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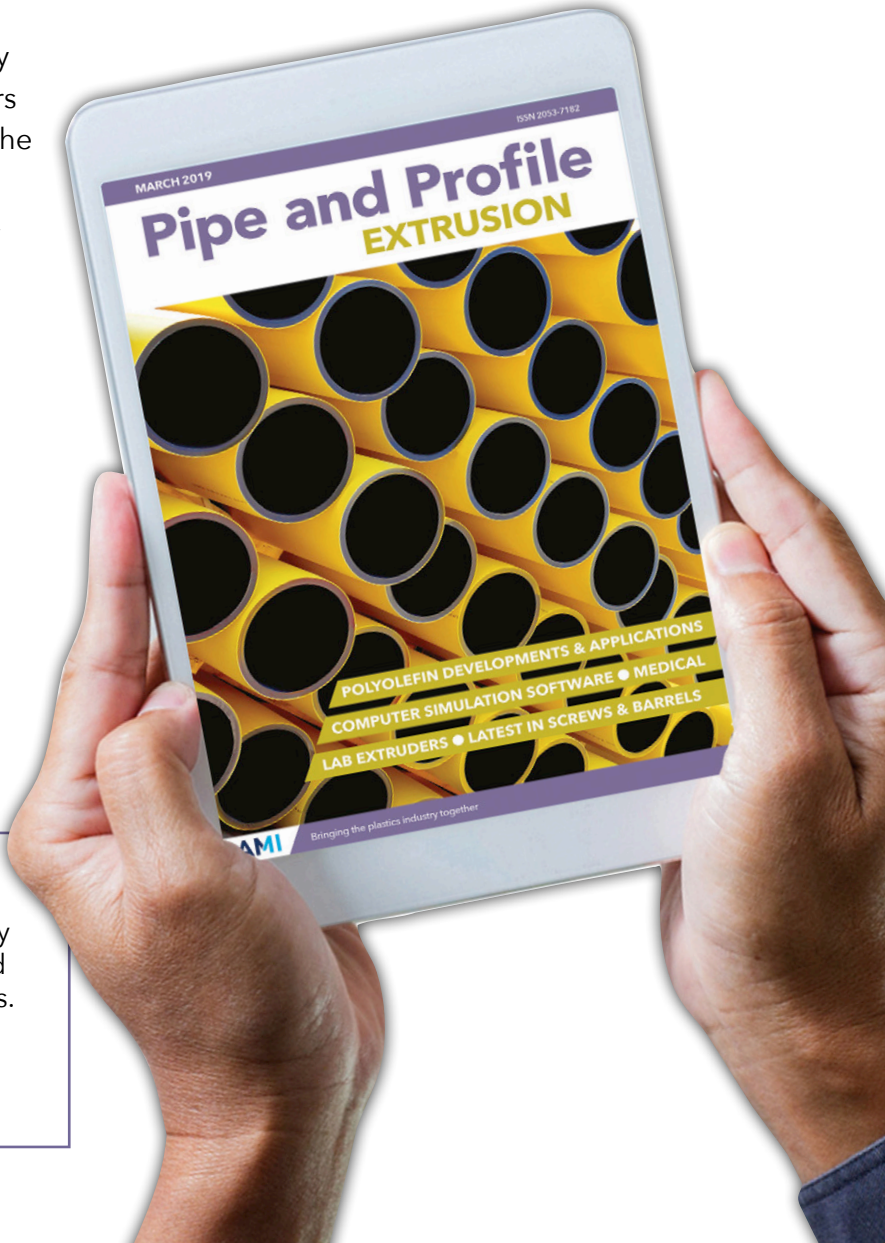

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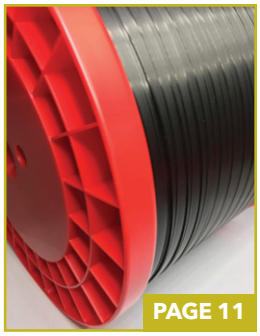
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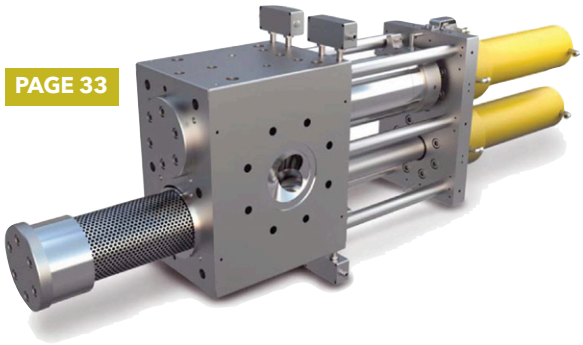
Chemical recycling presents new opportunities for dealing with plastics waste but what does the technology involve? Who are the key players? And how does it fit in the established recycling hierarchy? Produced by AMI's Magazines and Consulting teams, Chemical Recycling Global Insights 2022 presents an easy-to-digest introduction to this rapidly-evolving sector.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Pipe and Profile EXTRUSION

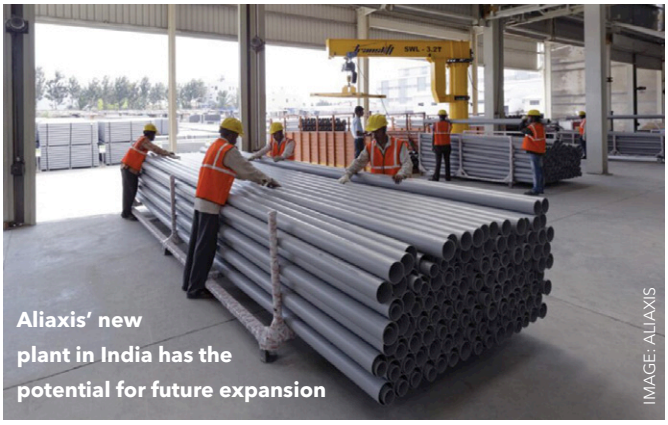
Aliaxis grows with India plant and US acquisition

Belgian pipe maker Aliaxis has expanded operations in Asia and North America.

Firstly, the company has opened a new plant in Durgapur, in north-eastern India, that makes HDPE pipe.

"The new site will serve as a model for the future expansion of our operations in India," said Rajeev Chawla, chief operating officer of Ashirvad, the Indian subsidiary of Aliaxis.

The facility sits on nine acres of land, which will allow it to be expanded in future, he added. It incorporates a number of environmental and energy saving measures – such as the use of energy-efficient machinery, and the use of solar power.



Aliaxis' new plant in India has the potential for future expansion

IMAGE: ALIAXIS

In addition, Aliaxis has further expanded its operations in the USA by acquiring pipe fittings manufacturer Harco.

Harco's annual revenues were roughly US$75 million in 2021. The transaction is subject to regulatory approval.

› **www.aliaxis.com**

Trex starts building a new HQ

US-based Trex has begun construction of a new headquarters in Winchester, Virginia.

The 64,000 sq ft office facility is situated on eight acres of land.

The new building will house around 200 corporate employees, who are expected to move in by mid-2023. Overall, Trex expects to add over 350 new jobs. In addition, it will build a third US manufacturing facility in Arkansas.

"These expansions should ensure we have the capacity and resources to meet the needs of our customers," said Bryan Fairbanks, president and CEO of Trex.

› **www.trex.com**

Profile maker's expansion

US-based profiles manufacturer Engineered Profiles has further expanded by acquiring a manufacturer of extrusion dies.

It has acquired West Virginia-based Co-Ex Plastic Tooling, which specialises in tools for a variety of extruded products, including profiles, sheet, tubing and co-extrusion.

At the same time, Engineered Profiles is adding a 93,000 sq ft production facility in Ironton, Ohio. This is expected to create 55 new jobs – including machine operators and toolmakers – over the next five years.

"We're experiencing tremendous growth, and this acquisition – coupled with our expansion efforts – will position us to support customer needs well into the future," said Mike Davis, president and CEO of Engineered Profiles.

› **www.engineeredprofiles.com**

Piovan acquires ancillaries maker in USA

Piovan of Italy has expanded its position in ancillary equipment by acquiring US-based IPEG.

IPEG owns four ancillary brands, of which the best known are Conair and Pelletron. The deal is expected to close in the first quarter of 2022.

The new combined company will employ more than 1,800 people across 14 worldwide facilities. It is expected to have a turnover of more than €450 million (US$508m), says Piovan.

"The acquisition of such an important American player will allow us to achieve important growth opportunities on a global scale," said Filippo Zuppichin, CEO of Piovan. "It will also allow us to access a formidable customer base in North America."

Piovan's product range encompasses a range of ancillary products including conveyors, dryers, dosers, granulators and temperature control. Conair also offers a wide range of ancillaries – including blenders and control equipment – while Pelletron is known for materials handling. IPEG's other two brands are Thermal Care, which makes process cooling equipment, and Republic Machine, which makes shredders for plastic recycling.

Earlier this year, Piovan began construction of a new facility in China. The new plant, in Suzhou, will cover 10,000 sq m and be dedicated to automation systems for plastics and other industries.

› **www.piovan.com**

› **www.ipeg.net**

WL buys PE pipe assets

Texas-based pipe extruder WL Plastics has bought the polyethylene (PE) pipe extrusion assets of Charter Plastics.

WL – which is wholly owned by chemicals giant Ineos – says the acquisition allows it to diversify its product offerings, expand its customer base and enter new regional markets.

Charter's site – in Titusville, Pennsylvania – produces a broad range of PE pipe for applications including potable water, reclaimed water, sewer, geothermal, gas and irrigation.

"We are delighted to bring such an established and well-positioned asset kit into the broader manufacturing base of WL Plastics," said Mark Wason, CEO of WL Plastics.

› **www.wlplastics.com**

North America: machine sales up in Q3 of 2021

Sales of primary plastics machinery in North America rose in the third quarter of last year.

The Committee on Equipment Statistics (CES) at the US-based Plastics Industry Association says that sales reached nearly US$334 million in Q3 – a rise of nearly 9% compared to the same period in 2020, and 4% up on the second quarter of 2021.

Sales of twin-screw extruders rose more than 61% (compared to Q3 2020) and by around 44% compared to Q2 2021. Single-screw extruder sales rose nearly 16% compared to the same period 2020, and by 7% to the previous quarter.

For comparison, sales of injection moulding machines rose nearly 6% compared to Q3 2020, and by less than 2% over the previous quarter.

"Plastics equipment shipments picked up in the third quarter as the economy continued to emerge from the pandemic," said Perc Pineda, chief economist at the association. "The increase was consistent with higher plastics production – which rose 5.9% compared to a year earlier."

In the latest CES quarterly survey, three-quarters of respondents expected market conditions to improve or hold steady in the next quarter (lower than the 93% who expressed the same view in the previous quarter). For the next 12 months, 75% expect market conditions to be steady-to-better – a shade lower than the response in Q2.

"While the survey shows that growth expectations have moderated, it also reveals that plastics machinery suppliers are optimistic about market conditions four quarters ahead," said Pineda.

Exports rose to US$390m – an increase of 6% compared to the previous quarter. Mexico and Canada remained the top export markets for the USA. Combined exports to USMCA partners in the Q3 reached nearly US$173m, which was 44% of total plastics machinery exports. Imports fell 3% to US$848m, resulting in a US$458m trade deficit. The US plastics machinery trade deficit fell by almost 10% in Q3.

"The outlook for plastics machinery in the second half of 2021 is positive, though shipments will continue to fluctuate," said Pineda.

"The likelihood of continuing supply-chain issues remains high."

› **www.plasticsindustry.org**

Molecor installs 22km of PVC-O pipe

Molecor of Spain has installed 22km of oriented PVC (PVC-O) pipe at a mining project in Serbia. The pipe, which is up to 1,000mm in diameter, forms part of a treatment plant that pumps away surface water. Molecor says the pipe was chosen due to its high installation performance – even when the terrain and water table slow down the work – and its superior corrosion resistance compared to iron or steel pipe.

› **www.molecor.com**

IMAGE: MOLECOR

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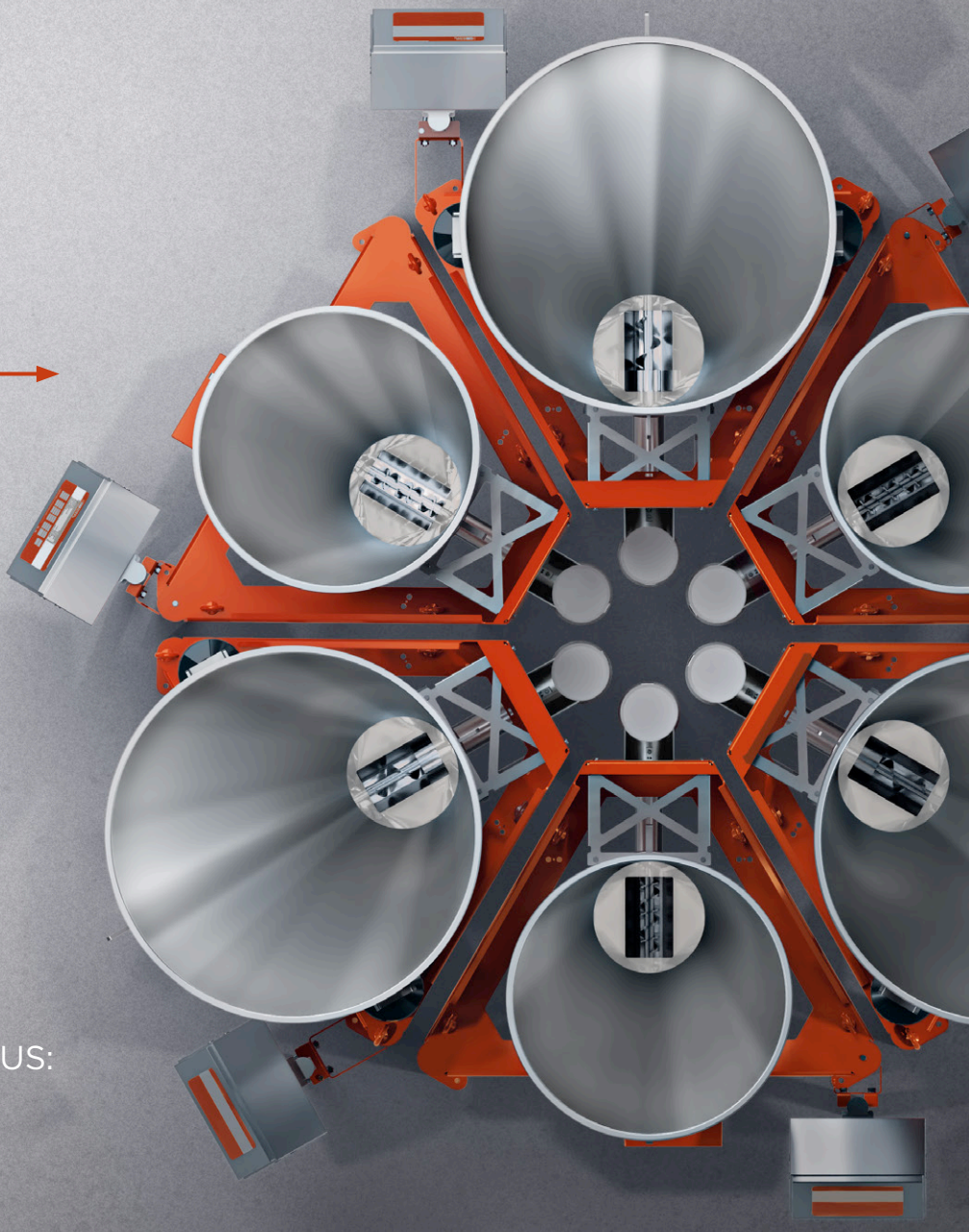

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Italy machine sales up in first nine months of 2021

Italy's plastics and rubber machinery manufacturers saw a rise in sales for the first nine months of this year.

Amaplast, the trade body that represents them, said that revenues rose by 14% for the first three quarters of 2021. This was largely due to a healthy domestic demand, said Amaplast. In addition, orders rose by 41%, "ensuring more than a six-month production horizon".

In the third quarter alone, turnover grew 17% compared to the same period in 2020, and orders were up by 30%. While Q3 sales were again driven by domestic demand – especially for full machinery – the export market was dominated by the need for replacement parts.

Expectations for the final quarter remain positive. Thanks mainly to international demand, orders are set to rise by 17% and revenues by nearly 60%. Warehouse stock remains stable with a slightly downward trend – indicating faster delivery.

In terms of markets, packaging and medical have shown most growth, while construction and automotive are more static, said Amaplast.

It added that several factors threaten to "compromise" the recovery – including price rises in both raw materials and components, plus low availability and longer delivery times.

"These serious issues have plagued logistics for over a year now, without any near-term resolution in sight," said Amaplast.

Energy bills are also "beginning to weigh heavily on the books", which could make Italian production in the sector less competitive than that of foreign competitors, it added.

Ongoing travel restrictions are also a problem, as they prevent machinery manufacturers from installing and repairing equipment. Amaplast said its members derive around three-quarters of their revenue from export sales.

› **www.amaplast.org**

Norner opens polymer centre to extend its plastics research

Norwegian plastics research and testing firm Norner has completed its Polymer Exploration Centre at its new headquarters facility at Porsgrunn.

Covering 4,600 m², it describes it as a modern international research and technology centre for the plastics industry that will provide research services throughout the value chain.

The centre includes laboratories for advanced testing of chemical and mechanical performance, lab pilots for new process technology and catalyst evaluations, a variety of extreme polymer material performance testing and a high-tech plastic processing equipment, and a recycling, application and packaging centre.

› **www.norner.no**

IMAGE: NORNER

Above: Norner CEO Kjetil Larsen in front of the Polymer Exploration Centre

IN BRIEF...

Uponor has completed the acquisition of Capricorn, a Polish manufacturer of components for heating and sanitary installations. The purchase price has not been revealed. Capricorn employs 400 people and had net sales of around €25 million (US$28m) in 2020. Uponor says the new company will be integrated into its building solutions division.
www.uponorgroup.com

Baerlocher is to increase capacity by more than 50% at its calcium stabilisers plant in Bury, UK. The company will install more mixing and granulation units during 2022. It says this will support growing demand for products in new and recycled PVC applications. This is due to "increasing regulatory pressure to convert from liquid stabilisers in many PVC applications", said the company.
www.baerlocher.com

Egeplast of Germany has become the sole owner of **Extena**, a Swedish manufacturer of polyethylene pipes and fittings. In January 2022, Egeplast acquired the final 25% of the company. Extena makes pipes in Norsjö, Sweden, and distributes them across the Nordic region – where it also offers Egeplast products. In these markets, the company will continue to use its established Extena brand.
www.egeplast.de
www.extena.se

VinylPlus project will recycle medical PVC across Europe

VinylPlus has begun a European collaborative project to recycle single-use PVC medical devices.

VinylPlus Med builds on the earlier VinylPlus-funded RecoMed recycling scheme. It is developing a recycling scheme for single-use PVC medical devices in Belgium to help hospitals sort their PVC medical waste stream.

The scheme will focus on clean, REACH-compliant PVC waste that can be recycled into a wide range of products marketed across Europe. In partnership with the Europe Hospitals group, high-quality PVC waste from various departments will be collected and recycled. Most of the waste has not been in contact with patients.

"Most PVC medical waste is non-infectious and can be recycled when properly sorted and collected," said Brigitte Dero, managing director of VinylPlus. "We are keen to enhance PVC's recyclability in this critical sector."

IMAGE: VINYLPLUS

Above: Van der Perre (centre): "A project like this helps towards the renewal of raw materials"

Other partners are waste management company Renewi and recycler Raff Plastics. All Belgian VinylPlus Med partners are located in a radius of 120 km, to minimise transport distances and reduce carbon footprint.

"There are many materials that could be recycled but – due to unfavourable circumstances – are sent to landfill or incineration," said Caroline Van der Perre, co-owner of Raff Plastics. "A project like this helps towards the renewal of raw materials."

PVC medical devices are recycled in eight countries including Australia, New Zealand, UK, South Africa, Canada, Guatemala, Colombia and Thailand.

› **https://vinylplus.eu**

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IMAGE: SHUTTERSTOCK

Pipes made from engineering thermoplastics (ETPs) and composites are finding increasing use in the oil and gas sector, due to its demanding conditions

ETPs: raising performance in oil and gas exploration

The oil and gas sector is one of the most demanding there is – meaning that materials used here must be able to withstand punishing conditions.

For this reason, engineering thermoplastics (ETPs) and composites are often specified in pipes that replace those made from steel. This substitution generally leads to a lighter pipe that is easier to install – but factors such as strength, mechanical properties and chemical resistance must be checked rigorously.

Speakers at the recent *Oil & Gas Non-Metallics* conference – held in the UK – revealed a growing number of ETP and composite applications within the onshore and offshore industries.

Alexandre Paternoster, team lead for material technology at Netherlands-based **Strohm**, explained how thermoplastic composite pipe (TCP) can be engineered to transport a variety of fluids – including hydrocarbons, carbon dioxide and hydrogen.

Different fluids will have varying effects on plastic materials. Pipes must be designed for chemical-, RGD- (rapid gas decompression) and swelling resistance. Strohm products include PE reinforced with E-glass fibres, and both PA12 and PVDF with carbon fibres.

"The orientation (angle) of each composite layer of the TCP determines its capacity to respond to the variety of load cases," said Paternoster.

Design optimisation includes minimising the thickness of the pipe – yet ensuring that it meets the critical load case.

For hydrogen transport, the key is to achieve high material utilisation (of nearly 98%). For CO2 transport, material utilisation is above 99.9%. For hydrocarbons, it is down to around 92%, as a thicker structure is needed in order to carry the load.

"The differences in optimised structures and resulting stresses are related to the plasticisation of the material," said Paternoster. "Hydrocarbon is the most onerous application."

In future, the company has plans to establish design requirements specific to hydrogen and carbon dioxide transport.

Main image: The oil and gas sector has increased its use of pipe made from engineering thermoplastic and composites

Right: Suprem's fibre-reinforced tape has been used to make various types of pipe

Steel comparison

Mark Breed, eco efficiency project manager, at **Teijin Aramid** in Germany, told delegates that plastic pipes reinforced with its Twaron para-aramid fibre can compete with their steel equivalents.

The company has carried out a life cycle comparison analysis (LCCA) between an RTP pipe based on Twaron, and a typical steel pipe of the same diameter (6 inches).

The analysis compared the total contribution of manufacturing, installation, operation and end of life. In manufacturing, the plastic pipe's contribution was about one-third that of the steel pipe. It was similar in installation, due mainly to the plastic pipe being five times less dense. The cost of installation was also around 28% less for the plastic pipe. Overall, the plastic pipe's total cost of ownership was about 20% lower, while its global warming potential was around 35% that of the steel pipe, said Teijin.

In addition, Teijin has been reducing the carbon footprint of Twaron. It began using only green electricity last year, and has plans to switch completely to renewable energy and use only renewable carbon raw materials by 2050.

Jean-Baptiste Deyts, technical manager at **Suprem** – a Swiss materials specialist – explained how thermoplastic composite tape can be used to make high pressure pipes in an automated manufacturing process.

It begins with 'UD tape' – which have a rectangular cross section made of fibre-reinforced thermoplastic. The tapes are made from a range of polymers, including Peek, PPS and PA12. Fibres are continuous and made of carbon, aramid or glass. Tapes are laid on top of one another and need to

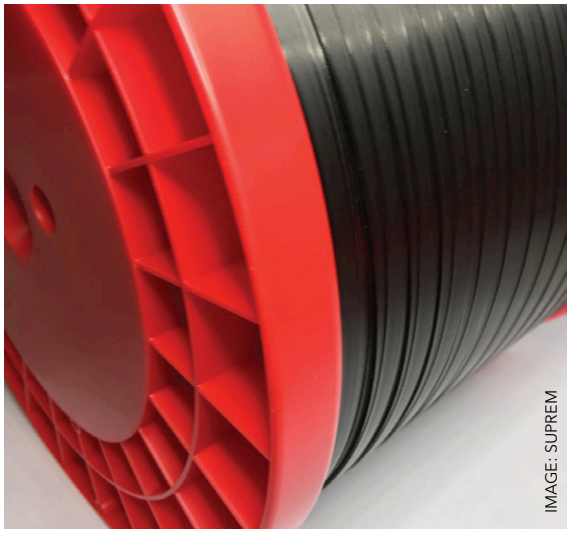

IMAGE: SUPREM

be softened (by heating).

In one example, a 40mm diameter pipe was made from six plies of Suprem tape consisting of PVDF with carbon fibres. It used heated tooling for the first ply lay-up and the line operated by 12m/minute in a "very stable and repetitive process".

Emerging applications

Garry Kendall, product development and validation leader for offshore flexible pipe systems at UK-based **Baker Hughes**, revealed how unbonded flexible pipe is being used in emerging oil and gas applications.

One aspect of this is to determine barrier service life in deep water flexible risers. This has involved using a combination of techniques such as small-scale fatigue testing, local strain analysis and project damage assessment.

Fatigue performance of the polymer is

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Above: Strohm is a leading supplier of thermoplastic composite pipe (TCP) to the oil and gas sector

established through small-scale fatigue testing of a range of machined notches and extruded barrier profiles. The curvature range of each sample under displacement was obtained through finite element analysis (FEA) to ensure temperature dependant elastic/plastic behaviour was represented, he said.

The company has also developed a PVDF pressure sheath – which have been used for many years in flexible pipe – called Flex130.

"Older generation polymers have some limitations that required a new PVDF to offer improved performance," said Kendall.

In this case, Flex130 was designed to have higher fatigue performance (making it superior in single-layer designs), higher pressure performance (over 12,000psi) and greater temperature resistance (working up to 140°C).

Pipe comparisons

Denis Melot, of **Total Energies** in France, told delegates that composite pipelines have become more widespread within the oil and gas industry – but have some limitations.

These include glass-reinforced (GRE) pipes, thermoplastic composite pipes (TCPs), reinforced thermoplastic (RTP) pipes and unbonded flexible pipes. All, to some extent, have been used to substitute traditional steel pipe.

As an example, GRE pipe can reduce the cost of planning – compared with steel pipe – especially for fast-track, small diameter short flowlines onshore, he said. RTP flowlines can also offer advantages – such as ease of installation compared to GRE. TCP offshore jumpers have also been successfully implemented in a growing number of projects.

Non-metallic pipes have been successfully installed for a number of reasons, he said. These include: in-depth understanding of the designs; a good business case compared with carbon steel; and good results from installations.

However, he warned there were also a number of hurdles to their implementation. For once, he said there are limitations in diameter, temperature and pressure. In addition, each supplier offers a bespoke design, with no standardisation. Also, some poor installation and qualification procedures have led to early failures.

Failure modes

Andreas Stoffers, manager of polymer testing at **Evonik Operations**, explained that the company had carried out a series of slow crack growth (SCG) tests on offshore pipes that experience a hot hydrocarbon environment.

Materials such as PA12 – which Evonik supplies – are typically used as a 'barrier layer' to protect flexible pipes from damage.

"During qualification, polymers are seldom investigated for SCG under cyclic loading in service conditions," he said.

In use, stress intensification through dynamic loading (waves) can act as potential starting points for crack initiation, he added. This initial defect leads to a stress 'singularity' which acts as a starting point for micro-voids and crazes – leading eventually to cracking.

Evonik carried out cracked round bar (CRB) testing to determine SCG under cyclic loading. It has been shown to have good correlation with strain hardening results for unplasticized PA12 grades.

In-situ, hot hydrocarbon testing involved saturating 14mm rods in diesel at 80-100°C. Rods were made from PE-RT or PA12 (plasticised and unplasticized). PE-RT showed a 30% drop in SCG resistance, while PA12 proved "highly resistant" against crack initiation, he said.

"Under hot hydrocarbon conditions, PA12 shows no significant drop in CRB lifetimes compared to dry testing – and maintains its mechanical strength," he said.

■ The next *Oil & Gas Non-Metallics* conference, organised by AMI, is held in London in December 2022. For more details, contact Harriet White (**harriet.white@ami.international**) on +44 (0) 117 314 8111.

Cracking result

Several speakers at last year's PPXX conference also addressed advances in ETPs and composite pipe – including the subject of PA12 resistance to SCG.

Mario Messiha, of the **Polymer Competence Centre Leoben** (PLLC) in Austria, presented results of a study that investigated how changes in the molecular structure of PA12 affect SCG resistance.

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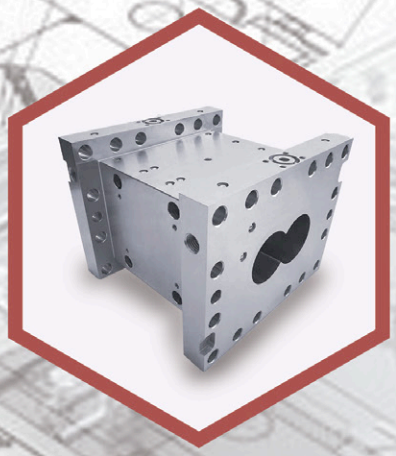

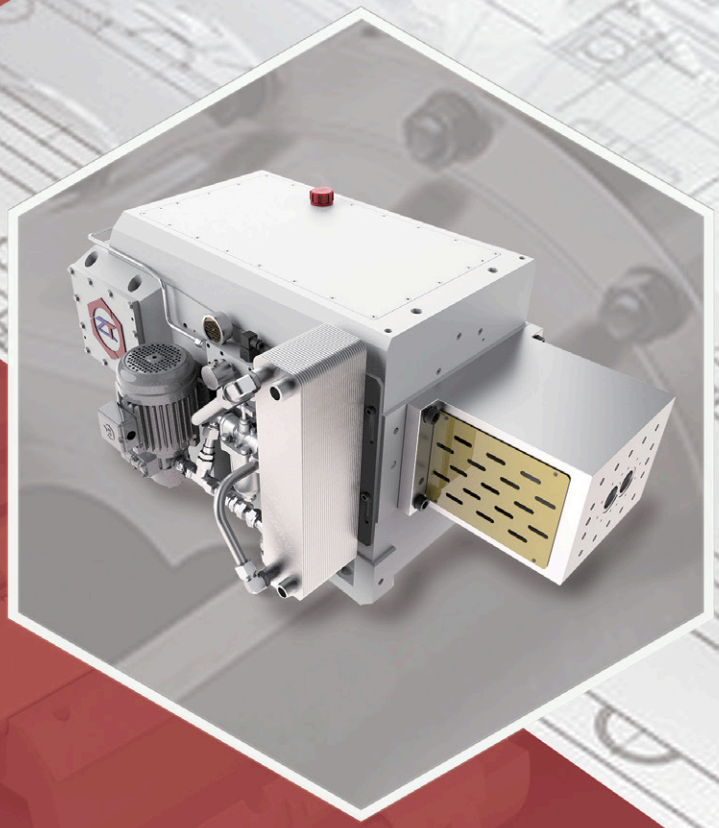

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IMAGE: SHUTTERSTOCK

Above: Researchers have investigated whether typical tests to assess welds could be applied to PA12 pipe

The study used the CRB test, as well as strain hardening (SH). It investigated four grades of unplasticised PA12 – three pure 'non pipe' grades and one compounded pipe grade.

"A majority of field failure of viscoelastic plastic pipes can be attributed to SCG and has become crucial in terms of characterisation of newly developed materials – particularly if they are designed for pressurised pipe applications," he said.

Both methods correlated strongly for the non-pipe grades. However, the results showed much higher failure times for the compounded pipe grade in the CRB test – while SH test results did not differ much from the results of the non-pipe grades.

"This can be associated with a change in the nature of guiding failure mechanisms during crack propagation – an observable transition from crazing to shear yielding in the cyclic CRB test," said Messiha.

Another key element in the cyclic CRB test study was the formation of plastic zones prior to crack growth – via crack freezing analysis. This showed relatively large plastic deformation, and 'blunting' effects near the crack tip for the PA12 compound.

This, said Messiha, showed a higher ability of the pipe grade to store larger amounts of the crack-driving energy – by forming deformation zones.

Creep testing

US research has measured the effect of liquid hydrocarbons on the long-term creep rupture properties of PA12.

Jim Mason, of **Mason Materials Development**, explained that PA12 tensile bars were conditioned in light hydrocarbons, then subjected to uniaxial stress rupture testing. For comparison, the study was also performed in water. The experiments were performed beyond 6,000 hours in the two environments, at 60°C.

The stress rupture line for each was analysed according to ASTM D2837. The parallel lines were separated by a stress gap, which showed the effect of the hydrocarbon on the material.

The results showed that the regression line for the hydrocarbon-conditioned bars was at 5% lower stress than the 'water' line.

This showed experimental evidence that a fluid service factor of 0.95 should be applied to unplasticised PA12 pipe designs for use in hydrocarbon transport.

"Designers are advised to seek the results of similar studies for other polyamides intended for use as pressure pipe," he said.

Joint research

Two research institutes in Germany and the UK have teamed up to assess the quality of welds in PA12 pipes.

The research, from **SKZ** and **TWI**, investigated whether typical quality tests for welds could be applied to PA12 pipe. These included destructive tests such as the technological bending test, and non-destructive tests such as phased array ultrasonic testing.

"PA12 is increasingly used in pipe applications, especially in the gas sector," said Marc Eckes of SKZ. "However, the material behaviour in the usual quality tests for pipe welds has not yet been thoroughly investigated."

Pipes were joined using either electrofusion socket welding or butt fusion welding, and tested with a variety of methods.

The technological bending test showed that PA12 is generally easy to join using butt fusion. In some cases, a test specimen did not achieve the minimum bending angle or ram displacement. However, welds with the lowest bending angles were mainly at the lower end of the process window (220°C, 0.2 MPa). All welds at the upper end (230-240°C, 0.3 MPa) exceeded the minimum requirement according to DVS 2203-1 supplement 3.

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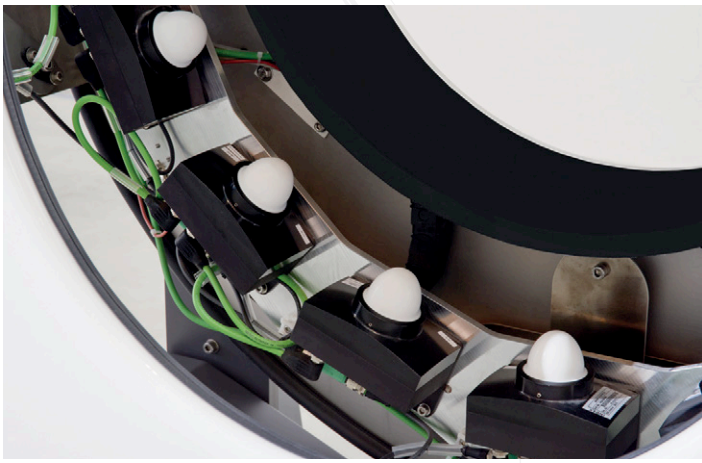

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IMAGE: SHUTTERSTOCK

Shifting to the white

Regulatory issues over titanium dioxide – coupled with rising prices – could see increased use of alternative white pigments in future. Peter Mapleston reports

Regulatory issues could change the way in which a major pigment – titanium dioxide – is used in plastics.

Historically, it has been the material of choice for colouring products white – from PVC window frames to plumbing pipe. However, European regulators have recently taken aim at TiO_2 – labelling it a potential carcinogen – meaning that alternative white pigments may become more widely used in future.

Tight supply

For now, the main issue for TiO_2 users is tight supply – and, as a consequence, rising prices.

Users of TiO_2 have become accustomed to price hikes, which have been happening for several months – and may yet continue. These have been triggered by the rising cost of TiO_2 feedstocks, says consultant Reg Adams. He points to civil unrest that caused a two-month shutdown of the world's largest slag supplier – Rio Tinto in South Africa – and a shortfall in rutile supply from Iluka, Sierra Leone, with the threat of a two-year shutdown.

In addition, the cost of chlorine is rising for US chloride-route producers; sulphate-route suppliers, especially in Asia, are having to pay more for sulphuric acid. Rising ocean container freight rates on most shipping routes are yet another complicating factor. Tight supply has arisen as demand has strengthened.

"Packaging plastics demand increased because of pandemic lockdown-related factors in 2020, leading to more on-line retailing – which remained strong in 2021," said Adams in October 2021. "This has increased demand for TiO_2 and most other plastics pigments."

Gerry Colamarino, managing director at **TiPMC Consulting**, said that with inventories low, the market was looking for a "slow Q4" in 2021 to help drive a restock – but questioned whether that was plausible.

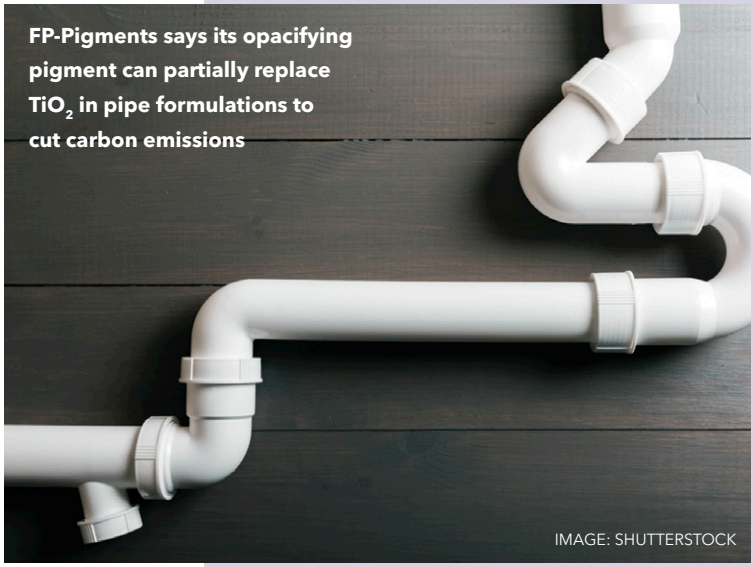
"Chinese suppliers are at full capacity, but being forced to reduce production, even as environmental enforcement is curtailing available power," he said. "The stage is set for methodical price increases."

Sulphate route

Tomaž Pevcin, sales manager at Slovenian TiO_2 supplier **Cinkarna**, expressed similar sentiments. Cinkarna uses the sulphate production route, and Pevcin says sulphur prices have risen by 250% in less than a year. The rises have so far been reflected in TiO_2 prices, but he suspects there may be a disconnect in the near future.

Most Cinkarna product are used in paints and coatings – a market that "went crazy during the

Main image: Titanium dioxide supply is tightening as demand strengthens, say industry watchers



FP-Pigments says its opacifying pigment can partially replace TiO_2 in pipe formulations to cut carbon emissions

IMAGE: SHUTTERSTOCK

'Smart' TiO_2 for sustainable pipe formulations

At the recent 'Plastic Pipes 20' (PPXX) conference in the Netherlands, Andy White of FP-Pigments explained how his company's FP-550 opacifying pigment could be used as a partial replacement for titanium dioxide in pipe formulations.

"When replacing 10-35 wt% of the TiO_2 in a PVC pipe formulation, the unique particle morphology and functionality enables the manufacturer to better optimise formulations and enhance the overall performance of PVC pipe systems," he said, in a paper written with colleague Paul Dietz.

They said that the key to the opacifier's performance was its refractive index of 1.9, which gives it an "inherent light scattering facility".

Replacing a portion of the TiO_2 with the opacifying pigment increases the average distance between TiO_2 particles via the 'dilution effect' – replacing the volume with 'optimally spaced' TiO_2 particles. This helps to scatter light more effectively – and improve surface appearance.

The authors said that replacing some TiO_2 with FP-550 led to greater cost efficiency, as the opacity pigment is typically cheaper.

White added that FP-550 production led to around half the carbon dioxide emissions of titanium dioxide – so was also more sustainable.

pandemic, with people doing more home decorating" he said.

However, the picture is changing as the company looks to develop grades for plastics. It already has a grade for non-durables, but expects to launch a grade for durables within a year.

Another supplier very reliant on the sulphate process – but on a larger scale – is **LB Group** (formerly Lomon Billions). It is the world's third largest supplier of TiO_2 pigment ,with the capacity to produce more than 1 million tonnes annually at its five production plants in China. It recently simplified the branding of its TiO_2 pigments: all of them are now branded Xuelian in China and Billions elsewhere. It has dropped the Lomon brand name.

It has increased its chloride process production capacity, which is now at around 300,000 tonnes/year. This will grow by another 100,000 tonnes/year when its next line begins production in 2022. Increases elsewhere will take total chloride capacity to around 700,000 tonnes/year by the mid 2020s.

Raising chloride capacity is helping LB Group to grow its chloride process product range, says Julie Reid, LB Group marketing director. Recent additions are aimed at coatings and paper laminates, but grades for plastics are being developed – including a weatherable pigment that is expected to be commercially available within two years.

Regulatory pressure

Something that TiO_2 suppliers are likely to be monitoring is how demand will be affected by new EU legislation – which came into effect from October 2021 – mandating warning labels on various products containing more than 1% TiO_2. This includes masterbatch – but not bags full of TiO_2 – due to its classification as a possible (category 2) carcinogen.

This has been strongly contested by industry body **TDMA**, which said: "The classification does not correlate with a vast body of scientific evidence that already demonstrates that TiO_2 does not cause cancer in humans."

This year, it is likely that TiO_2 will be banned as a food additive in the EU, unless an objection is adopted by the end of the year by either the European Council or European Parliament.

TiO_2 alternatives

For companies considering alternatives to TiO_2, or at least ways to stretch it out, there are other minerals that can be used.

Finnish company **FP-Pigments** uses a proprietary technology for its FP Opacity Pigments, which encapsulates TiO_2 in a high-purity precipitated calcium carbonate. It recently completed a study

investigating the potential to use its FP-550 Opacity Pigment to improve the optical performance of TiO_2 masterbatches.

In the study, the pigment was used to produce a 60% TiO_2 masterbatch in which the level of 'normal' TiO_2 was 55% and the amount of LDPE 20%. The remaining 25% was made up of FP-550 (which contains 20% 'optimally spaced' encapsulated TiO_2). This was compared with a regular masterbatch of 60% TiO_2 and 40% LDPE, and a third masterbatch in which half of the LDPE was replaced by calcium carbonate (so it also contained 60% TiO_2). Colour and opacity results from all three were compared in blown films and injection moulded plaques containing respectively 5% and 2% masterbatch in LDPE.

In films, the masterbatch containing FP-550 gave results that were said to be at least equivalent to the standard and significantly better (over two units of Contrast Ratio) than with the $CaCO_3/TiO_2$ masterbatch. L* value results were in line with the opacity measurements, with the FP-550 masterbatch showing a superior performance. The b* values showed FP-550 to be slightly bluer while a* values remained similar.

For moulded plaques, the masterbatch containing FP-550 Opacity Pigment gave results that were better than the standard while the $CaCO_3$ replacement resulted in poorer L* value results.

"The reason that this substitution is possible is due to the unique spacing of the TiO_2 inside the FP-Pigment particle matrix," said Andy White, business unit director for paints and plastics.

The technology has also been used in pipe formulations (*see box story*).

Omya recently launched OmyaPET, a family of functionalised calcium carbonates for use as an opacifier in white opaque PET bottles or BOPET film. Karsten Schulz, business development director for polymers, said that high opacities can be achieved with OmyaPET – but when a 100% light barrier is required, some TiO_2 is needed.

"In single-layer PET milk bottles, the use of 10% TiO_2 is common and Omya has shown that 70% of the TiO_2 can be replaced by OmyaPET."

Another calcium carbonate supplier, **Reverté**, is also offering a product to complement TiO_2. It recently introduced a new grade for making white masterbatch. Calcipore 80T AL is designed to offer high productivity and filler level in the masterbatch and can help to reduce levels of TiO_2 in white masterbatch, the company said.

Left: Reverté says its Calcipore 80T AL can help reduce levels of TiO_2 in white masterbatch

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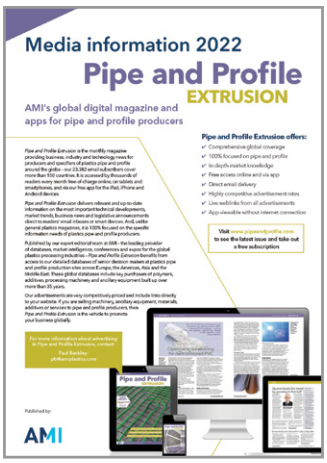

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Mission control: boosting the extrusion process

Augmenting extrusion and ancillary equipment with extra control helps to ensure that production processes run more smoothly and efficiently than before

IMAGE: SIKORA

Main image: Sikora offers three separate Ecocontrol processor systems

Core machinery and ancillaries sit at the heart of the extrusion process – yet often it is necessary to augment them with external control in order to boost performance.

In one recent example, **Maguire** has made its Ultra dryer touchscreen controller more powerful and feature-rich by incorporating its FlexBus Lite software.

FlexBus Lite, a standard feature on all touch-screen blender controls, is now integrated into the Ultra dryer. This allows users to complete pump and receiver control in a cell, in a user friendly and straightforward control system, says the company.

FlexBus Lite features an Intuitive receiver and pump control – with features typically only found on larger central system controls. It allows control of one vacuum pump and full system functionality control of up to 10 materials receivers. The Icon-based touchscreen shows each receiver's activity in real time – whether it is calling for material, receiving material, or showing material discharging. Pump and receiver settings can be easily adjusted by the operator in real time.

"With the dryer, vacuum chamber and material retention hopper on load cells, you can completely regulate the drying rate to the process rate," said Frank Kavanagh, vice president of sales and marketing at Maguire. "This allows the operator to program a shutdown to any specific day and time."

The control system then monitors the rate so that the loader will stop calling for material and the dryer is empty. With the control system monitoring the rate, this makes material changes even easier, said Kavanagh.

FlexBus Lite on the Ultra dryer offers full conveying control with several advantages, according to the company. The system is designed to handle single or multiple dryers (up to 10 receivers) with ground level receiver and pump control. A single operator-friendly touchscreen controls the dryer's onloading and offloading. Controlling up to 10 receivers means that one Ultra dryer can manage the conveying of an entire cell.

No additional controls are necessary with FlexBus Lite. The control system can work with any Maguire product – and with any third-party system.

Dry from the desktop

Dri-Air has developed a desktop app that can control a large number of dryers.

SmartView is a web-based application that can control multiple dryers using their unique IP addresses. This allows control from a single screen without the need to visit the plant floor.

The app, available with SmartTouch controlled dryers, allows all dryers to be controlled from a central location. It shows dryer status, dewpoint, hopper status, regeneration status and the dryer's IP address. From this screen, operators can start and stop dryers, set hopper temperatures and even customise the names of individual dryers. ›

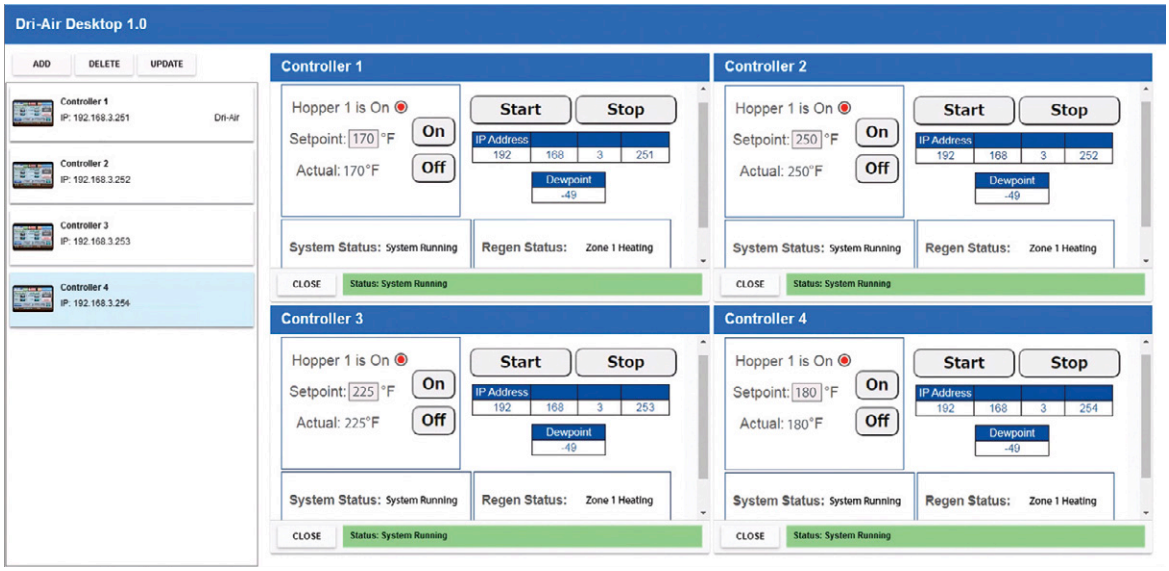

IMAGE: DRI-AIR

Right: Dri-Air's desktop app allows it to control a large number of dryers

Dri-Air previously introduced the SmartTouch controls in 2020. The SmartTouch controller features a 7in colour touchscreen with easy-to-use prompts for temperature, time and dewpoint display. It is standard on HP series dryers and dual hopper dryers, and optional on the two-bed, Arid-X dryers.

SmartTouch features include: -49F dewpoint monitor; seven-day timer for automatic start and stop; diagnostic functions, with trending for temperatures and dewpoint; and OPC-UA open platform, for maximum connectivity.

Remote installation

Movacolor has developed an updated version of its software for dosing plastic additives.

The new software includes extra features such as sensor neck integration, fast calibration options and a single shot test button for taking verification samples. It is also possible to contact support staff from Movacolor directly, via remote control.

"We would normally travel a lot to customers to help with installation or to provide support – but this is not an option during the Covid-19 pandemic," said Gerhard Dersjant, managing director of Movacolor. "We have made it our mission to serve our partners as best we can remotely. This new software allows us to help by temporarily taking over control of a machine that is thousands of kilometres away."

The software is available in 20 languages and is free of charge.

Below: Bausano has developed a centralised extrusion control system called Orquestra

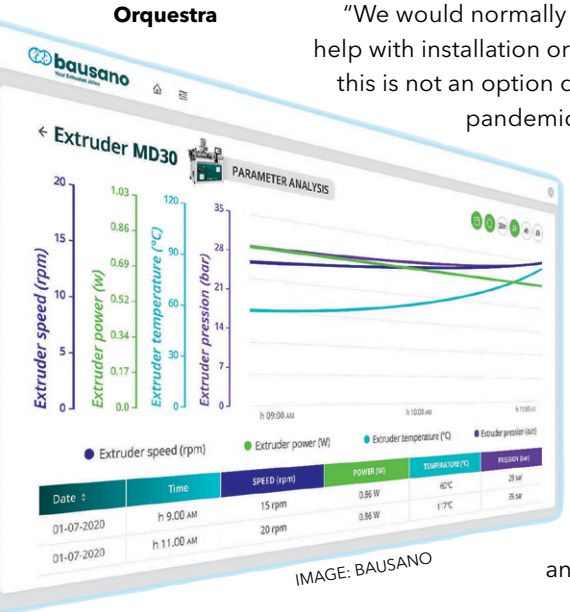

IMAGE: BAUSANO

Common platform

Conair is implementing a common control platform for all its ancillary equipment in order to deliver a consistent user experience.

The company says that the new platform and HMI have already been implemented in the company's new SmartFLX material handling control, truck-fill line-proofing system, blenders and temperature-control units. It is scheduled to be released on dryers in the third quarter – while chillers and other equipment will follow later. Other systems, such as Wave Conveying and Conair's RFID-proofed resin-selection system, are controlled through the SmartFLX Platform.

The development took two years to complete, according to Matt Shope, director of engineering at Conair. Conair wanted a common control platform to reduce training time for its customers, he said, and it worked with a design firm on the HMI.

The controls are compatible with SmartServices, Conair's cloud-based Industry 4.0 solution for machine monitoring and data collection. The Machine Control portion of SmartServices mirrors the same control screen that an on-the-floor operator would see, said the company.

The latest version of SmartServices gives users expanded naming, grouping, and sub-grouping features, an increase from three to ten customisable KPIs for each machine type, and new resin usage features.

Predictive maintenance

Bausano of Italy has developed a centralised control system that integrates all parts of an extrusion system.

The software, called Orquestra, is able to carry out smart diagnosis and predictive maintenance. It allows real-time monitoring of all production

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IMAGE: SIKORA

Above: Sikora's X-Ray 6000 Pro has helped Russian hose producer Svarog to raise quality

parameters, and can generate immediate reports, in graphical form, on factors such as performance indicators, quantity of waste produced and operating hours.

All machines on a site can be integrated with corporate management systems such as ERP, MES and CRM. Raw data collected by Orquestra can be analysed by end users, helping them to optimise the extrusion process.

In particular, it allows users to move from scheduled to predictive maintenance, which can raise productivity and save both time and resources. Bausano can remotely access the machine's operation indicators and point out possible malfunctions in advance. This can be done through Bausano's augmented reality app, Acty. Sharing data in the cloud enables Bausano to offer consultancy, which can make production processes more efficient.

"With Orquestra, end users have a system to help them constantly improve their performance in terms of product quality and lead-times," said Clemente Bausano, vice president of Bausano. "Analysing the parameters of our lines during operation will help form a virtuous circle – where we and the customers design the future of extrusion, together."

Optimised measurement

Sikora says that its Ecocontrol processor systems – available in three models – help to control and optimise production processes.

Ecocontrol processor systems are available with 22', 15' or 8.4in TFT screens. All models are characterised by their simple, intuitive touchscreen operation and a clearly arranged display.

Recorded production data can be stored on the

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IMAGE: INOEX

Right: A 21-inch terminal shows all information from the Inoex Warp system on a single display

internal SSD hard disk or directly on a server. Production reports (time-, length- and batch-based) are also available for all Ecocontrol models. These are used in quality control – and in daily production – to document product quality over a defined period of time.

The Ecocontrol series has all standard market interfaces, such as Fieldbus and OPC UA, to transfer measurement data. The devices are ideally suited for use in modern tube and pipe extrusion lines with increasing levels of automation, says Sikora.

As well as displaying and documenting measured data, the series offers its own automatic control with the Set Point module. Here, the processor system modifies the haul-off speed or extruder speed to control to the nominal value of the wall thickness. The Ecocontrol models enable a higher degree of automation (especially for older extrusion lines) and raise process reliability.

Hose improvement

At the same time, Sikora's X-Ray 6000 Pro system – which monitors product parameters such as wall thickness – has helped a Russian hose producer to raise quality.

Svarog, a specialist in high-pressure rubber hoses, is based in Novokuznetsk in Siberia. Since last year, it has used the X-Ray 6000 Pro system to measure wall thickness, eccentricity and diameter of its high-pressure rubber hoses during extrusion. Sikora says it is the first device of this kind installed on a rubber high pressure hose production line in Russia.

Quality requirements of rubber high pressure hoses are high, and determined by standards. Since 2007, when the plant began, Svarog has focused on meeting the European standard DIN EN.

Svarog's product range includes different types of rubber hoses with outer diameters of 9.4 to 54mm – which can include multi-layer metal wire braiding. Before choosing the X-ray measuring device in 2021, Svarog was measuring only the outer diameter. The X-Ray 6000 Pro also makes it possible to measure the wall thickness of the outer layer after the metal wire braiding – and also the inner layer of the hose on the mandrel. The real-time measuring values give the customer the necessary information to meet required specifications.

For maximum benefit, Svarog plans to integrate the device into the production line controller, for automatic control of the production process.

Below: The AccuScan Pro series from NDC is for single-axis diameter measurement of extruded products such as pipes

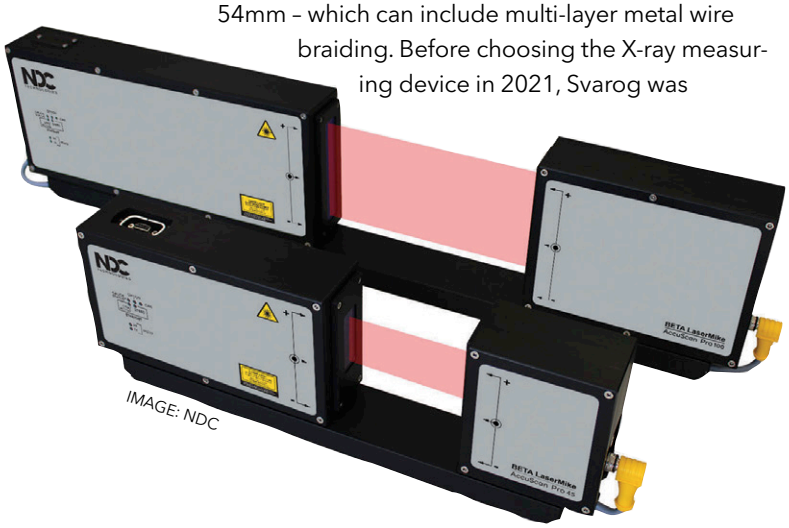

IMAGE: NDC

Accurate measurement

NDC Technologies has introduced a new range of devices for single-axis diameter measurement of extruded products such as pipes and cables.

Its AccuScan Pro series is built on the same optical engine and electronics platforms that underpin its existing Beta LaserMike AccuScan family of gauges. Designed with a compact footprint, AccuScan Pro offers high versatility. It can be integrated into the process for real-time control of product diameter or used as a stand-alone solution for off-line diameter applications.

Manufacturers benefit from higher product quality and material savings, says the company. AccuScan Pro devices can be used to measure plastic pipe, hose, tube and other extruded or drawn cylindrical, flat or unique profile products.

Devices in the series measure product diameters up to 100 mm across a range of applications – either online or offline. Two or more devices can be stacked together to measure larger diameters and perform single-scan flaw detection of lump and neckdowns.

The series also supports a variety of communication protocols for easy integration into processes.

Radar measurement

Jet Stream – a US-based manufacturer of pipe

systems – has used a Warp radar system from **Inoex** to monitor pipe diameter.

One of Jet Stream's specialities is C900 PVC pipe for high pressure water distribution, in diameters of 4-24in – which must not be made out of specification. Before using a Warp system, Jet Stream did not have a good way to measure critical pipe attributes during production. Instead, it relied on inspection after pipe had been sawed to its final length. The C900 line is quite long – with two cooling tanks, a haul-off unit and sawing station after the vacuum tank. This means that a lot of material was already in process if a problem was detected in inspection.

After Jet Stream installed a Warp unit after the vacuum tank it could see what was happening in the process in real time. It can now see impending problems immediately and adjust for them before non-conforming product is produced.

"We can also see how our process spread looks relative to the tolerances – and adjust so we don't give away all this free material," said Paul England, assistant plant manager at Jet Stream.

Jet Stream has also found that the measurement data enables it to get start-ups producing good pipe more quickly. Initial projections on the payback time for the system were very accurate. Through material savings and reduced scrap, it is already paying for itself, said the company.

Separately, Inoex recently expanded its geographical presence by adding a new sales office in Dubai, in the United Arab Emirates.

The expansion is part of the company's strategy to improve its position as a global supplier of measurement and control technology. For many years, it has supplied to pipe manufacturers in the region.

From Dubai, Ineox will supply to the UAE and nearby countries including Bahrain, Qatar, Saudi Arabia, Libya and Egypt. Local sales responsibility will be taken over by Mohamed Abdou, who has more than 15 years of experience in the plastics extrusion industry.

"This new sales office helps us communicate more closely with our customers in the UAE and countries in the region, as well as react to local market needs," said Jan Lohoff, managing director of Inoex. "Dubai has increased in importance as a location for plastics extrusion in recent years. The new office is an ideal starting point to expand sales in this region."

The opening coincided with the opening of the ArabPlast exhibition, where Inoex exhibited as part of the German pavilion – presenting a range of systems including the Warp portable.

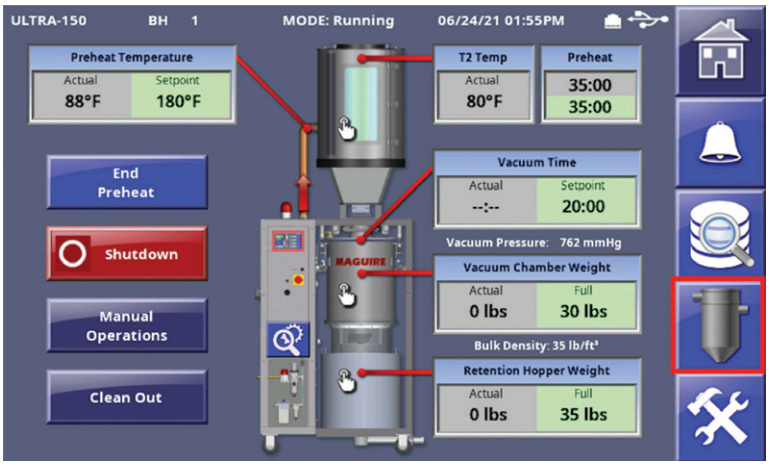

IMAGE: MAGUIRE

Above: Maguire's Ultra dryer touch-screen controller now incorporates its FlexBus Lite software

Faster measurement

Pixargus says that its AllRounDia DualVision system has helped Uponor speed up production of composite pipes.

When Uponor introduced new production technology for its OD 16 to 32mm composite pipes, production speed almost doubled. The inspection systems used in quality control were unable to cope with this. So, the company invested in new inspection technology from Pixargus – its AllRounDia DualVision (DV) system.

Pixargus says it is the first 360-degree inspection system for round products. It combines surface inspection and dimension measurement within one sensor head and shows the measured data in real time on the display. The first system has been in operation at Uponor in Zella-Mehlis for one year.

Uponor uses the quality data to optimise the production process. Process parameters can be analysed over time. In this way, Uponor can see whether certain machine settings lead to more or fewer defects – allowing it to refine its recipes.

"The system can measure the diameter and ovality, and inspect the complete surface area of round extruded products for a wide range of materials," said Michael Frohn, sales manager at Pixargus.

After the successful commissioning of the first system, Uponor has ordered three more AllRounD-ia DV systems.

CLICK ON THE LINKS FOR MORE INFORMATION:

- **www.maguire.com**
- **www.dri-air.com**
- **www.movacolor.com**
- **www.conairgroup.com**
- **www.bausano.com**
- **www.sikora.net**
- **www.ndc.com**
- **www.inoex.de**
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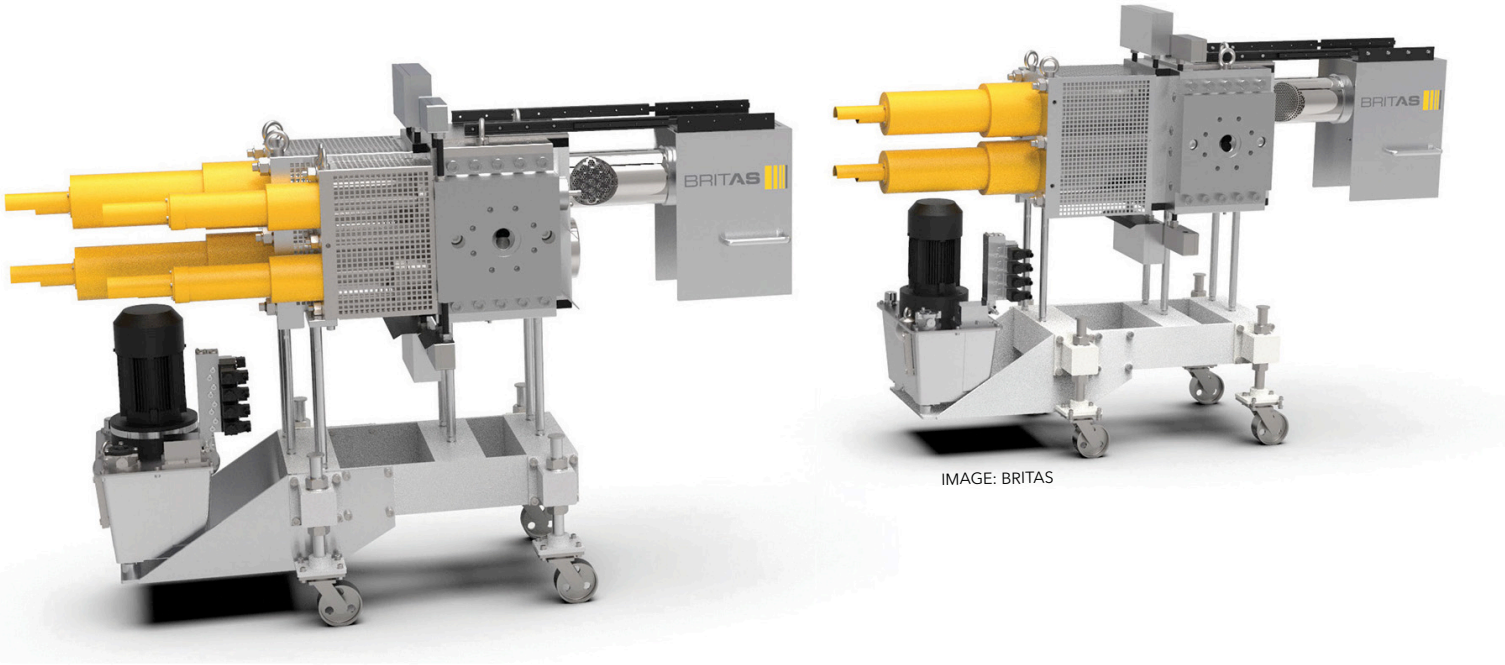

IMAGE: BRITAS

Clean zone: advances in screen changers

Suppliers are developing new products – with some expanding operations – in order to meet growing demands for screen changers and melt filtration systems

As recycling – and the use of recyclate – becomes more important in plastic extrusion, so the demand for melt filtration is growing. Manufacturers of screen changers and melt filters are responding by developing new technology that offers a combination of higher throughput capacity and reduced melt losses – allowing the production of higher-quality extruded products.

Britas of Germany showcased its CMF piston screen changer at the recent Fakuma exhibition.

The CMF series includes four lines – in both continuous and discontinuous versions. The screen changers are designed for the recycling of slightly contaminated plastic waste. The series includes the CMF continuous version and the DMF discontinuous version. They have four different filter types that can handle a range of requirements.

"Piston screen changers are typically used in post-industrial and post-production applications, as well as for virgin material," said Thomas Lehner, CSO of BritAS Recycling-Anlagen. "Depending on the required throughputs and different operating modes, customers choose between the discontinuous version – which mainly has one piston – or the continuous version, with two pistons."

The company offers a number of variants. For instance, the DMF-rd has a round housing, which is heated with ceramic heating bands.

"This more cost-effective filter version is mainly used as pre-filter for coarse contaminations, as pump protection or in case of reduced space in co-extrusion," said Heiko Henss, COO of BritAS Recycling-Anlagen.

Due to its angular housing, the DMF-sq is suitable for temperatures up to 350°C and pressures up to 500 bar. It is heated with heating cartridges. Both types can be used for polyolefins, hotmelt adhesives and technical plastics.

In addition, Britas has extended its ABMF series of melt filters with a new model. Its ABMF PET-C Continuous features double-cavity technology and is used to process heavily contaminated PET. To filter contamination out of plastic waste efficiently, a clean screen mesh is inserted automatically without stopping production.

Up to three screen belts can be inserted simultaneously, which allows an exact adjustment of different filter fineness. ›

Main image: Britas showcased its CMF piston screen changer at the recent Fakuma exhibition

IMAGE: ACERETECH

Right: Aceretech's SCF series disc-type self-cleaning filtration system

Contaminant removal

Nordson says that its BKG melt filtration products help recyclers of very contaminated materials to remove contaminants effectively while minimising melt loss.

Its BKG HiCon R-Type 250 melt filtration system is designed for polyolefin and styrenic materials that have high level of impurities – such as aluminium content above 15%.

The greater efficiency of the FlexDisc filter stack reduces the frequency of backflushing and the amount of backflush volume, he said.

"In addition, it achieves finer filtration, higher throughputs, and longer filter service life. Due to the larger filtration area, it might be possible to use a smaller screen changer," said Christian Schroeder, global product manager for BKG melt filtration systems.

The FlexDisc filter stack can be retrofitted to screen changers that use piston-actuated backflush technology, such as Nordson's BKG HiCon V-Type 3G. This has four screen cavities, and each screen is automatically cleaned via backflushing, while production continues through the other three.

Replacing standard screens with the new filter stack in the screen cavities provides a larger filtration area than with conventional round screens. The actual increase depends on the size of the cavities.

Below: Fimic is increasing production capacity for its melt filtration systems due to rising demand

Factory expansion

Fimic of Italy has recently carried out a major expansion of its headquarters and manufacturing facility in Padua. This has allowed it to increase production capacity, support new product development and provide a faster service to customers, it says.


IMAGE: FIMIC

Its renovated production hall occupies 1,200 sq m and the facility is now equipped with a new production line. This, says Fimic, will allow it to expand production beyond the existing annual output of 70 machines.

"This will significantly increase its production capacity and accelerate manufacturing times to offer an even faster service to customers," said the company.

The project also includes a new two-storey building with 500 sq m of space, to hold offices, showrooms and conference rooms. Fimic says the building is designed under an 'open space' concept, while using insulation and energy-saving technologies to reduce environmental impact.

Self-cleaning

China-based **Aceretech** has developed the SCF series – a disc-type, self-cleaning filtration system. The technology can handle and remove up to 5% contaminants in the melt flow including paper, wood, aluminium, unmelted plastic and rubber. It consists of a hardened steel screen plate, rotating unit, hydraulic section, contaminant-removing blades and discharging screw.

A large filtering area has up to 2.32 million micro-drilled holes, with filtering accuracy of 120 microns. It is an easy operation to replace the disc screen in 30 minutes, according to the company.

Irrigator recovery

Pure Loop, part of Austria's **Erema Group**, has developed a recycling system – which includes a Powerfil laser filter – to produce recycled pellets during the production of irrigation pipes.

Manufacturers with this kind of shredder-extruder combination in place are reusing up to 20% of production waste without any loss of quality, compared to production from pure virgin material, it says.

"This level of reuse can be significantly increased thanks to the high quality of the recycled pellets," said Manfred Dobersberger, managing director of Pure Loop. "The high demands on the recycling process result from the high volume of the bulky input material as well as the material composition."

As well as being used for irrigation pipes, the method also works with drip tapes – another key product used in agriculture.

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IMAGE: EREMA

Above: Pure Loop says its shredder-extruder combination, plus laser filter, makes recycled pellets during irrigation pipe production

To test whether irrigation pipes meet the strict quality standards – of a maximum of two pinholes per 10 kilometres – one customer pressure-tests them with water.

"The proportion of foreign polymers in this material is a real challenge in recycling, but one that our combination of ISEC Evo shredder-extruder combination – with double degassing – and laser filter can handle," said Dobersberger.

In the laser filter, three scrapers remove contaminants – which mainly consist of silicone – from the filter screen during each revolution. The filter's high efficiency enables high throughput rates in the recycling process and high quality of the recycled pellets, according to the company.

In the Powerfil laser filter, contaminated plastic melt flows via a circular distributor ring into a housing between two parallel configured laser-drilled screen discs. The melt is pressed through the discs, flows through and leaves the filter in a clean state via the collection channel.

Contaminant particles collect on the screen as the melt flows through – and are removed by the three scrapers. The pressed-on scrapers lift the contaminants from the discs and transport them to the discharge system

The recycling machine can process bulky hose bundles as well as other production waste such as start-up lumps and regrind material or complete rolls with drip tapes.

Single-shaft shredders and double feed ram systems flexibly adapt to individual logistic requirements and – thanks to the conical transition to the extruder – the material is compacted and oxygen is reduced, so that the plastic is processed very gently.

Range improvement

Maag says it has managed to reduce maintenance requirements and improve operational reliability by redesigning its melt filters. Its portfolio includes continuous melt filters, semi-continuous melt filters with high-speed hydraulics, and discontinuous melt filters for batch processes or where continuous processes are not required.

Maag's established DSC and CSC piston screen changers are available with three different cavity options: the standard round cavity for very high filler contents; the enlarged 'PE' cavity designed to provide versatility for balancing throughput and filler loading; and the 'R' cavity with a curved screen that is claimed to provide four times larger filter area.

Maag cites a number of improvements across the portfolio, including: optimised flow channels through modified screen-bolt guiding; improved safety guarding; low viscous sealing possibilities; and a metal hybrid seal system for all flat-slide, HSC or FSC-D3 melt filters.

The new metal-hybrid seal can be used over a wide range of viscosities and at temperatures up to 320°C. The company says it can be used in operations running with melt viscosities from 5 to 5,000 Pa.s (independent of temperature) and is easily exchanged with a standard sealing ring.

In addition, Maag says its Micronex candle filter elements are designed to optimise flow and maximise filter area. Each is tailor-made using a combination of filter media layer, number and height of pleating, hardware materials and end fitting design.

CLICK ON THE LINKS FOR MORE INFORMATION:

- **www.britas.de**
- **www.nordson.com**
- **www.fimic.it**
- **www.aceretech.com**
- **www.pureloop.at**
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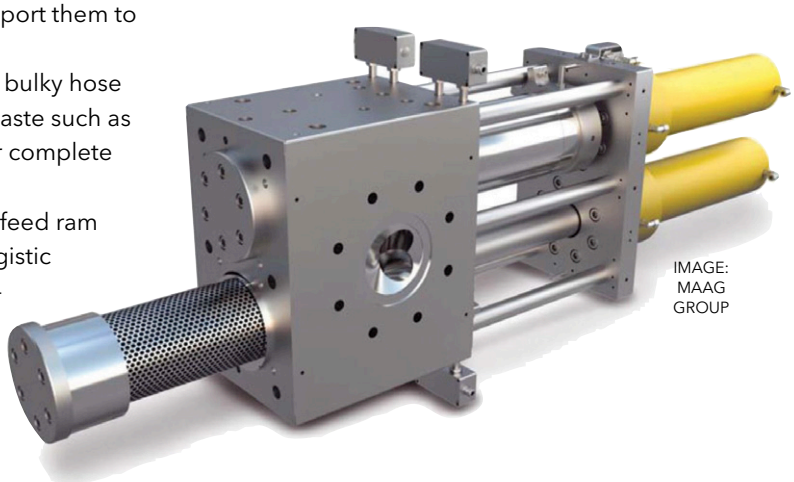

IMAGE: MAAG GROUP

Right: This CSC piston screenchanger from Maag is fitted with its high surface area 'R' type curved screen

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PVC

Vinyl profiles improve sustainability of solar energy generation system

A solar energy project has used plastic tubing made from Teknor Apex PVC compounds to replace traditional steel – helping to boost sustainability.

Hyperlight Energy has developed a concentrated solar power (CSP) system that helps to "decarbonize oil recovery". CSP projects usually look like massive fields of mirrors with a tall tower at the centre. After a decade of research, Hyperlight has developed its technology in multiple successive generations, at a fraction of the size of traditional CSP projects.

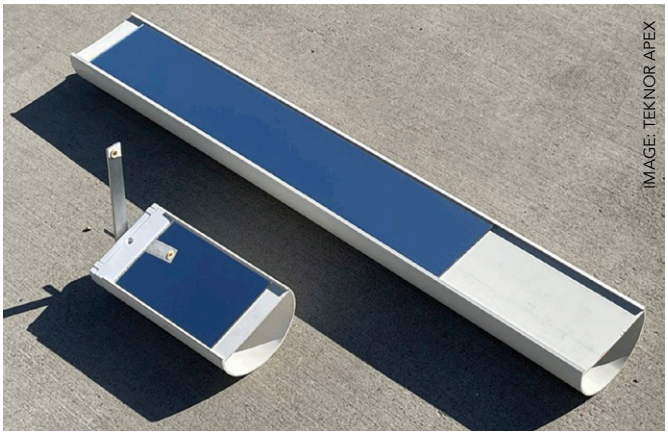

IMAGE: TEKNOR APEX

Usually, CSP projects must operate at massive scale – and use lots of steel. Hyperlight's Hylux system uses domestically produced, recyclable tubes made from Teknor Apex vinyl compounds. The compound is used to extrude a hollow profile that holds the mirrors for the photovoltaic technology – completely replacing steel.

The compound provides other key benefits, such as UV stability – which ensures there is no cracking or degradation over time.

"We have a system that eliminates 90% of the steel and concrete of a traditional CSP by replacing them with plastic," said John King, CEO of Hyperlight CEO.

Mike Patel, director of marketing for the vinyl division of Teknor Apex, added: "Providing domestic and recyclable PVC has allowed for a greener and more affordable alternative to traditional concentrated solar projects."

› **www.teknorapex.com**

ACRYLICS

Colour range expanded for co-extruded profiles

IMAGE: PROFINE

Profine has expanded the range of colours available with its AcrylColor PMMA profiles.

The profiles are co-extruded with PVC to make window frames that have a protective shield with scratch resistance and long-lasting colour fastness. A heat treatment process creates the acrylic layer, which bonds tightly to the PVC.

The new surface variant is available in the Kommerling 76 centre seal system, the residential door version of the Kommerling 76 double seal programme and the Kommerling 76 PremiDoor 76 lift/sliding system. Initially, the profiles are available in five colours: four contemporary grey tones and a sepia brown.

PMMA finishing is a long-standing technology at Profine stretching back to the 1970s – with AcrylColor being the latest development.

"With Kommerling AcrylColor, we can offer customers another option in the growing market for coloured windows," said Stefan Schäfer, chief product and marketing officer at Profine.

› **www.profine-group.com**

POLYOLEFINS

Bimodal PE aimed at pipe

Borouge has launched a new polyolefin for use in the infrastructure sector

Borstar HE3477-RT is a PE-RT Type II bimodal material designed for heating and industrial pipes. It can achieve more than a 50-year lifetime at elevated temperatures and is designed as a replacement for conventional metallic materials in district heating and industrial applications.

The material adds to the company's HE3466-RT PE-RT Type I grade.

› **www.borouge.com**

EXTRUDERS

Groove feed performance moves to a higher level

Davis-Standard has extended its range of groove feed extruders with its SHO (super high output) model.

It is equipped to save space while offering outputs up to 20% higher than existing groove feed models, says the company. An optimised feed section and high-performance DSB barrier screw are beneficial for high-viscosity HDPE applications such as pipe extrusion – where lower melt temperature, reduced power consumption and improved energy efficiency are critical.

"Improving energy efficiency equates to tangible savings for your operation, while reducing your carbon footprint," said John Christiano, VP for technology at Davis-Standard. "The SHO builds on our existing groove feed technology with a more streamlined, compact footprint."

IMAGE: DAVIS-STANDARD

It includes Davis-Standard's next-generation gearcase – which optimises production space – plus a streamlined hopper, low-profile power panel, rugged base and fully enclosed components. This leads to improvements in output, output consistency, melt quality and energy efficiency – as well as reducing purging and changeover time.

It is available in sizes of 2-6in (50-150mm) with an L/D of 42:1.

› **www.davis-standard.com**

FIBRE EXTRUSION

Processing natural fibre waste

Bausano of Italy has enhanced its custom extrusion lines to extrude products from waste plastic and natural fibres.

The lines combine waste materials such as PVC, PE or PP with a range of natural fibres. As with WPCs, the materials are suitable for applications such as flooring and decking.

Bausano's extrusion technology can incorporate up to 100 phr of wood or natural fibre. The counter-rotating twin-screw configuration achieves accurate mixing between melted polymer and fibre, passing it through the mould without the need for a melting pump.

› **www.bausano.com**

TESTING

Latest generation of digital force gauges

IMAGE: AMETEK

Chatillon – part of Ametek – has introduced a new range of digital force gauges.

Its DF3 Series have an ergonomic design that ensures a stable grip. Features include a full-colour screen display and rugged rubber keypad. An intuitive user interface, plus other advanced features, makes the DF3 Series easy to use – helping users to optimise their processes and save time.

Some features help users become more efficient in force testing, such as the test setup functionality: here, users can pre-define test setups, auto-save test results and automatically export them for further analysis. A battery life of up to 40 hours reduces the need for recharging.

The new series offers two models, which are available in several capacities and with a sampling rate of 30 kHz.

The DFE3 series is an economy gauge designed for simple applications without compromising functionality. Available in capacities from 2lbf (10N) to 500lbf (2500N), it has an accuracy of 0.2% of full scale.

The DFS3 series is a high-end gauge for basic and complex applications. Available in capacities from 0.5lbf (2.5N) to 500lbf (2500N), it has an accuracy of 0.1% of full scale.

Loads are displayed in multiple units. The force gauges are supplied with durable carrying cases and adaptors.

› **www.ametektest.com**

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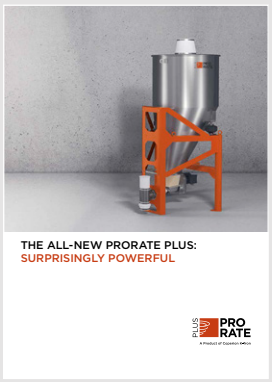

The new ProRate Plus feeder system from Coperion K-Tron offers a cost-effective and simple-to-configure gravimetric option for processors looking for reliable handling of pellets and free-flowing bulk powders.

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MIXACO: MIXING TECHNOLOGY

Mixaco has been driving innovation in PVC mixing technology for more than 50 years and has 7,500+ machines installed worldwide. This brochure explains some of the details that make its HM and KMH heating cooling mixers stand out.

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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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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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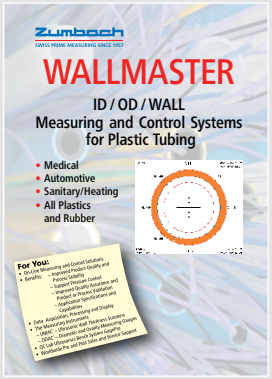

This eight-page brochure details the main features of Zumbach's Wallmaster measurement and control system for improving product quality, process stability and data capture in plastic tube and pipe extrusion applications.

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Polywood

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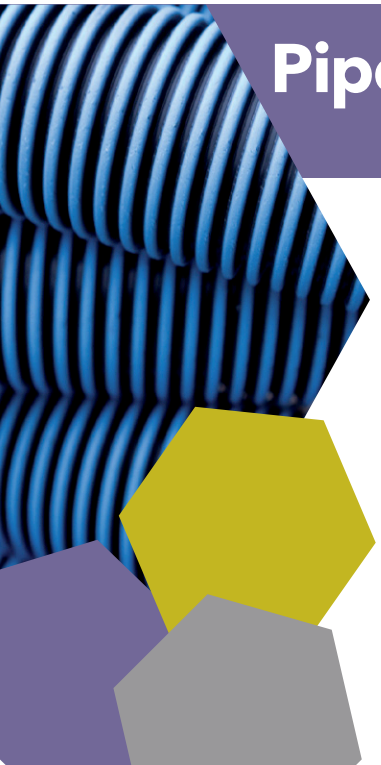
Managing director:	Digvijay Dhabriya
Founded:	1992
Ownership:	Public (listed on BSE, Mumbai)
Employees:	Around 300
Turnover (2020-21):	R1,064 million (around US$14m)
Profile:	Polywood, established in 1992 by Digvijay Dhabriya, is a manufacturer of PVC profiles for a variety of building and interior applications. These include doors, windows, wall panels, fencing, furniture and foam board, which are made in a number of production facilities.
Product lines:	The company has a number of brands for its various product lines. For example, Everluxe is its brand of PVC door profiles, while its furniture brands include Dyncron and Dynasty. Its PVC windows include a variety of designs, such as sliding, casement and bay windows. The same is true of its door panels, which also include folding doors and those for wet areas. The company's PVC foam board is used in applications such as kitchen interiors, wardrobes and office furniture. Its fencing products are a weather-resistant alternative to wood – being resistant to both UV light and insects.
Factory locations:	The company has five manufacturing facilities in India – three in Rajasthan in north-west India and two in Tamil Nadu, in the south. Between them, they have a combined capacity of around 10,000 tonnes/year of profiles. In addition to profile extrusion, Polywood has its own R&D facilities and develops tools and dies to match the specific design requirements of customers.

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



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March/April 2021
Screws & barrels
Polyolefin developments
Computer modelling software
Chinaplas 202 preview

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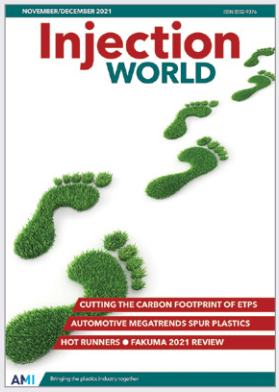

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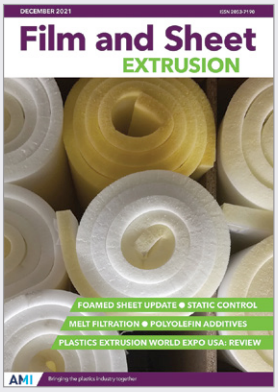

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	5-8 April	FIP, Lyon, France	www.f-i-p.com
	25-28 April	Chinaplas, Shanghai, China	www.chinaplasonline.com
	3-6 May	GreenPlast, Milan, Italy	www.greenplast.org
	26-30 September	Colombiaplast, Bogota, Colombia	www.colombiaplast.org
	4-7 October	Plastex, Brno, Czech Republic	www.bvv.cz/en/plastex
	19-26 October	K2022, Dusseldorf, Germany	www.k-online.com
	20-22 November	Plastics Extrusion World Expo, Cleveland, USA	https://na.extrusion-expo.com
	1-3 December	Plastic Print Pack West Africa, Accra, Ghana	www.ppp-westafrica.com
2023	**17-19 January**	Swiss Plastics Expo, Lucerne, Switzerland	https://www.visit.swissplastics-expo.ch/de
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Date TBA	PVC Formulation Asia, Bangkok, Thailand
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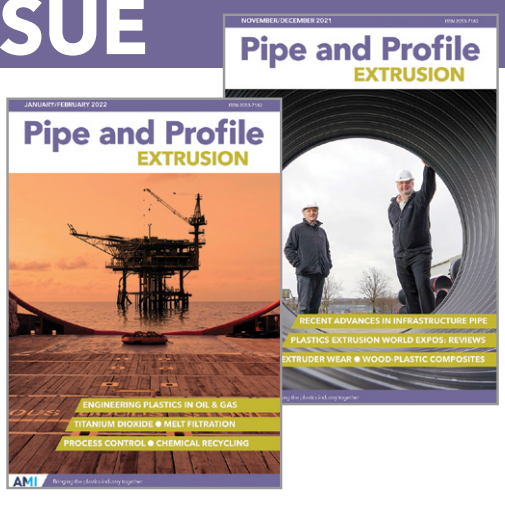

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Chemical Recycling

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Chemical Recycling
GLOBAL INSIGHT 2022

Letter from the Editor

Welcome to Chemical Recycling Global Insight 2022, a special publication written and produced by AMI Magazines, with support from AMI Consulting. The development of chemical recycling is a response to the global problem of waste plastics in the environment. Its advocates see chemical recycling as complementary to mechanical recycling which is itself growing in importance.

In this publication, we look at the market prospects for chemical recycling and how the industry is taking shape.

The articles cover not just the scope of the waste plastics problem, but also influencing factors such as legislation and targets for use of recycled content. There is an article on the various technologies that come under the chemical recycling umbrella term, offering a guide to their differences and relative advantages.

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. Some of the players in this fast-moving industry are featured in a series of company profiles.

We hope you find this publication informative and useful.

David Eldridge – Editor
AMI Magazines

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The need for more plastics recycling

The problem of plastics waste has come to dominate the outlook for the plastics industry. Many polymer producers and technology companies are now turning to chemical recycling as a possible solution

IMAGE: SHUTTERSTOCK

Main image: Mixed plastics waste is the source of feedstock for many plastics recycling companies

The circularity of plastics has risen rapidly up the agenda for the global plastics industry. It is now the top talking point at any conference, forum and exhibition at which industry companies gather. Campaign groups have tried to highlight the problem of plastic waste in the environment for many years, but it only cut through to the public as a mainstream issue in 2018. The blanket media coverage of plastic pollution in oceans and on beaches has receded since then, but the problem of what to do about waste plastics remains just as strong.

The European Union responded quickly with actions to tackle plastic packaging waste, including its Plastics Strategy, setting medium-term targets for reducing plastics waste, and more immediate action to ban plastics in certain single-use items. But it's not just in Europe that the issue has achieved such prominence. The challenge has been recognised in all regions of the world and many countries have implemented or are planning to implement regulations, notably China's ban on most plastic waste imports, which was followed by other Asian countries imposing similar import bans.

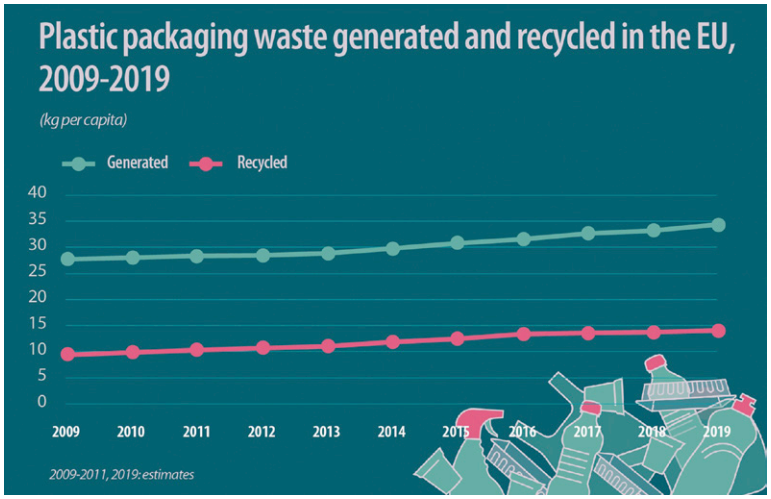
A key approach to the problem is circularity, which encompasses reduction in material usage and the recycling of materials so that loops are created in material production and use, thereby cutting the amount of waste. Multinational brand-owners have become active in reducing virgin plastics and increasing recycled plastics in packaging of their products.

Ellen MacArthur Foundation has been at the forefront of the drive towards a circular economy in plastics packaging, along with other areas such as fashion and food. In November 2021, it published the third annual progress report on its New Plastics Economy Global Commitment. It said signatory businesses, accounting for 20% of all plastic packaging produced globally, have progressed towards their 2025 targets to create a circular economy for plastics.

The report was nonetheless critical of companies in terms of reducing packaging: "There is very little evidence of ambitious efforts to reduce the need for single-use packaging in the first place."

Chemical and mechanical recycling can be used for plastics waste that arises in all sorts of industries, including automotive, electronics and others. But it is plastics packaging that is the major focus for many companies in the plastics industry, because of the huge volumes of packaging waste and because this is where social concern is the greatest.

Plastics packaging recycling has actually been increasing in the EU for more than a decade. A study published by Eurostat in October 2021 indicated a 41% EU recycling rate for plastics



SOURCE: EUROSTAT

packaging waste in 2019. Between 2009 and 2019, the recycling volume of this waste increased by 50%. However, a burgeoning plastics packaging market in the decade meant that the volume of waste generated per inhabitant over the decade increased by 24%.

Recycling of plastics packaging waste has not kept pace with the growth in the EU packaging market. So the pressure is on the plastics industry to deal with the problem and plastics producers have turned to chemical recycling as a solution.

Mechanical recycling is a more established transformation route for waste plastics, and it has the advantages of being a cheaper and less energy-intensive process than chemical recycling. But current small capacities for mechanical recycling are not enough to deliver the huge tonnage of recycled plastics that are necessary to meet regulatory and corporate targets. This is where large-scale polymer producers believe they can step in and help.

In May 2021, PlasticsEurope, the representative body for polymer producers in Europe, announced a significant increase in planned chemical recycling investment, from €2.6bn in 2025 to €7.2bn in 2030. Its member companies are aiming to increase their investment in chemical recycling to produce 1.2m tonnes of recycled plastics in 2025 and 3.4m tonnes in 2030. Advocates of chemical recycling state that this growth will not impact on the further development of mechanical recycling, as the focus would be on mixed plastics waste and other types of hard-to-recycle waste streams.

PlasticsEurope said: "Chemical recycling allows us to recycle plastic waste which is otherwise incinerated or sent to landfill. It delivers significant quantities of recycled material with virgin plastic properties. It is complementary to mechanical recycling and has a huge potential for creating quality jobs and contributing to a climate neutral and competitive Circular Economy in Europe."

The American Chemistry Council is supporting US-based polymer producers involved in projects to increase capacity for chemical recycling, or advanced recycling as it is more commonly called in the USA. A chemical recycling report from ACC in 2019 estimated the US could support investment in 260 new facilities converting plastics waste to products such as feedstocks for new plastics and chemicals.

ACC's polymer producing members have set a goal for 100% of US plastic packaging to be reused, recycled or recovered by 2040. To help reach that goal, ACC has drawn up its Roadmap to Reuse which highlights six key areas for plastics makers and the value chain to focus on to help solve plastic waste challenges.

Increased plastics recycling capacity will certainly be needed as plastics usage is set to grow over the next decade in all regions of the world. According to a forecast by AMI Consulting, China accounted for almost one-third of commodity polymer demand in the world in 2019. By 2030, China is forecast to account for 38%. This contrasts with slower virgin polymer demand growth in Europe (0.2% annually to 2030) and in North America (1.1% annually) and South America (also 1.1% annually). South East Asia and the Middle East/Africa are both forecast to grow by 3% per year. The Indian Subcontinent will be a hotspot with its polymer demand forecast to grow by 5.3% per year up to 2030.

In its *Chemical Recycling Global Status 2020* report, AMI Consulting presents its expectations for the global chemical recycling market in 2025 and 2030. It is forecasting a compound annual growth rate (CAGR) for global chemical recycling of 28.0% up to 2030. Europe is expected to grow fastest and have a lead over North America by 2030 due to the more advanced legislative agenda of the European Union. But North America will not be far behind, and Asia is likely to also experience good growth.

Of the four types of chemical recycling technologies – pyrolysis, gasification, depolymerisation and dissolution – pyrolysis will be the dominant one in terms of total waste recycled (also see separate technology article). This is due to a few factors: the greater number of pyrolysis projects currently being developed; less complexity than other processes; fewer concerns about the scale required to achieve commercial viability.

Mixed polyolefins can readily be recycled in large amounts using pyrolysis. Depolymerisation technologies will mainly be used for PET waste types, such as coloured material, that mechanical recycling is not targeting. Polystyrene waste will be recycled by different technologies, especially dissolution and depolymerisation. ■

IMAGE: SHUTTERSTOCK

Explaining chemical recycling processes

Chemical recycling is an umbrella term that includes a variety of technologies, each with their own process characteristics, input requirements and outputs. We explain the technologies

Few in the plastics industry will not have heard of chemical recycling but that simple term covers a huge range of quite different technologies. Today's chemical recycling technologies can be classified into three broad concepts: dissolution, depolymerisation, and thermal cracking. These three approaches differ, at a conceptual level at least, in the type of materials they can handle, the amount of "chemistry" involved, and the product that results.

Dissolution technologies use carefully selected solvents to dissolve the polymer from the mixed waste, allowing insoluble contaminants such as fillers and pigments to be filtered out. The dissolved polymer can then be precipitated and recovered from the solvent, which is reused. This is a physical process – the chemical composition and structure of the polymer is unchanged. As a result, many of its proponents consider it to be closer to mechanical than chemical recycling and promote it accordingly, using terms such as solvent-based purification or physical or material recycling.

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 polypropylene with a technology licensed from P&G while Canada's Polystyvert is focusing its efforts on polystyrene.

The need for a relatively homogenous waste stream does not necessarily mean that dissolution technologies are suitable only for mono-material plastic waste. Germany's APK, for example, is developing its technology to recover LDPE and PA from multi-layer films. ›

Main image: Some chemical recycling involves changes in chemistry, but not in the case of dissolution

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

Depolymerisation is certainly a chemical recycling process, typically using heat (and often a catalyst) to convert a polymer back to its building block monomers – for this reason it is sometimes referred to as monomer recovery. It is most suitable for use with step-growth polymers such as PET, which are polymerised by polycondensation.

A number of companies are developing various processes to depolymerise PET, with pilot projects underway at Carbios in France, CuRe Technology and Ioniqa in the Netherlands, Rittec in Germany, and BP Infinia, Eastman and Loop Industries in North America.

Depolymerisation of polycondensation polymers typically involves reintroducing the molecular component that was eliminated during the original polymerisation process. Several solvolytic processes are being investigated to do this, including hydrolysis, glycolysis, methanolysis and transesterification. These are all multi-step processes that include 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 thermal depolymerisation technologies that are capable of converting PS polymer back to styrene monomer.

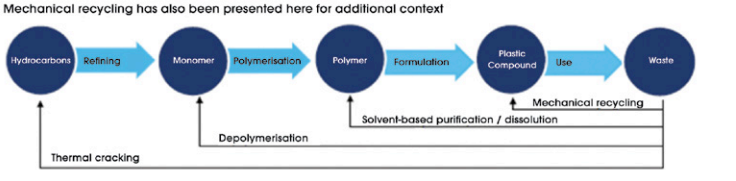
By converting polymers back to the original monomers, depolymerisation can lead to new polymers of virgin quality. However, it uses highly specific chemical processes so the incoming waste stream has to be consistent in terms of polymer composition, meaning considerable cost may be incurred in pre-sorting. Energy requirements can also be quite high.

Thermal cracking converts waste plastic – and many of the contaminants the 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). Two processes are used to thermally crack – or feedstock recycle – polymers: pyrolysis cracks the polymer chains at high temperature in the absence of oxygen; gasification heats the polymer with a controlled but limited amount of oxygen. Both yield a different mix of end products with targeted applications ranging from fuels to chemical feedstocks.

Conventional pyrolysis thermal cracking is a relatively simple technology. Waste goes through a pre-sorting and shredding process and is then pyrolysed at high temperature – typically 400-600° – to create vapour and gas, which is then purified to create a range of hydrocarbons. These hydrocarbons can include gas, wax, oils and char. Yields of each can be controlled to some extent by adjusting temperature, pressure, and residence times, as well as through the use of particular catalysts and thermal profiles.

As pyrolysis occurs in the absence of oxygen, 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 waste streams with a mixed polymer composition that would be highly challenging for either mechanical or dissolution and depolymerisation chemical recycling methods. That said, it is an energy intensive process and the quality and mix of the output materials is still dependent to some extent on the input materials. In addition, much of the gas and oil output from pyrolysis plant is likely to be burnt as fuel, either to provide energy for the process itself or because of the need for additional purification steps to upgrade it to be used as a cracker or chemical plant feedstock. Under most regulatory and accreditation regimes, the use of



	Mechanical recycling	Solvent-based purification / dissolution	Depolymerisation	Thermal cracking
Feedstock	PET, POs, PS, PVC, mixed plastics	POs, PS, PVC, PET	PET, PS	Mixed plastics, POs, PS
Output	Plastic compound	Polymer	Monomer, oligomer	Hydrocarbon mix
Status	Industrial scale	Pilot stage	Pilot stage	Pilot, industrial

Four types of plastics recycling
Source: AMI Consulting

outputs as a fuel is not recognised as recycling.

Major players in the development of pyrolysis-based technologies include Luxembourg-headquartered Clariter, Enval, Recycling Technologies, Renew ELP and Plastic Energy in the UK, Fuenix Ecogy in the Netherlands, OMV in Austria, Quantafuel in Norway, Brightmark, Encina, Nexus Fuels and Alterra Energy in the US, GreenMantra Technolgies in Canada, and Licella in Australia.

Gasification thermal cracking differs from pyrolysis in that the process takes place in the presence of a controlled but limited amount of oxygen. It can handle almost any organic material – including plastic waste and biomass – and can take on polymers containing oxygen and halogens. The end result is syngas that, depending on its composition and purity, can be used as a production feedstock.

The gasification process involves fewer steps than pyrolysis: pre-treatment of the waste (including water removal); gasification; and cleaning of the gas to remove tars and other contaminants. That final purification step is required to remove impurities such as ammonia, H_2S, alkali metals, NO_x and tars.

Gasification is not a new technology. Texaco developed and licensed its TCP (Texaco Gasification Process) technology back in the 1980s to handle hazardous waste organics. It is a non-catalytic, partial oxidation process capable of converting organics to syngas and chars. However, the TCP process does not produce feedstocks suitable for reintroduction into plastic-to-plastic or other value-added chemical synthesis chains.

A number of companies are investigating gasification processes to crack plastic waste to heavy oil and non-condensable gases and condensable gases. The non-condensable gases are used as process fuel while condensable gases and heavy oils can be gasified with oxygen and steam. These processes typically involve use of high temperature gasification at more than 900°C, which is energy intensive, followed by additional purification steps.

Gasification thermal cracking technologies are under development by a number of companies, including Enerkem in the Netherlands, Eastman in the US, and Showa Denko and Sekisui/Sumitomo in Japan.

Chemical recycling is still a very young technology. However, it seems clear from the work carried out to date that hopes that it will solve the challenge of handling mixed waste streams may be misplaced. The reality is that most of the technologies currently under development will need some level of homogeneity in waste feedstock. That means that, initially at least, chemical recycling is likely to draw on the waste sources and supply infrastructure developed for mechanical recycling.


IMAGE: BASF

Above: BASF's Andreas Kicherer holding a jar containing pyrolysis oil

Drawing on the same collection and sorting infrastructure does not necessarily mean that chemical recycled material will compete directly with mechanical recycled material. Compared to mechanical recycling, all chemical recycling processes are more complex and are likely to be more costly. So, where high quality waste streams are available, mechanical recycled polymer is likely to win out simply on economics.

Chemical recycling, on the other hand, begins to look a lot more attractive where waste streams are less homogenous than is preferred for mechanical recycling, or where volumes of recycled material exceed the capacity for reuse in new applications (either for reasons of regulation or for deterioration in material properties).

There may be some competition for feedstocks, but even that is likely to be limited. In its most recent *Chemical Recycling Global Status* report, AMI Consulting says that while the potential exists for competition to develop between the two recycling technologies in some areas – it cites the example of PET bottles and trays – it is also quite conceivable that separate markets may emerge. PET waste with the lowest levels of contamination, for example, could be sought out by mechanical recyclers while PET waste streams with higher contamination levels may be processed by depolymerisation, the report authors say.

Looking at feedstocks for the thermal cracking processes – either pyrolysis or gasification – that are expected to account for the majority of chemical recycling in volume terms, the AMI consultants say the fact that mechanical recycling can only offer a "downcycling" solution for mixed plastics waste makes it a prime stream for the chemical route. The study authors conclude that the likelihood of feedstock competition "is minimal for the vast majority of chemical recycling." ■

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IMAGE: GR3N

What's new in chemical recycling projects

The number of companies getting involved in chemical recycling of plastics waste has been growing rapidly. This article provides an update of recent developments in projects around the world involving chemical recycling of mixed waste, plus ones focussed on PS and PET

Announcements of new plastics chemical recycling projects have been coming out regularly in recent months, along with progress reports on previously announced projects. Most operations are set for the 2022/23 time frame. What follows is a non-exhaustive review of projects in various states of construction and operation around the world, mostly related to mixed plastics waste but also for individual polymer streams (PET and polystyrene).

Plastic Energy, probably the most prominent independent technology company operating in chemical recycling, already has two commercial chemical recycling plants in operation, in Almeria and Seville, Spain. They have been running since 2015 and 2017 respectively. Each has a capacity of 5,000 tonnes/yr. The technology uses a thermal anaerobic conversion (TAC) process to produce what Plastic Energy brands as Tacoil. The Spanish facilities take waste, mostly film, collected by a waste management company that would normally send the material to landfill.

Main image: Swiss company Gr3n has constructed a demonstration plant for its PET recycling technology

Plastic Energy says it is continuing to increase its portfolio of European projects, with a 20,000 tonnes/yr plant currently under construction in the Netherlands with partner **SABIC** in a joint venture called SPEAR (SABIC Plastic Energy Advanced Recycling), and a 25,000 tonnes/yr plant that has recently started construction in France, along with a collaboration offtake agreement with ExxonMobil.

The company also has a joint venture with **TotalEnergies** (previously Total) for a 15,000 tonnes/yr recycling plant at the latter's Grandpuits "zero-crude platform" site in France, with construction expected to start soon. This will be France's first chemical recycling plant using pyrolysis to produce Tacoil.

The plant in the Netherlands is expected to become operational in 2022, with SABIC building a treatment facility to purify the pyrolysis oil coming from this joint venture, before feeding the oil into its own processes. Both plants in France should be operational in 2023.

This October, Plastic Energy also announced a partnership with Freepoint Eco-systems and its first recycling project in the US, with plans to build a 33,000 tonnes/yr plant in Texas, and a collaboration offtake agreement with TotalEnergies; it should be operational by mid-2024. In addition to this, Plastic Energy has an MoU with Petronas for a recycling project in Malaysia, and says it is working towards expanding in other parts of Asia.

SABIC is also exploring opportunities in other regions. It is for example working with Saudi Investment Recycling Company (SIRC). The two companies are cooperating in Saudi Arabia to build the first chemical recycling facility in the country, producing feedstock for SABIC's local polymer units. SABIC is also doing something similar in Asia and in the Americas, but no announcements have yet been made.

In March, **BP** and SABIC signed a new agreement to work together to drive a circular economy in the petrochemical activities at the Gelsenkirchen chemical complex. The two companies have a long history of cooperation on the site, dating back to when the SABIC operations were owned by DSM.

Below: BP and SABIC are working to drive a circular economy in petrochemical activities at the Gelsenkirchen chemical complex

IMAGE: SABIC

Pyrolysis oil will be processed at BP's Gelsenkirchen refining site and then used by SABIC in its Gelsenkirchen polymer plants to produce certified circular products, which SABIC brands as Trucircle. After successful trials in December 2020, polymer production using the alternative feedstock started at the site early this year.

BP and **Brightmark**, a global waste solutions company that has proprietary chemical recycling technology, have signed a Memorandum of Understanding (MoU) to jointly evaluate opportunities for development of the next generation of plastic waste renewal plants in Germany, the Netherlands, and Belgium. BP is already the offtaker for Brightmark's 100,000 tonnes/yr pyrolysis plant in Ashley, Indiana, USA, which is currently undergoing final commissioning. The Ashley facility produces plastics-to-fuel and waxes. "Moving forward, all facilities will be designed for circular end products," says a representative.

In January, Brightmark and **SK Global Chemical**, headquartered in South Korea, signed an MoU to create a partnership to build a commercial scale pyrolysis plant in South Korea with a 100,000 tonnes/yr capacity. Both parties are currently carrying out a feasibility study. By the end of this year, they should have completed evaluation of the most optimal methods to operate, scale and develop the technology within South Korea.

In September, Shell Ventures and BlueAlp Holding announced a strategic partnership to develop, scale and deploy BlueAlp's pyrolysis technology. Shell has taken a 21.25% equity stake in BlueAlp as part of the agreement.

Shell and **BlueAlp** will form a joint-venture company to build two new conversion units in The Netherlands, which are forecast to convert more than 30,000 tonnes/yr of plastic waste. The units are planned to be operational in 2023 and will supply 100% of their pyrolysis oil as feedstock to Shell crackers in The Netherlands and Germany. Shell is exploring licensing a further two units for deployment within Asia to supply the Shell Energy and Chemicals Park Singapore.

In October Shell Chemicals Europe also announced a strategic cooperation and offtake agreement for pyrolysis oil made by Rotterdam-based company **Pryme** from recycled plastic waste. Pryme will supply Shell from its first plant located in Rotterdam. Currently under construction, the plant

is scheduled to become operational in 2022 and is forecast to convert 60,000 tonnes/yr of plastic waste into pyrolysis oil by 2023.

The agreement also includes provision for future supply to be delivered from Pryme's proposed second plant in the region. This will have an estimated annual pyrolysis oil production capacity of 350,000 tonnes.

Eastman has two chemical recycling technologies that tackle different feedstock streams. Polyester Renewal Technology processes polyester feeds (see section on PET below), while its Carbon Renewal Technology can recycle most other thermoplastics, with the exception of PVC. In late 2020, Eastman said it expected to use up to 50m pounds (close to 27,000 tonnes) of waste plastic in Carbon Renewal Technology operations in 2020, with projects underway to significantly expand that amount. No update was available at the time of writing.

In early November, **Aduro Clean Technologies**, a Canadian developer of patented water-based technologies to chemically recycle plastics and transform heavy crude and renewable oils into new resources and higher-value fuels, announced a pending partnership with Brightlands Chemelot Campus in Limburg, The Netherlands.

Aduro says the objective of this partnership is to complete an installation that applies Aduro Hydrochemolytic technology (HCT) to demonstrate, on a tonnes per day scale, the conversion of polyethylene waste to useful feedstock for chemical processes, including production of new PE.

Ofer Vicus, CEO of Aduro, says: "This year we plan on doing our proof of concept. This is nearly done and we are working on the data to submit it to a third party," says Vicus. "Our next step in the road map is to work on the pilots – this is happening now with Brightlands and possibly others."

He says: "Traditional methods rely on high temperatures from 400°C to as high as 1,100°C, and on hydrogen produced by conversion of fossil fuels at between 700°C and 1,000°C. Aduro Hydrochemolytic processes operate at only 240-390°C."

Marc van Doorn at the Brightlands Chemelot Campus says: "We are at the early stages and it still needs quite a lot of development, but lab results were quite interesting. Aduro is planning to scale the process up to pilot plant level at our campus, where we have a number of other things going on in chemical recycling."

Another chemical recycling process that relies on water – super-critical steam in this case – has been developed by **Mura** in the UK. In April, it announced a partnership with Dow Chemicals to support the rapid scaling of its HydroPRS (Hydrothermal Plastic Recycling Solution) process. Dow will also take recycled materials from the first plant, in Teesside, UK. The first of four 20,000 tonnes/yr lines is expected to be operational in 2022. Dow and Mura are looking to co-operate on offtake at a number of additional European projects, currently in Mura's development pipeline.


IMAGE: EASTMAN

Above: Eastman has two chemical recycling technologies that tackle different feedstock streams

Alongside its first plant in the UK, Mura also has four 100,000-tonnes/yr sites under development in Germany and four of the same capacity in the US – Washington State has just been announced as the first location. It also recently announced the sale of the first HydroPRS licence to Mitsubishi (MCC), which has plans to develop the process to commercial operation by 2023 at its Ibaraki site, Japan. It will have the capacity to handle 20,000 tonnes of plastic waste per year – with MCC studying the possibility of increasing capacity in the future. Initially, the project will aim to use post-industrial plastics.

"Our ambition is to have 1m tonnes of plastic recycling capacity in operation or development by 2025," says a representative.

Dow says it is actively pursuing a number of commercial partnerships with customers and brand owners to scale chemical recycling technology. Two years ago, for example, it announced its partnership with Fuenix Ecogy Group for the supply of pyrolysis oil feedstock made from recycled plastic waste, to be used in the production of new polymers at Dow's production facilities in Terneuzen, The Netherlands. It has since announced additional investments in Fuenix to help scale this advanced recycling technology further. Most recently, in October 2021, Dow and Fuenix announced the construction of a second plant in Weert, which will process 20,000 tonnes of waste plastic.

As well as its partnership with Mura Technology, Dow has also established a multi-year agreement with New Hope Energy, based in Tyler, Texas, USA to supply it with pyrolysis oil feedstocks derived from plastics recycled in North America, which Dow


IMAGE: RENASCI

Above: Renasci's ISCC PLUS-certified recycling centre in Oostende, Belgium

will use to produce circular plastics.

BASF is working with several partners to further develop pyrolysis technology. In 2019, it invested €20m in **Quantafuel**, a Norwegian company specialised in the pyrolysis of mixed post-consumer plastic waste and the purification of the resulting oil. In September 2020, Quantafuel started up its first pyrolysis plant with a capacity of approximately 20,000 tonnes/yr in Skive, Denmark. "Together, we are also working on further developing and improving the process," says BASF. "Developing suitable catalysts for the new process technology is an important aspect of this. These catalysts aim to ensure that high-purity pyrolysis oil is always produced, even when the composition of the plastic waste varies."

In late August, Quantafuel said the Skive plant would undergo upgrades before the end of the year, allowing for stable, long-term commercial production. "We are working on removing the last known obstacle," said Quantafuel's interim CEO Terje Eiken. In September, it announced plans to expand into the UK, with a plant in Sunderland that could be up and running "in a few years." Additional sites are also being considered by Quantafuel UK. The Sunderland plant will be designed to process more than 100,000 tonnes/yr of waste plastics, to be sourced from across the north of England.

In June, **Borealis** announced an exclusive agreement with **Renasci** which has enabled Borealis to offer commercial volumes of chemically recycled base chemicals and polyolefins since May. (Borealis has a10% share of Renasci.) Borealis obtains chemically recycled material from Renasci Oostende Recycling in Belgium. Projected output is 20,000 tonnes/yr. Feedstock will be subsequently processed in the Borealis steam crackers, initially at its production location in Porvoo, Finland.

Earlier, in April, Borealis announced a feasibility study for a chemical recycling unit to be established at the Borealis production location in Stenungsund, Sweden is being carried out with project partner Stena Recycling, and could lead to operations beginning in 2024. Borealis will also co-operate independently with Fortum Recycling and Waste on a project involving the sourcing of plastic waste to the chemical recycling unit.

In October, **ExxonMobil** announced plans to build its first, large-scale plastic waste advanced recycling facility in Baytown, Texas, USA, which is expected to start operations before 2023 with a planned capacity of 30,000 tonnes/yr. A smaller, temporary facility, is already operational and producing commercial volumes of certified circular polymers that will be marketed by the end of this year.

ExxonMobil's initial trial of its proprietary process recycled more than 1,000 tonnes of plastic waste and has demonstrated the capability of processing 50 tonnes per day.

The company says it is developing plans to build approximately 500,000 tonnes/yr of chemical recycling capacity globally over the next five years. As mentioned earlier, it is collaborating with Plastic Energy on a plant in Notre Dame de Gravenchon, France, which is expected to process 25,000 tonnes/yr of plastic waste when it starts up in 2023, with the potential for further expansion to 33,000 tonnes/yr. ExxonMobil is also assessing sites in The Netherlands, the US, Canada, and Singapore.

At the beginning of November, **Honeywell** announced the commercialisation of its UpCycle Process Technology, which incorporates pyrolysis. Sacyr, a Spain-based global engineering and services company with operations in more than 20 countries worldwide, will be the first to deploy the Honeywell technology. The two companies will form a joint venture to operate a facility in Andalucía, Spain, with a capacity of 30,000 tonnes/yr of mixed plastics waste. Production is expected to begin in 2023.

Arcus Greencycling uses a pyrolysis process that can handle a wide range of polymers found in mixed waste, from PP, PE, and PS to more difficult polymers like PVC and ABS. The company has a co-operation agreement regarding pyrolysis technology with Karlsruhe Institute of Technology.

Arcus is currently building a 4,000 tonnes/yr industrial-scale pilot plant in Frankfurt am Main, Germany. The company expects this to start operations in the second quarter of 2022. "This plant will offer customers a highly robust process at an industrial scale to either test the suitability of a wide variety of waste streams for chemical recycling and/or utilise the facility to produce commercially usable pyrolysis oil," it says.

Clariter says its chemical recycling technology

enables it to make end products, not a feedstock like pyrolysis oil. The company has developed a three-stage process for recycling mixed plastics waste. First it uses thermal cracking which generates a wide range of hydrocarbons. Stage two is a hydro-refining process developed to remove impurities and form naphthenic and paraffinic hydrocarbons. The third distillation stage results in three product families, waxes, solvents and oils for industrial and consumer use which are sold to its customers.

Clariter's technology has been proven through an operational pilot plant in Gliwice, Poland, and a demonstration plant in East London, South Africa. In 2021, it has announced collaborations with DSM and Mitsubishi. In addition, South African chemicals group AECI has made a €2.5m investment in Clariter and is exploring construction of full-scale plants in South Africa, Germany and USA.

Recycling Technologies, in Swindon, England, has developed thermal cracking technology that it says can be installed at existing waste sites anywhere. Its RT7000 machine produces pyrolysis oil branded Plaxx. A demonstration plant and testing facility has been operating at Swindon Borough Council's recycling facility since 2017. The first commercial-scale unit will be installed at Binn Eco Park in Perth, Scotland, in collaboration with Binn Group and Zero Waste Scotland.

Polystyrene

Chemical recycling of polystyrene is well-advanced. This April, Recycling Technologies was selected by **Ineos Styrolution** as the technology provider for commercial scale recycling of PS back to styrene monomer. Prior to building the commercial scale recycling plant, a PS recycling pilot plant will be built in Swindon, UK. It uses the same basic technology as the RT7000 but the machine to recycle polystyrene will have a different name.

Ineos Styrolution plans to build its full commercial scale recycling facility in Wingles, France, but has not given a date; capacity should be 15,000 tonnes/yr. **Trinseo** has said it plans to build a dedicated 15,000 tonnes/yr plant at its Tessenderlo, Belgium location, to come into operation in 2023.

In May, Trinseo announced that it could supply recycled polystyrene (rPS) for food contact applications with the launch of the first yogurt pot integrating rPS (again from Yoplait), now on shelves in France. Styron CO2RE CR55 contains 55% recycled content resulting from depolymerisation.

In September, Trinseo and Indaver, a leader in sustainable waste management in Europe, signed an offtake agreement for recycled styrene monomer. Trinseo said it would buy a minimum of 50% of the monomer produced at Indaver for a 10-year period, following start-up of the plant planned in 2023.

Indaver will collect post-consumer polystyrene, such as yogurt pots and single-use packaging, and produce new styrene monomer through a proprietary depolymerisation technology at its Antwerp, Belgium site, for repolymerisation at Trinseo's Tessenderlo, Belgium site.

At the end of last year, Total (now TotalEnergies), sheet extrusion company Intraplás, and yoghurt producer Yoplait said they had successfully run a pilot test aimed at using certified chemically recycled polystyrene in yogurt pots. Total said that by converting mixed plastics waste in its steam cracker in Antwerp, it can produce certified chemically recycled polystyrene.

Canadian technology company **Pyrowave** is involved in a major polystyrene chemical recycling project in a partnership with Michelin in Europe. Pyrowave manufactures modular equipment that uses microwave technology to depolymerise polystyrene and it licenses its use. Michelin will operate the equipment at a location yet to be decided. It will acquire several units from Pyrowave. Michelin will use the styrene monomer as a feedstock to make rubber for tyres.

At the end of last year, the two companies said they would work together to fast-track the industrialisation of Pyrowave technology with a view to a certification and commercial roll-out in international markets. The joint development agreement will ultimately account for an investment of more than €20m. Michelin and Pyrowave are working together to develop an industrial demonstrator, funded and operated by Michelin, by 2023.

PET

Eastman is building the world's largest polyester chemical recycling facility at its site in Kingsport, Tennessee, USA, employing its Polyester Renewal Technology (PRT) which uses methanolysis. Eastman expects the facility to be mechanically complete in late 2022. "Our goal is to recycle 250m pounds (around 113,000 tonnes) annually by 2025 and 500m pounds annually by 2050," says a representative.

"We pioneered the technology decades ago when we were formerly part of Eastman Kodak and used methanolysis to recycle polyester including Kodak films. We've retained that R&D knowledge and actually improved on it in the decades since."

Aquafil Engineering designs polyamide and polyester polymer plants based on its own patented technology and production know-how. It also offers several recycling solutions under the brand

IMAGE: CARBIOS

Abve: The Carbios demonstration plant

name EverPET for internal, industrial or post-consumer waste. It has recently been building a recycling unit to produce 100% PCR PET on a small scale for customer and test samples for different PET customer applications (bottle, film, yarn, multi-layer packaging).

In the chemical EverPET process, the raw materials (oligomers, monomers and BHET) are recovered from previously cleaned polyester wastes, which can be re-processed into a high-quality polyester by downstream polycondensation.

Carbios, which has developed an enzymatic recycling technology (C-Zyme) for depolymerising PET using hydrolysis, brought its first demonstration plant onstream in September. The plant includes a 20 m^3 depolymerisation reactor capable of processing 2 t of PET per cycle, which is the equivalent of 100,000 bottles. It is co-located with a Michelin tyre production plant in Clermont-Ferrand, France; Michelin is a major shareholder in Carbios, and is interested in using various recycled or renewable materials in its tyres.

Martin Stephan, the company's Deputy CEO, says Carbios will also build and operate a 40,000 tonnes/yr reference unit, the first industrial plant. Its intention is to start up the plant in 2025 and that the plant will be adjacent to an existing PET production line. Carbios has Expressions of Intent with at least one PET supplier.

Swiss company **Gr3n** has another technology that uses alkaline hydrolysis. A demonstration plant should be fully operational early next year. Fabio Silvestri, Head of Marketing and Business Development, says the first industrial plant, with a capacity of 30,000 tonnes/yr, could start up before the end of 2024. He says the company has had confirmation that its technology can depolymerise textiles. Gr3n has an MoU with Kolon Industries to accelerate the commercialisation and the implementation of its technology throughout Asia.

Ioniqa, a clean-tech spinoff from the Eindhoven University of Technology in The Netherlands, has a 10,000 tonnes/yr plant producing BHT monomer from bottles using glycolysis, which it currently supplies exclusively to Indorama. Maarten Stolk, the company's Business Developer, says that it plans also to use fibre as a feedstock. The company is currently in discussions with a plant engineering firm so that it can sell licensed packages.

In June, **Loop Industries** in Terrebonne, Quebec, Canada, announced a strategic partnership and equity investment from SK Global Chemical (now called SK Geo Centric); Loop and SKGC intend to form a joint venture with exclusivity to build recycled PET resin and polyester fibre manufacturing facilities using Loop's depolymerisation technology throughout Asia. SKGC currently has a 10% shareholding in Loop. In August, plans were announced for the first Infinite Loop Asian facility in Ulsan, South Korea, to begin preparation in 2022.

Loop recently completed the conversion of its Terrebonne, Québec pilot plant to a small production facility. In September of this year, together with French mineral water company Evian, Loop unveiled the Evian Loop bottle, made from Loop's 100% recycled PET coming from waste plastic and fibre. The bottles will be rolled out at commercial scale in South Korea in 2022, with the goal of launching in other markets later. ■

CLICK ON THE LINKS FOR MORE INFORMATION:

- **https://plasticenergy.com**
- **www.sabic.com**
- **https://totalenergies.com**
- **www.bp.com**
- **www.brightmark.com**
- **http://eng.skglobalchemical.com**
- **www.shell.com**
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- **www.pyrowave.com**
- **www.aquafileng.com**
- **www.carbios.com**
- **https://gr3n-recycling.com**
- **https://ioniqa.com**
- **www.loopindustries.com**

Aquafil

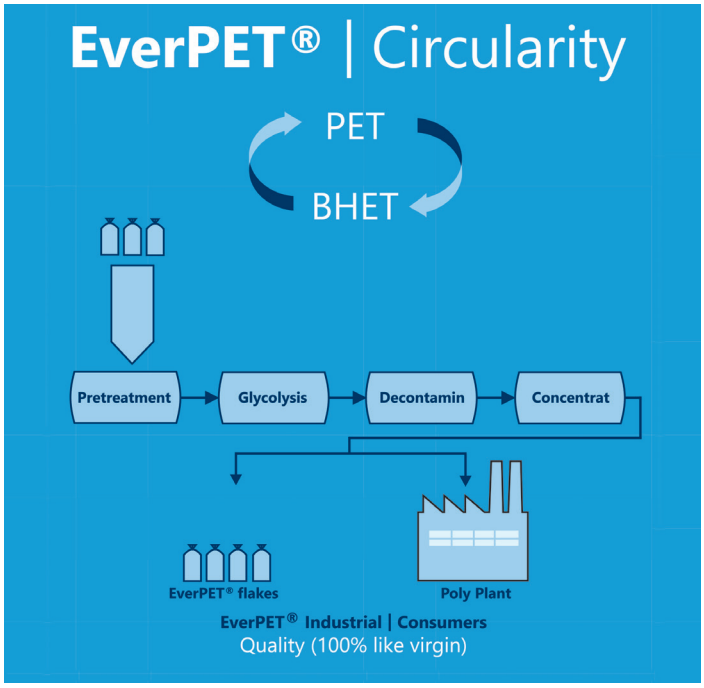
Aquafil Engineering: Experts in polyester and polyamide recycling plants

Aquafil Engineering, an independent company of Aquafil Group, is located in Germany, and is one of the worldwide leading companies in technology and equipment design for polyamide, polyester and recycling plants. The plant design is based on patented technology and production know-how which provides customers with state-of-the-art technology combined with high quality, flexibility, efficiency and sustainability.

Aquafil Engineering understands itself as provider for customised solutions for fibre, film, technical and bottle applications.

The EverPET™ technologies are the newest developments in polyester recycling. EverPET™ is the brand name for a collection of different recycling systems and includes solutions for mechanical (extrusion) as well as for chemical (glycolysis) recycling.

› **www.aquafileng.com**



Arcus

Leading the way to recycle mixed and dirty plastic waste
Arcus leads the way in providing a chemical recycling solution for currently non-recyclable mixed plastics waste streams with as little as possible prior sorting or cleaning of the waste. Our process successfully handles a wide range of polymers from PP, PE, and PS to difficult to process PVC, ABS, or PET.

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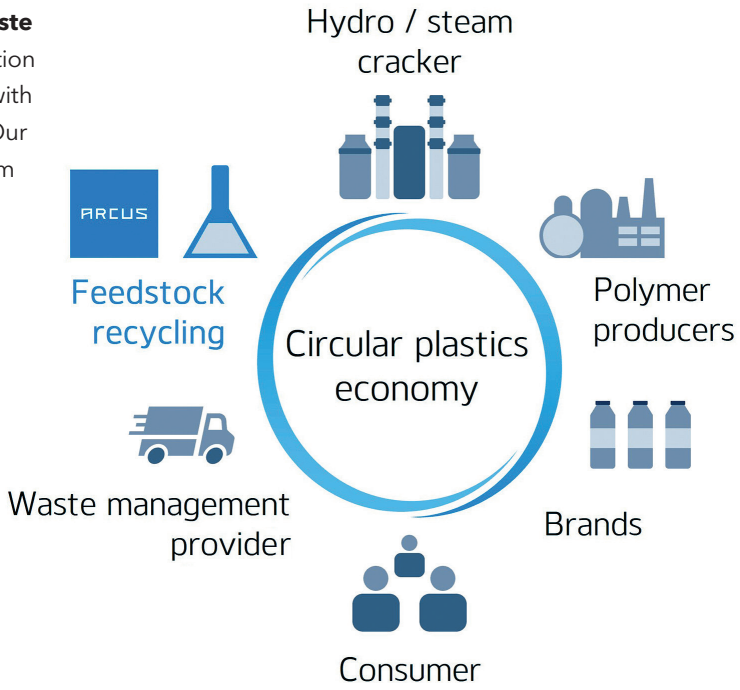
Arcus is currently building a fully authorised (BImSch approved, REACH registered, end-of-waste status acknowledged as well as ISCC, RedCert2, and EfbV certified) 4,000 tonnes per year industrial-scale pilot plant in Frankfurt am Main, Germany, which will go live in the second quarter of 2022. This plant will offer customers a highly robust process at an industrial scale to either test the suitability of a wide variety of waste streams for chemical recycling and/or utilise the facility to produce commercially usable pyrolysis oil.
› **www.arcus-greencycling.com**



The ARCUS Greencycling solution: Closed loops are the model for a world without plastic waste and lack of resources

- Variable and truly mixed inputs (incl. PP, PE, PS, PVC, PET, etc.)
- High-value feedstock for the petrochemical industry (incl. REACH registration)
- Longstanding operations and research track record
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Clariter

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A Clean Slate

Clariter takes plastic waste no one wants and transforms it into products everybody needs. While the recycling industry is turning plastic waste into new plastics, fuels, or intermediates that require further processing and blending, Clariter's innovative technology transforms most plastic waste streams, even those with the lowest value, into pure, ready-to-use industrial products: aliphatic solvents, mineral oils, and snow-white waxes.

According to the latest Life-Cycle Analysis, Clariter's process is preferable to landfill, incineration, and other pyrolysis-based solutions. This is a real paradigm shift and a resource efficient approach to meet circularity standards in the EU and beyond.

The company unlocks the value of the circular economy without compromising on profitability or sustainability. Clariter's short-term plan is to build and operate full-scale plants in Israel, Poland, and the Netherlands.

Each plant will recycle 60,000 tons of plastic waste and produce 50,000 tons of clean products annually.

Clariter's solution bridges the world of recycling and the petrochemical industry by replacing crude oil with upcycled plastic waste, thus saving significant amounts of CO_2, cleaning the earth of plastic waste, and making sustainable products for the market with 1000+ end applications, e.g. paints, shoe polishes, degreasers, detergents, inks and even ski waxes.

› **https://clariter.com**

Watch the video Clariter in Brief

Above: Clariter's Industrial-scale plant has been in operation in East London, South Africa since 2018

Left: Clariter's technology transform plastic waste into aliphatic solvents, mineral oils and paraffinic waxes

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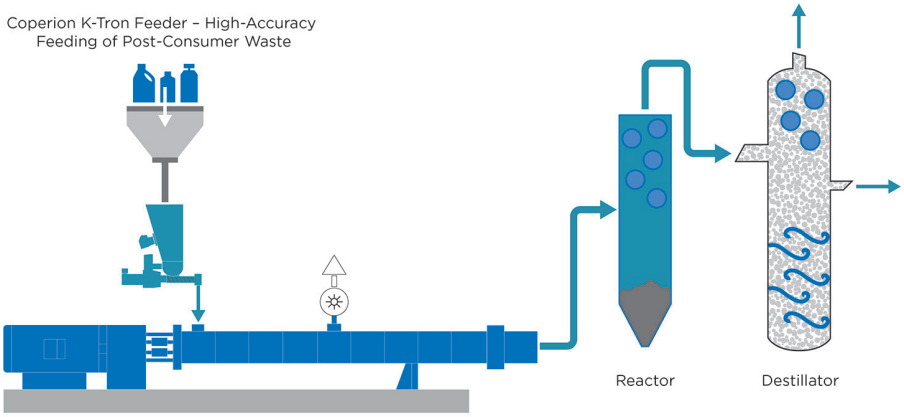

Next the melt is further processed to the reactor and destillator to transform it into marketable products such as oil, heavy fuel, or waxes.

Contact: Jochen Schofer
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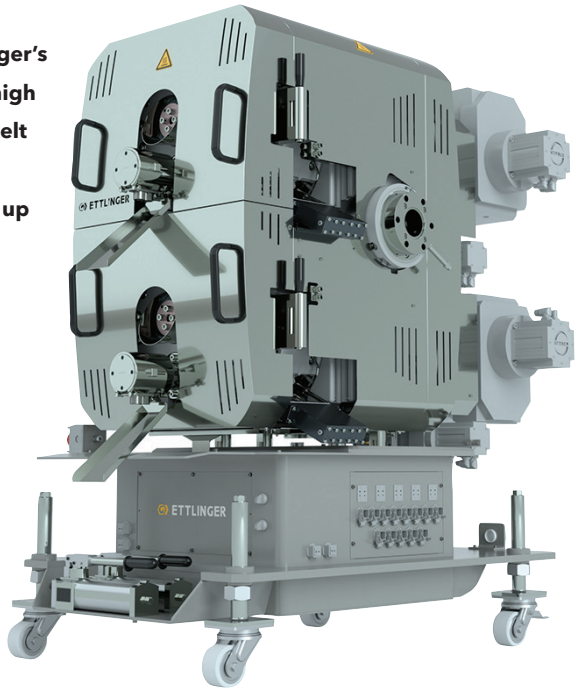
As a specialist for polymer filtration and recycling systems, we have developed custom melt filtration and pelletising systems that meet the strict requirements of our customers. Our systems provide solutions to process the most demanding material streams and turn them into valueable resources.

Our goal is to preserve material properties and produce pellets that are equal in quality to virgin materials when processing post-consumer and post-industrial plastic materials.

› **https://maag.com**

MAAG Group company Ettlinger's new ECO 500 high performance melt filter achieves throughputs of up to 4,000 kg/h



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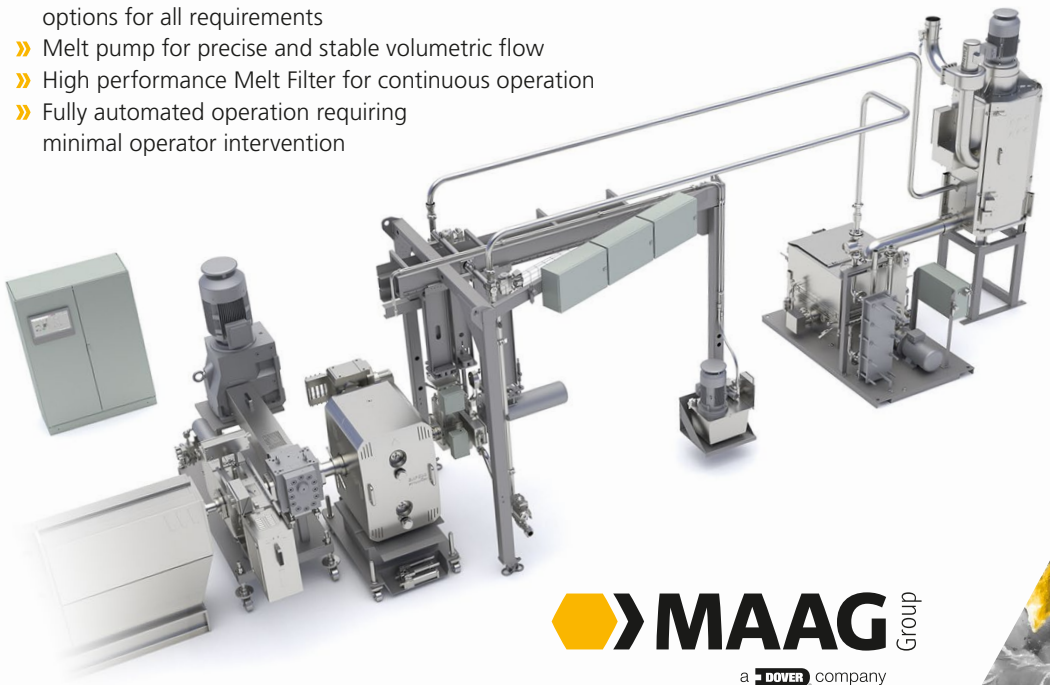

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Pryme

Pryme contributes to a meaningful solution to the global plastic waste problem by enabling the circularity of plastic. We convert plastic waste into valuable petrochemical products using a proven pyrolysis process that is enhanced with proprietary characteristics and has a low carbon footprint.

Our R&D team has worked long to take the pyrolysis process to a higher level, so we teamed up with a reactor manufacturer that boasts over 80 years of experience in this area. As a result, our reactor ensures a very precise and controlled application of heat at lower temperatures, which makes the recycling process more energy-efficient.

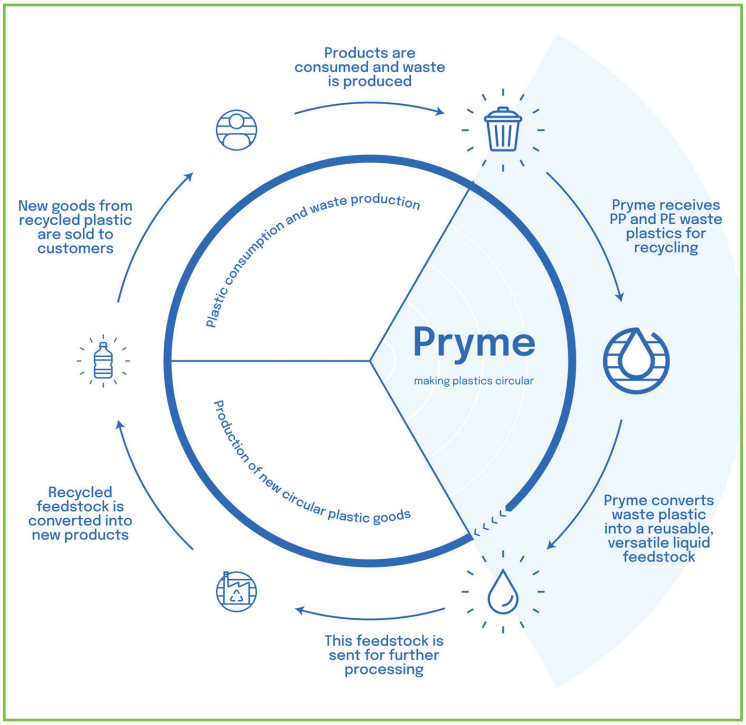
In addition, we have enhanced the process in order to remove contaminants such as chlorine, which we know oil majors don't want in recycled oil because it is highly corrosive. Moreover, we can process more waste than our competitors do, giving us an extremely high conversion rate: 100% of the plastic waste that we treat is converted to value-added streams.

Thanks to our tweaks to the process and installation, we can ensure a high input and output capacity and can rapidly scale the technology, which is key for market feasibility. Pryme's first plant will start production in 2022 in Rotterdam. This plant will have an initial intake capacity of 40,000 tons of plastic waste per year and produce 30,000 tons of feedstock in its first year. That tonnage will grow by 50% by 2023.

Pryme is an ambitious and innovative company, so if you're interested in our business, technology or job opportunities, be sure to contact us via our website.

› **https://pryme-cleantech.com/**

Above: Sander Schiereck, Michiel Kool and Joeri Dieltjens at the site of the new Pryme plant



Above: Pryme provides a sustainable, circular solution to converting waste plastics into valuable feedstock

IMAGE: SHUTTERSTOCK

Realising the opportunity

How will the chemical recycling industry develop? We look at factors that have a major influence on the industry's progress, including legislation and the mass balance concept

The chemical recycling industry has started on a growth path as the drive for greater plastics recycling volumes stimulates demand. As well as supply-demand dynamics, there are other important factors that are helping to shape the chemical recycling industry, such as legislation.

In Europe, regulatory impetus in plastics recycling comes from the European Union's Strategy for Plastics in a Circular Economy which the European Commission announced in 2018. This set out a series of targets focussed on packaging recycling: a target for recycling 65% of packaging waste by 2025 and 70% by 2030, and a specific target for plastic packaging recycling of 50% by 2025 and 55% by 2030.

Another aim is for all packaging to be recyclable by 2030, which would not only help grow mechanically recycled volumes but would also benefit chemical recycling by reducing contamination in waste feedstock.

Going hand-in-hand with legislation is funding support from the EU. Among collaborative R&D projects is Demeto, in which 13 partners are developing a PET depolymerisation process using microwave-based process intensification, and which receives funding from the EU's Horizon 2020 research and innovation programme. Other EU projects are not looking at packaging but focus on other areas, such as the Plast2BCleaned project in WEEE plastics recycling, and the Circular Flooring project which is investigating the CreaSolv process as a means for recycling PVC flooring.

Associations have been set up to provide collaborative platforms as the chemical recycling industry grows. The European Coalition for Chemical Recycling was founded in early 2019 by Cefic and PlasticsEurope, which supports the work of the EU Circular Plastics Alliance and its aim to ensure that 10 million tonnes of recycled plastics find their way into new European products by 2025. Chemical Recycling Europe's members are companies fully focused on chemical recycling technology rather than production of plastics, although it does hope to involve petrochemical companies as well.

Voluntary commitments are also acting as a focal point for mechanical and chemical recycling companies. Many polymer producers are among the corporate signatories of the Global Alliance set up by Ellen MacArthur Foundation, which has also led the way for individual countries to formulate specific recycled plastics content targets within its Plastic Pacts initiative. Sector-specific recycling is supported by Extended Producer Responsibility (EPR) schemes in different countries. But the extent to which EPR schemes proliferate remains to be seen after some poor results and scheme failures.

The chemical recycling industry in the USA is also being influenced by legislation. In the past couple of years, federal bills formulated by often cross-party sponsors have targeted aspects of plastics waste, recycling and environmental improvement. The Break Free from Plastic Pollution Act envisages a producer responsibility scheme involving a 10-cent beverage container deposit

Main image: Mass balance aims to measure the waste plastics contribution from chemical recycling in a much larger manufacturing process and allocate that to the end product

IMAGE: RECYCLING TECHNOLOGIES

Above: Recycling Technologies makes its Plaxx pyrolysis oil from waste plastics at its plant in Swindon, UK

program to operate nationally, minimum recycled content targets, phasing out some single-use plastics items, and a temporary halt to new polymer production plants being built. The RECOVER Act focuses on allocating federal grants to states and municipalities to invest in improving their recycling programs and infrastructure.

In addition to federal and state legislation, the Environmental Protection Agency has developed a National Recycling Strategy with a goal of achieving a 50% recycling rate for all materials by 2030. The American Chemistry Council, representing petrochemical and polymer producers, has been proactive and developed its own Roadmap to Reuse to support its members' aim for all US plastics packaging to be reused, recycled or recovered by 2040.

In the ACC's opinion, crucial to the US achieving its plastics sustainability ambitions is the need for official recognition of chemical recycling and its contribution to the country's efforts. Placing chemical recycling on a par with mechanical recycling is also desirable for plastics producers working in Europe. The risk for the chemical recycling industry is that its processes are not defined as recycling if the European Commission holds the position that the waste plastics input can be converted to fuel either for processing purposes or in the creation of new fuel products. After much lobbying of the European Commission, it has still not officially announced if its definition of plastics recycling includes chemical recycling processes.

Mass balance

A counter approach is being followed by chemical recycling companies with regard to the input-output of their plants and its use in the production of new plastics: it's called the mass balance approach. Tracking use of recycled material is relatively straightforward in the mechanical recycling supply chain but not so easy in chemical recycling, where outputs typically take the form of basic hydrocarbons that subsequently make their way through multiple and complex cracking and polymerisation processes. The solution for the chemical recycling industry is to follow the principles of mass balance.

Already applied in sectors as varied as electricity marketing and Fair Trade agriculture, the mass balance concept aims to determine and measure the contribution of a particular component in a much larger manufacturing process and allocate that accordingly 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 a product leaving it.

While this may sound a simple task, the reality is much more complex as different approaches can be taken with regard to what and where to allocate. For instance, the entire output of a chemical recycling process could be allocated as a contributor to any polymer or chemical production process – so called free-attribution. Alternatively, it may be decided to allocate only the non-fuel components. Or, at its strictest, only those components used as a non-fuel contributor to production of a polymer.

Chemical Recycling Europe leans toward the free-attribution approach. In a recent white paper it said: "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, favour more restriction. Zero Waste Europe, together with several other environmental NGOs, this year published 10 recommendations to ensure that mass balance does not undermine circularity goals. These include only allowing 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 (an approach being followed by Sweden's Perstorp with its traceable mass balance scheme).

Mass balance will be essential in the development of chemical recycling as an industrial process and to that end must be 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, last year the International Organisation for Standardisation (ISO) announced it had started work on a global mass balance standard. ■

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