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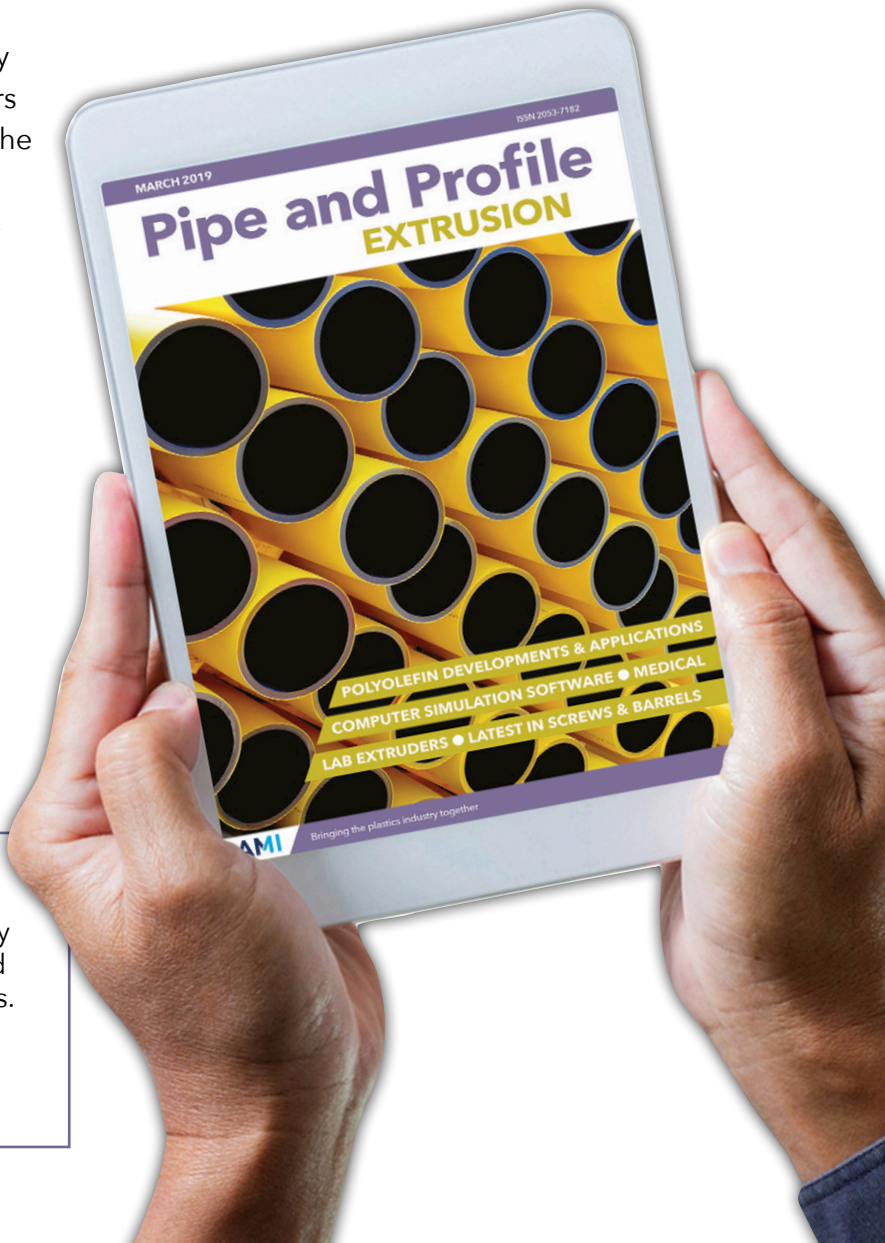

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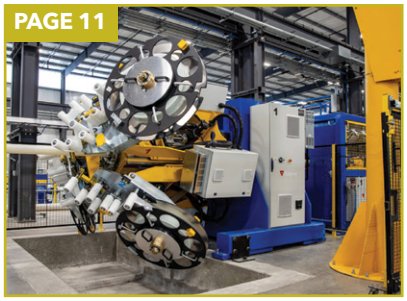
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Unigasket acquisition expands operations in North America

IMAGE: UNIGASKET

Calissi: "Acquiring MTO will help us strengthen our positioning in North America"

Italy-based Unigasket has acquired MTO Hose Solution, a US producer of PTFE tubes.

MTO, based in Newark, Delaware – with a separate branch in Texas – has been active for over 20 years in markets including medical, aerospace and automotive. Its turnover last year was around US$10 million.

Unigasket says the takeover consolidates its position in North America – and takes its annual turnover to more than €100m. In addition, Unigasket strengthens its position in fluorinated polymers.

Unigasket is headquartered in Villongo, Italy and makes industrial PTFE tubes and hoses, gaskets and sealing at a 16,000 sq m factory. It also has branches in Romania, Poland and the Netherlands, and employs around 500 people. It has an export share of around 60%.

Since 2018 it has been 75% controlled by private equity fund PFH Palladio Holding, while 25% is held by its president and founder, Vittorio Calissi.

"MTO is a company of extraordinary quality in terms of its range of products and reference customers," said Calissi. "By exploiting synergies with Unigasket, we will be able to obtain important results in the near future – and strengthen our positioning in North America."

› **www.unigasket.it**

Danish and Polish pipe component firms merge

Two pipe fittings companies – in Denmark and Poland – have merged in order to "achieve the best possible position in the future European market".

Salling Plast of Denmark and BG Industry of Poland are both specialists in fittings and plastic components for the district heating sector and for pipe manufacturers.

Geert Skovsgaard, CEO of Salling Plast, said the move would help in areas such as capacity, competitiveness and increased customer focus.

"Through the merger, we become one of the largest players in the European market," according to Skovsgaard. "We will offer a stronger product range and geographical proximity to the largest customers."

IMAGE: SALLING PLAST

The new company's factory in Zabrze, Poland – which employs 60 people – will focus on large-scale manufacturing and machining of HDPE components. The Danish plants in Ranum and Hurup Thy, with 80 employees, will concentrate on pre-insulated fittings and valves.

Hurup Thy develops and manufactures customised solutions and pressure pipe components, mainly in large dimensions. The plant in Zabrze is in the process of being replaced by a new 7,500 sq m facility, that is due to open in the first half of this year.

› **www.sallingplast.com**
› **www.bgindustry.com**

US plastics industry up in 2022

The US plastics industry continued to grow in 2022 against a backdrop of weaker domestic and global economic growth, said the Plastics Industry Association.

"All told, demand for plastics and plastic products stayed stable in 2022," said the organisation.

As an example, it said resin production in December 2022 was 1.5% ahead of the same period in 2021, while the value of resin sales rose 2% for the year.

Industrial capacity also rose steadily over the year – from around 112.5 to nearly 115 (using 2017 as a base of 100).

Capacity utilisation also reached around 81%.

› **www.plasticsindustry.org**

US grants available for PVC recycling projects

The US-based Vinyl Institute, which represents PVC manufacturers, has launched a grant programme to encourage recycling of the material.

The programme, called Viability, will provide up to US$1 million per year for the next three years from four US-based resin manufacturers: Formosa, Oxy, Shintech, and Westlake.

"Each year, more than 1.1 billion pounds of vinyl material is recycled in the US and Canada," said Ned Monroe, president and CEO of the Vinyl Institute. "However, post-consumer material accounts for less than a fifth of that total."

He said the scheme should help the industry reach its goal of increasing post-consumer recycling volume to 160 million pounds by 2025.

Grants are available to organisations such as trade associations, material recovery facilities and recyclers – in amounts up to US$500,000. Funds can be used for everything from equipment and process investments to research and development or educational programmes.

The first round of applications is due on 1 March 2023.

"It is our responsibility to identify pathways to grow PVC recycling," according to Monroe. "We are eager to identify worthy vinyl recycling programmes."

› **www.vinylinfo.org**

Strohm triples TCP production

Dutch thermoplastic composite pipe (TCP) producer Strohm has expanded its production plant in Ijmuiden, near Amsterdam.

The company says it will now triple its production capacity to 140km of normalised pipe per year. The expansion is Strohm's "biggest capital investment" since setting up the facility in 2012, it said.

IMAGE: STROHM

The plant now has a dedicated production line for research and development; an extrusion line for liner, coating, and weight coating materials; and two large lines using composite tape winding and proprietary melt fusion technology.

"With the new production line, we can now produce heavier, longer, and stiffer products for the industry," said Hubert Brinkhuis, operations director at Strohm.

› **www.strohm.eu**

Italy 2022 machine growth flat

Italy expects to see a 1% growth in plastic machinery production in 2022.

Amaplast, which represents machinery manufacturers, says the figure – which amounts to sales of €4.5 billion (US$5bn) – "consolidates the recovery seen during the previous year".

In 2022, exports – which represent about 70% of production – are expected to grow by around 2% (to €3bn), domestic sales by 1% and imports by 5%.

In the first nine months of 2022, the main growth markets were Asia (especially India), South America (especially Colombia) and Europe.

However, Amaplast sees "low or negative growth" in 2023 – with an expected downturn of "a few percentage points".

"Companies will have to make significant effort to innovate in order to improve the technological attributes of their machinery and stay abreast of increasingly specialised demand," said Dario Previero, president of Amaplast.

› **www.amaplast.org**

Maag buys gear pump manufacturer Witte

Maag has acquired Witte Pumps & Technology, a German developer and manufacturer of gear pumps and aftermarket parts.

Following the purchase, Maag will integrate Witte's gear pump operations with its own to create a combined Gear Pumps business unit.

"The acquisition of Witte represents a major step in making Maag the go-to partner for our customers' most critical and demanding gear pump needs," said Ueli Thürig, president of Maag.

He said the move would extend the group's product portfolio and geographical coverage.

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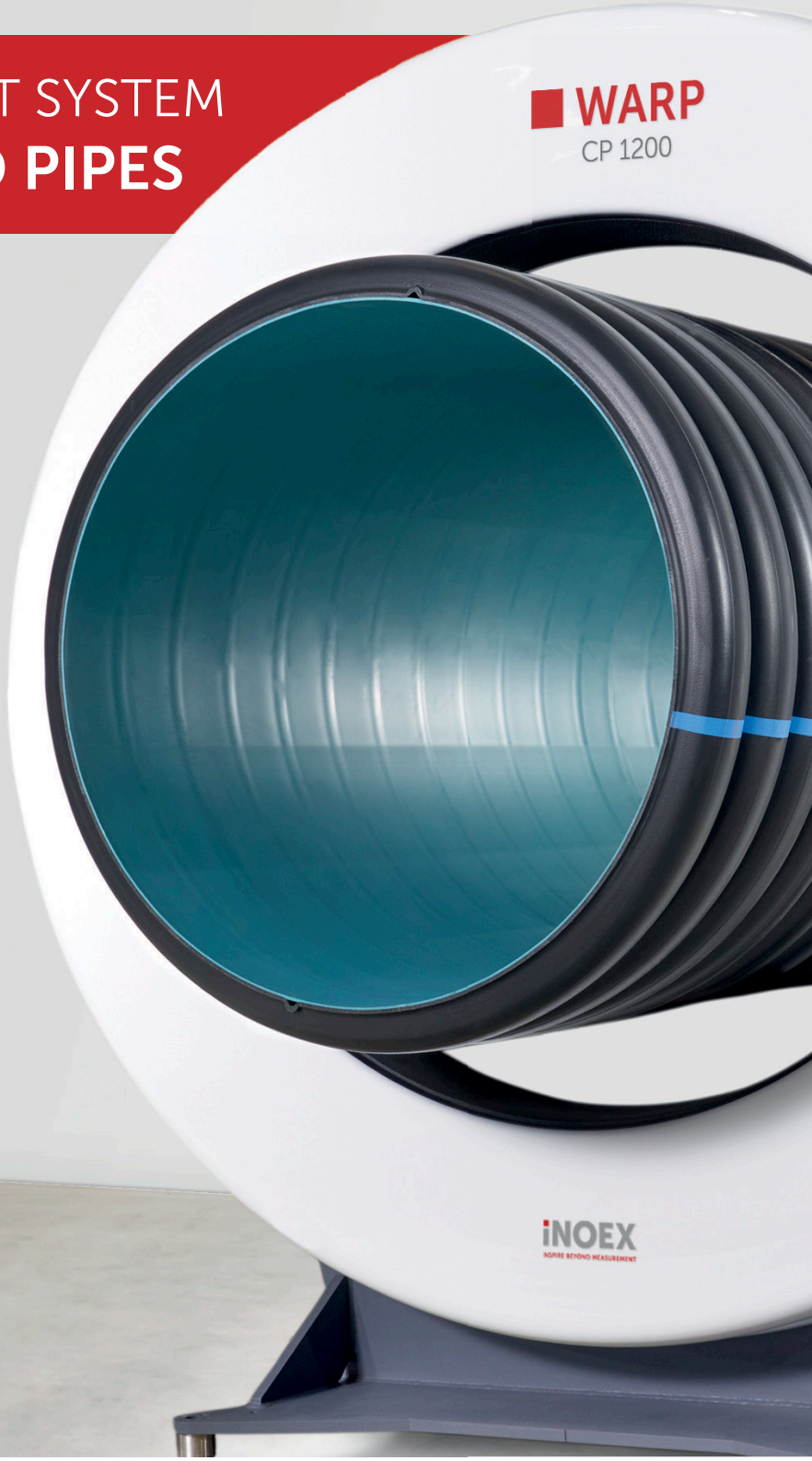

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Aliaxis buys Italy pipe firm

Pipes major Aliaxis has acquired Italian pressure pipe manufacturer Lareter.

Financial details of the agreement have not been disclosed.

Lareter makes pressure pipe for the water treatment and other industrial end-markets including swimming pools.

Its main European markets are Italy, France and Germany.

The company, founded 60 years ago, generates an annual turnover of around €40 million (US$44m) and employs 80 people at its Fiesso Umbertiano plant in northern Italy.

"This underlines our push for complete customer solutions across our entire portfolio," according to Eric Olsen, CEO of the company.

"The acquisition will give our customers access to a range of advanced solutions in the industrial segment, beginning with water treatment."

› **www.aliaxis.com**

Cleveland expos attract record visitor numbers

The AMI Plastics World Expos – which took place in Cleveland, USA late last year – attracted record numbers of exhibitors and visitors.

The event brought together four tradeshows – the Plastics Extrusion World, Compounding World, Plastics Recycling World and Polymer Testing World Expos.

"We were delighted to welcome over 300 exhibitors and more than 4,600 attendees to this year's exhibitions, representing year-on-year increases of 36% and 53% respectively," said Kelly DeFino, exhibition sales manager at AMI.

Five conference theatres hosted more than 100 speakers and were a major attraction once again – with standing-room only for some talks and panel discussions. The evening networking party also proved popular, with more than 450 people attending the event at the Punch Bowl Social Cleveland.

Visitors welcomed the information exchange and collaboration that the expos encouraged. Daniel Mata, process engineer at flooring manufacturer Mohawk Industries, said: "I would definitely like to come back. I think it's a great opportunity for anyone that would like to learn. There's a lot of information here."

IMAGE: AMI

Above: AMI's co-located events were well attended – attracting more than 4,600 visitors

Manfred Hackl, CEO of the Erema Group, appreciated the complementary nature of the focused expos, stating: "The combination of recycling, compounding, analytics and extrusion is the high value of the show."

Exhibitors were also positive about the size and quality of the audience. Slayton Altenburg, application specialist at TPEI, said: "The show is very well attended, and the quality of conversations has been great."

There will be two AMI Plastics World Expos this year. The next event will take place in Essen, Germany on 14-15 June 2023. The Expos return to Cleveland on 15-16 November 2023.

› **www.ami.international/exhibitions**

ADS plans manufacturing site in Florida

IMAGE: ADS

US-based pipe maker Advanced Drainage Systems (ADS) is proposing to build a 100-acre manufacturing site in Florida.

According to local news outlet *Lake Wales News*, the land is near a railroad spur, which would be used "to ship in raw materials in the form of recycled polyethylene plastic pellets". The material would be used to make corrugated pipe, said the report. The proposed plant – operating over three shifts – would employ 65 people.

The proposal will be heard at a meeting of the planning and zoning board in early February.

› **www.ads-pipe.com**

US agency rejects petition to classify PVC waste as 'hazardous'

The US Environmental Protection Agency (EPA) has published a "**tentative denial**" of a petition that waste PVC materials should be listed as hazardous waste.

The decision follows an agreement the EPA entered into with the petitioner – The Center for Biological Diversity – in May last year. It called on the EPA to "promulgate regulations governing the safe treatment, storage and disposal of PVC, vinyl chloride and associated dialkyl- and alkylarylesters of 1,2-benzenedicarboxylic acid, commonly known as phthalate plasticisers."

IMAGE: SHUTTERSTOCK

Above: The EPA has rejected a call to treat PVC waste as hazardous

In its tentative denial, the EPA said: the petition did not provide sufficient evidence to suggest listing PVC as hazardous waste would have a significant impact on phthalate exposure; had not shown that exposure to phthalates resulted from current waste management practices; had not demonstrated that tighter incineration rules under RCRA would reduce emissions; and had not established proper evidence of plasticiser leaching from discarded PVC.

The EPA also said the petition conflated exposure with hazard and added that the resource-intensive process of listing PVC hazardous waste would preclude it from more pressing hazard programmes. It is requesting public comment.

› **www.epa.gov**

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IMAGE: STROHM

Building a composite picture

Composite pipes – ranging from pure GFRP to multi-layer TCPs – are finding increasing use in applications as diverse as infrastructure and the oil and gas sector

Pipe manufacturers typically turn to composite materials to ensure high performance in a variety of end-use applications.

Composites rely on a combination of materials – such as a polymer matrix, a reinforcement and even metals such as aluminium or steel – to imbue pipe with added strength. While this is typically more expensive and complicated to produce, the combined effect helps to lift attributes such as burst strength and mechanical performance.

Composite pipes are a relatively small part of the market and are subject to a large amount of fundamental research, in order to further expand their performance.

Burst strength

A recent paper in the *International Journal of Pressure Vessels and Piping* investigates the long-term rupture pressure in PEX-Al-PEX composite pipes.

This type of pipe is widely used in a building's hydronic heating and cooling and plumbing systems. It comprises three main layers: outer and inner layers of PEX, and an aluminium (Al) middle layer. A polyethylene adhesive is typically used between the layers to prevent slipping of the polymer layers over the Al layer.

One of the most vital parameters in making these pipes is the tolerated internal long-term hydrostatic pressure, say the Iran-based researchers. The rupture pressure of composite pipes depends on operating temperature and time – as well as each layer's dimensions (inner polymer, outer polymer, and aluminium layer), the mechanical properties of the layers, and the welding types of the aluminium layer.

The researchers measured the long-term life behaviour of PEX multi-layer pipes for up to 1000 hours – for different diameters and welding types. The hoop and radial stress of the pipe layers are calculated analytically, based on classical elasticity theory. The pressure that can be tolerated by each layer was defined as a function of long-term hydrostatic pressure, size, and mechanical properties of both the aluminium and PEX layers in the pipe.

The results showed that the pressure bearing by the aluminium layer is 84-91% of the pipe's hydrostatic pressure. The PEX outer layer pressure bears less than 3% of the hydrostatic pressure – with the rest taken up by the PEX inner layer.

Overcoming defects

Similarly, researchers at **Robert Gordon University** in Aberdeen, UK, have assessed manufacturing defects in thermoplastic composite pipes – and how this can affect performance in oil and gas applications.

Thermoplastic composite pipes (TCPs) use fibre reinforcement to add benefits such as light weight

Main image: Strohm has won a contract to provide thermoplastic composite pipe for a green gas terminal in Germany

Right: Composite pipes are commonly used in infrastructure applications

and corrosion resistance. However, defects introduced during manufacturing can affect performance. Closer monitoring of the process can help to overcome this. When a defect is spotted, the process can be stopped and action taken. However, stopping the process is costly – so it is vital to decrease downtime during manufacturing.

"Potential solutions are through process optimisation for defect reduction and an in-depth understanding of the effect of parameters that cause defect formation in the pipe," say the researchers, in the journal *Applied Composite Materials*.

A well-manufactured TCP will rely on a number of factors, including both the materials and processes used. For instance, TCPs are made using a melt fusion bonding process involving heating and consolidation – plus other factors such as the consolidation speed and pull force.

"Thermal behaviour is essential at this phase, as it determines the curing rate," said the researchers. "This study indicates that laser heating is the better heat source in efficiency terms."

Defects such as fibre misalignments, voids and delamination can be induced during manufacturing. There are many sources for these. Voids are the most commonly studied manufacturing defect for composite parts. They are essentially "unfilled pores…occupied with gas rather than solid material".

The study says there is a need to explore the best defect characterisation methods during TCT manufacture.

"In-situ characterisation aims to derive high-quality TCP with reduced defects – or need for repairs – at increased production rate, while maintaining the current manufacturing process," said the researchers.

Sewage failure

Failure analysis is critical in understanding how and why pipes – and other components – fail in service. This allows designers and manufacturers to fix the problem in future designs.

Researchers at **Sichuan University** in China have analysed failures in glass fibre-reinforced polymer (GFRP) pipe in high-pressure sewage transport.

The research was carried out on failed GFRP pipes from sour oilfield gathering and transportation pipelines. The matrix material was an epoxy resin of an aromatic amine system that destructively cracked after 15 years of operation.

To find the underlaying cause, the failed part of the pipe was compared to the undamaged area. Then, the pipe's micro-morphological structure, chemical composition and mechanical properties were examined.

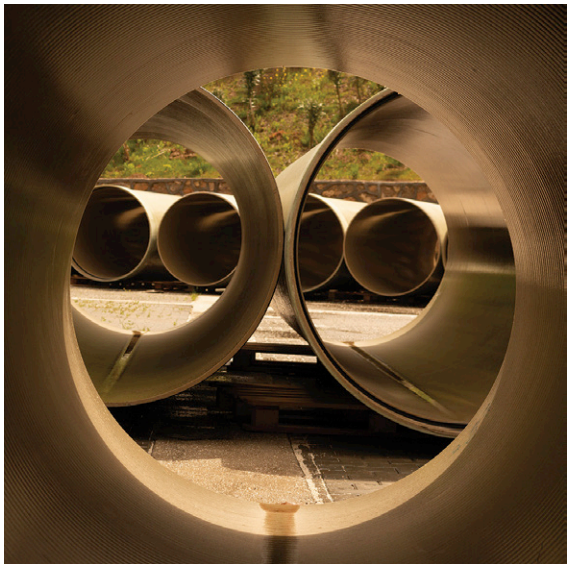

IMAGE: SHUTTERSTOCK

Results revealed cavity defects in the GFRP pipe with insufficient air bubbles and resin filling. In addition, the overall resin content of the pipe was low; the curing degree of the outer layer of the damaged area (DA-OL) was insufficient; and the fibre bonding strength was weak.

Fourier transform infrared spectroscopy (FTIR) and X-ray electron spectroscopy were used to characterise the degradation of the amine curing agent in the outer layer of the pipeline and the oxidative decomposition of the resin. These revealed that an irreversible chemical degradation process had occurred, reducing the performance of the fibre-matrix interface.

"Data from nano-indentation and dynamic thermomechanical characteristics confirmed the reduction of nano-hardness and elastic modulus in the outer layer of the GFRP tubes," said the researchers, in the journal *Engineering Failure Analysis*. "The failure of the pipeline was caused by the interaction of these factors."

Under pressure

Although composite pipes have properties such as high strength and strong resistance to external pressure, they are typically subjected to a sustained load – which leads to creep over the long term.

Researchers at **Nanjing Tech University** in China have developed an analytical approach to determine the viscoelastic properties of this type of pipe – leading to a potentially more accurate way of assessing creep behaviour.

"In the literature, only the viscoelastic property of a single-layer pipe– or the bonding interlayer in composite pipes – has been investigated," said the researchers, in the journal *Buildings*. "Few studies have addressed viscoelastic composite pipe, in which all of the pipe layers are viscoelastic."

›

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IMAGE: SHUTTERSTOCK

Above: The oil and gas sector is increasingly turning to composite pipe

Also, pipes in existing studies are usually subjected to uniform radial load – and not sustained compression, they said.

A key finding of the research was that the pipe layers and the bonding interlayer both exhibit viscoelastic properties. Equations for the viscoelastic composite pipe combine the exact elasticity theory with the viscoelastic theory. Solutions are derived using a Fourier series expansion followed by a Laplace transform.

"Results indicate that this solution has a higher computational efficiency than the finite element solution," said the researchers.

In addition, they found that the modulus and thickness of each layer had a significant influence on the stresses and displacements. These can be optimised by adjusting the modulus and thickness of each layer in the viscoelastic composite pipe.

Pipe bending

At the same time, researchers at **Wuhan University of Technology** in China have investigated the circumferential bending of glass fibre-reinforced plastic (GFRP) pipes with varying fibre content across a range of temperatures.

"Up to now, most studies on the stiffness of GFRP pipes have been conducted mainly under ambient conditions," said the researchers, in a paper published in the journal *Polymers*. "Temperature is an important parameter affecting the mechanical properties of GFRP."

The pipes were tested at 30, 50 and 70°C. They were also classified into three types, depending on their formulation. Type I was a near-equal mix of resin, fibres and sand; Type II contained more fibres and less sand; and Type III was around one-third resin and two-thirds fibres (with no sand).

Results showed that bending performance tended to decrease as temperature rose. Retention of circumferential stiffness was 80-85% and retention of bending strength and damage displacement was 25-40% from 30 to 70°C.

The rate of decay of ring stiffness, bending strength and damage displacement was much higher at 30-50°C than it was at 50-70°C. The damage pattern was affected by both temperature and continuous fibre content.

At 30°C, delamination occurred at the top and bottom of the Type I GFRP pipe before fracture damage happened at the left and right ends. Fracture damage occurred at both the left and right ends of the Type II and Type III GFRP pipes. Delamination happened at the upper and lower ends of the GFRP pipes at 50°C and 70°C.

"The results provide a solid support for the study of temperature on the bending performance of GFRP pipes," said the researchers.

Environmental stress

Composite pipes are used widely in infrastructure applications, transporting everything from drinking water to sewage. This means that the composite material is tailored to each different application.

Now, researchers at **Gheorghe Asachi Technical University** in Romania have studied the change in the structure of glass-reinforced plastic (GRP) composite materials caused by the characteristics of the surrounding soil.

Starting with three types of soil – basic, acidic and neutral – which affect composite materials, the researchers calculated the pipe damage index and Pearson correlation coefficients for axial tension. The results showed the significance of soil pH on the long-term behaviour of the buried composite pipe.

They analysed three pipe samples: one from a petroleum field (acidic); one from a salt field (basic); and a third from neutral soil. Samples were analysed at the OSPA laboratory in Romania.

Sample pipes made of GRP composite material – used to make buried water transport pipes – were also buried in the three experimental locations. After 24 months, the samples were recovered. ›

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IMAGE: SHUTTERSTOCK

Right: Researchers at Robert Gordon University have assessed manufacturing defects in TCPs in oil and gas applications

Three specimens were extracted and evaluated using electron microscopy and X-ray diffraction.

Pipe buried in basic ground showed leaks and colour changes, though no significant damage to the fibreglass; acidic ground caused significant damage to the glass fibre.

"Laying the pipe in acidic soil significantly reduces its life, which should be taken into consideration during the design phase," said the researchers, in the journal *Materials*.

They concluded that a one-unit pH change in the acidic spectrum decreases pipe life by around 10 years. So, if a pipe in neutral soil (a pH of 7) is expected to last 50 years, it would lose 40 years of that lifespan at a pH of 5.

To avoid deterioration of buried GRP pipes over time, the researchers recommended specific measures during the design phase: a petrochemical study, to determine the pH of the soil at the required depth; and the presence of Na+, oil residues and other forms of pollution.

In addition, using a higher class of pressure and rigidity than that obtained from the static calculation will retain mechanical characteristics for safety in operation – despite their steep regression over time.

Hydrogen hub

Strohm has won a contract from Econnect to provide more than 11km of thermoplastic composite pipe (TCP) for the TES Wilhelmshaven green gas terminal in Germany. The project aims to provide clean energy in the form of green hydrogen, green gas and green power.

In the initial phase, due to start in the second half of 2023, the terminal will be used to import natural gas. TCP is an integral part of the solution, being used for the transfer of gas between the floating storage and regassification unit (FSRU) and the onshore terminal – a distance of about 2km.

Strohm will provide six 8in flowlines with a

length of approximately 2km each, qualified for transfer of natural gas and prepared for CO_2.

In the second phase of the project, its TCP will be repurposed for liquid CO_2 transport. Using TES's approach to clean hydrogen production, CO2 is a designated circular carrier to enable cost-effective transport of green hydrogen in the form of synthetic methane. Following capture of the hydrogen, the CO_2 is returned to the green hydrogen production source using the TCP flowlines.

"Our TCP is perfectly suited for this project as it is field-proven in the harshest offshore environments in the world : it does not corrode and is compatible with CO_2," said Martin van Onna, CEO of Strohm. "Its low carbon footprint compared to steel pipe further enhances its suitability for the project."

Flexible installation

Delegates at the recent *Oil & Gas Non-Metallics* conference – organised by AMI – discovered several benefits of composite pipe.

In one example, Jean-Louis Poisson, lead polymer materials engineer at **Baker Hughes**, described the use of spoolable composite pipes in high-temperature, high-pressure installations.

Poisson said that composite pipe has comparable strength to steel, but superior durability. Installation cost was also far lower, he said.

Other advantages include high corrosion- and erosion-resistance, flexibility and ease of installation.

Pipe up to 8in diameter typically uses separate polymers – such as HDPE, PA or PPS – in various layers, including a base liner, tie-bond layer, centre layer (for high-temperature strength), a reinforcement layer and an abrasion-resistant jacket.

Such a structure will have around 25% of the carbon footprint of steel, he said.

He estimated the time and cost of installing 20km of pipe made from either steel or composites: a steel line might require nearly 1700 connections and take 24 weeks to install – by 30 workers – at a cost of US$10 million; the composite line, in contrast, might need 70 connections, which could be done by three workers in one week – at a cost of around US$40,000, he said.

Polyketones performance

Abderrazak Traidia, an R&D specialist at **Saudi Aramco**, told delegates about potential applications of aliphatic polyketones (POKs) in oil and gas pipe.

POKs are semi-crystalline thermoplastics resin made from olefin monomers (ethylene and propylene plus carbon monoxide. The carbonyl group in the polymer backbone provides properties such as mechanical strength, thermal and barrier performance, and chemical and wear resistance.

IMAGE: BAKER HUGHES

Above: Baker Hughes is a leading manufacturer of flexible onshore composite pipe

It was originally commercialised by Shell in 1990, but was discontinued in 2000. It was later reintroduced to the market by Hyosung in 2014.

Traidia gave an overview of a testing programme to assess the possible use of POK in wet sour aromatic hydrocarbon (HC) service at high temperature.

The key findings were:

- good retention of mechanical properties after exposure to HCs at 93°C with no apparent signs of chemical degradation;
- limited swelling and weight uptake compared to PE-RT aged at the same temperature;
- good barrier properties towards $H_2S/CO_2/CH_4$ permeation when compared to PE-RT at 82°C;
- strong discoloration and oxidation at higher temperatures (220F) – which was also observed during extrusion; and,
- significant reduction in ductility when exposed to HCs and water at 104°C, possibly due to polymer chain scission and hydrolysis in the amorphous regions.

"Further investigation is required to properly conclude on the operating envelop of POK in wet HC service," he said.

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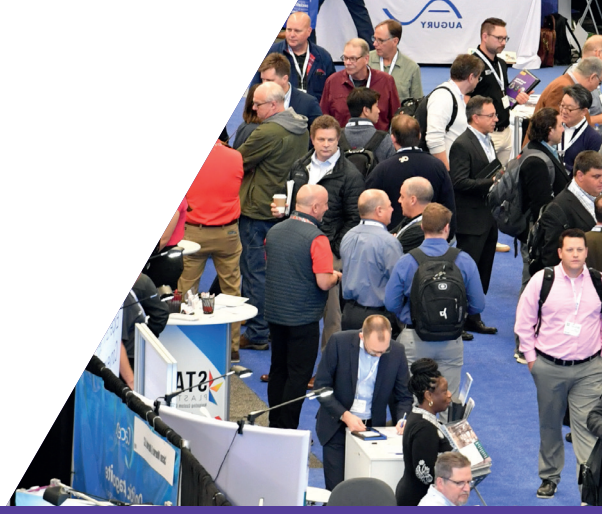

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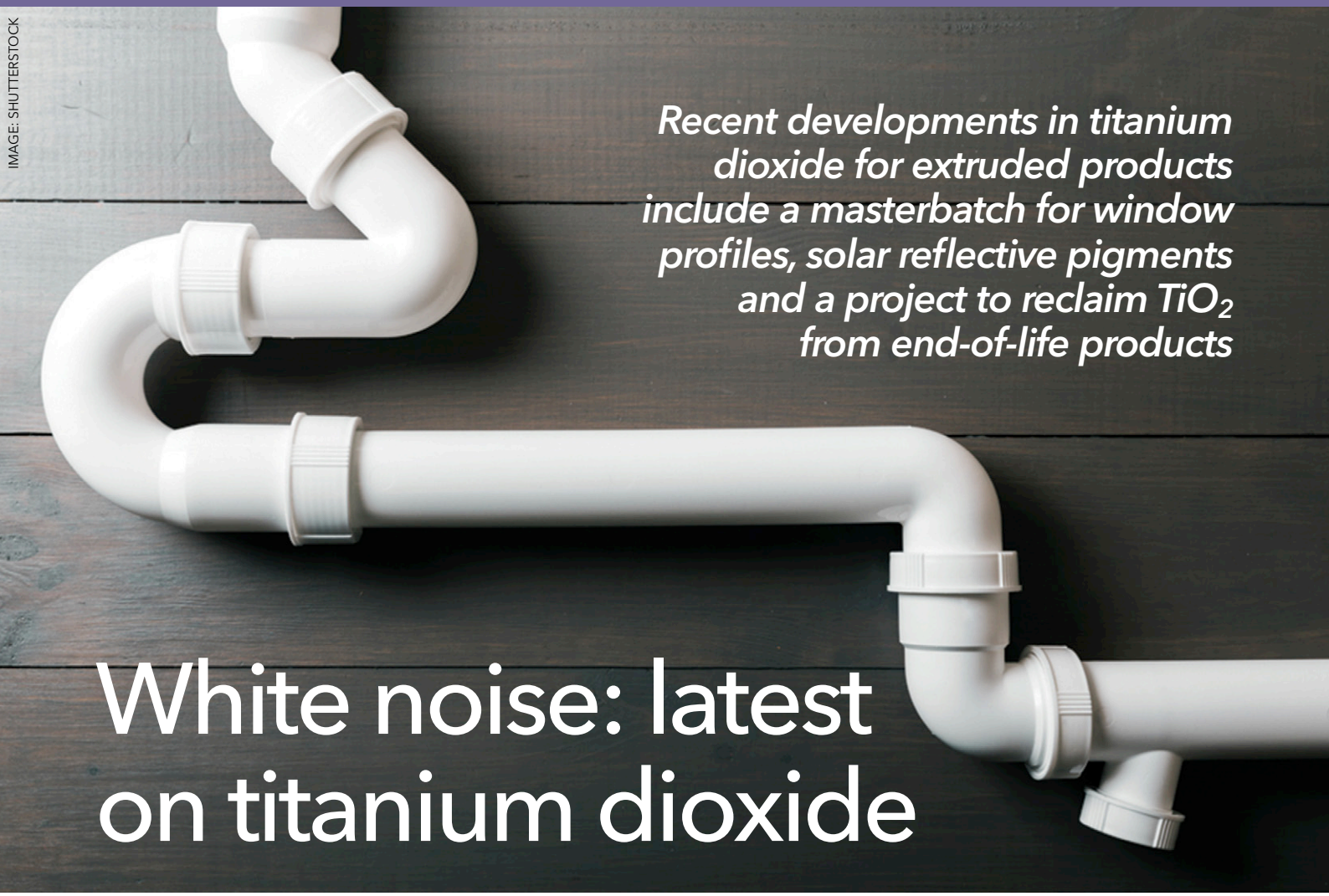

IMAGE: SHUTTERSTOCK

Recent developments in titanium dioxide for extruded products include a masterbatch for window profiles, solar reflective pigments and a project to reclaim TiO_2 from end-of-life products

White noise: latest on titanium dioxide

K2022 may have ended some time ago, but a number of titanium dioxide producers unsurprisingly used the show to launch new developments in the main white pigment used in plastic products.

Delta Tecnic of Spain introduced a range of new masterbatches for PVC at K2022 – including one based on titanium dioxide.

One range of colour PVC masterbatches – for window profiles – are designed to provide fast dilution, high colour consistency and weather resistance. Area manager Filipa Martins says that using masterbatch rather than powder pigments is a cleaner solution for profile extruders producing their own compounds.

In addition, the company offered new colour masterbatches for recycled PVC in black, white and brown. The white masterbatch has a high content of titanium dioxide – and other ingredients – to help restore the appearance of recycled white PVC that has yellowed over its lifetime. All the masterbatches have high concentrations of pigments and are formulated to deliver good dispersion.

Showcase brands

LB Group (formerly Lomon Billions) showcased a number of its titanium dioxide pigments for plastics at K2022.

"Our Billions TiO_2 pigments are global brands, approved and used by leading plastics producers worldwide," said Julie Reid, marketing director at LB. "The Billions BLR-688 pigment, made by the sulphate process, is a customer favourite for exterior plastics, including profile and pipe applications."

Separate to this, the Billions BLR- 886 pigment is made by the chloride process. The blue- toned white pigment is suited to polyolefin masterbatch, high-temperature extrusion coatings and engineering plastics.

LB says it has invested heavily in TiO_2 pigment manufacturing – giving it an annual production capacity of over 1100kt – including 460ktpa chloride-process capacity at its manufacturing sites in Jiaozuo in Henan Province, and Chuxiong in Yunnan Province.

"Annual manufacturing capacity has grown from 700kt to over 1100kt since 2018," according to Reid.

Its latest 100ktpa chloride-process TiO_2 pigment production line, constructed at Jiaozuo, was commissioned in Q1 2022, while it is building a new 200ktpa chloride-process TiO_2 pigment manufacturing capacity at Chuxiong that is scheduled for commercial production in 2023. ›

Main image: Plastics pipes are a major application of titanium dioxide

ECJ rules on TiO_2 regulation

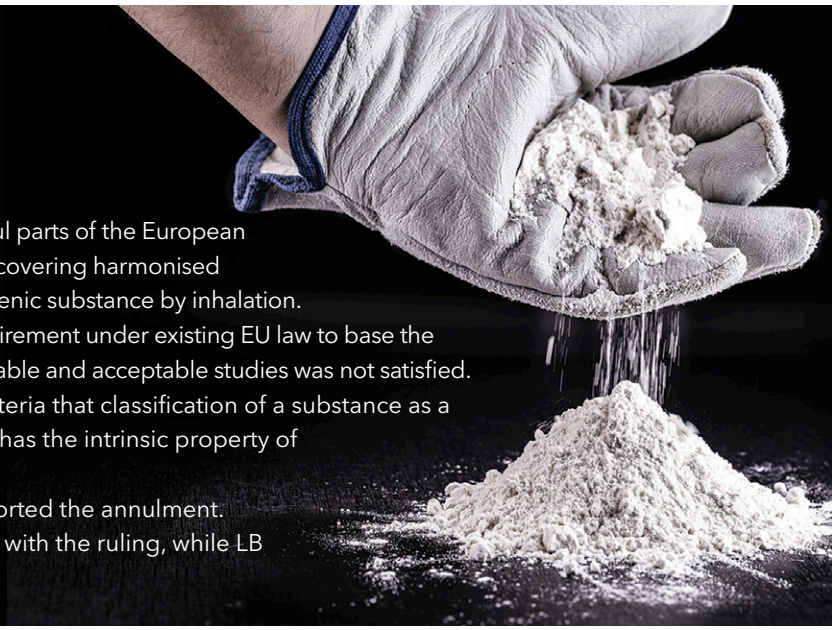

IMAGE: SHUTTERSTOCK

The European Court of Justice has ruled to annul parts of the European Commission's Delegated Regulation 2020/217 covering harmonised classification and labelling of TiO_2 as a carcinogenic substance by inhalation.

In its judgement, the court ruled that the requirement under existing EU law to base the classification of a carcinogenic substance on reliable and acceptable studies was not satisfied.

It also ruled the Regulation infringed the criteria that classification of a substance as a carcinogen can only apply to a substance that has the intrinsic property of causing cancer.

Manufacturers of TiO_2 pigments have supported the annulment. Slovenia-based Cinkarna said it was "satisfied" with the ruling, while LB Group said it "welcomes the outcome".

Above: The European Court of Justice has annulled certain rules that labelled TiO_2 as a carcinogenic substance by inhalation

"The additional capacity strengthens our global competitiveness and allows us to increase our chloride and sulphate TiO_2 pigment portfolio to manufacture more high-performance TiO_2 pigments for a wider range of applications including growing our portfolio for plastics applications," she added.

Reflective mood

Venator demonstrated a number of pigments for the plastics industry at K2022 that have solar reflective capabilities.

Its solar reflective pigments include its Altiris range of titanium dioxide (TiO_2) pigments, which improve the durability of plastics and prevent warping and discoloration caused by the sun.

Specific products include Altiris W400 – a near infrared-reflecting pigment that can improve the thermal stability and durability of white, bright, and light-coloured plastics used in exterior applications such as window and door profiles, sidings, decking, soffits and fascias. Venator also offers Altiris 550 and 800, for mid to dark-coloured plastics.

"Plastics producers need to think seriously about integrating solar reflective pigments into their formulations as standard," said Jörg Hocken, global application manager at Venator. "As we all make changes to help combat rising global temperatures, this decision could make a huge difference to the longevity of plastic products used across an array of applications."

Also at K2022, Venator showed its Deltio 48X pigment – a free-flowing titanium dioxide pigment that is aimed at masterbatch producers and compounders who want to improve material flow through their systems and minimise the risk of costly blockages.

Tioxide TR48 pigment is a TiO_2 grade with excellent coloristic properties that is easy to disperse and integrate into polyolefin masterbatches, while Tioxide TR42 is a blue-tone white pigment that is easily integrated into rigid PVC and other materials.

Circular concerns

As with many other parts of the plastics industry, circularity is a concern. In response, TiO_2 producer **Chemours Titanium Technologies** is leading an initiative called Remove2Reclaim.

This aims to develop an efficient, cost-effective, and sustainable process for recovering TiO_2 – as well as other additives and polymers – from end-of-life plastic products, such as those found in post-consumer plastic waste.

"The goal is to create a new recycling strategy that could enable reclaimed TiO_2 and polymers to be returned to high-value applications, contributing to the circular economy," said Cherie Stancik, product development manager for the plastics segment at Chemours.

In the project's first year, research partners have developed a sorting mechanism to effectively identify plastic wastes that contain TiO_2 and determined solvent-based extraction techniques to remove it from different polymer matrices.

Other project milestones include developing methods and equipment to detect TiO_2 in specific polymer matrices, recovering TiO_2 from the polymer by dissolution, and eventually reusing the TiO_2 and polymer in new products.

Other partners include Ineos Styrolution, Deceuninck, Matco Plastics, Vito, Ghent University, and KU Leuven. ›

Mixing it up

Zeppelin Systems used K2022 to show systems that improve the mixing of titanium dioxide (TiO_2) into compounds and masterbatches.

It said this is one of the more difficult polymer sector applications because – since October 2021 – TiO_2 has been classified within the EU as a carcinogen if inhaled on its own or in mixtures where the substance or mixture contains 1% or more of TiO_2 particles smaller than 10 microns.

It cites the example of a company wanting to produce a white PVC compound for window profiles. Due to the processing method in heating/cooling mixers, the TiO_2 has to be metered into the mixer in powder form. This is the only way to generate a bond to the PVC grain in the process of hot mixing at temperatures of up to 130°C. After cooling to a storage temperature of 40-50°C for silo storage, the pigment has completely attached itself to the plastic particles – which are now significantly larger, at 100-300 microns – and exposure to free TiO_2 powder is prevented.

TiO_2 pigments have a particle size of 0.01 to 1 micron. This represents a challenge for dust-free processing, which needs to take place in dust-tight units. Zeppelin says that to process the mix without putting dust into the local atmosphere – and to dehumidify it for further processing – it combines the mixers with a special aspiration and filter system.

"The Vent tec and HMA aspiration systems have proven their worth here," the company said. "In combination with the BVD and BVC jet filters, they ensure good dehumidification of the mix while withstanding the pressure fluctuations, high temperatures and chemical stresses occurring in the process."

Zeppelin says its CMQ container mixer also allows users to work in dust-free conditions – helping processors benefit from efficient mixing, low temperature rises and cleanability.

"The dust cloud that remains in the free space of the mixing container is effectively aspirated before undocking," it says.

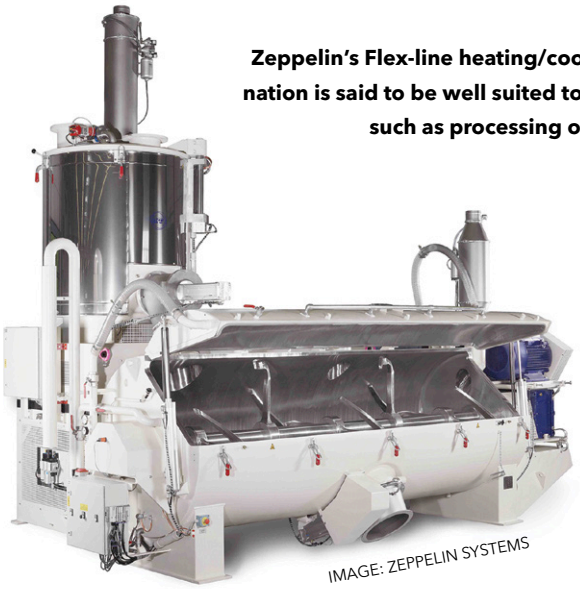

IMAGE: ZEPPELIN SYSTEMS

Zeppelin's Flex-line heating/cooling mixer combination is said to be well suited to demanding tasks such as processing of titanium dioxide

It adds that a sealing system between the container and mixing plate prevents dust from escaping. This reduces the excess pressure, and the remaining dust is extracted over the entire container surface.

The two-stage sealing system initially only opens the mixing chamber to aspiration when the container is undocked, which prevents dust escaping. The wide area aspiration – and an additional intake of external air via a filter system – enables an efficient air exchange, it says. Dust particles are transported "quickly and safely" out of the mixing chamber into a suitable aspiration system; aspiration openings are positioned to avoid cross-contamination.

CLICK ON THE LINKS FOR MORE INFORMATION:

- **www.deltatecnic.com**
- **www.lomonbillions.global**
- **www.venatorcorp.com**
- **www.chemours.com**
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Close control: new ways to raise product quality

IMAGE: PIXARGUS

Downstream add-ons, software additions and product upgrades are just some of the ways in which extrusion companies can boost control of their machinery – and improve product quality

Controlling extruder conditions – from energy consumption to product dimensions – helps to ensure manufacturing efficiency and final extrudate quality. This can be done in a variety of ways, from add-ons to software upgrades.

Pixargus says that its SawControl module makes profile cutting an integrated element of quality control – helping to minimise waste.

It has been used by Cooper Standard – a leading supplier to the automotive industry.

The new software module uses results from the Pixargus ProfilControl 7 inspection systems to optimise profile cutting. SawControl ensures that all profiles cut to customer-specified lengths are free of defects, and any profile sections that contain flaws are cut away.

Even the standard version of ProfilControl 7 can send defect signals to the cutting saw to ensure that flaw-containing parts are cut out. However, the new module 'tells' the saw the correct spacing for cuts

"We have integrated all inspection and defect detection activities, such as defect marking and the spacing within the cuts, into one control loop," said the company. "Therefore, the system now plays a pivotal role for this process step."

If ProfilControl 7 detects a flaw in the product, SawControl will cause the saw to make an extra cut in real time at a shorter spacing. After the 'defect' has been cut out, the saw will resume cutting at the regular interval.

Cooper Standard, a US-based supplier to the automotive industry, is already using the new module at its location in Lindau, Germany, where it produces sealings for body shells.

"The Pixargus module integrates the profile cutting process into our quality control system, which provides a number of benefits," said Dominik Schramm, senior manager in sealing extrusion at Cooper Standard. "We can establish a straightforward link to the sawing unit control – even in

Main image: The SawControl module from Pixargus cuts profiles to length – and removes defective portions

existing lines using older models."

■ In addition, Pixargus recently upgraded its ProfilControl 7 S inline inspection system for corrugated tubing – saying that it reduces the effort of checking these pipes for flaws.

In corrugated tube extrusion, inspection systems must deal with alternating sections of corrugated and plane structures. Certain sections may require other inspection modes – or the corrugator may engrave features into an extruded product that must not be detected as defects. For this, the updated product offers special algorithms that raise automation in quality inspection.

"It is our aim to supply systems that ideally need no setting up by the operator," said Jürgen Philipps, managing director and head of technological development at Pixargus.

PVC output

At K2022, **Battenfeld-Cincinnati** revealed details of Steady Flow – a software module that minimises pulsation in PVC extrusion. This helps ensure even, continuous output – for reliable, high-quality products.

In PVC processing with counter-rotating twin screw extruders, pulsations of the material flow are unavoidable. These are caused by C-shaped chamber profiles formed by the pair of screws. For smaller throughputs – such as when making small technical profiles – the fluctuations are more significant.

The new module harmonises these fluctuations for constant material discharge.

Melt pressure in front of the extrusion die is measured continuously, and screw speed during each screw rotation is constantly re-adjusted on the basis of the pressure fluctuations. The software includes a learning function, which automatically calculates optimal parameters for the compensation of pulsation during the first production run with any new products or new materials.

The screw speed correction parameters identified are saved in the product recipe and remain available for new production start-ups. Pressure fluctuations are then reduced – with the result of a low-pulsation melt flow passing into the forming die. This leads to better semi-finished product quality with fewer dimensional fluctuations – for optimal utilisation of the material.

Steady Flow can optionally be integrated into the BCtouch UX control system of every new PVC extrusion line. It can also be retrofitted to existing lines with a modern control system from the UX series. The product is already being used by several customers.

IMAGE: BAUSANO

Right: Bausano's Smart Energy system helps reduce energy consumption when fitted to a Nextmover twin-screw extruder for pipe production

Extruder add-ons

Bausano of Italy showed a number of add-ons for its extruders that allow closer control of energy use and extruder output.

Its Smart Energy system – for cylinder induction heating – helps to reduce energy consumption. During the show it was fitted to a Nextmover twin-screw extruder and an E-Go R single-screw extruder – whis is designed for recycling plastics.

The system features force-cooled induction coils with special openings that allow air to pass through and a temperature sensor to be installed. The coil is wrapped in insulating materials to minimise heat loss from the cylinder. Thanks to its internal design, airflow is channelled directly to the plasticising cylinder, to give faster cooling than resistive systems.

Advantages include: even heat distribution and lower coil surface temperature; fast heating up to 250°C; and accurate temperature control – thanks to reduced thermal inertia.

The Digital Extruder Control, with 21in screen, accurately monitors energy consumption at each stage of the process. Running in real-time, it allows intervention to manage motor power, temperature, oil control unit inspection, screw adjustment and other parameters. The line can also communicate with third-party systems – such as an in-line measurement tool – for accurate assessment of pipe's internal and external diameter and wall thickness.

Pipe checker

Molecor of Spain has developed an app called GeoTom, which helps installers to geolocate all parts of a piping network that they are fitting – and share project information with multiple users.

After downloading it for free – for both Android and IOS devices – the user requests access from Molecor. Once this has happened, pieces of the

network – such as pipe lengths – can be overlaid on a map. Molecor components can be added and geolocated automatically by scanning a QR code; other components can be entered manually.

Images and information can also be added about each component. Incidents can be reported directly from the app, to pinpoint its location.

The app, which was introduced at K2022, is available in multiple languages.

Keep talking

Thorsten Kühmann, managing director of **VDMA** Plastics and Rubber Machinery, told delegates at K2022 that machines must increasingly communicate with one another – using a 'global language' such as OPC UA.

At the show, around 40 companies from eight countries were running an OPC UA demonstration project, involving 85 machines. Each had an OPC UA logo and a QR code that visitors could scan with their smartphones. From here, they were taken to the UMATI internet platform, where they could see live data from each machine.

"For greater clarity, we installed a large dashboard in the VDMA Dome – where visitors could navigate each individual machine to see defined data," said Kühmann.

The most important factor, he said, is for "all machines to speak the same language and use the same system".

OPC UA implementation has already happened for core machinery such as extruders – and is now being extended to areas such as particle foaming and ancillaries, he said.

"This includes temperature control units and hot runner units, or liquid silicone metering," he said. "This is the horizontal level. Machines next to each other in a production hall can communicate with each other."

However, Kühmann said that many processors are still cautious about OPC UA applications.

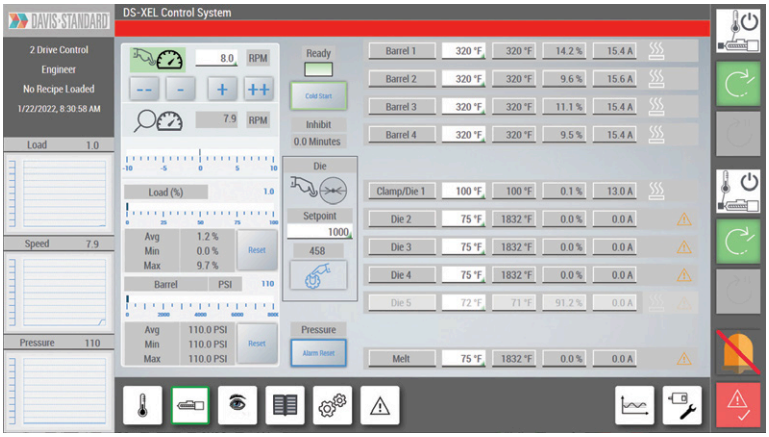

IMAGE: DAVIS-STANDARD

Above: Davis-Standard says its DS-XEL control system meets the needs of modern manufacturing

"They are worried that their data will not be handled carefully – and even that their competitors may gain access to it."

Part of the problem is that these data platforms have only been offered by individual companies or small consortia – which users do not trust. For this reason, VDMA is trying to establish a trustworthy, neutral platform that anybody can use.

Higher functionality

Davis-Standard has introduced its DS-XEL control system.

The system, which replaces mature discrete controls, implements high-performance HMI features to meet the data and process information needs of modern manufacturing, says the company.

It focuses on active functions for a better operator experience and improved connectivity, according to the company. The DS-XEL will be the new standard control for Davis-Standard's Super Blue and HPE extruder lines and is compatible with the DS Activ-Check cloud-based platform. It is also available as an upgrade to existing extruder controls.

"This controller merges the latest PLC and HMI offerings to enable an operator-friendly package with greater attention to detail," said John Clemens, director of extrusion controls at Davis-Standard. "It also incorporates key features only available


IMAGE: CONAIR

Righ: Conair's Thermolator TW-T temperature control unit helps to simplify operation and maintenance

with larger system controllers for troubleshooting and process improvement."

The system shows on-screen graphic trending of essential extruder parameters, with visual tracking of temperature, barrel pressure, motor speed and motor load. Speed deviation from setpoint is displayed, along with an extruder maintenance run timer and heater zone alarms – indicating deviation, process temperature, power failure, heater load and sensor break. Maximum, minimum and average motor load is captured during each production run.

Recipe creation and storage allows repeatability of multiple products on the same line.

Other advantages include process alarm logging, real-time and historical data trending, auto and self-tuning of heat zones for quick die changes, and an on-screen display of individual zone heaters.

At the recent K2022 show, the company also gave a live demonstration of its DS Activ-Check – a platform that can be installed on both Davis-Standard and Maillefer machinery. It comprises a suite of analytical tools, cloud and local data storage options, and process and equipment technology algorithms.

Simplified operations

The Thermolator TW-T temperature control unit (TCU) from **Conair** includes several new features that simplify operation and maintenance.

TW-T units sized at 3 hp and below also require 15% less floor space than earlier designs. All sizes (from 0.75 to 10 hp) have an open-back cabinet that allows air flow around pumps and other internal components while enabling visual maintenance inspection without having to remove cabinet panels.

One new feature, automatic phase detection, causes an alarm to sound if the TCU is powered up using incorrect wiring. This means it is no longer necessary to look at pump shafts to determine rotation.

The new model also has a dynamic maximum setpoint. Cooling-water supply pressure determines the machine's maximum setpoint, allowing processors to work around plumbing limitations. Low-pressure installations can now operate at lower temperatures, while higher water pressure gives access to a full high-end range of setpoint temperatures.

In addition, a modulating cooling valve ensures consistent temperature control without valve changes or deadheading.

TW-T units are also now equipped with Conair's common control platform – which delivers the same user experience regardless of equipment type.

With the new TCU control, calculated flow rates – or current readings from an optional integrated flow meter – are always available. Also, trend curves of historical readings can be used to help identify potential problems before they arise.

Below: Technotrans has launched a new oil temperature control unit

IMAGE: TECHNOTRANS

High temperatures

Technotrans has launched a new oil temperature control unit.

Its Teco CT 130 Base 60 is compact and has high power density – offering temperatures up to 130°C and a heating capacity of 6 kW. Customised versions go up to 400°C and have a heating capacity of 750 kW

"By adding to our product series, we now offer an extensive portfolio of oil temperature control units with a temperature range of 130-350°C and a heating capacity of 4-54 kW," said Ralf Radke, head of the temperature control sector of Technotrans.

The unit has a recirculation rate of up to 60 litres/minute. Thanks to its integrated 'longlife' stainless steel heating cartridge, heat is transferred in a loss-free manner. In addition, multi-voltage variants from 400 to 460 V – as well as dual-frequency versions for use in 50 Hz and 60 Hz networks – are also available. A large heat exchanger surface provides a cooling capacity of up to 30 kW.

The new unit has a microcontroller and a membrane keypad with a seven-segment display.

CLICK ON THE LINKS FOR MORE INFORMATION:

- **www.pixargus.com**
- **www.battenfeld-cincinnati.com**
- **www.bausano.com**
- **www.molecor.com**
- **http://vdma.org/plastics**
- **www.davis-standard.com**
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Frankfurt, Germany

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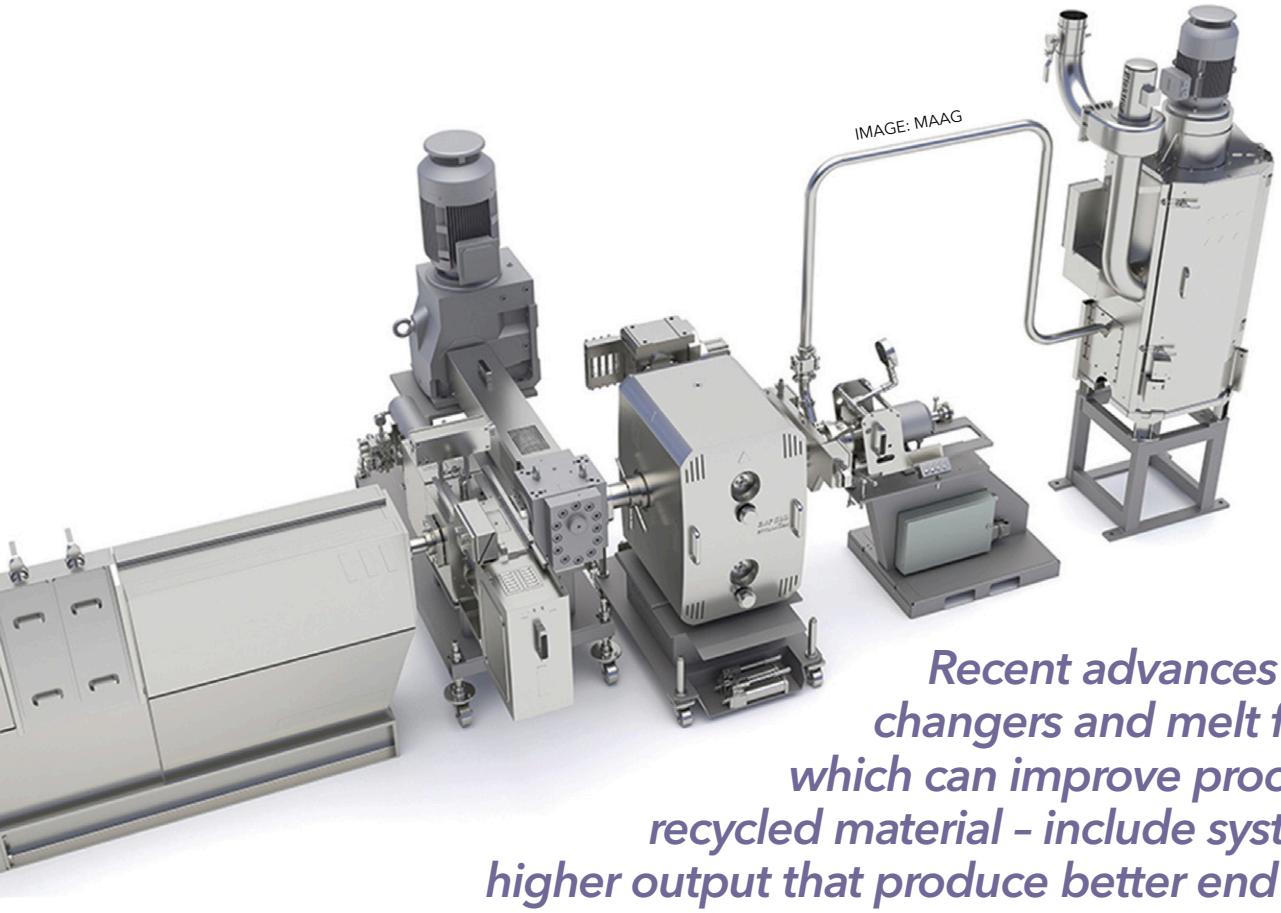


Recent advances in screen changers and melt filtration – which can improve processing of recycled material – include systems with higher output that produce better end products

Filtered information: latest in melt filtration

There is increasing use of recycled materials in extruded products such as profiles. Producers must be confident of maintaining product quality – and one way to do this is with more effective filtration of the polymer melt. There are many systems to do this – and are typically exhibiting improvements such as higher throughput, greater accuracy and the ability to work at constant pressure.

Constant pressure

Nordson says that a new feature of its BKG filtration systems – a melt pressure-controlled venting start – makes them a good fit for profile extrusion.

A screen change is a sensitive step in the filtration process. The piston is exposed to the atmosphere, and air enters the cavity. Air entrapments in the polymer melt can appear in the final product – reducing its quality.

BKG continuous filters have an elaborate venting system, ensuring that air escapes completely before filtration continues, says Nordson.

Air is displaced during the venting process when the melt floods into the cavity after the piston moves back into the housing. It escapes through special venting grooves in the piston. Timing and precision are critical here. Producers need the air out and the piston back in the filtration position as quickly as possible. However, if the cavity fills up too fast, it can cause pressure fluctuations. This can cause discontinuations in the process and problems with the end product.

In Nordson's piston-type melt filters, the piston design allows a controlled melt inflow, ensuring that the cavity fills slowly – and no pressure drops occur.

With the melt pressure-controlled venting start, processors can control the melt inflow more precisely. First, they determine a maximum allowed pressure drop by considering the processed material and the product requirements. The piston then moves in a stepwise fashion, and the cavity fills up slowly. Pressure is monitored closely. If the cavity fills too fast – and pressure drops below the allowed value – the piston moves back. This cuts

Main image: The Ettlinger recycling melt filter sits at the heart of Maag recycling systems

the amount of melt flowing into the cavity. The piston then moves forward in smaller steps to ensure the melt is gradually withdrawn from the production flow.

Nordson says its BKG filtration systems ensure that melt is clean – being particularly useful when incorporating recycled content – and help to create a uniform, high-quality end product.

As well as constant pressure, it is also important to control flow rate – and this can be achieved using a product like a BKG EP extrusion pump. These deliver constant, reliable pressure, to provide a well-metered flow rate. The pumps help to reduce pressure fluctuations and balance out dosing and pulsing issues by the extruder.

Recycling systems

Maag says that its recycling systems help users to remove heavy contaminants such as paper, aluminium and wood to produce reusable pellets. The systems are co-ordinated to each other and can be operated via the company's proprietary control system.

Modern recycling systems must be able to handle feedstock of varying quality grades. Maag says its EX125-6 recycling pump provides precise, uniform pressure for downstream filtration over a wide range of feedstock inputs.

At the heart of Maag recycling systems is the Ettlinger recycling melt filter, which runs continuously at high performance, it says. Melt with contamination content of 16% and particle sizes up to 4mm can be pumped into the filter for removal and discharge. The Eco 1000 achieves throughputs up to 10,000 kg/h depending on filter fineness ranging from 60 to 1800 microns. Both the ERF and Eco series are capable of filtering almost any polymer used in recycling operations, says Maag.

All Ettlinger recycling melt filters operate continuously, keeping the volume and pressure of the melt stream constant. This avoids increasing extruder speed, and as a result, cuts energy consumption by as much as 30%.

Below: Erema's new 406 laser filter has a 50% larger screening area, to reduce pressure and temperature

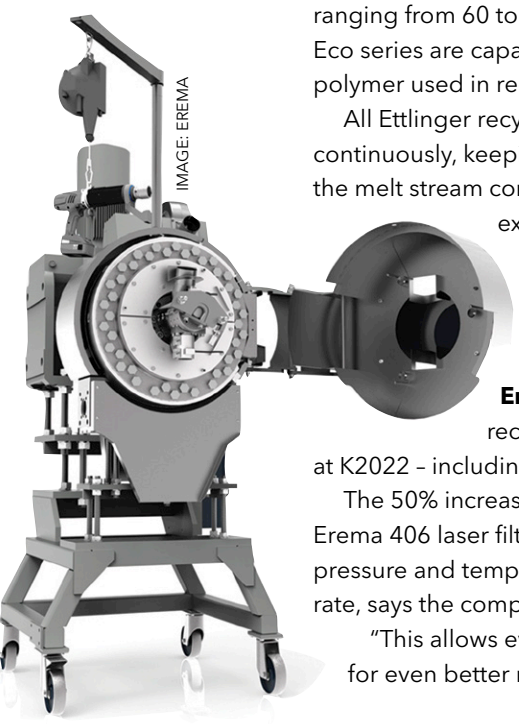


IMAGE: EREMA

Laser precision

Erema presented several new recycling systems and components at K2022 – including a new laser filter.

The 50% increase in the screen area of the Erema 406 laser filter helps to ensure lower pressure and temperature at the same throughput rate, says the company.

"This allows even finer screens to be used – for even better results – in quality-intensive

Real time oil quality sensor and data collection and monitor from US company Early Warning Technologies

IMAGE: EWT

Oil monitoring unit to protect gearboxes

Process + Filtration Products in the USA provides technologies for filtration of polymers, water and oil. It sells Rajhans Plastics Machinery RJC and RJSC dual-channel screen changers, made in India. The company, headed by Bob Vogel, also has a business called Early Warning Technologies (EWT), which offers sensor-based technologies and a dedicated alarm and monitoring system to provide alerts of potential failure of engines and equipment using lubricating or hydraulic oils.

He says one of the key factors in proper performance of gearboxes is maintaining the protective qualities of the lubricating oil. Oil will, over time, lose its lubricating protective qualities. This will be as a result of being subjected to excessive heat, the effects of shear, contamination by dirt and water or particulates. The deterioration of the oil will eventually cause gear components, seals and other parts of the gear box to wear requiring maintenance or replacement.

EWT's oil monitoring program incorporates an oil quality sensor and Express Monitor technology developed by Tan Delta Systems to provide continuous monitoring of the oil by sampling it every 60 milliseconds with a sensitivity of 15 ppm.

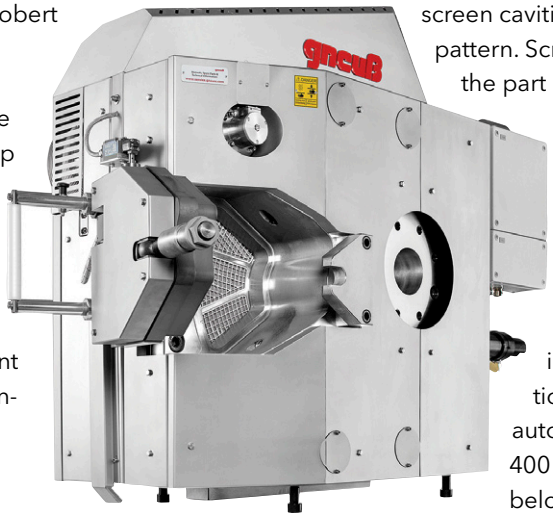
The real time data collection and analysis will indicate trends and sources of accelerated oil degeneration, pinpointing the exact time and its nature. Sensor data is captured and displayed in a traffic light format for an immediate visualisation of the oil condition. The monitor also shows the TD Number index, representing oil quality values from new to end-of-life, rate of change and temperature. EWT's technology group provides support in data interpretation and identifying potential sources of oil degeneration.

plastics applications," said Robert Obermayr, head of Erema's Powerfil subsidiary.

The Quattro version of the LF 406 laser filter can filter up to 9,000 kg/hr of melt.

"Plastic recycling has become a must-have, even for input streams with higher levels of contamination," said Obermayr. "Efficient filtration systems are indispensable for achieving the specified melt quality using existing extrusion systems."

IMAGE: GNEUSS



Left: The RSFgenius, from Gneuss, has integrated back-flushing that offers effective self-cleaning

For this reason, the company offers the melt filters as individual components for existing Erema machines and third-party extrusion systems. The product range includes the SW RTF partial area backflush system and the laser filter.

Both types of filter are easy to integrate into an existing recycling plant and available in many sizes and variations. Whether the customer uses the backflush filter or the continuous laser filter depends on the throughput and level of contamination of the material. The laser filter is ideal for heavy contamination, says the company – and can handle impurity levels up to 5% and filtration as fine as 70 microns while continuously cleaning the screen with a scraper.

Models on display

Gneuss exhibited several different models of its patented rotary filtration systems at K2022. These are characterized by a filter disk on which the screen cavities are located in a ring pattern. Screens can be changed on the part of the filter disk that is not active in the melt channel, while production continues without interruption.

Its main model, the RSFgenius, has an integrated back-flushing system offering self-cleaning for demanding applications. Screens can be automatically re-used up to 400 times and filtration fineness below 10 microns/1200 mesh is available. An RSFgenius 250 was on display at K2022. It has an active screen area of 1350 sq cm and throughputs of several thousand kilos per hour, depending on the type of polymer and the filtration fineness.

Retrofitting an RSFgenius to an existing extrusion line allows the use of more contaminated – and often cheaper – material, says Gneuss.

There was also an SFneos 150 and SFXmagnus 90 on display. These are also continuous, pressure and process constant, but not backflushing – so the systems are for applications that do not require self-cleaning.

CLICK ON THE LINKS FOR MORE INFORMATION:

- **www.nordson.com**
- **www.maag.com**
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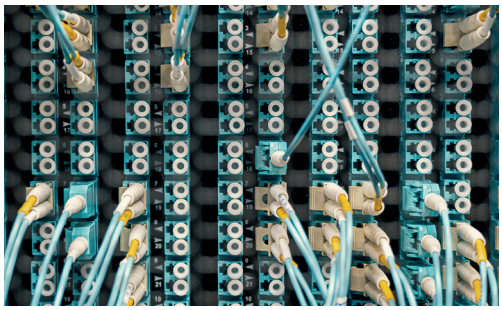

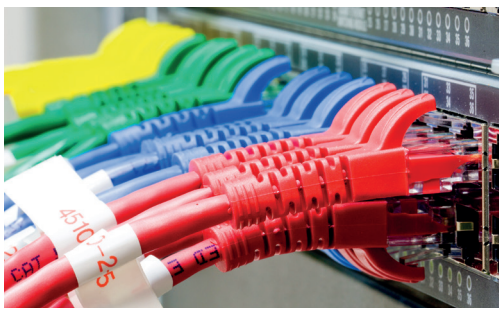

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RECYCLING

Phthalate plasticisers improve electrochemical recycling of PVC

Researchers at the University of Michigan in the USA have devised a way to recycle PVC electrochemically – using phthalate plasticisers within the material to drive the reaction.

"PVC is the kind of plastic that no one wants to deal with because it has its own unique set of problems," said Danielle Fagnani, co-author of a paper on the research in *Nature Chemistry*. "PVC usually contains a lot of plasticisers, which contaminate everything in the recycling stream and are usually toxic. It also releases hydrochloric acid really rapidly with some heat."

When PVC is mechanically recycled, the heat used in the process can cause plasticisers to leach out of the material and into the recycling stream, say the researchers. In addition, hydrochloric acid is released – which can corrode equipment and threaten worker safety.

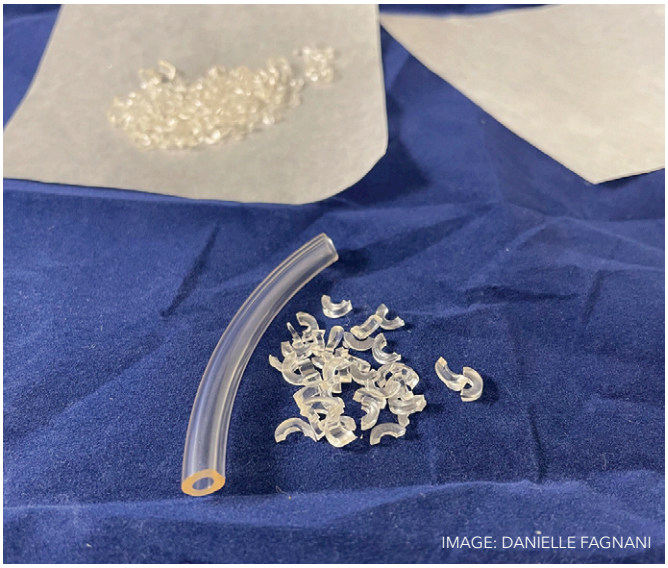

IMAGE: DANIELLE FAGNANI

To find a way to recycle PVC that did not require heat, the researchers looked at electrochemistry – and found that the presence of plasticisers helped to improve the efficiency of the process.

"We found that it still releases hydrochloric acid, but at a much slower, more controlled rate," said Fagnani.

Using electrochemistry – rather than heat – introduces an electron into the system, which gives it a negative charge. This breaks the carbon-chloride bond in PVC, producing a negatively charged chloride ion. Controlling the rate at which electrons are introduced into the system helps to control how quickly hydrochloric acid is produced.

The acid produced can be used by industries as a reagent for other chemical reactions. The chloride ions can also be used to chlorinate small molecules called arenes – which can be used in pharmaceutical and agricultural components.

Fagnani says the study shows how scientists might think about chemically recycling other difficult materials.

› **https://umich.edu**

PVC

Wastewater system uses bio-attributed PVC

Vynova has supplied 'bio-attributed' PVC to Nicoll – which it is using in its Hometech silent wastewater evacuation system.

Nicoll says this will enable it to offer a low-carbon solution without compromising on quality, durability or performance.

Under the agreement, Vynova is supplying bio-attributed PVC – under its VynoEcoSolutions brand – to Nicoll in France. It is estimated to have a 60% lower carbon footprint than the conventional end product.

"This new bio-attributed resin is a logical next step in our sustainability ambitions," said Benoît Fabre, vice president of Aliaxis France – Nicoll's parent company.

The bio-attributed PVC is produced from biomass feedstock that does not compete with the food chain. The VynoEcoSolutions portfolio also includes circular-attributed and renewable PVC ranges.

IMAGE: NICOLL

› **www.vynova-group.com** › **www.nicoll.fr**

DIES

Cross-heads coat single- and multi-layer pipes in diverse applications


IMAGE: CONEXTRU

Austria-based Conextru has developed a range of cross-heads that can coat both steel and plastic pipes.

Pipe coating offers flexible production and can be integrated into existing extrusion lines.

The coating structure can be mono- or multi-layer. Monolayer coating is mostly as a final protection layer and applications are diverse. Examples include a PP protection layer for water pressure pipes, or a PE-RT layer for an RTP pipe used in oil and gas applications.

"The range in diameters goes from very small up to 1200 mm," said Josef Dobrowsky, managing director of Conextru.

Multi-layer structures are also possible, and can be applied to steel or plastic pipe. Typical polymers for such applications include polyamide, PET, EVOH and PPS.

A cross-head system typically consists of a helical or radial spiral distributor. Conextru offers a library of geometries for this melt distribution systems and – depending on material and output – the most suitable geometry is applied.

There is no standard product range as each head is tailored for a project. Making a new one typically takes between three and five months.

The largest head produced so far is a monolayer head up to 1200 mm for coating steel-reinforced RTP pipes. The smallest so far is for applying a two-layer coating to a 16 mm pipe.

› **www.conextru.eu**

MEDICAL

Teaming up for polycarbonate pipettes

Conair, Davis-Standard and Zumbach Electronics will demonstrate extruded polycarbonate pipettes at the forthcoming MD&M West/Plastec West 2023 show in Anaheim, USA.

The pipettes are made by extruding medical-grade, 0.25in polycarbonate tube, which is then cut into 5in pipettes that need no secondary cleaning or finishing operations. Several Conair products are used on the line.

The polycarbonate will be pre-conditioned using a Conair dX25 Carousel Plus desiccant dryer. It regulates critical drying setpoints and resin moisture and automatically regulates material movement through to the extruder. Polycarbonate moving from the hopper to the extruder also passes through Conair's Moisture Minder, an in-line device that reads the moisture content of moving resin.

The material is processed in a Davis-Standard 1.25-inch HPE Horizontal Extruder, which has the torque capacity to handle high-viscosity resins. It is available in sizes from 0.75in (20 mm) to 1.75in (45 mm).

From here, the melt passes through sizing inserts as it enters a water-filled, non-contact calibration head mounted at the front end of a Conair MedLine MedVac 235 vacuum sizing tank – which supports cleanroom applications and is equipped with automatic vacuum control and touchscreen HMI.

IMAGE: CONAIR

The vacuum chamber in the MedVac sizing tank creates a differential in air pressure that exerts slight outward pressure in the extruded tube, stabilising its dimensions. Here, ultrasonic wall-thickness gauges from Zumbach measure the OD and wall thickness of the tube, first as hot extrudate enters the tank and also later as it cools.

This is used to calculate the ID of the tube – the dimension most critical for medical fluid delivery.

› **www.conairgroup.com**
› **www.davis-standard.com**
› **www.zumbach.de**

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INOEX: WARP PIPE MEASUREMENT

The WARP contact-less radar-based pipe measurement system from Inoex uses terahertz technology to provide simple and effective multi-point dimensional control of thick and thin wall plastic pipes. Learn more in this brochure.

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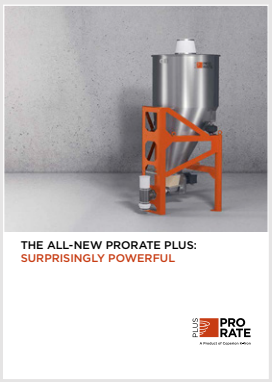
COPERION: PRORATE PLUS FEEDER



The new ProRate Plus feeder system from Coperion K-Tron offers a cost-effective and simple-to-configure gravimetric option for processors looking for reliable handling of pellets and free-flowing bulk powders.

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MIXACO: I4 CONTAINER MIXER

Mixaco is a leading innovator in container mixing technology. It developed its i4 Container Mixer design to deliver the level of performance, flexibility, quality and efficiency expected in the age of Industry 4.0.

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DAVIS-STANDARD: PIPE & PROFILE

Davis-Standard supplies a wide range of extruders and extrusion systems for pipe, profile and tubing applications, including medical tubing. This brochure details the range of equipment available and key performance benefits.

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NDC: PRECISION GAUGING

The Accuscan Pro series single-axis diameter gauges are the latest addition to the NDC Technologies precision on-line measurement product line. Learn more about performance and features in this four-page brochure.

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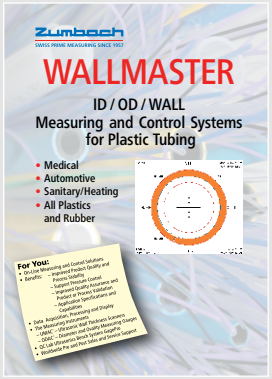
ZUMBACH: MEASUREMENT CONTROL



This eight-page brochure details the main features of Zumbach's Wallmaster measurement and control system for improving product quality, process stability and data capture in plastic tube and pipe extrusion applications.

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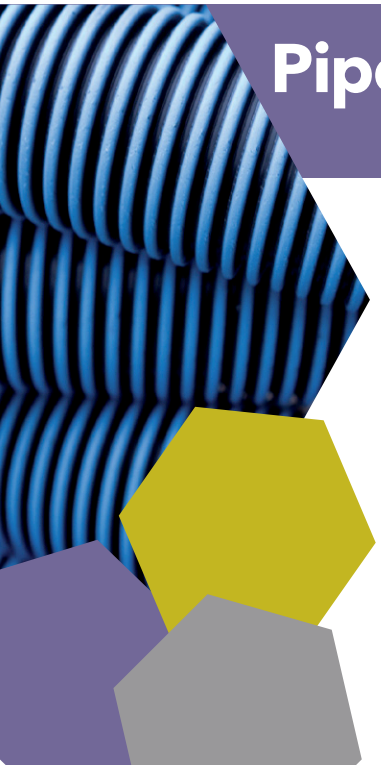
Politejo

Head office:	Estarreja, Portugal
CEO:	Pedro Catela
Founded:	1978
Employees:	Around 400
Turnover:	Around €180 million/year
Ownership:	Private
Profile:	Politejo, a producer of thermoplastic pipes and fittings, was founded in 1978. It supplies into a number of markets, including infrastructure, construction, agriculture, industry and mining – and some specialist operations such as desalination. The company has manufacturing operations in Europe, Africa and South America.
Product lines:	The company makes pipe up to 2000mm in diameter, in materials including PE, PP and PVC. In infrastructure, its products include pipe for water, drainage, sewage, gas and cable protection (including its Ambidreno grooved HDPE pipe). Construction applications include water pipe, and its Polidom PVC sewage pipe in diameters up to 200mm. In agriculture, it supplies its Lusogreen flat drip belt, which covers most crop water requirements. Its Polihidro HDPE pipes are used widely in applications including mining and desalination.
Factory locations:	Politejo has nine manufacturing plants across five countries – Portugal, Spain, Brazil, Mozambique and Angola – and exports its products across the world. The company recently supplied HDPE pipe up to 1100mm diameter for an onshore and offshore pipeline project in Galicia in northern Spain, using a special 'low sag' grade of HDPE from Borealis.

To be considered for 'Extruder of the Month', contact the editor on lou@pipeandprofile.com



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The next issues of Pipe and Profile Extrusion magazine will have special reports on the following topics:

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Editorial submissions should be sent to Lou Reade: lou@pipeandprofile.com

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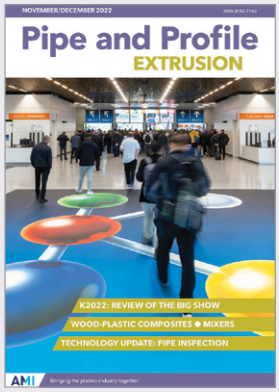

Pipe and Profile
November-December 2022
The November-December of Pipe and Profile Extrusion investigates how formulations with high recycled content are making wood-plastic composites more sustainable. Other features look at what's new in pipe joining and batch mixing, plus there is a review of K2022.

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Pipe and Profile
October 2022
The October edition of Pipe and Profile magazine looks at the latest advances in pipe inspection. This issue also explores new developments in material handling equipment and PVC-O pipe technology. Plus, a preview of some of the new material introductions to see at K2022.

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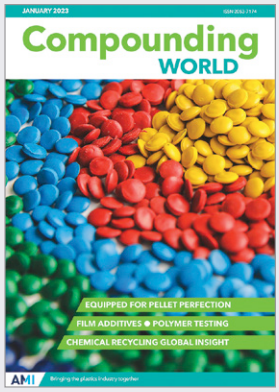

Compounding World
January 2023
The January 2023 edition of Compounding World magazine starts the year off with a look at efficiency gains in new pelletisers, pellet inspection, additives for film production, and developments in polymer testing.

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Plastics Recycling World
November/December 2022
This edition of Plastics Recycling World takes a look at the latest PET recycling equipment that was on show at K2022 in Germany. It also explores new EU regulations on food contact process authorisation and reviews progress in chemical recycling.

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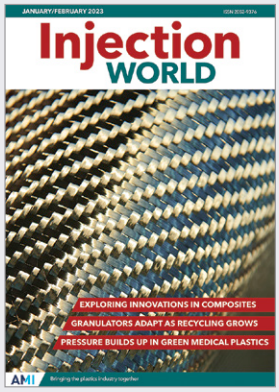

Injection World
January/February 2023
The first 2023 edition of Injection World magazine looks at the latest developments in thermoplastic composites. It also explores the latest granulator introductions and highlights some of the newest materials for the demanding medical sector.

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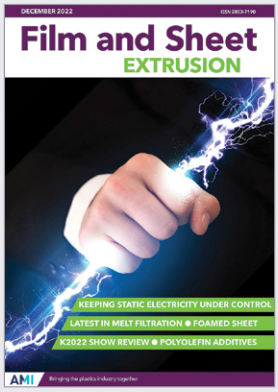

Film and Sheet
December 2022
The final 2022 edition of Film and Sheet Extrusion looked at some innovations in the field of static control. It also explored the latest developments in melt filtration, foamed sheet, and new additives for clarifiying and nucleating polymers.

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17-20 April	Chinaplas, Shenzhen, China	www.chinaplasonline.com
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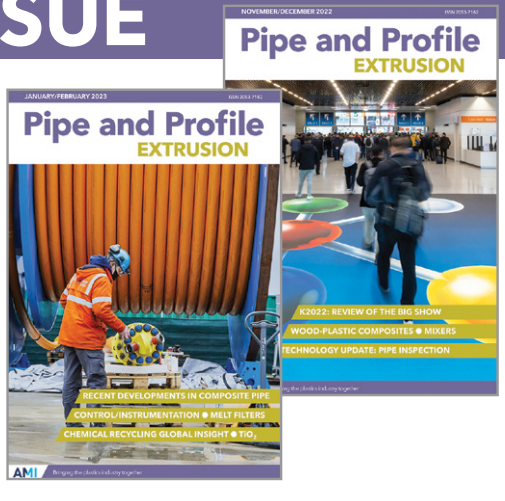

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Chemical Recycling
GLOBAL INSIGHT 2023

Letter from the Editor

Welcome to Chemical Recycling Global Insight 2023, a special publication written and produced by AMI Magazines, with support from AMI Consulting. This takes the story forward from the 2022 publication a year ago, updating news and information on the evolving chemical recycling industry.

The opening article is written by Silke Einschuetz, the chemical recycling specialist in our consulting team, who draws on the knowledge she has gained in preparing an in-depth 2022 report for AMI to present the challenges currently facing the industry.

Included are informative articles on: the various technologies used in chemical recycling, including their differences and relative advantages; a model pyrolysis feedstock specification which aims to improve the quality of input material; and mass balance, as applied in chemical recycling.

You will find our article on what's new in chemical recycling projects very helpful in staying up-to-date with the many facilities being built around the world.

David Eldridge – Editor
AMI Magazines

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IMAGE: SHUTTERSTOCK

Chemical recycling issues, such as feedstock availability, echo some of those in mechanical recycling. ***Silke Einschuetz****, author of AMI Consulting's Chemical Recycling Global Status 2022 report, writes about the challenges for the industry*

An assessment of the industry's challenges

Mechanical recycling of plastics has recorded significant growth over the past years, but it comes with technical and legal limitations especially where more highly contaminated material streams are concerned. In particular:

- it has limitations regarding the types of polymers and formats it can process (for example, flexible films, multilayer structures);
- the quality of the polymer deteriorates with each recycling cycle leading to losses in material properties and build-up of additives and other contaminants;
- legal frameworks do at present put strict limitations on the mechanical recycling of materials to be used for food contact applications.

In addition, it is becoming increasingly clear that the volumes of recyclate required because of legislative targets and voluntary brand commitments cannot be delivered by mechanical recycling alone within the given time frame.

Chemical recycling is thus considered as a complementary technology to mechanical recycling to meet legislative targets and voluntary pledges, and to accelerate the transformation to a more circular economic model. It enables the recycling of plastic materials that cannot currently be mechanically recycled, including contaminated, multi-layer and mixed plastics, and some food contact materials.

Based on AMI's research, global installed input capacity for chemical recycling in 2022 was 1.2m tonnes, forecast to increase to 8.7m tonnes by 2030. Pyrolysis is forecast to account for 46% of installed input capacity by 2030.

Four chemical recycling technologies are present in the market landscape today, together with a number of 'other' technologies which to date do not neatly fit into a defined category. (also see Technologies article p9). They differ in the types of polymers they can process, the outputs they produce, and the stage of maturity the facilities present in the market have achieved to date. ›

Chemical and mechanical recycling both have the goal of producing quality products

In its report *Global Plastics Outlook: Policy Scenarios to 2060,* the OECD describes plastic pollution as one of the great environmental challenges of the 21st century. Under current policies the report states that, by 2060, both the use of plastics and the amount of plastic waste could almost triple globally, with half of all plastic waste still being landfilled and less than a fifth recycled.

Feedstock questions

Theoretically, there should thus be plenty of feedstock available for both mechanical and chemical recycling. The challenges lie in the fields of waste collection and sorting – only plastic waste that is collected and, at the same time or in a subsequent step, separated from non-plastic waste and sorted and cleansed is available for recycling processes. Feedstock sourcing can thus be challenging for both mechanical and chemical recycling facilities, with the extent of the challenge growing with a facility's input capacity (also see Feedstock article p16).

Several factors combine to make feedstock sourcing challenging, with the extent of the challenge growing with a facility's input capacity. Closely related to models of feedstock sourcing is the establishment of feedstock aggregation centres and preparation facilities which ensure that feedstock is of the required specification when it enters chemical recycling plants. The development of these facilities has emerged as a clear industry trend during 2022.

Depolymerisation plants and providers of solvent-based purification/dissolution technologies, with some exceptions, tend to design facilities with more moderate annual feedstock volume requirements, as the need to be more selective in the feedstocks they can process presents additional feedstock sourcing challenges. In contrast, some pyrolysis and gasification plants are designed at larger capacities, based on their claim to be able to process a more diverse mix of plastic waste and thus encountering fewer challenges in accessing suitable feedstocks.

When looking at facilities' capacities it also must be considered that feedstock volumes in excess of stated capacities must be sourced to account for feedstock loss during the material preparation process. In any case, chemical recyclers need to make the securing of sufficient feedstock supplies a key focus for their activities, with investors demanding evidence of feedstock security as one of the criteria when making investment decisions. Key questions to be asked include the following:

Volumes – How much feedstock is required for a given time period as well as for the years ahead based on any capacity expansion plans?
Security of supply – How secure are the volumes available from the feedstock sources/suppliers under consideration going forward, which contractual arrangements are necessary to secure supplies?
Composition – How much detail is available on feedstock composition and how homogenous are the volumes delivered over a course of time?
Pre-processing – How much pre-processing is required (sorting, cleaning etc)?
Cost – Is there a cost or a revenue stream associated with feedstock sourcing?
Logistics – Over what distances does the feedstock have to be transported and at what cost?

Despite chemical recyclers' pledges to focus on feedstock not suitable for mechanical recycling, at present, no clearly defined line can be drawn between feedstocks going to mechanical recycling and those targeted by chemical recyclers. As a result, concerns have been raised within the industry about the growing feedstock requirements of the chemical recycling industry creating competition for feedstock with mechanical recyclers.

At AMI Consulting, our detailed assessment of chemical recyclers' feedstock requirements by technology suggests that market forces – developments in the pricing of different types of feedstocks – will have their part to play in deciding which feedstocks will be accessible to the different elements in the recycling industry.

Regarding chemical recycling outputs, the mass balance approach is intended to provide a set of rules for how to allocate recycled content to different end products to be able to claim and market the content as "recycled", especially where pyrolysis technology is used (also see Technologies article). Ultimately, the amount of recycled feedstock that enters a steam cracker needs to equal the amount exiting it, thus providing a means to estimate the average recycled content in a product.

Regional differences

The development of the chemical recycling industry differs between regions across the globe. Europe is at present considered to be at the forefront of technological developments in chemical recycling technology. Combined with a better developed collection, sorting and recycling system and the presence of a variety of research centres and grant funding it has been leading the industry so far. Over coming years, developments in North America are,

however, forecast to accelerate at a faster pace.

South-East Asian markets are attractive for the industry owing to a large and growing population and the associated volumes of post-use plastics. Waste collection and sorting infrastructures do, however, remain largely underdeveloped and, with a few exceptions, there is an initial focus on mechanical recycling.

Approaching the last quarter of 2022, the chemical recycling industry had reached a significant threshold. Following many years of developments and announcements the first commercially active facilities are operating, and a significant number of plants are scheduled to start fully commercial operations imminently and during 2023. Even larger capacities are in the pipeline and scheduled to become operational during the forecast period to 2030.

Across the industry, there appears to be the perception that the time has come to deliver on the multitude of announcements made over recent years. Supply chain partners and investors are keen to see facilities starting fully commercial operations, proving that the relevant technologies can be scaled up to operate in an efficient and financially viable manner in the long term. Evidence that they can do so is, in many cases, still outstanding. The same applies to claims relating to carbon footprints, energy efficiency, risks to human health, and environmental externalities.

Lock-in effect?

Many concerns associated with the growing industry are related to the perception that it, together with other (re)-emerging technologies such as, for example, carbon capture and storage, attempt to offer a technological fix to the world's problems of high carbon emissions and plastic pollution, while otherwise business continues as usual.

A particular concern is that investments into what is a capital-intensive industry will potentially divert attention away from reducing virgin plastic production and plastic waste generation by creating a "lock-in effect" to an industry and supply chain that relies on a growing stream of waste plastic material for its operations.

It is for the chemical recycling industry to show, verified by independent third-party bodies, that it can deliver on its claims and promises without creating the lock-in effects outlined above, and by operating as a complementary technology to mechanical recycling, itself an industry characterised by innovations and advancements for the processing of a growing range of post-use plastics.

What is of concern in the ongoing debate around chemical recycling technology is the strong polarisation of opinions. While some proponents of the associated technologies praise their capabilities and promise the "biggest", "most efficient", "lowest CO2 footprint" plant which will contribute to solving the shortage of recycled material, opponents are quick to condemn "chemical recycling" as if it was one single technology, often with the claim that it involves "burning plastics".

Neither of these two positions is helpful. Overpromising and neglecting the (in some cases) justified concerns regarding facilities' externalities has the potential to damage the chemical recycling industry overall, while point blank criticism disregards the valuable contribution chemical recycling technologies can make in treating previously non-recyclable material streams.

Rather than focusing on the potential competition between two sets of technologies, each of which will need to play its part in improving recycling rates, a whole system approach to waste management and recycling needs to be developed. For this to happen, the focus of attention needs to shift to the ways in which waste material streams are being managed today. This would see the waste management industry evolving from a system that channels significant volumes of unsorted waste into landfill and incineration solutions, towards a system that aims to bring as many materials as possible back into circularity in a clear and decisive recognition of post-use plastics as a valuable resource rather than waste.

In many cases, this will require letting go of long-established vested interests and solidified structures of managing waste, and to move towards a higher level of co-operation and partnerships with the common goal of turning waste into valuable resources.

About the report

AMI Consulting's recently published ***Chemical Recycling Global Status 2022*** consists of two parts: a PDF report and an interactive Excel file. The file lists 181 chemical recyclers and their 456 sites. For each site, AMI analyses feedstock supply and offtake agreements. It provides a view of chemical recyclers' partnerships along the value chain at site level, putting their operations into the context of a network of industry relationships, investors, feedstock suppliers, technology partners, and buyers. The data includes available input capacity by region, technology and polymer to 2030.

To find out more about the report and how to purchase it, contact **astrid.dellaporta@amiplastics.com**.

Contact the author of the report, AMI consultant Silke Einschuetz, at **silke.einschuetz@amiplastics.com**.

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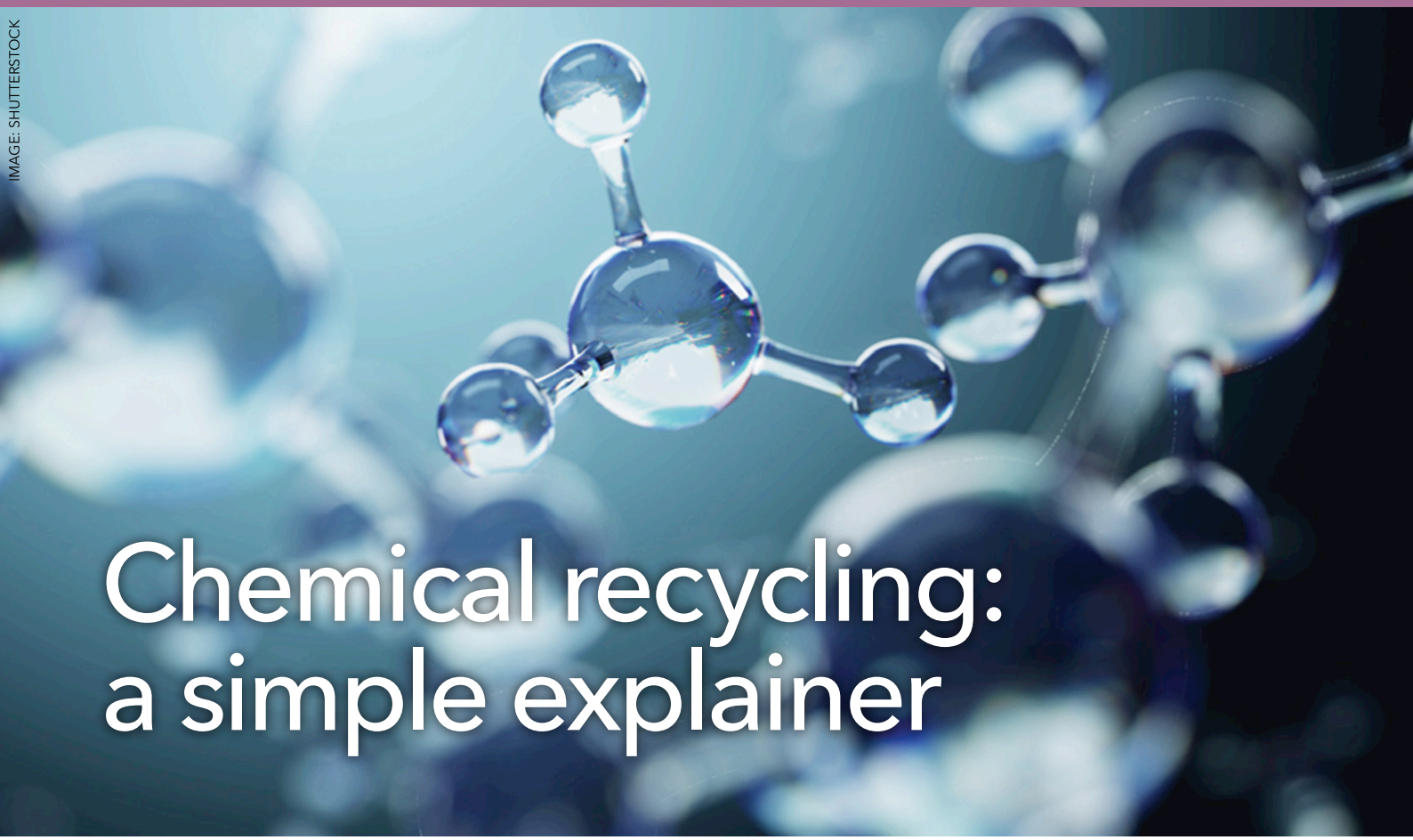

IMAGE: SHUTTERSTOCK

Chemical recycling: a simple explainer

Chemical recycling is a simple term encompassing a wide variety of technologies. ***Chris Smith*** *discusses the key features*

Chemical recycling – referred to as advanced recycling by some – is a simple name that brings together a quite broad portfolio of technologies, not all of which are, strictly speaking, chemical in nature. The first three most certainly are: depolymerisation, pyrolysis and gasification. The fourth – dissolution – does not fall so clearly into the "chemical" classification but is arguably much closer in process terms than it is to established mechanical recycling.

Depolymerisation is clearly a chemical recycling process, typically making use of heat and selected catalysts or enzymes to convert polymer back to building block monomers. It is most suitable for use with step-growth polymers such as PET, which are polymerised by polycondensation. A number of companies are developing processes to depolymerise PET, with pilot projects underway from Carbios in France, CuRe Technology and Ioniqa in the Netherlands, Rittec in Germany, and Eastman in the US.

Depolymerisation of polycondensation polymers generally involves reintroducing the molecular component eliminated during the original polymerisation process. Several solvolytic processes are being investigated to do this, including hydrolysis, glycolysis, methanolysis and transesterification. They involve multiple process steps including pre-treatment of the waste, followed by depolymerisation, monomer recovery, repolymerisation, and finally extrusion and pelletising.

Solvolytic depolymerisation techniques are not suitable for use with polymers produced by chain-growth or polyaddition reactions, such as PE, PP and PS. However, some companies – including Pyrowave in Canada and Agilyx in the US – are working with alternative depolymerisation technologies that have been shown to be capable of converting PS polymer back to styrene monomer at pilot scale.

Depolymerisation technologies produce new polymer of virgin quality. However, the chemistry used is highly specific so the incoming stream has to be consistent in terms of polymer composition, meaning considerable cost may be incurred in pre-sorting. Process energy requirements can also be quite high.

Pyrolysis is a thermal cracking technology that converts waste plastic – and contaminants that waste may carry – back to basic feedstock components such as hydrocarbons and syngas (a gaseous mixture of CO, CO_2, H_2 and CH_4). It involves heating the pre-sorted and shredded waste to temperatures of 400-600°C in an oxygen-free system to produce

Main image: Chemical recycling technolgies include numerous processes with very different inputs and outputs

IMAGE: TOTALENERGIES

Above: TotalEnergies is to take feedstock from a 30,000 tonne/yr Honeywell pyrolysis-based recycling plant, under construction in Spain

a range of hydrocarbons. These include gases, waxes, oils and char. As in conventional oil cracking, the yields of each component can be controlled to some extent by adjusting temperature, pressure, and residence time, as well as through the use of particular catalysts and thermal profiles.

Pyrolysis takes place in the absence of oxygen, so the process is only really suitable for polymers with a limited oxygen content, such as PE, PP and PS. Polymers containing high levels of oxygen or halogens – particularly PVC and compounds containing brominated flame retardants – must be sorted and removed from the waste input stream.

Oxygen and halogen concerns aside, pyrolysis can handle mixed polymer waste streams that would be highly challenging for mechanical or depolymerisation chemical recycling methods. However, it is an energy intensive process and the quality and mix of output materials is still dependent to some extent on the input stream. Much of the gas and liquid output from pyrolysis operations is likely to be burnt as fuel, either to provide energy for the process itself or because it is not of sufficient purity to be used as a chemical feedstock. Many of the companies active in this area prioritise conversion to fuel products but, under some regulatory and accreditation regimes, this is not recognised as recycling.

Key players in the development of pyrolysis technologies include Luxembourg-headquartered Clariter, Plastic Energy in the UK, Quantafuel in Norway, Encina, Nexus Fuels and Alterra Energy in the US, and GreenMantra Technologies in Canada.

Gasification is also a thermal cracking process but it differs from pyrolysis in that it is performed in the presence of a limited but controlled amount of oxygen. It can process almost any organic material – including plastic waste and biomass – and unlike pyrolysis can, in theory at least, accept polymers containing oxygen or halogens. The end result is predominantly syngas that, depending on its composition and purity, can provide production feedstocks.

Compared to pyrolysis, gasification requires fewer process steps. Pre-treatment of the waste (including water removal) is followed by the gasification step and then a cleaning stage to remove contaminants such as ammonia, H_2S, alkali metals, NO_x and tars. Like pyrolysis, it is an energy intensive process involving temperatures of 900°C or more and a significant part of the conversion output is used for energy.

Gasification technologies are under development for plastic waste applications by, among others, Enerkem in the Netherlands, Eastman in the US, and Showa Denko and Sekisui/Sumitomo in Japan.

Dissolution differs from depolymerisation, pyrolysis and gasification in that the plastic waste is not chemically converted to a new form but is dissolved in a carefully-selected solvent that allows fillers, pigments and other contaminants – potentially including secondary polymers – to be separated out.

Proponents of dissolution emphasise that the polymer undergoes a physical, rather than chemical, change and use terms such as solvent-based purification. However, it is clearly not a mechanical recycling process and, if for no other reason than its emergence as a recycling contender at the same time as chemical-based technologies, is usually considered as a chemical recycling process.

The key to success in dissolution is the selection of a solvent that recovers only the target polymer. This means it is best suited for use with relatively homogenous waste streams. A number of pilot projects are already well advanced – Purecycle Technologies in the US, for instance, is targeting PP with a technology licensed from P&G while Canada's Polystyvert is focusing its efforts on PS. Germany's APK is exploring technology to recover LDPE and PA from multi-layer films. And Fraunhofer's CreaSolv process is being further developed by CreaCycle in Germany and its PS Loop project in the Netherlands.

In theory, dissolution exposes the polymer to less thermal and physical stress during the recovery process than conventional mechanical recycling. However, as the recovered polymer is likely to require compounding or pelletising to make it suitable for further use, that gain may be mitigated. In addition, the cost of the numerous processing steps involved– pre-treatment, dissolution, filtration, precipitation, solvent removal and reformulation – is likely to make dissolution most attractive for processing of largely material waste streams with a relatively high level of contaminants that would be difficult to remove mechanically otherwise.

What's new in chemical recycling projects

IMAGE: TOTALENERGIES

The chemical recycling industry continues to be very active in construction, with progress made in pilot and production projects and the launch of major new investments.

Spurred by regulatory pressure and sustainability targets, the sheer number of chemical recycling projects entering the planning and development stages was evident in 2021 and continued through 2022. What follows is a round-up of recent developments around the world.

At the start of 2022, **Plastic Energy** announced its intention to build a second chemical recycling plant in Sevilla, Spain, which will transform end-of-life plastic waste into a feedstock called Tacoil using its patented recycling technology based on pyrolysis. **TotalEnergies** will use this feedstock to produce virgin-quality polymers. The new plant will process up to 33,000 tonnes/yr and is expected to be operational in early 2025.

In what proved to be a busy period for the French oil and energy company, shortly afterwards TotalEnergies entered into a commercial agreement with **New Hope Energy** under which the US company would build a pyrolysis plant in Texas to transform end-of-life plastic waste into feedstock. TotalEnergies has committed to purchase 100,000 tons/year of output. The plant is due to start operations in 2025. New Hope Energy's first plant, which has been operating in Tyler, Texas, since 2018, is currently undergoing an expansion which would make it the largest pyrolysis facility in the world.

In January, plastic feedstock management company **Cyclyx** (a consortium led by Agilyx) signed an agreement with **ExxonMobil** and **LyondellBasell** to develop a new $100m plastic waste sorting and processing facility in the Greater Houston area dubbed the Cyclyx Circularity Centre. The plant will produce feedstock for both mechanical and chemical recycling, and also use new and emerging technologies to analyse plastics based on their composition and sort them according to customer specifications. Engineering work has already begun with commercial start-up expected in 2024.

Pure Cycle Technologies received a financial boost after it made a $250m private placement of common stock and warrants to shareholders in March and welcomed new investor **SK Geo Centric,** which will support construction of its solvent-based PP recycling facility in Augusta, Georgia, US.

Eastman announced in January it was planning to invest up to $1bn in a material-to-material molecular recycling facility in France using its polyester renewal technology. The multi-phase project would include units to prepare mixed plastic waste for processing, a methanolysis unit to depolymerise it, and polymer lines to create a variety of materials for specialty, packaging, and textile applications. The plant, along with a new innovation centre, is expected to be operational by 2025.

In a significant development for chemical recycling in Asia, **Agilyx** and **Toyo Styrene** announced they would be entering into the construction phase of a large-scale project in Japan. Using Agilyx's depolymerisation technology, the plant will convert post-use polystyrene into styrene monomer purified using Toyo's proprietary purification process. The monomer produced can then be converted into high value polystyrene products.

LG Chem made a sizeable equity investment in **Mura**, which in 2021 announced a high-profile

Main image: TotalEnergies has production projects with partners in Europe and USA

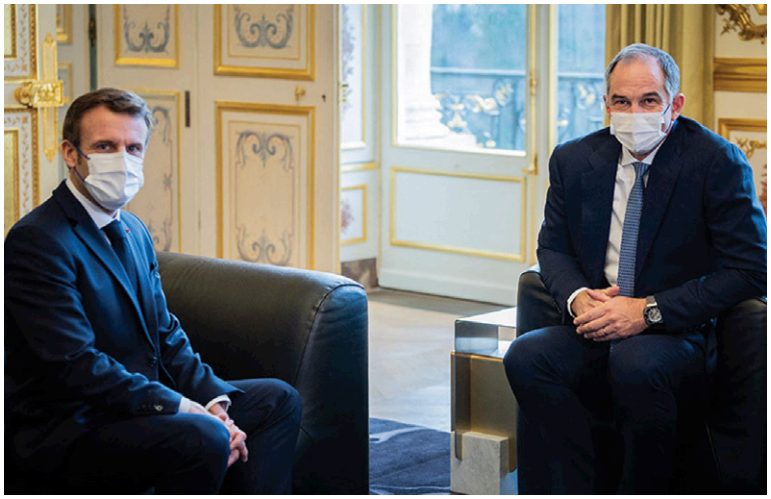

IMAGE: ELIOT BLONDET/ABACAPRESS.COM

Above: French President Emmanuel Macron (left) and Eastman CEO Mark Costa jointly announced Eastman's plan to invest up to $1bn in a recycling facility in France

partnership with **Dow**, and purchased a process licence from Mura's partner KBR to use Hydro-PRT technology in a hydrothermal upgrading facility in South Korea to recycle up to 25,000 tonnes/yr. A new Mura plant situated at Dow's Böhlen site in Germany is set to become the latest in a series of planned projects around the world designed to rapidly scale chemical recycling technology. The facility, expected to be operational by 2025, would deliver approximately 120,000 tonnes/yr at full run-rate. This and the other planned units could collectively add as much as 600,000 tonnes/yr of capacity by 2030.

Honeywell is forming a joint venture with **Avangard Innovative** to co-own and operate a chemical recycling plant within Avangard's NaturaPCR complex in Waller, Texas. This will use Honeywell's UpCycle Process Technology, a pyrolysis-based technology that Honeywell launched in 2021. The planned facility will have the capacity to transform 30,000 tpa and production is expected to begin in 2023.

Honeywell also signed a MoU with Egypt's **Environ Adapt** for **Recycling Industries** to explore the possibility of opening the first UpCycle-equipped facility in the country. The MoU enables Environ to conduct a feasibility study to explore trends, feedstock availability and potential markets, as well as perform technical studies pertaining to the operation of the plant and produce an overall project schedule.

US chemical recycling company **Encina** secured $55m of equity capital with participation from **IMM Investment Global** and **SW Recycle Fund**. It said it would use the funds, in addition to $20m in secured equity financing it had previously acquired, to move forward with the commercialization of its plastic waste-to-aromatics recycling business. Encina's current planned projects include facilities in the US and offshore projects in Asia and South America. Each plant is expected to process approximately 450,000 tonnes/yr of waste.

Early in 2022, **Neste** conducted a feasibility study to examine capacity for pre-treatment of liquefied waste plastic at its refinery in Porvoo, Finland. By mid-July it had secured a positive grant decision for up to €135m from the EU Innovation Fund for what by then was known as the Pre-treatment and Upgrading of Liquefied Waste Plastic to Scale Up Circular Economy (PULSE) project.

Neste also purchased European rights to **Alterra Energy**'s liquefaction technology, having acquired a minority stake in the US company in 2020, and will use it at the plant they are constructing with **Ravago** in Vlissingen, Netherlands, announced in October 2021.

Südpack and **Clean Cycle** signed an agreement for a long-term investment in **Carboliq** technology developed by **Recenso.** The catalytic tribochemical conversion process has been successfully used on mixed waste plastics at a pilot plant in Ennigerloh, Germany.

In Spring, **Toray Films Europe** and **Axens** announced a collaboration to study a potential PET chemical recycling plant in Saint-Maurice-de-Beynost, France. This would use Axens' Rewind PET depolymerisation process with purification steps to remove organic and inorganic compounds in waste PET, including colorants and pigments.

Norwegian chemical recycling company **Quantafuel** and French investment firm **Eurazeo** made an agreement to build a 50/50 sorting facility in Esbjerg, Denmark. The plant, based around a high-tech sorting system capable of separating plastic waste into mono fractions, will have 160,000 tonnes/yr capacity and be operational by the second half of 2023.

Ineos Styrolution signed an offtake agreement with **Indaver** in June to access styrene monomer recovered from waste yoghurt pots using the latter's depolymerisation technology. Indaver is building a plant in the Port of Antwerp, Belgium which is expected to recycle 65,000 tonnes/yr from 2024.

In a development that broadens its circular products offering, **Borealis** introduced its Borvida portfolio of circular base chemicals. The range will initially be based on non-food waste biomass and chemically recycled waste, and in the future will also draw from atmospheric carbon capture. The range will offer base chemicals or cracker products such as ethylene, propylene, butene and phenol with ISCC Plus-certified sustainable content from Borealis sites in Finland, Sweden, and Belgium.

In July, London-based clean tech company **Itero** announced that it had secured €6m (£5m) in funding to design and build its first demonstration

plant at the Brightlands Chemelot Campus in the Netherlands and awarded the construction contract to US engineers Fluor. The plant will employ Itero's patented modular technology based on pyrolysis to convert 27,000 tonnes/yr of plastic waste into oils, waxes and gas.

Valoregen is building what it says will be the largest hybrid recycling site in France combining mechanical and chemical recycling at a location in Damazan. It is hoped bringing these technologies together under one roof will minimise waste and increase energy efficiency. When it opens at the end of Q1 2023, the facility will have the capacity to process up to 70,000 tonnes/yr.

In late August, **Technip Energies** and Agilyx announced the launch of TruStyrenyx, an all-in-one solution for the chemical recycling of polystyrene combining Agilyx's pyrolysis process and Technip's purification technology. This launch followed favourable results from pilot plant testing conducted on various types of waste polystyrene including samples laden with flame retardant.

A collaboration between **Clariter**, **BioBTX**, **Bollegraaf**, and **N+P** unveiled in the autumn will see the construction of what is described as Europe's largest and most advanced chemical recycling sorting plant at Delfzijl in the Netherlands. With a capacity of 350,000 tonnes/yr, the facility will target the lowest-grade plastic waste and is expected to come online by 2025.

KTS, a Koch Engineered Solutions company, and **Ioniqa**, announced a partnership to scale up and commercialize Ioniqa's PET depolymerisation technology. As part of this collaboration, KTS committed to investing up to €30m.

In September, LyondellBasell announced the successful start-up of its MoReTec pyrolysis-based recycling pilot facility at its Ferrara, Italy, site. Then in October, it signed an agreement with **23 Oaks Investments** to create Source One Plastics, a joint venture to build an energy efficient sorting and chemical recycling facility at the Wesseling site in Germany. The final investment decision for the proposed 50,000 tonnes/yr plant is set for the end of 2023.

IMAGE: CARBOLIQ

Above: Carboliq technology

SK Innovation announced it will invest around $1.2bn to build a multi-process chemical recycling plant at its facility in Ulsan, South Korea. The complex could have a capacity of 250,000 tonnes/yr, and will include high-purity polypropylene extraction, PET depolymerisation and pyrolysis. Construction is scheduled to begin in September 2023.

At the K Show in October, **Sabic** presented a video celebrating the one-year construction milestone of the site it is building with Plastic Energy in Brightlands Chemelot, the Netherlands, known as SPEAR-SABIC Plastic Energy Advanced Recycling BV. The plant, which will produce ISCC-accredited circular polymers, is on schedule for an official opening in Q2 2023.

CLICK ON THE LINKS FOR MORE INFORMATION:

- **www.agilyx.com/cyclyx**
- **https://corporate.exxonmobil.com/**
- **www.lyondellbasell.com**
- **www.clariter.com**
- **www.agilyx.com**
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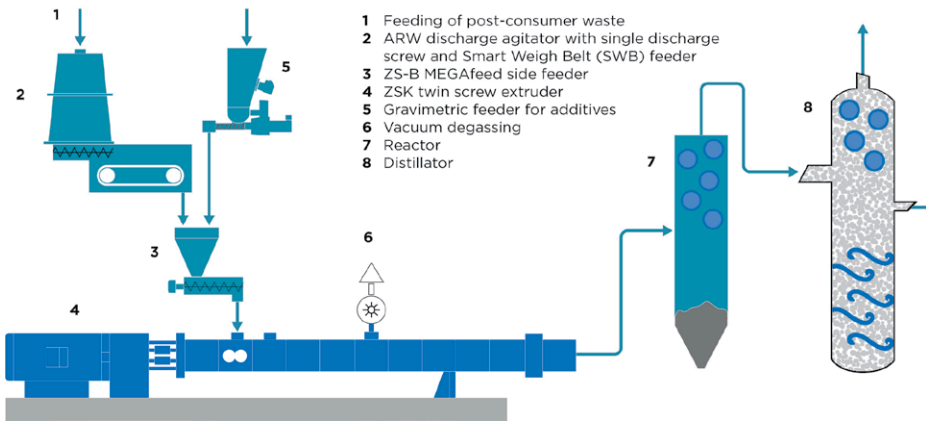

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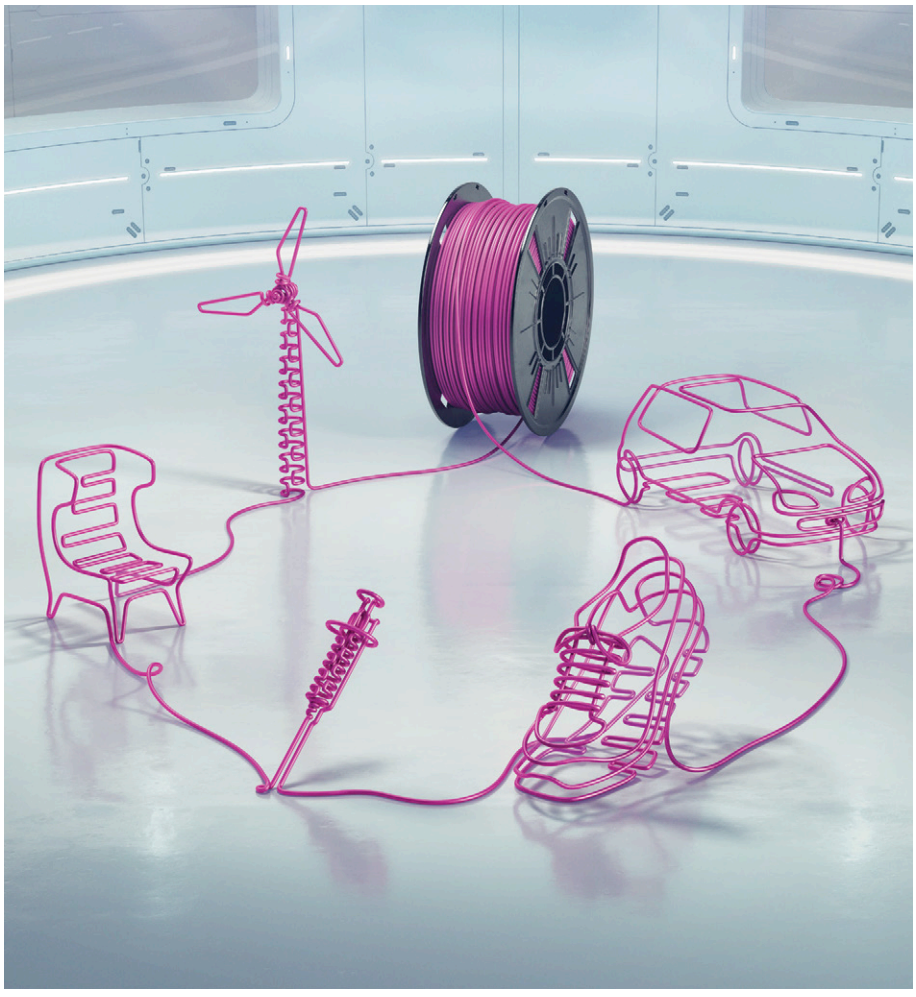

Every Circle needs a Center: Evonik Center for Circular Plastic Solutions.

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IMAGE: SHUTTERSTOCK

Improving pyrolysis feedstock quality

A model specification has been published showing contamination limits for waste input to pyrolysis processes

Pyrolysis recycling of mixed plastics waste requires feedstock with a consistently low level of contaminants, just as mechanical recycling does. Poor quality input results in poor quality pyrolysis oil output. The subject of input quality has been under the radar until recently but is gaining prominence as pyrolysis plant operators discuss their feedstock needs with waste suppliers during pre-commercial development projects.

"Improving our knowledge of feedstock requirements for pyrolysis can help progress the industry's understanding of how chemical recycling and mechanical recycling can work alongside each other," said Martyn Tickner, Chief Advisor of the Technical Solutions Centre at the Alliance to End Plastic Waste. In August, the alliance published a white paper commissioned from Eunomia which provides guidelines for a pyrolysis feedstock model that can be used in supply discussions.

The report *Feedstock Quality Guidelines for Pyrolysis of Plastic Waste* is based on interviews with 32 companies and organisations in Asia, North America and Europe. It finds that pyrolysis operators generally require well-sorted, clean feedstock comprising about 85% PE and PP. Moisture limits of around 7% are recommended and the report includes indicative thresholds for contaminants, such as PVC, PS and multilayer film barrier materials PET, PA and EVOH.

The model feedstock specification in the report allows a maximum of 1% contamination from PVC and PVDC films, as they introduce chlorine atoms

Model pyrolysis feedstock spec

Items made of PE and PP such as containers, trays, cups, films, and bags.

Minimum 85% PE or PP

Maximum moisture content: 7%

Maximum total contamination: 15%

The following individual contaminants must not be present in amounts exceeding their specified thresholds, and the combined presence of all contaminants should not exceed 15%:

PVC/PVDC: 1%

PET/EVOH/Nylon: 5%

PS: 7%

Rigid metal/glass/dirt/fines: 7%

Paper/organics: 10%

Source: Alliance to End Plastics Waste

into the pyrolysis process which can cause corrosion to equipment and persist into the pyrolysis oil as heteroatoms (atoms of any element other than hydrogen or carbon). The potential for chlorine damage led several operators to express a near-zero tolerance for PVC/PVDC, although others indicated a threshold higher than 1%.

The model contamination limit for PS is 7%. The report says: "Polystyrene is generally not viewed as a prohibitive contaminant, and one operator even expressed a preference for using measured amounts of polystyrene as a process aid. Nonetheless, it is common for pyrolysis operators to set limits on the amount of polystyrene in their feedstock."

The materials used in multilayer films are particularly problematic. The model specification places a 5% limit on contamination from PET, PA and EVOH. Oxygen atoms in the feedstock results in oxygenated products, which reduce yield and negatively impact the quality of pyrolysis oil. Also, some more complex hydrogen-carbon structures, such as PA and PET, do not break down as easily as those of PE and PP, and some by-products of their decomposition act as impurities in the finished product.

"Offtakers can accommodate these impurities by diluting the product with larger volumes of virgin hydrocarbons, using the product for lower-grade applications such as fuel, or conducting hydrotreatment, in which hydrogen atoms are reacted with the product to chemically combine with impurities, facilitating their removal. Hydrotreatment can also be done by the pyrolysis operator prior to the offtaker, but this is rare and generally viewed by pyrolysis operators as being cost-prohibitive," the report says.

A 7% contamination limit applies to metal, glass, dirt and fines. The main problem with these contaminants is their abrasive effect on process equipment. As they are relatively heavy, they can also increase costs as input feedstock is typically purchased on a per-unit-weight basis. Pyrolysis operators did not express any specific concern about the aluminium used in laminated packaging.

Responding companies gave a fairly broad range of thresholds for contamination by paper and organics, and the report suggests a 10% limit. Post-pyrolysis refinement can remove impurities, such as by-products of hydrogen, present in the oil. Hydrotreatment, for example, is a process in which hydrogen atoms are reacted with the product to chemically combine with impurities, facilitating their removal. But, as the report points out, hydrotreatment plants are high-cost and are therefore ruled out by pyrolysis operators.

The report concludes that both mechanical and pyrolysis recycling operators require well-sorted, clean and largely homogenous feedstock, but a difference is that pyrolysis operators can take a mix of polyolefins and colours and have a different set of considerations surrounding contaminant threshold limits. One development that would benefit both mechanical and pyrolysis recycling, it says, is changing packaging design to reduce the number of materials. This has started to happen with the launch of mono-material films designed to substitute widely-used multilayer polyolefin films.

The report says the model feedstock specification describes a recycling stream that does not exist at scale today. It says it is important to understand what barriers exist to creating that stream, and to find solutions that take into account existing feedstock streams for mechanical recycling.

It is expected that some operators will have different tolerances to the thresholds in the model feedstock specification. This is similar to feedstock specifications for mechanical recyclers where each recycler has its own process and value considerations. The report also notes that many pyrolysis operators are in early stages of refining and optimising their processes, and their feedstock requirements are likely to evolve over time.

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Understanding mass balance as used in chemical recycling

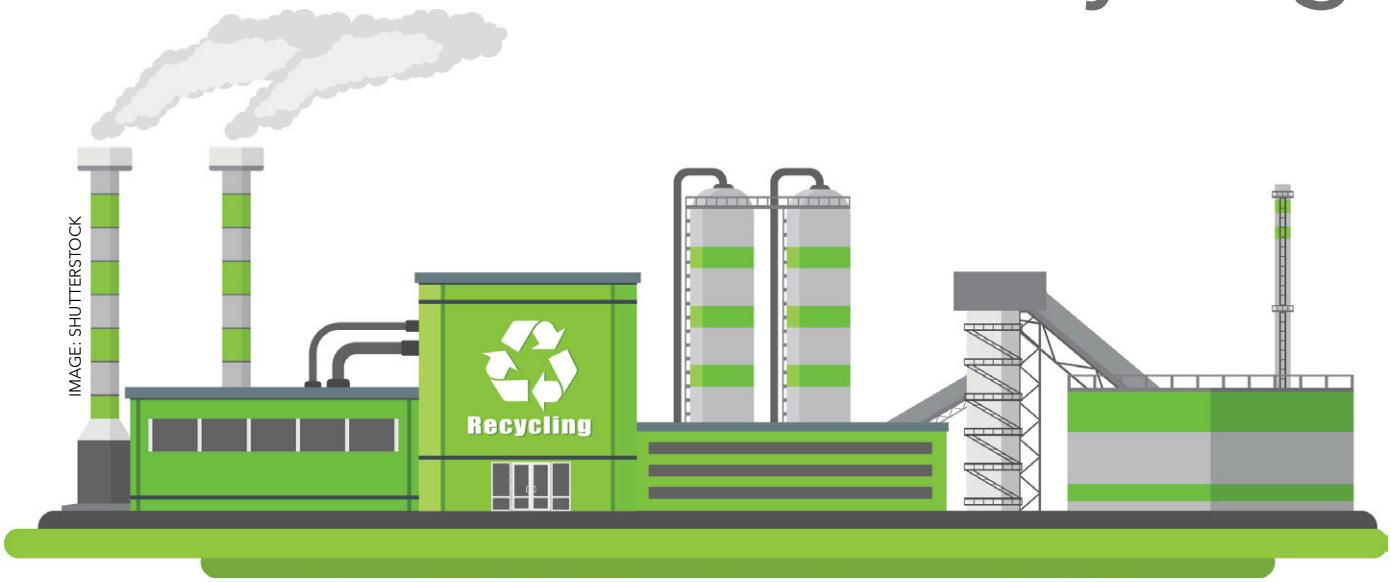

IMAGE: SHUTTERSTOCK

Main image: How are inputs and outputs treated in a chemical recycling process?

Tracking use of mechanically recycled material is straightforward – the recycled resin is simply used as supplied or blended in with virgin. It is not so easy in chemical recycling, where recycled content takes the form of basic hydrocarbons fed into complex cracking and polymerisation processes. Individual molecules cannot be tracked but have to be accounted using the principles of mass balance.

The idea behind mass balance is to measure the input of an individual component in a much larger manufacturing process and allocate its contribution to each unit of end product. In the case of chemical recycling, it aims to ensure that the amount of recycled feedstock entering a production plant equates to any claims made about the recycled content of products leaving it. It is not a new concept; the idea is already applied in sectors as varied as electricity marketing and Fair Trade agriculture.

As with many ideas, however, the challenge is in implementation. Different approaches can be taken with regard to what to allocate and where to allocate it. For instance, the entire output of a chemical recycling process – including both fuels and feedstocks – could be allocated as a contributor to any polymer or chemical production process, whether or not there is any direct link. This is called free-attribution. Alternatively, it may be decided to allocate only non-fuel components. Or, at its strictest, only those components used as a non-fuel contributor to production of a polymer.

Trade association Chemical Recycling Europe leans toward the free-attribution approach. In a **white paper** it says: "Our position is that all mass-balance interpretations should ensure that the full recycled output from chemical recycling finds a credible value and recognition though the system."

Others, however, take a different approach. Zero Waste Europe, together with several other environmental NGOs, has published **10 recommendations** it argues will ensure the use of mass balance does not undermine circularity goals. This involves only including post-consumer waste streams, not allowing trading of recycled content credits, and ensuring allocations are restricted only to processes where there is a direct link between feedstock and final product.

Mass balance will be essential in the development of chemical recycling as an industrial process and to that end it is important it is seen to be transparent and trusted – consumers, for example, must understand the claims made and, more importantly, have confidence in them. A number of organisations are already running certification programmes, of which the best known are International Sustainability and Carbon Certification (ISCC) and RedCert (both headquartered in Germany). In addition, the International Organisation for Standardisation (ISO) has started work on a global mass balance standard – ISO/AWA 13662 Chain of Custody-Mass Balance-Requirement and Guidelines. This is currently in the preparatory stage.

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