintenance on the pumps as they weighed over 100 kg each and sat at the bottom of a 4 m-deep tank. He said that this was problematic from a logistical and work health and safety (WHS) perspective. On top of this, the submersible pumps were only lasting five to eight years.

After reviewing the application, engineers at Hydro Innovations recommended that the council move to a Gorman-Rupp self-priming wastewater pump so that operators could have easy access to the pump, without the need for lifting devices. The company also recommended that the council try the Eradicator version of its Gorman-Rupp Super T series of wastewater pump to minimise the chances of blockages by stringy materials such as rags and wet wipes.

The council then proceeded to purchase and install the pump.

During a "post-commissioning" check (performed by Hydro Innovations after all newly purchased pump-sets have been installed), the Hydro Regional Manager for South Australia met up with Ryan Steklin from the council. Steklin has the responsibility of keeping everything going and said he was "pleased the pump eliminated many OH&S problems associated with the submersible pumps and means we don't have to lift the heavy pumps out of the tank to replace or perform maintenance on". He also said that it "allowed us to frequently check the pump performance because it is easy to do so".

Gorman-Rupp wastewater pumps are suitable for municipalities and general industry to replace submersible pumps to improve access and safety for operators. They are available in a range of sizes to suit flows from 4 L/s through to 200 L/s, so can be retrofitted into most wet wells.

Hydro Innovations
www.hydroinnovations.com.au

Diverting C&D waste from landfill to produce new products

Mildura-based Waters Excavation has invested in a construction and demolition wash plant designed to recover valuable recycled sand and aggregates from concrete waste.

The 80 Tph wash plant, designed by wet processing expert CDE, is being used by the family-run business to produce a range of sand (0–2 mm, 0–4 mm) and aggregate (4–10 mm, 10–16 mm and 16 mm–oversize) products, which have been recovered from concrete waste.

The solution incorporates the EvoWash sand wash plant, AggMax modular logwasher, a feed hopper and stockpile conveyor.

The S20 Hopper meters feed to the plant, with a feed conveyer that includes an integrated magnet for steel recovery.

The high-frequency Infinity D1-63 pre-screen removes sand prior to the attrition process, with high-frequency screening action for maximum sand removal. The incorporation of the Infinity D1-43 screen dewaters organic and lightweight wastes

from the attrition process, enabling the production of two sands.

CDE's RotoMax logwasher can be used in the processing of a variety of materials including sand and gravel, crushed rock, construction and demolition waste material, and a range of mineral ores. The logwasher scrubs material for maximum attrition.

The incorporation of the AggMax modular logwasher upward flow function rejects lightweight contaminants, which are dewatered on the integrated trash screen. The Infinity H2-60 sizing screen separates the material into three washed aggregates and allows the removal of sand liberated by the RotoMax attrition process.

The solution is allowing the business to produce a range of five high-quality sand products to meet local demand, whilst also diverting waste from landfill.

According to the Director of Waters Excavation, Michael Waters, one of the plant's main features is the ability to scrub aggregates of clay and float off lightweight contaminants such as leaves, sticks and light plastics.

"It's been a real success," he said. "I'm blown away with the level of contaminants we were able to remove from the waste stream and how clean the end products were."

CDE Global Australia Pty Ltd
www.cdeglobal.com

EV battery testing solution

iStock.com/Nattapon Kongbunmee

Automotive components undergo rigorous testing to meet regulatory standards, guarantee performance, and ensure consumer safety. These components continually require investment in innovation to meet the expressed governmental, consumer and commercial use requirements.

One of the vehicle components that is undergoing intense change is the battery. The market is heavily focused on increasing mileage use and life, which includes the shift from single-use lithium batteries to lithium-ion batteries that are rechargeable.

These customer sentiments are noticeable in the growing global electric vehicle (EV) and hybrid electric vehicle (HEV) demands for sustainable and longer-lasting battery solutions. Customer satisfaction and commercial applications are closely intertwined with a vehicle's ability to travel longer distances without refuelling or charging. The demands and changes drive robust test and measurement programs to bring new battery models and designs to market.

In 2021, it is estimated the EV battery market exceeded 38% of total battery sales. As technology continues to improve the lifecycle and reduce battery costs, Precedence Research estimates 32% CAGR through 2030. This translated to $46bn in the US alone of market share, while Asia–Pacific is leading the production of EVs and overall demand for EV batteries. Based on global adoption of electric vehicles, supported by government initiatives and an intense focus on reduced carbon emissions, the EV battery market is expected to continue expanding around the world.

The testing of batteries is growing in complexity with the increase in number of cells, modern designs, materials, cycles, installation, vehicle models, certifications and charging equipment to name a few. Battery simulation and real battery integration testing are two examples of commonly used T&M programs used to validate battery adaptability and use requirements. In battery testing, accuracy and quality of the measurement devices are vital. The following are the most common battery types today:

- Lithium-ion Battery
- Lead-Acid Battery
- Sodium-ion Battery
- Nickel-Metal Hydride Battery
- Others

Due to the market shift to EVs, the lithium-ion battery is the number one battery type today. The domination of the lithium-ion battery exceeded all other battery types in 2021. Manufacturers of EVs prefer partnering with OEMs of newer model Li-ion batteries because they are lighter in weight and have higher energy density. The following details one of many Interface solutions offered to automotive component and battery manufacturers.

Electric vehicle battery monitoring

The EV battery manufacturer required a system to monitor its lithium-ion batteries. Normally, lithium-ion batteries are measured through voltage and current measurements (ICV) to analyse and monitor the battery life. In consultation with the design and testing engineers, Interface recommended a solution that required installing the LBM Compression Load Button Load Cell in between two garolite end plates, and measuring the force due to cell swelling or expansion. Instead of monitoring through voltage (ICV), this method is based on measured force (ICF). To monitor the testing, the load cell was paired with the 9330 Battery Powered High Speed Data Logging Indicator. This instrumentation solution provides the ability to display, record and log the force measurement results with supplied software.

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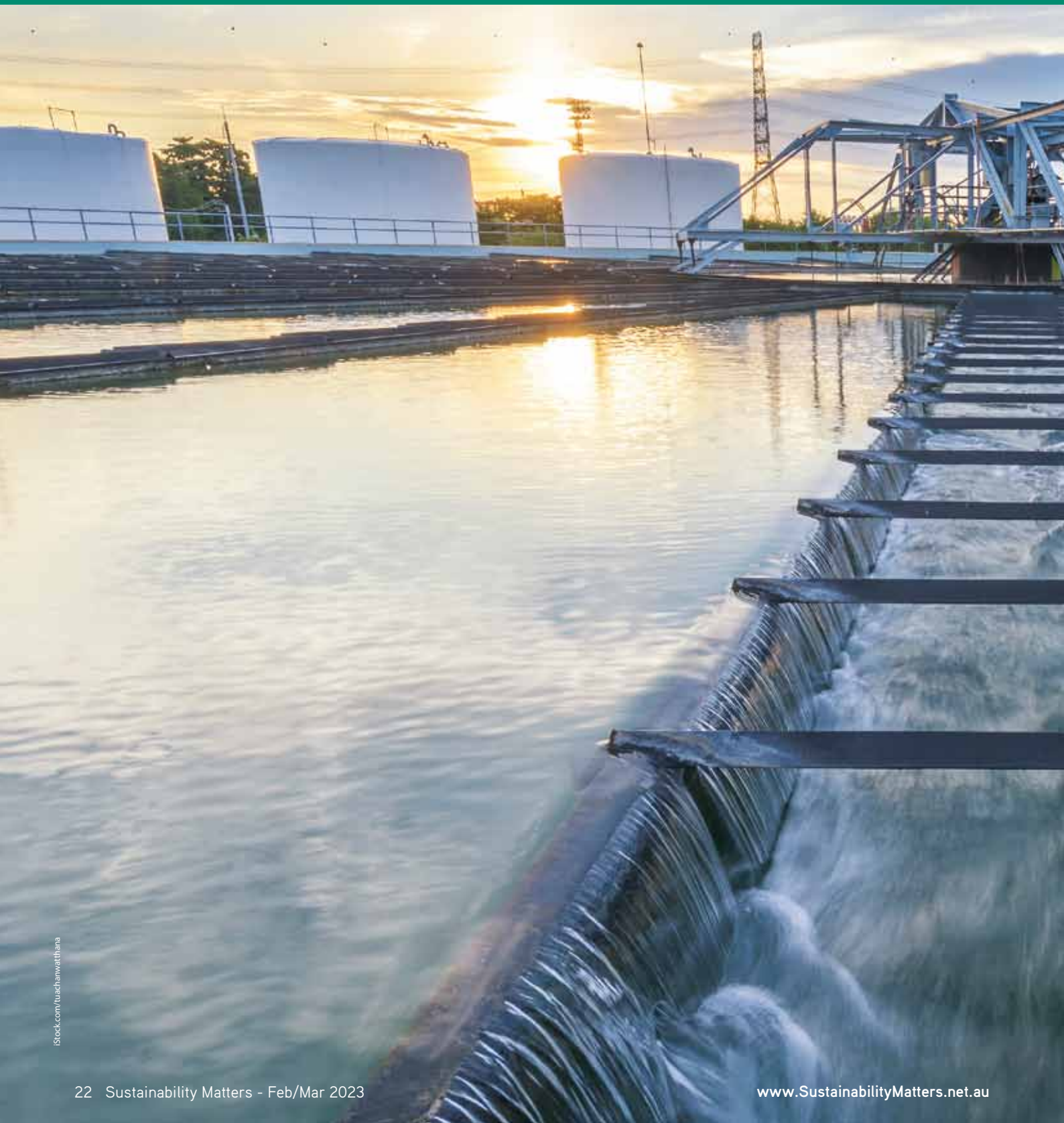

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"A delivery control valve's primary purpose is to mitigate the effects of pressure surges within a pressurised rising main during pump start/stop sequences.

Australia's aging water distribution infrastructure and growing population are placing a strain on water networks, leading to increased demands for maintenance and capacity upgrades. This is a significant challenge for utilities, but the correct equipment selection can bring about new efficiencies through increased operational reliability and functional performance.

Several recent projects in Sydney highlighted these efficiency possibilities with potable water pump station capacity upgrades. These projects involved upgrading pumps, piping systems and delivery control valves with specific automation features. The piping systems ranged from 200 to 900 mm, with system pressure ≥ 35 bar and each station having a uniquely different functional demand.

Improved efficiencies at these pump stations were achieved following a thorough investigation, identifying the design of valve most suited to the arduous conditions encountered during the opening and closing sequences with the pump running at full RPM. The importance of this valve within a pump station is essential in reducing mains ruptures, particularly with aging piping infrastructure.

Delivery control valves, or DCV, is a term applied to the function of a slow operating on/off isolation valve installed downstream of a fixed speed or variable speed pump. A delivery control valve's primary purpose is to mitigate the effects of pressure surges within a pressurised rising main during pump start/stop sequences. The valve opens and closes at an adjustable speed, providing a smooth, predictable transition of pump discharge pressure and volume into the network lines. The upshot of slow cycling is to sustain cavitation transients which the valve must be capable of withstanding over a long operation life cycle.

With the application pressures ≥ 35 bar, the conditions meant that the high-pressure

differentials that the valve would experience resulted in high mechanical contact loads at the seating interfaces and the bearing journal of the valve. Together with these elevated pressures was the high-level demand for continuous operation. Pump discharge control valves need to be consistently reliable with predictable valve availability, with little to no maintenance while operating in high velocity and turbulent conditions over 20 to 30 years.

During the initial tender stage, the successful contractor selected and purchased a product for the application. Following the installation and during commissioning, the valves failed to perform the functional requirements and the client classified the valves as non-conforming. The contractor installed two other valves from the same valve supplier. Both options failed due to external leakage through the valve shaft, premature mechanical wear and corrosion of the disc edge and seating element.

Following the client's investigation of the failures and compliance with the specification, the client decided to undertake the selection process internally, ensuring a suitably compliant and fit-for-purpose solution.

EBRO Armaturen's HP300 series triple eccentric butterfly valve was viewed as the best-fit solution, installed in 2021, and continues to provide the availability and controllability specified by the client.

Prior experience with pump station delivery control valves across Australia and New Zealand meant that EBRO Armaturen Pacific provided a tailored solution comprising a unique disc-to-shaft positioning and orienting of the valve in such a way as to assist pump start-up.

When reviewing a particular valve design for a delivery control valve application, consider the services of a company with industry or application expertise. Having a technical understanding of the valve design when reviewing application parameters

allows one to highlight concerns or nominate particular features to enhance performance.

The HP300 series high-performance butterfly valve is precision engineered with a triple eccentric construction available in stainless or carbon steel materials. Various options are available for the seating and shaft sealing elements, with a leakage rate of A (EN12266). Thus, it is suitable for water, refineries, power/energy and chemical applications. Its inherent features make it suitable for extreme temperature and pressure conditions up to 63 bar, and temperature ranges from -60 to 650°C (higher temperatures on request).

Ebro Armaturen Pacific Pty Ltd

www.ebro-armaturen.com.au

Food scraps and wastewater could be used to power homes

More than 80% of Australia's food waste is currently disposed of in landfill where it decomposes to form methane, a potent greenhouse gas.

Food scraps, wastewater, fats, oils and grease from homes and businesses could be diverted from landfill and converted to renewable energy at a new waste hub in western Sydney.

The Advanced Water Recycling Centre in the Western Parkland City will have the potential to convert waste into energy using a mix of existing and innovative technologies — potentially generating enough energy to power 120,000 homes.

Economic modelling commissioned by Sydney Water and Circular Australia and completed by the UTS Institute for Sustainable Futures showed that co-digestion could divert up to 30,000 tonnes of organic waste from landfill each year by 2030.

The Managing Director of Sydney Water, Roch Cheroux, said the Upper South Creek Advanced Water Recycling Centre is the organisation's largest investment in water resilience in a decade and will use water and resource recycling technology to harness renewable energy.

"Every $1 million spent turning food waste into energy generates $2.67 million worth of value," Cheroux said. "We can generate enough renewable electricity through biogas power to reduce annual emissions by 70,000 tonnes, as well as promote skills and create jobs in the state's largest growth area."

The safe collection and disposal of fats, oils and grease will also prevent the formation of fatbergs in the sewage system and eliminate problems caused by these blockages. There is the potential to produce bio solids with a value of up to AU$2.8m annually at Upper South Creek.

The project is currently in procurement phase, with plans to award the construction contract for stage one in the coming months and completed in 2025 in time for the opening of the Western Sydney International Airport.

The centre is expected to be operational by 2026.

Recycling initiative launched for dairy farmers

Animal health business Zoetis is working with Australian dairy farmers and veterinarians to contribute to a greener environment and help local communities. It has launched a recycling initiative for dairy farmers in partnership with TerraCycle, with the aim of keeping plastic waste out of landfill. The initiative sees plastic syringes melted down and pelletised, with the raw material able to be made into new items such as garden beds, watering cans and outdoor furniture.

The program supports the recycling of empty Teatseal Syringe packaging. Teatseal is a non-antibiotic product used to prevent mastitis infections during the dry-off period. It is administered using a plastic syringe that is not recyclable in kerbside bins — which can generate significant plastic per farm depending on herd numbers.

"Teatseal is made from a mix of plastics that can't go in kerbside recycling. Through our new partnership with Zoetis, we're able to provide farmers and veterinarians with solutions to divert these plastics from landfills so they can be repurposed," said Jean Bailliard, General Manager, TerraCycle ANZ.

Zoetis has partnered with 100 veterinary clinics across Australia to enable farmers to return used syringes to their local participating clinic, where they are placed in a recycling box.

In the last three years, the Australian Government strengthened its commitment to ensure the Australian agriculture sector is contributing to global sustainable development goals. Australia produces around 8000 t of waste farm plastics a year, with only a small percentage currently being recycled.

Lance Williams, Zoetis Senior Vice President and Cluster Lead Australia & New Zealand, said following the success of a similar program in New Zealand, Zoetis is "impressed" by the willingness of veterinary clinics and dairy farmers to participate in the initiative.

The program has returned over 495 kg of plastic since its launch, a figure that Zoetis plans to build on to achieve carbon neutrality by 2030.

Zoetis

www2.zoetis.com.au

Sloppy sludge could address prominent sewer pipe problem

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To address the problem of cracking sewer pipes in Australia, a project led by University of South Australia sustainable engineering expert Professor Yan Zhuge is trialling a novel solution designed to halt corrosion in aging concrete pipelines. The project could see 117,000 km of sewer pipes being prevented from cracking without any intervention by humans, and may save $1.4 billion in annual maintenance costs.

The lifespans of pipes are being reduced by corrosive acid from sulfur-oxidising bacteria in wastewater, along with excessive loads, internal pressure and temperature fluctuations, costing hundreds of millions of dollars to repair every year across Australia.

The solution may be 'self-healing concrete', in the form of microcapsules filled with water treatment sludge.

"Sludge waste shows promise to mitigate microbial corrosion in concrete sewer pipes because it works as a healing agent to resist acid corrosion and heal the cracks," Zhuge said.

Microcapsules with a pH-sensitive shell and a healing agent core containing alum sludge — a by-product of wastewater treatment plants — and calcium hydroxide powder will be developed by researchers. This combination will be designed to be highly resistant to microbially induced corrosion (MIC).

To protect from breakage, the capsules will be embedded inside concrete at the final step of mixing. They will release the healing agents when the pH value changes as acid levels build up.

"This technology will not only extend the lifetime of concrete structures, saving the Australian economy more than $1 billion, but it will promote a circular economy as well by reusing sludge that would normally end up in landfill," Zhuge said.

Existing repairs of deteriorating concrete are often short-lived, with 20% failing after five years and 55% failing after 10 years.

Existing methods to contain acid corrosion in sewer pipes are unsuccessful for a variety of reasons. Chemicals that may be added to wastewater to stop corrosion are costly and contaminate the environment. Another option involves increasing the speed of sewage flow by amending pipe hydraulics, but this may be ineffective. A popular option is surface coating, but it is time-consuming and temporary.

According to Zhuge, the construction industry is being forced to transit to a circular economy to be carbon-neutral by 2050.

"Industry by-products or municipal wastes that would normally be discarded in landfill sites, potentially generating pollution, may now be reused in the construction production chain," she said.

A single drinking water treatment plant generates up to 2000 t of treated water sludge annually, most of which is disposed in landfill, causing environmental issues and costing more than $6 million each year. Mainland Australia alone has about 400 plants.

Disposing of one tonne of sludge in landfill releases approximately 29.4 t of carbon dioxide emissions — much higher than cement production — and leaks aluminium into the soil and water, a risk factor for Alzheimer's disease.

"We are confident this novel self-healing concrete based on advance composite technology will address issues of sewer pipe corrosion and sludge disposal in one hit," Zhuge said.

The project involves researchers from the University of South Australia and University of Queensland, partially funded by a $501,504 Australian Research Council grant.

University of South Australia

www.unisa.edu.au

From sugar to aviation fuel: fast-tracking the conversion

Researchers from the University of Queensland (UQ) have found a way to convert sugarcane into a building block for aviation fuel and other products.

A UQ team, in collaboration with the Technical University of Munich (TUM), has focused on a specific enzyme to speed up the slowest step in processing sugar into a chemical called isobutanol.

Prof Gary Schenk, UQ School of Chemistry and Molecular Biosciences, said isobutanol from a renewable resource can be used to make fuels, plastics, rubbers and food additives.

"Our research into this particular enzyme means we can accelerate the production rate and yield of isobutanol from sugarcane, ultimately enabling biomanufacturers to make diverse products at scale sustainably and efficiently," Schenk said.

According to Schenk, the research used only a small number of a sugar acid-specific dehydratase enzyme as a production platform during the biomanufacturing process. The use of these sugar-converting enzymes, which operate outside of a cellular environment, meant that many of the pitfalls of more traditional cell-based biomanufacturing methods were bypassed, leading to higher yields of isobutanol with fewer unwanted side products.

Cell-based production of isobutanol from sugar created about 25 g/L of liquid cell culture, but in the UQ study, the cell-free method produced at least 10 times that amount.

"The cell-free method gives biomanufacturers more control and results in much higher yields, meaning a higher return on their investment and a more sustainably produced product — it's a win-win," Schenk said.

Developments in enzyme engineering and production have led to more enzymes being available for large-scale production of products such as aviation fuel, which had previously been unachievable.

"We're only at the dawn of what is a very exciting age in this space," Schenk said.

Prof Damian Hine from UQ's Queensland Alliance for Agriculture and Food Alliance said the research proved the potential of cell-free biomanufacturing.

"While there have been commercial limitations to producing the enzymes, we now have enough evidence to show that large-scale manufacturing using the cell-free enzymes process is commercially viable and should play a major role in future biomanufacturing," he said.

University of Queensland
www.uq.edu.au

TOTAL CHLORINE ANALYSER

With its reagent-less amperometric sensor design, the TC80 Total Chlorine Analyser from ECD eliminates consumables, simplifies installation and reduces maintenance to lower the total cost of instrument ownership over its long life.

ECD's TC80 Total Chlorine Analyser is panel mounted and ready to use right out of the box. Its versatile design monitors total chlorine in drinking water, industrial cooling and rinse water, wastewater or other disinfected fresh water samples that contain chlorine over a wide range that can be scaled depending on the user's needs.

Its total chlorine sensor is a precision three-electrode amperometric sensor which measures all chlorine species in the water, combined chlorine and free chlorine. It is available in either a standard high-range configuration measuring Cl2 from 0.05 to 20 ppm or a standard low-range configuration of 0.005 to 2.000 ppm. The analyser comes factory pre-calibrated to the chosen measurement range before shipment, which speeds up set-up.

This solution requires no additional third-party components. Everything needed comes in one box and is assembled on a panel mount board. The plumb-plug-and-play design incorporates a flow control device, the pH sensor, the chlorine sensor and the T80 transmitter, which are all mounted on the instrument's ready-to-mount PVC panel.

The analyser's automatic flow control and large flow tubes and cells greatly reduce clogs and blockages and allow for easy cleaning. It can be ordered with an auto cleaning option to keep the chlorine sensor clean from contaminants for an extended period of time. The time scheduled pressure-spray washer keeps particles from adhering and building up on the sensor.

It is available with either 110–240 VAC or 24 VDC power. The TC80 graphically displays both the total chlorine and pH levels, which supports trend analysis. The standard configuration has two 4–20 mA outputs and three alarm relays, 24 VDC or 110/220 AC power.

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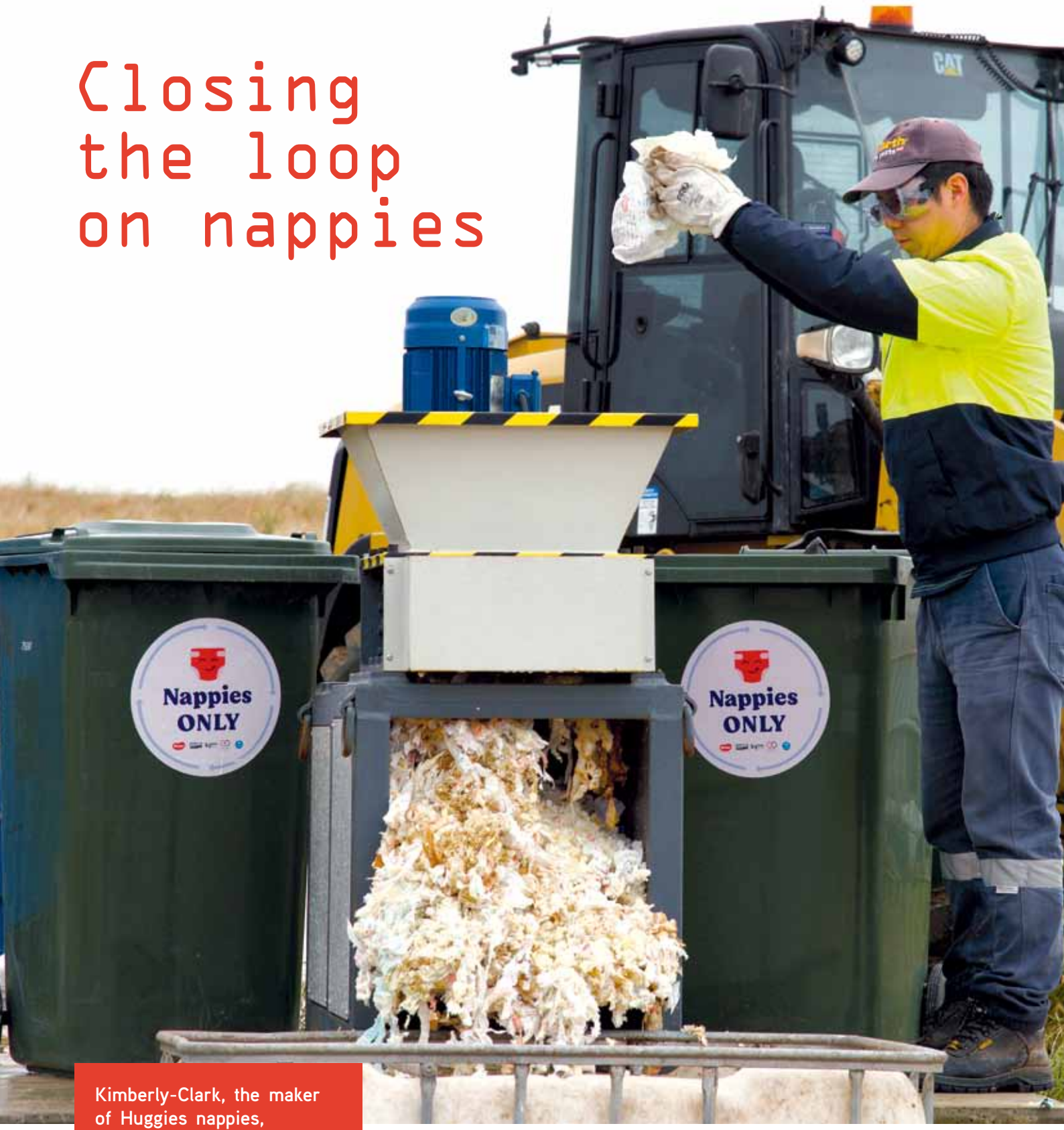
Closing the loop on nappies



Kimberly-Clark, the maker of Huggies nappies, has announced a nappy recycling trial that may be Australia's answer to the 1.5 billion disposable nappies that end up in landfill each year. Approximately 300,000 babies are born in Australia every year, and about 95% of them wear disposable nappies.

The Nappy Loop has been underway in South Australia since July 2022. Claimed to be the first nappy recycling trial of its kind in Australia, it uses anaerobic digestion to turn the organic materials in used Huggies nappies into nutrient-rich compost, as well as bioenergy that is captured and used to power the recycling process.

Led by Kimberly-Clark Australia, along with CSIRO, Peats Soils and Garden Supplies, Solo Resource Recovery, and early learning and care provider G8 Education, the Nappy Loop team has collected and recycled almost two tonnes of used Huggies nappies, to help prove that anaerobic digestion is a viable option for the nappy recycling process.

> After a five-month trial, The Nappy Loop is exploring the opportunity to scale the program in South Australia and nationally.

Kimberly-Clark ANZ Managing Director Belinda Driscoll said, "Families and day care centres across the country rely on the convenience and performance of disposable nappies and while we work to innovate and create more sustainable products, recycling is one solution for disposable nappy waste. Identifying a recycling solution that works hasn't been easy due to the availability of technology and collection systems. Today is a very proud day for us, announcing that we have trialled right here in Australia, and it represents a big step in Kimberly-Clark ANZ's sustainability strategy."

How the trial worked

The Nappy Loop trial has adopted a B2B model. Solo collected used Huggies nappies from G8 Education's Welly Road Early Learning Centre in Mount Barker and delivered them to the Peats composting facility for processing. There, the anaerobic digestion process takes place and the plastic components from the nappies are separated from the organic matter and evaluated for future recycled products. In addition, bioenergy captured from the anaerobic digestion process is used to power the Peats composting facility.

CSIRO is validating the results of the trial and the full report will be available soon. However, initial results show:

- The anaerobic digestion process was beneficial in biodegrading the organic matter in nappies (post separation of plastics) when mixed with expired food waste and beverages with high sugar content. Food waste and beverages not only help in separating the plastics from the shredded nappies but also provide additional liquid content and sugars for the anaerobic digestion process.
- The anaerobic digestion process was able to turn the fluff pulp and other organic components of the soiled nappies (after separating plastics) into nutrient-rich compost and biogas. CSIRO is still assessing how much biogas is produced from the degradable organics in nappies. However, early test results indicate a successful conversion of organic carbon during the digestion of nappies (post separation of plastics) to biogas.

CSIRO's Principal Research Scientist Dr Anu Kumar said, "CSIRO is working with Kimberly-Clark Australia to provide scientific validation of The Nappy Loop pilot to help tackle waste. Our research for this Australian trial will help inform the team on the potential scaling of the program to help reduce the amount of nappies ending up in landfill."

Managing Director of Peats Soils and Garden Supplies Pete Wadewitz said: "Anaerobic digestion is a growing area of focus and possibility in Australia. The process has been used successfully in Toronto, Canada to recycle disposable nappies and we are excited to be introducing this innovative approach in the Southern Hemisphere as we work to solve the nappy waste issue."

G8 Education Head of Early Learning and Education Ali Evans said, "Through this partnership the nappies changed every day at our Welly Road centre are recycled instead of going into landfill. As educators of our future generations, sustainability is a core focus in all our 440 centres across Australia and we're excited to contribute to this partnership and the positive environmental impact it can make."

After a five-month trial, The Nappy Loop is exploring the opportunity to scale the program in South Australia and nationally. This includes a partnership with APR Plastics to test the recycling of the recovered plastic from the nappies using pyrolysis, with the aim of having results available in early 2023.

Kimberly-Clark Australia
www.kcprofessional.com

Improving mixed-plastic pyrolysis

iStock.com/8213erika

A strategy for addressing Earth's growing plastic pollution problem is turning plastic waste into useful products. A study has found it may be possible to improve one method, called pyrolysis, to process hard-to-recycle mixed plastics — like multilayer food packaging — and generate fuel as a by-product.

Pyrolysis involves heating plastic in an oxygen-free environment so the materials break down and create new liquid or gas fuels. Current commercial applications of pyrolysis either only operate below the necessary scale or handle certain types of plastics.

"We have a very limited understanding of mixed-plastic pyrolysis," said Hilal Ezgi Toraman, assistant professor of energy engineering and chemical engineering at Penn State (pictured). "Understanding the interaction effects between different polymers during advanced recycling is very important while we are trying to develop technologies that can recycle real waste plastics."

The scientists conducted co-pyrolysis of two of the most common types of plastic, low-density polyethylene (LDPE) and polyethylene terephthalate (PET), along with different catalysts to study the interaction effects between the plastics. They found one catalyst may be a good candidate for converting mixed LDPE and PET waste into valuable liquid fuels. Catalysts are materials added to pyrolysis that can aid the process, like inducing the plastic to break down selectively and at lower temperatures.

"This type of work can allow us to provide guidelines or suggestions to industry," Toraman said. "It's important to discover what kind of synergies exist between these materials during advanced recycling and what types of applications they may be right for before scaling up."

LDPE and PET are commonly found in food packaging, which often has various layers of different plastic material to keep products fresh. These are generally difficult to recycle with traditional processes because each layer has to be separated. According to Toraman, pyrolysis can handle the complexity of these materials.

The first step to developing new commercial pyrolysis processes is having a better mechanistic understanding of how plastic waste mixtures decompose and interact.

The scientists conducted pyrolysis on LDPE and PET separately and together, observing interaction effects between them during tests with each of the three catalysts they used.

"We saw products that can be very good candidates for gasoline application," Toraman said.

The team developed a kinetic model that was able to showcase the interaction

Hilal Ezgi Toraman, Virginia S. and Philip L. Walker Jr. Faculty Fellow in the John and Willie Leone Family Department of Energy and Mineral Engineering at Penn State

effects observed during the co-pyrolysis process. Kinetic models attempt to predict the behaviour of a system and are important for better understanding why reactions are occurring.

"Systematic and fundamental studies on understanding reaction pathways and developing kinetic models are the first steps toward process optimisation," Toraman said. "If we don't have our kinetic models right, our reaction mechanisms accurately, then if we scale up for pilot plants or large-scale operations, the results won't be accurate."

Toraman would like the research to lead to better environmental responsibility in the recovery, processing and utilisation of Earth's resources.

Penn State University

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SEW EURODRIVE

Biological and environmentally friendly

GearFluid by SEW-EURODRIVE – 84% less CO_2 emission compared to conventional polyglycol lubricants

1. Sustainable biomass made from green and food waste, among other things
2. Processing and synthesis of the biomass into the basic oil for the GearFluid
3. Mixing in high-quality additives creates the finished GearFluid
4. Filling the gear units and canisters with GearFluid by SEW EURODRIVE

www.sew-eurodrive.com.au