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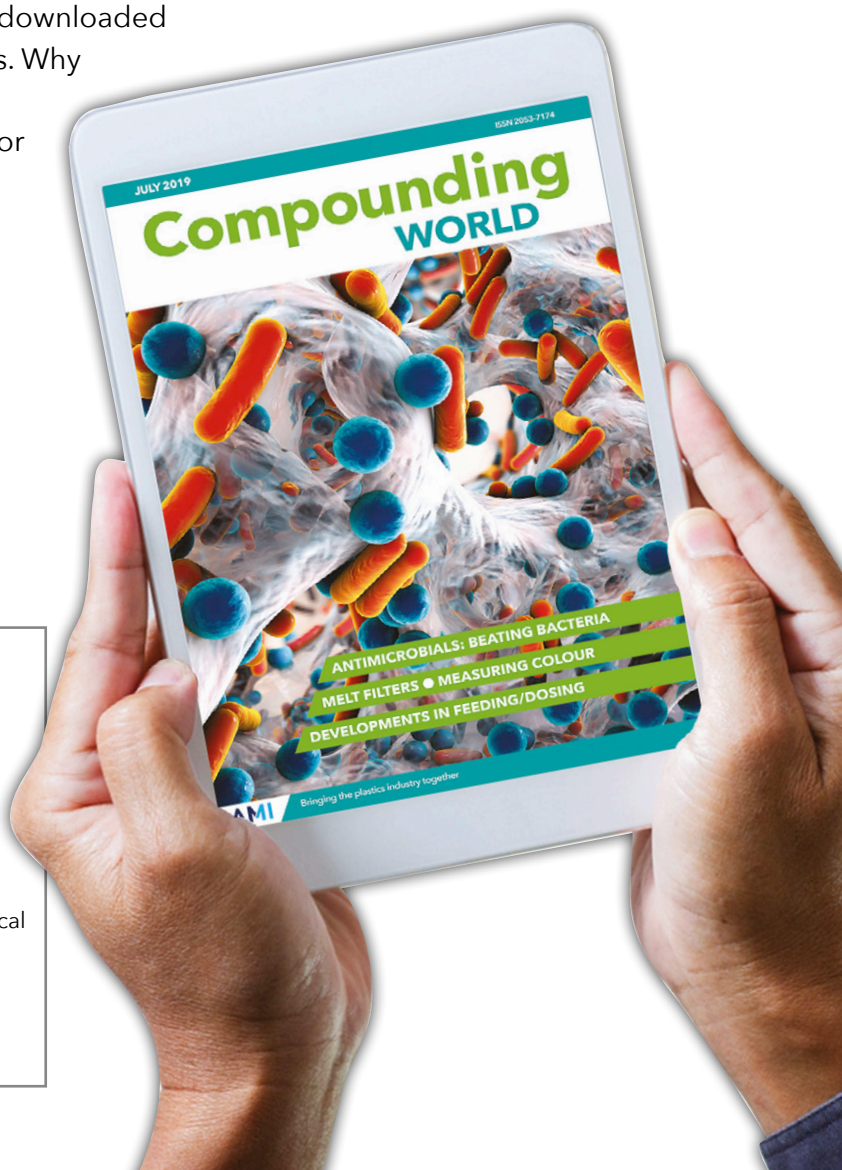

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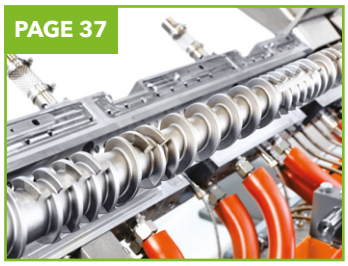

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› Impact modification › Small batch compounding › Compounds for EVs
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Lanxess to pay $1.1bn for Emerald Kalama

Lanxess is to buy Emerald Kalama Chemical from private equity firm American Securities for $1.1bn. The deal is expected to be completed in 2H 2021, subject to securing the necessary regulatory approval.

Based at Kalama in Washington State in the US, Emerald Kalama also has sites in the UK and the Netherlands. It posted sales of $425m last year, around 45% from North America.

Around 75% of Emerald Kalama's revenues come from consumer-focused markets such as food preservatives, flavours and fragrances, and animal nutrition. However, it also has a strong industrial business and a range of products for the plastics sector, including the K-Flex non-phthalate plasticiser line.

"The businesses of Emerald Kalama Chemical are an ideal fit for us," said Lanxess Chairman Matthias Zachert. "We will further strengthen our Consumer Protection segment and open up new application areas with strong margins, for example in the food industry and animal health sector. In addition, we will also enlarge our presence in our growth region of North America."

IMAGE: EMERALD KALAMA

Part of the Emerald Kalama production facility in the Netherlands

Lanxess said Emerald Kalama's highly efficient manufacturing model, which is focused on only three production sites, will allow it to be rapidly integrated into its own structure.

Lanxess said the acquisition will be earnings-per-share accretive in the first fiscal year and it expects an annual EBITDA contribution of €25m within three years from synergy gains.

› **www.lanxess.com**

› **www.emeraldkalama.com**

ADM invests in Aquapak

Private equity firm ADM Capital Europe has made an undisclosed investment in UK-based Aquapak Polymers. The new funding will be used to further develop Aquapak's Hydropol water soluble polymer technology.

Hydropol is said to be biodegradable and non-toxic while displaying resistance to low temperature solubility and high barrier. Aquapack claims it is up to three times stronger than alternatives and processes easily into films, laminates and moulded parts. It can also be recycled, composted and is compatible with anaerobic digestion.

Current applications include organic waste disposal bags and laundry bags for infection control. Aquapak is also developing it for food packaging, and as a non-woven fibre.

› **www.aquapakpolymers.com**

EMS sales down in 2020; outlook improving

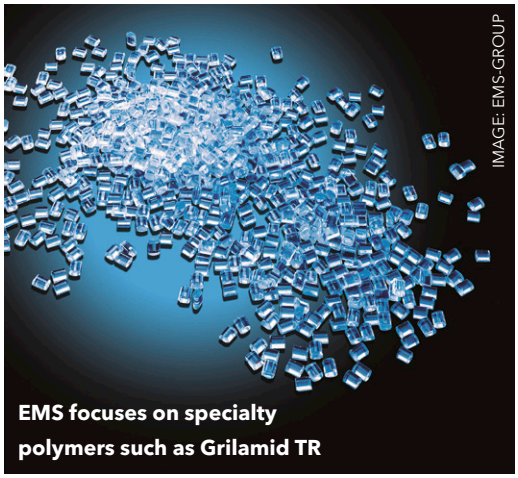


IMAGE: EMS-GROUP

EMS focuses on specialty polymers such as Grilamid TR

Swiss specialty chemicals and engineering plastics group EMS saw net sales fall by 16.3% to CHF1.8bn (€1.6bn) last year. Organic sales were down by 11.0%, with the shortfall attributed to the disposal of the EMS-Patvag airbag activator subsidiary in November and the strong Swiss franc.

The company said the impact of Covid-19 saw net sales fall to historically low levels in the first half of 2020, particularly in the automotive sector. However, they recovered in Q3, reaching pre-crisis levels in China, and were above Q4 2019 levels globally in Q4. EBITDA for the year was down by 15.9% to CHF569m (€514m) but margin (31%) held at 2019 levels.

EMS is active in High-Performance Polymers and Speciality Chemicals. Polymers, including the EMS-Grivory business, is the larger sector. The company it said it expects to achieve higher net sales and higher EBIT in 2021 than 2020.

› **www.ems-group.com**

Akdeniz Chemson starts up new fire retardant capacity

Turkey's Akdeniz Chemson has started production of zinc borate flame retardants from a new 3,000 tpa expansion of its plant at Izmir.

The expanded capacity commenced production in December last year with work on a second phase due to start in the second half of this year for a predicted 2022 start-up, according to a company spokesperson. When both phases are in operation, it will lift the company's zinc borate capacity to 6,400 tpa.

IMAGE: AKDENIZ CHEMSON

Left: The Akdeniz Chemson plant at Ismir in Turkey

Akdeniz produced its first zinc borate products in 2018 on a 400 tpa plant, also at Izmir. The new manufacturing capacity, together with the expansion of its ability to produce the required zinc oxide feedstock, marks its intention to become a world-leading flame retardant chemical producer, the company said.

Offering flame-retardant and smoke-reduction properties, zinc borate is used in polymers such as PVC, PA, polyester and high temperature-resistant plastics for production of cables and parts for electrical and electronic, automotive and aerospace applications.

Akdeniz Chemson is a world leading producer of PVC stabilisers with an annual capacity of around 250,000 tonnes. Part of the OYAK group, it was formed last year through the merger of Turkey's Akdeniz Kimya with Austria's Chemson.

› **www.akdenizchemson.com**

IN BRIEF...

Italian compounder **Xenia Materials** has opened the Xenia Footwear Materials Lab, which will develop high performance thermoplastic composites for injection moulding of footwear items such as shells, cuffs, midsoles, sole inserts, cleats and other parts for use mainly in winter sport, outdoor and cycling applications.
www.xeniamaterials.com

Pritzker Private Capital, a family direct investment firm based in Chicago in the US, has acquired speciality chemicals company **Vertellus** from Arsenal Capital Partners. Current CEO John Van Hulle is a co-investor and will remain in place.
www.ppcpartners.com
www.vertellus.com

Elix launches E-Loop branding

Styrenic compounds maker Elix Polymers has created a brand name, E-Loop, that brings together its circular economy activities.

The new brand covers the company's strategic 'Circular Plastics' and 'Responsible Innovation' strategies. These include industry sustainability initiatives such as the Plast2bCleaned project to develop a safe recycling process for waste electrical and electronic equipment containing flame retardants and the Styrenics Circular Solutions initiative to improve styrenics recycling.

› **www.elix-polymers.com**

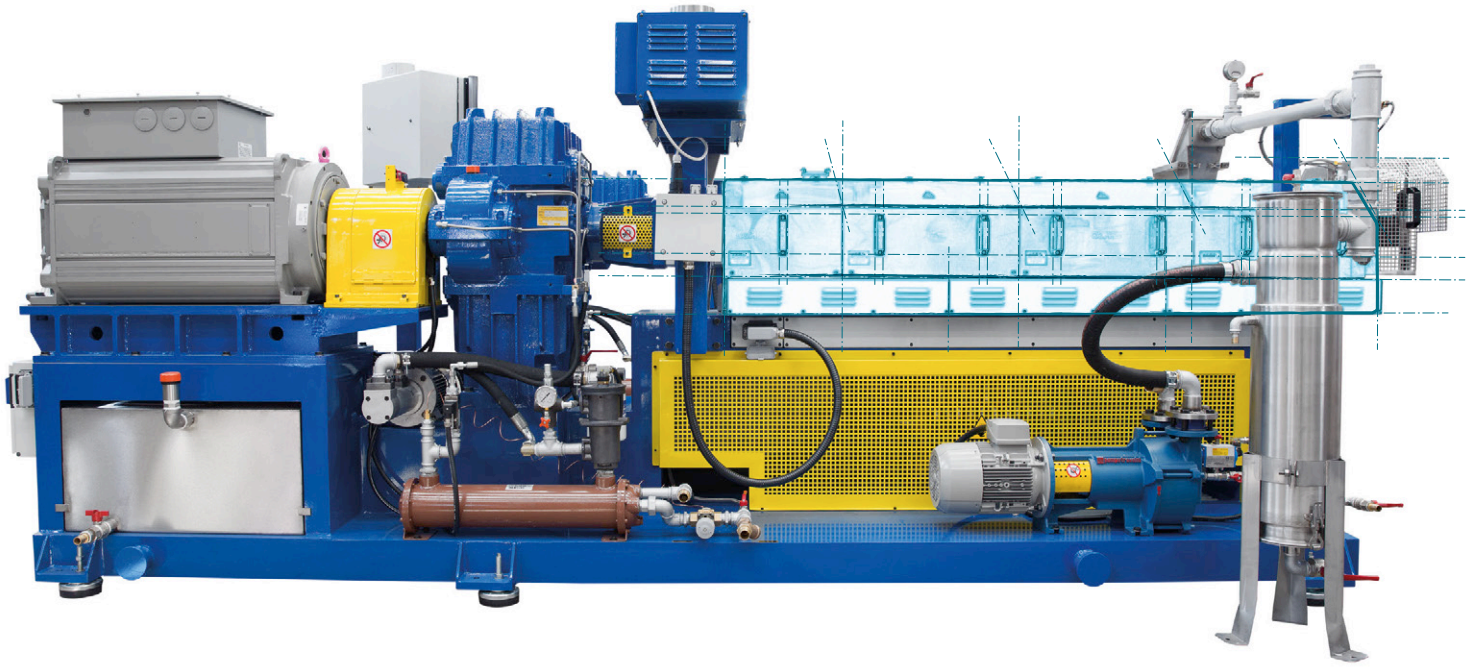
BASF aims at automotive with P-stabilised Ultramid PA6

BASF has introduced Ultramid B3PG6 BK23238, a heat-stabilised 30% glass fibre-reinforced PA6 aimed at applications in ICE and EV cars where performance demands are becoming increasingly stringent.

The new grade features the company's halogen and metal-free P-stabilisation technology, which is claimed to provide long term heat resistance up to 190°C and to prevent galvanic corrosion on metallic electrical parts. It is also said to be suitable for vibration and hot gas welding.

The Ultramid B3PG6 BK23238 grade has been tested for use in charge air duct components, where BASF claims it meets the necessary high temperature requirements while offering better aging properties than the PA6 GF30 systems currently in use.

› **www.plastics.basf.com**



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IN BRIEF...

Danish medical polymers distributor and compounder **Melitek** has broken ground on the first stage of a planned expansion at its site at Nørre Alslev. The company is building a 2,000 m² high-storage warehouse for its proprietary Meliflex production that will provide an extra 1,800 tonnes of storage capacity.
www.melitek.com

Microtec, part of Italy's **Sirmax Group**, has launched four new bio-based plastic grades. Biocomp IM 95, IM 95CP, IM DPLA and IM CFLE have all been developed specifically for injection moulding and extrusion and thermoforming.
www.sirmax.com

BASF is increasing prices globally for its plastics additives by 10%. The company is also raising prices in Europe for its Ecovio F, M and T part-renewable biodegradable plastic materials by €350 per tonne.
www.plastics.basf.com

HPF starts up in Korea

Quarzwerke subsidiary HPF The Mineral Engineers has started production at its high performance fillers facility at Dangjin in South Korea, its first production unit in Asia.

HPF Minerals Tech is a wholly-owned subsidiary of Quarzwerke. According to the company, the new plant uses world-class technologies for processing and surface coating minerals. It will process raw materials such as silica sand and wollastonite from local regional sources.

Initially, the operation will produce a variety of Silbond and Tremin grades for the regional Asian market. It will offer silane-coated products as well as uncoated mineral flours and high filling grades with optimised particle-size distributions.

IMAGE: QUARZWERKE

The new HPF minerals processing unit at Dangjin in Korea

› **www.hpfminerals.com**

Bada expands its PA portfolio

Germany's Bada said it has extended its Badamid range of engineered PA compounds with new high-temperature PPA and PA blend grades.

Badamid PPA-HT offers dimensional stability to near 300°C, together with high rigidity and low water absorption. It is available with fibre loadings to 60%. Badamid PPA-GP grades offer slightly reduced performance but can be processed at mould temperatures below 100°C.

The company has also introduced four lines based on blends and alloys of aromatic and aliphatic PAs. These are said to provide good processing and surface quality. Badamid PPA-HPX is said to offer a similar mechanical and thermal profile to PA66, Badamid PPA-HP2X is optimised for weld line strength, Badamid PPA-HP offers a high surface quality, and Badamid PPA-HP2 is formulated to provide good weld line stability in PA66-like processing conditions.

› **www.bada.de**

TetraPak certifies its recycled PE polymers

TetraPak has introduced certified recycled polymers for its food and beverage packages, in the process gaining Roundtable on Sustainable Biomaterials (RSB) Advanced Products certification.

The packaging producer worked with Ineos to source recycled PE that met its performance and purity requirements. The recyclate used is certified under the RSB attribution model, which tracks recycled and non-recycled materials through the company's supply chain and is verified by external audit.

The move is part of a commitment to incorporate a minimum of 10% recycled plastic content on average across carton packages it sells in Europe by 2025.

› **www.tetrapak.com** › **https://rsb.org/**

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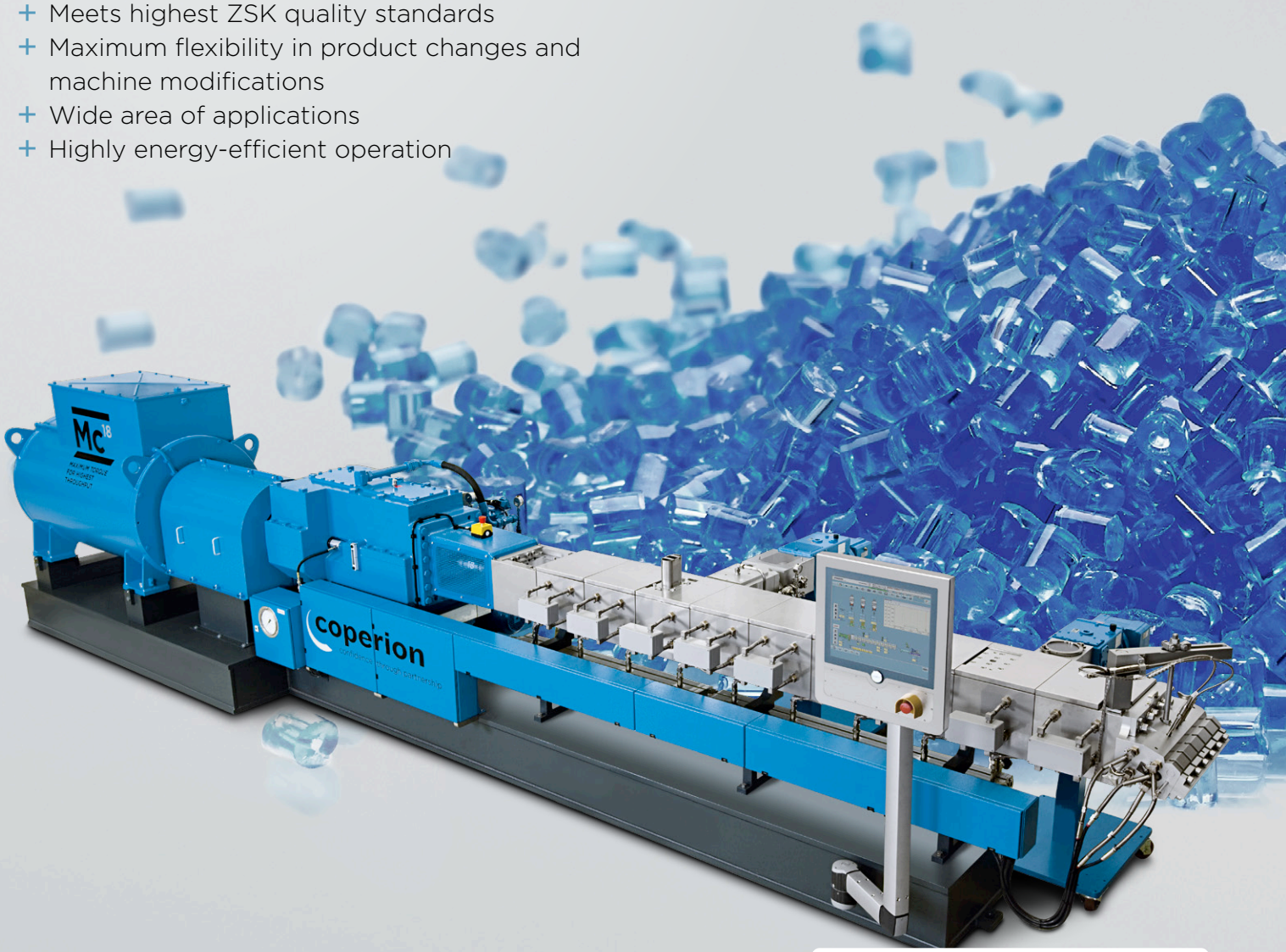

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Germany's processors see 5.6% sales drop

Germany's plastics processors saw a 5.6% sales decline in 2020, according to the GVK trade association. Sector sales stood at €61.5bn, while the total volume of plastics processed by the sector was down 2.8% to 14.2m tonnes.

"The ambivalence between confidence and uncertainty among companies, which was already established for 2019, has intensified under the impact of the corona pandemic," the GVK said. Around half of the companies it surveyed forecasted sales to rise again in 2021, but said they expect profits to fall.

Demand in the packaging and transport sectors picked up in Q4 2020, the association said. However, restricted raw material availability and increased raw material prices in these areas "will ensure that the development will remain fragile in the coming months".

One clear positive has been an increased public appreciation of the role of plastics in the COVID-19 crisis. GVK president Roland Roth said the industry intends to build on that by publicising its sustainability credentials more. "The GVK and thus the plastics processing industry are not only approaching the challenge of the circular economy as a necessity, but also as an opportunity for innovation," he said.

› **www.gvk.de**

Röhm and OQ to invest in MMA

Röhm and OQ Chemicals, the former Oxea, have signed a memorandum of understanding to evaluate construction of a methyl methacrylate (MMA) plant on the US Gulf Coast.

Basic engineering is under way on the 250,000 tpa facility, which will be integrated into OQ's existing site and could be operational by 2023. Röhm said it aims to make a final investment decision in the first half of this year.

The new plant will use Röhm's proprietary ethylene-based LiMA technology, which is claimed to be the most efficient MMA production technology yet developed.

› **www.roehm.com**

Polish plant for Sumika

Sumitomo Chemical subsidiary Sumika Polymer Compounds (SPC) is to set up a new compounding plant in Poland. It will start production in Q1 of 2022 with two lines and will have a capacity of 30,000 tpa of PP compounds.

The new 5,500m^2 subsidiary is to be located in Poznan, which SPC said is well positioned to service its customers in Poland, Germany and the Czech Republic.

SPC has long-standing production units in France and the UK. In 2019, it added further production capacity through the acquisition of Turkey's Emaş Group.

The new Polish plant will lift the company's European capacity to 170,000 tpa.

› **www.sumikaeurope.com**

Polykemi concept aims to smooth design

Swedish compounder Polykemi and sister company Rondo Plast – a specialist in recycled plastics – have launched the Complus Concept, which aims to present customers with a pre-selected portfolio of virgin and recycled grades suitable for all parts in an injection moulded assembly.

The aim is to allow customers to be able to quickly select and to substitute materials for any individual element at any time during the development of a complex assembly, giving them confidence they will be able to meet performance requirements and will not need to modify or replace moulds.

The company cites the example of a car door panel as a component that could benefit from the Complus Concept. These are typically comprised of a number of individual parts, each with their own demand profile, that must fit together perfectly and may be susceptible to dimensional and assembly issues if material choices are changed during development.

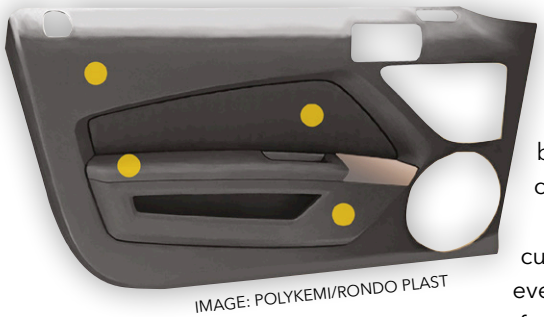

IMAGE: POLYKEMI/RONDO PLAST

Left: Developers of parts such as door panels may benefit from Complus Concept

"Our new concept gives the customers an incredible flexibility even far into a project, and the choice of materials can be adapted during the development work without the costs increasing dramatically. This ensures that the customer can reach the project's goals faster and in a safer way," said Complus Project Manager Johan Svenmo.

› **www.polykemi.se**

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Milliken moves to buy Zebra-Chem

US-based Milliken has acquired Zebra-Chem, a German manufacturer of peroxide and chemical blowing agent masterbatches suitable for use in modification of plastics including recycled materials.

Peroxide masterbatches allow compounders to modify the melt flow of polymers such as PP through shortening of the molecular chains. Milliken said such products, supplied both by itself and Zebra-Chem, make it possible to incorporate up to 100% recycled content into new plastic compounds.

"Zebra-chem's leading position in Europe allows Milliken to leverage its congruent innovation platforms, global presence and commercial expertise to accelerate market solutions that improve and increase manufacturing with recycled plastics," said Wim Van de Velde, VP EMEA for Milliken's Chemical Division.

› **www.milliken.com**
› **www.zebra-chem.com**

KD Feddersen to distribute Trinseo and Ascend lines

Hamburg-based engineering plastics distributor KD Feddersen announced two new distribution deals at the start of 2021. The company is now an official distributor in Germany and most other European countries for Trinseo's TPEs and for PA compounds from Ascend Performance Materials.

The Trinseo deal includes the full portfolio of TPEs, TPUs, EVA-based compounds and bioplastics the company acquired through its 2017 purchase of Italian compounder API. The arrangement with Ascend covers its Vydyne PA6 and 66 portfolio and the new HiDura Long-Chain PA 6,10 and 6,12 series.

› **www.kdfeddersen.com**


IMAGE: KD FEDDERSEN

Above: KD Feddersen has added Trinseo's TPEs to its product offer

Korean recycling deal near

South Korean petrochemicals firm SK Global Chemical has signed a memorandum of understanding with US-based Brightmark to build a commercial-scale (100,000tpa) "plastics renewal plant" in South Korea.

The plant will use Brightmark's proprietary pyrolysis technology, which is claimed to handle all types of plastic waste and is already in use at its own facility in the US, which is expected to reach full commercial scale this year.

The parties are to carry out a feasibility study this year to evaluate optimal methods to operate, scale and develop the technology.

› **http://eng.skglobalchemical.com**
› **www.brightmark.com**

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The need to handle recycled material and low bulk density natural additives is one of a number of new demands being addressed by compounding machinery makers, writes ***Peter Mapleston***

New applications drive machinery innovation

Suppliers of twin-screw compounding extruders continue to implement incremental improvements to their products, improving overall performance and optimising suitability for applications in new growth areas. One of these – perhaps no surprise given the rise of the circular economy – is recycling of waste material from in-house, post-industrial or post-consumer sources. And with so much uncertainty on the economic front brought about by the Covid-19 pandemic, machine suppliers are also exploring options that enable customers to obtain new equipment without having to make major up-front investments, including various leasing models.

"In the current market scenario, marked by a high degree of uncertainty and unpredictability, manufacturing industries need to be able to adapt quickly in order to meet an ever-evolving demand. Companies also need to carefully evaluate which investments can be postponed and which ones need to be made in order to continue to stay competitive," according to **Bausano**, the Italian producer of intermeshing counter-rotating twin-screw extruders.

The company says that, to help its customers, it is including an operating lease service for its compounding extrusion lines, in particular equipment for PVC pellet production. "The aim is to support, by limiting their investments, not only companies that have to deal with peaks in workload but also companies that want to diversify their business," the company says.

Bausano points to a number of tax, financial and organisational advantages with leasing. Firstly, according to the IFRS 16 accounting standard, new leased extrusion lines will not be recorded in the assets of financial statements and so the lease can be fully deducted. Secondly, leasing allows a customer to gain access to the latest and most efficient generation of production technology. And finally, the company says the disposal costs of capital goods, which are often not taken into account in the planning phase or are sometimes

Main image: New processing requirements present opportunities for alternative compounding options such as conical twin screw extruders, according to MAS

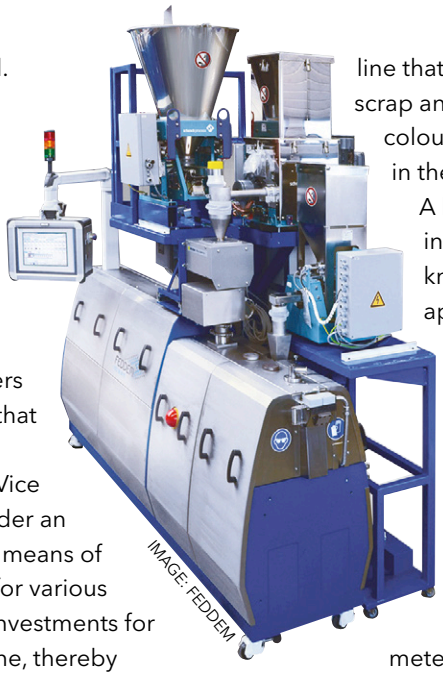


IMAGE: FEDDEM

Right: This FED 26 MTS system from Feddem is suitable for compounding regrind with virgin polymer pellets and additives

underestimated, can be reduced.

Bausano's scheme involves paying a fixed periodic fee for renting the entire extrusion line (except for the cylinder and screws, which are custom-designed and manufactured). "We are at an unprecedented time in history, which is why we want to be closer to our customers by offering alternative solutions that do not weigh down their lines of credit,' says Clemente Bausano, Vice President of Bausano. "We consider an operating lease to be a valuable means of encouraging companies which, for various reasons, have had to postpone investments for purchasing an entire extrusion line, thereby offering them benefits in terms of sustainability and financial stability."

Delivering results

Germany-based **Feddem** also points to the advantages of leasing when highlighting the increasing demand it is seeing for its twin-screw extruders at processors wanting to carry out in-house upcycling of scrap material. "This requires twin-screw technology to deliver the best results," says Klaus Hojer, Feddem's Business Development and Project Manager. To ease the entrance into this new area of in-house upcycling, the company says it can offer attractive leasing arrangements in cooperation with a leasing partner specialising in small to mid-sized machine investments.

Hojer cites the installation of one of its lines at an injection moulder making what he describes as sophisticated parts but at the cost of having multiple sprues and related larger amounts of clean-up waste. "As an alternative to selling the scrap they decided to invest into a compounding line that allows them to process the scrap and optimise melt viscosity and colour of the recycle material for use in their production," he says.

A big advantage is the space-saving setup of the line. "With kneading-block-free screws, the application only requires 32 L/D processing length," says Hojer. "There is some extra installation length required for strand pelletising, but the extruder and metering feeders have a small footprint as all the electronics are stowed away in the base frame of the extruder and the support frame of the metering feeders – so no stand-alone control cabinet is required."

The line was specially configured for the task so, for example, incorporates a swivel-mounted metal separator above the main feed port of the extruder to ensure that any metal fragments that could result from the grinding operation do not reach the compounding process. Other process-oriented features for recycling applications can include a high precision gravimetric metering system and vacuum degassing.

Last year, Italy's **ICMA San Giorgio** reported it had successfully tested a new recycling line based on one of its high-torque co-rotating twin-screw extruders prior to installation at a major Italian customer producing industrial components. This is the second line developed for the customer in two years.

The extruder has two lateral feeders managing addition of various types of fillers and is equipped with special high-vacuum pump units for enhanced extraction of volatiles. Otherwise, it shares the typical high-tech characteristics of systems developed for "regular" compounding, the company says. The screw profile was optimised to process various families of polyolefin waste, following intensive software simulation, modelling and granulation tests in ICMA's recently-built technology laboratory.

"ICMA has been a pioneer in the market of plastic recycling process technology, [which] has allowed my company over the years to accumulate a deep experience in shaping the right process in line with customer's needs. This is also very true for green field recycling/compounding projects where ICMA's well proven turn-key expertise and execution capabilities can make a difference," says owner Giorgio Colombo.

A similar message is delivered from fellow Italian

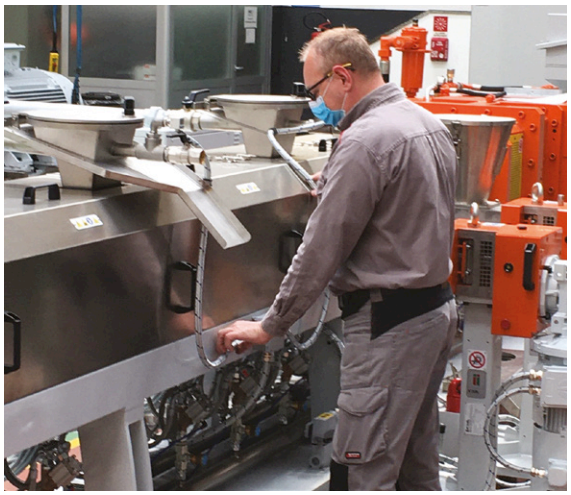


IMAGE: ICMA SAN GIORGIO

Right: A compounding line for recycled polymers under test at ICMA San Giorgio

extruder maker **Comac**. It sees co-rotating twin-screws becoming especially popular in recycling of flakes obtained from post-consumer PET bottles, as well as for recycling materials from industrial polyolefin-based moulded waste.

Adding value

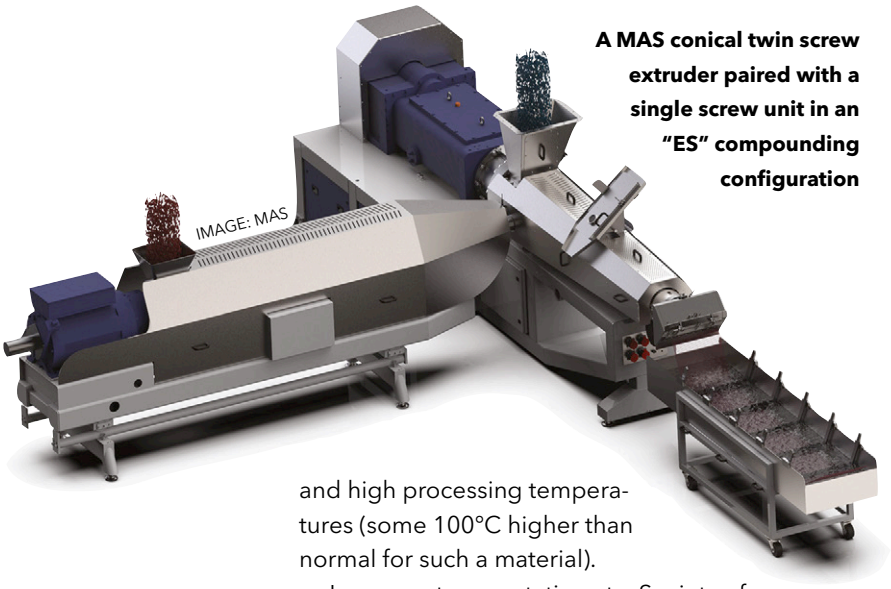
According to Charlie Martin, President of **Leistritz Extrusion** in the US, says twin screw compounding technologies offer unique opportunities to reprocess post-industrial and post-consumer recycled materials. "When utilised in a thoughtful way, the co-rotating intermeshing twin screw extruder can transform recycled materials into value-added products and parts," he says.

Martin points out the need for removing foreign contaminants such as metals – close-meshing twin-screws are not amenable to such off-spec materials, he notes dryly – and there is also the challenge of getting sometimes fluffy materials into the system, so a crammer may be required. "The feed system is critical," he says.

One example of the use of twin-screw compounding for post-industrial recycling highlighted by Martin enabled a customer to convert fractional-melt HDPE scrap from production of film into injection moulding material. The equipment was used to modify the MFI from 0.4 g/10 min to 2.2 g/10 min by what he calls "purposeful degradation." The extruder set-up involved the use of high-energy-input neutral and reverse kneading elements to maximise the energy imparted by the screws, high screw speeds (more than 800 rpm),

IMAGE: LEISTRITZ

Above: This Leistritz twin-screw extruder is fitted with a crammer feeder



A MAS conical twin screw extruder paired with a single screw unit in an "ES" compounding configuration

and high processing temperatures (some 100°C higher than normal for such a material).

In a recent presentation at a Society of Plastics Engineers event, Martin also described how twin-screw extruders can be used for processing polyolefinic post-consumer reclaim. Highlighting again the need for removing metals and also the need to eliminate moisture picked up during washing, he added that it may be preferable to use a single-screw extruder to melt and pump the PCR feedstock through a screen changer prior to mixing the fillers in the twin-screw unit.

A gear pump would then be mated to the exit of the screen changer to meter melt. "The TSE can now use a shorter L/D and smaller horsepower motor because of the upstream melting and filtration unit operations being performed before the melt enters the TSE," he said.

"The continued expansion of TSE technology as part of atypical extrusion systems will help improve manufacturing efficiencies in a wide variety of new applications that benefit from the consistent TSE in-line mixing process," says Martin.

Conical niche

Recycling also comes up in discussions with machinery maker **MAS**. This Austrian company has an unusual take on twin-screw extruder design with its conical co-rotating system. Conical counter-rotating extruders are, of course, well known in the PVC industry, but MAS applies its technology in a niche of its own. Most of its units are used for plastics recycling, particularly PET recycling, but some are also employed for compounding virgin materials.

A key point with the design, says the company's General Sales Manager Stefan Lehner, is that they can accept exceptionally large volumes at the input zone. This characteristic is ideal for regrind, especially for flakes, but also for any material with a low bulk density. So Lehner says MAS extruders are good for compounding mineral fillers, in powder and pellet form, as well as fluff.

In addition to the feeding capacity, the two screws, which taper to the melting/compression zone, support the use of high torque. This translates into high throughput with low screw speed, and also a very low shear rate. "The high screw filling rate of the MAS stands for high specific throughput," says Lehner. "That is the reason why MAS can extrude a wide range of polymers with very low melt temperatures."

The MAS extruder can be combined with the company's single screw TA series venting extruder downstream to improve degassing performance and to increase output. Another variant is the "ES" compound line, in which a single-screw extruder directly feeds polymer melt to the MAS extruder where fillers and/or fibres are fed into the MAS hopper. The company recently sold a line of this type with an output of around 1000kg/h to a company in Indonesia. It is scheduled for delivery this month.

MAS produces several models in its conical counter rotating twin screw line, ranging from the MAS 45 (with 1,190mm long screws that have a diameter of 100mm in the feed area and taper to 45mm) through to the MAS 93 (with 2,680mm long screws that taper from 186mm diameter down to 93mm).

Energy benefits

The MAS extruders are also particularly energy-efficient, according to Lehner. He says the short processing unit means residence times are low and so the installed extruder heating power required is also low. "As a result, the MAS extruder requires significantly lower specific energy than parallel twin-screw extruders," he says. An energy saving of up to 20% is said to be possible.

A further advantage of the design is that screw

IMAGE: COPERION

Right: RenCom's Renol lignin-based compound is produced on a Coperion ZSK twin screw extruder

IMAGE: COPERION

Right: A Coperion ZSK extruder fitted with tailored accelerometers to monitor gearbox wear

disassembly is relatively simple, the company claims. Once the melt filter or melt pump in front of the extruder is uncoupled, the cylinder can be swivelled to one side and the screws pulled out at the back. This is particularly advantageous when it comes to colour changes. "Disassembling of the screws on a MAS takes between 30 minutes to approximately two hours," Lehner says.

Continuing in the sustainability arena, US equipment supplier **Entek** points to ongoing growth in interest in bio-based formulations, saying this is at least in part due to the increasing use of new natural additive components.

Entek claims more than 20 years of experience in working with customers in development of new bio-based formulations. One example is BioRegion Technology (BRT) in the Pacific Northwest. This new entry to the sector has developed an innovative way to process agricultural by-products for use as additives for a variety of applications. It works with Entek directly in Oregon where it runs lab trials on materials. For production runs, it uses Interfacial Consultants (IFC) of Prescott, WI, which also has Entek equipment.

BRT's first product is Renew cellulose, which is developed as a drop-in replacement for other commercially available cellulose products. According to Dave Dowling, BRT General Manager, it is showing excellent results as a reinforcement agent for plastic parts. The company has several other products in development, which the company says could be "game-changing" for the plastics industry.

Bio-based options

Meanwhile, Swedish innovation company RenCom has just commenced production of its Renol biocompound using ZSK twin-screw technology from **Coperion**. Together, the two companies have developed what Coperion says is an innovative extrusion process to produce the lignin-based durable and reusable material (lignin is a by-product created by the forestry industry).

Coperion has delivered a line comprised of a ZSK Mv Plus twin screw extruder, gravimetric feeders, strand pelletising system, lignin bag dump station and big bag station to RenCom, which will be able to produce more than 1,000 tonnes/yr of the Renol products. According to the two partners, Renol can be used in ratios up to 50% in applications such as films for shopping bags, mulch films or retail applications and for injection moulded components for furniture and automotive. It can also be used as an infill material for artificial sports surfaces in place of rubber.

The ZSK machine is said to be well suited to processing the lignin-based compound. "The ZSK Mv PLUS series unites an optimally-balanced large free screw volume with high screw speeds and a high specific torque," Coperion says. "Thanks to the deeply cut screw flights, thermal stress on the raw material is very low and product processing is very gentle."

Coperion continues to develop predictive maintenance capabilities across its entire series of ZSK twin screw extruders. The company recently launched what it describes as a highly reliable yet affordable gearbox condition monitoring system for machines up to the ZSK 133.

The system uses a set of accelerometers tailored to the size and design of the corresponding gearbox in terms of sensor count and positioning. Coperion says that by using the ZSK control unit as a user interface, the condition monitoring system not only provides the

IMAGE: COPERION

Right: Coperion's ZSK twin screw extruders can be equipped with an electronically-secured gearbox lantern opening

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user with easy access to data visualisation, but also allows its company experts to remotely access raw data for the purpose of further investigations on possible vibration issues.

"The system was designed to be the perfect match for small and mid-sized machines targeting the reduction of unplanned down times and severe damage. It can also be extended to, for example, provide condition monitoring of the driveshaft bearings," the company says.

IMAGE: JSW

Right: JSW has updated its TKD screw element design to lift performance

Simplified service

Another recent Coperion development concerns the maintenance opening to the gearbox lantern – the enclosure around the connection between the gearbox and the extruder screws shafts. The company's ZSK twin screw extruders can now be optionally equipped with an electronic locking system so that, as soon as the screw shafts come to a complete stop, service personnel can open the lantern to gain safe yet secure, tool-free access to the screw shaft coupling.

The company says the feature, which is available on models from the ZSK 32 upwards, significantly simplifies screw changes and maintenance, reduces downtimes and improves overall efficiency of the system.

Turkey's **Polimer Teknik** offers its Poex T60-HT, T75-HT, and T94-HT series extruders for production of polyolefin-based compounds with mineral filler levels of up to 83% and says it has produced four lines based on the Poex T75-HT series over the past year. The compounds produced on the lines are used in production of blown film for applications including carrier bags, sacks, and construction film.

The company says that the type and number of degassing units are of particular importance for these applications. "The introduction of fillers automatically involves the inclusion of air between the particles, which is eliminated from the processing chamber by means of three atmospheric degassing systems and one vacuum degassing unit," it says.

Polimer Teknik also recently designed and supplied an explosion-proof line that is certificated in accordance with the EU ATEX Directive 2014/34/EU. "All potential risks have been avoided with special design and special components," it says.

A feature of the process zone of the company's larger twin-screw extruders (Poex T40, T50, T60, T75 and T94 models) is the use of a modular design with liner insert. "These modular systems enable easy assembly and disassembly, easy cleaning and maintenance, excellent heat transfer by liquid cooling and electrically heating in the control loop of the temperature device," the company claims. Each zone has its own heating and cooling system to provide users with a high level of flexibility in operation.

Below: The Poex T75-HT from Polimer Teknik is designed to handle heavily-filled polyolefins

IMAGE: POLIMER TEKNIK

Screw developments

Japanese machinery maker **JSW** has modified its TKD (Twist Kneading Disc) screw design to improve output. The twist angle of the kneading tips on the TKD screw, which was first developed by the company some 20 years ago, is said to prevent local high shear and heating and minimise local pressure peaks. As a result, JSW says it enables mixing with reduced energy consumption; processing at lower melt temperatures; improved dispersion of fillers; and reduced risk of wear of barrels and screw elements.

"Last year, we developed the improved TKD and realised the increase of throughput by 1.8 times with a customer which is one of the Japanese largest compounders," says Hayato Hobo, part of JSW's European team based in Düsseldorf, Germany.

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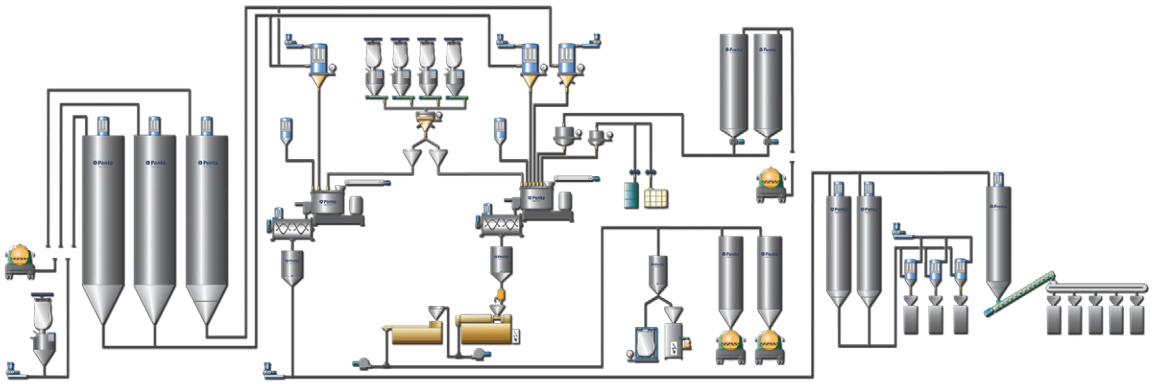

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Metallic effects shift up a gear

IMAGE: ECKART

Special effect pigments add sparkle and lustre to plastics, with the latest developments extending that to near metallic effects. Peter Mapleston takes a closer look

Special effect pigments can create a host of new finishes in moulded and extruded plastics components. They are not low cost additives but, by enabling users to do away with secondary decorating operations, can be very competitive at a system level. Most often, special effect pigments make use of the sparkling effects produced by minute particles of metals such as aluminium and silver as well as – for pearlescents – mica. Many of the longest established applications are in consumer packaging, but there is also a growing demand for the effects these pigments can deliver in more durable applications. And, when used in combination with more conventional pigments and additives or with laser treatment of finished surfaces, they can produce startling visual and tactile sensations.

Altana Group subsidiary **Eckart** describes its Stapa PP Reflexal product as a novel class of silver metallic effect pigment preparations tailored for moulded-in-colour applications. The preparations are mainly used for automotive interior trim applications where they can create a decorative finish very similar to that of a painted part. "Even a chrome-like appearance can be achieved," the company says. Other areas of application include the electronics industry and packaging (the dust-free pigment preparations are approved for food packaging applications).

"These products impress with their brightness and pronounced gloss," Eckart claims. "In terms of brilliance, this pigment group surpasses all previously known aluminium pigments. It can also be mixed very easily with coloured pigments."

Key considerations during the development of the Stapa PP Reflexal products were to achieve strong hiding power, ease of use, safe handling and good dispersibility, the company says. It offers the effect pigments in five different particle sizes: the very fine sizes produce a velvety structure-less effect with high opacity, while the coarser pigments offer a highly brilliant sparkle effect with strong reflection.

Different carrier options make Stapa PP Reflexal products suitable for polyolefins, styrenics, polyamides and other engineering plastics. They can be used with all common moulding and extrusion techniques.

The new Zenexo series of effect pigments from Germany-based **Schlenk Metallic Pigments** currently comprises two pigments for coatings,

Main image: Eckart's latest developments in effect pigments allow the creation of moulded in metallics and near chrome-like finishes

IMAGE: SCHLENK METALLIC PIGMENTS

Above: Colour wheel demonstrates the range available from Schlenk's Zenexo pigments

IMAGE: SCHLENK METALLIC PIGMENTS

Right: Schlenk's Zenexo pigments use the company's UTP technology

inks, and plastic applications: GoldenShine WB 21 and GoldenWhite WB 21 YS. Further pigments will follow, according to Dr Frank J Maile, Global Technical Director BU Effect Pigments.

Ultra-thin substrates

"Zenexo is based on UTP-Technology, which can be considered a breakthrough in effect pigment technology", says Maile. UTP stands for Ultra-Thin-Pigment-Technology, which the company says is based on an ultra-thin aluminium substrate encapsulated with silica. Schlenk says the technology enables production of substrates with a reproducible and perfectly uniform thickness distribution and an unmatched aspect ratio.

"For the first time, this new technology enables effect pigments with excellent hiding power, superior flop, and unrestricted safety in terms of transport, storage, and use as a non-hazardous material in powder delivery form," Maile says. A special surface treatment technology, called WB (which stands for water-borne), is said to enhance the good weathering and humidity resistance properties of Zenexo.

Processing at temperatures of up to 260°C is feasible and Maile says higher processing temperatures should also be possible "although this always depends on the respective parameter settings and the mechanical stress on the pigment itself – too high stresses can reduce the processing temperatures."

Maile says that Zenexo GoldenWhite WB 21 YS extends the potential colour palette with an elegant "champagne" colour mass tone. It is claimed to allow colourists to easily formulate in what he describes as a sensitive colour regime by mixing with the gold-coloured high chroma Zenexo GoldenShine 21 WB YY pigment.

Sparkling effects

US-based **Shepherd Color** says its StarLight special effect pigments take their name from their ability to capture the sparkle of stars in the night sky. To produce them, the company takes flat borosilicate glass and breaks it into specific particle sizes. These glass flakes are then coated on all surfaces with a nano-scale layer of pure metallic silver. "This Micro-Mirror technology gives a much more crisp and distinct sparkle than even highly engineered aluminium flakes," says Marketing Manager Mark Ryan. "Also, because an anti-tarnish treatment on top of the pure metallic silver totally passivates the StarLight particles, they are stable and highly weatherable."

StarLight is available in two product families. The FL grades are based on five-micron thick particles, which are said to exhibit "excellent" sparkle in plastics applications and to show no tendency to form flow lines. StarLight FX grades are based on one-micron thick glass flakes and feature a smaller particle size distribution than the FL grades. These grades are optimised for thinner systems. Ryan says they "give a more demure and sophisticated look than the eye-popping FL grades."

Pearlescent effect pigments are most typically associated with consumer packaging and shelf

IMAGE: SHEPHERD COLOR

Right: Shepherd Color's Starlight pigments are based on glass flakes with nano-coatings of silver

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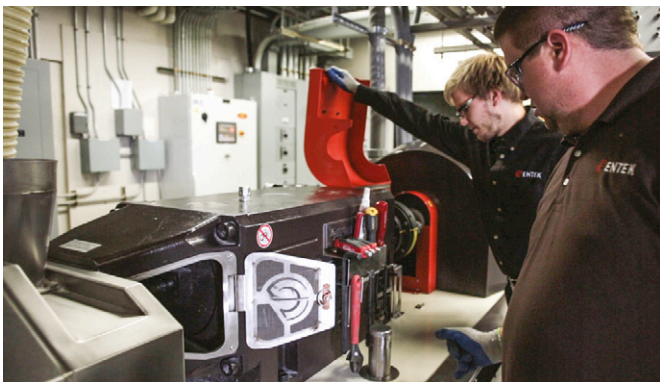

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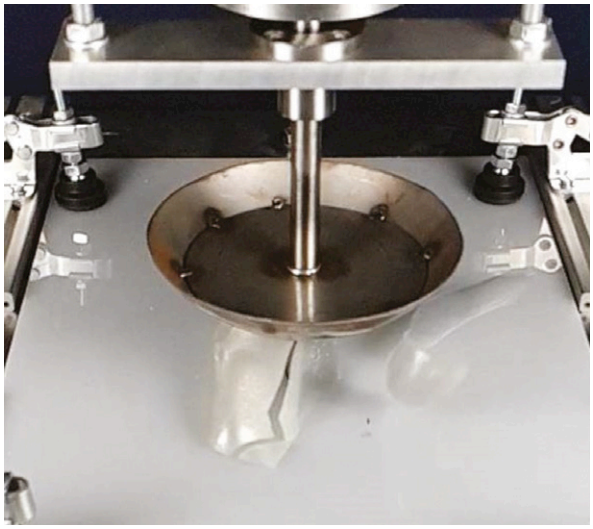

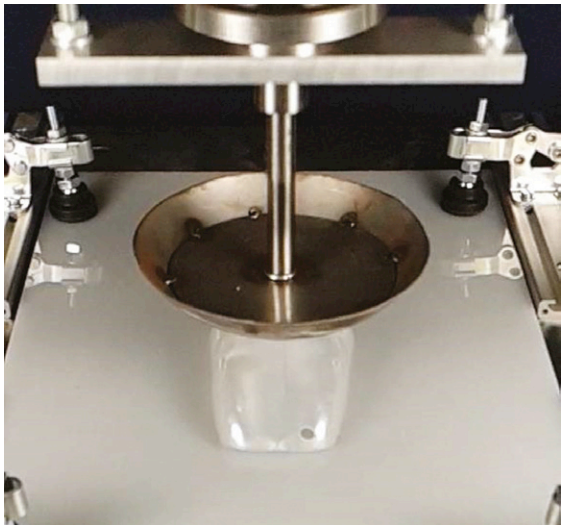

IMAGE: MERCK

Right: Drop tests show how pigments can impact on ageing. The part on the left uses a traditional colouring method, the part on the left Merck's WAY technology

impact. However, says Gordon Price, Technical Marketing Manager Plastics, at German pigments specialist **Merck**, recent environmental, regulatory, and sustainability developments – together with the trend towards paint replacement – means effect pigments are appearing more and more in non-packaging areas, where new and modified grades are often required to suit the specific application needs. Many of these application areas tend to use engineering polymers employing compounding as the colouring route.

"A prime consideration in most of these non-packaging applications, which are commonly for outdoors or long lifetime goods, tends to be weatherability, light stability and the inertness of the effect pigment in the polymer. Ordinary pearlescent effect pigments, intended for packaging, have a surface that can react with light and chemicals to degrade the polymer from within over a prolonged time period. Single trip or short lifecycle packaging doesn't necessarily need to retain long term properties, although one could argue the quality of any recyclate from recycled packaging may be reduced," Price says.

Long-term performance

"Exterior applications do need the longer term properties. Merck has developed the WAY range of pigments [WAY stands for Weathering and Anti-Yellowing] to give an effect pigment that has high light stability and a stabilised pigment surface that reduces the interactivity between the pigment and the polymer and additives package," he says.

According to Price, the inorganic treatment it uses withstands all plastic processing temperatures. In addition, because there is almost no photochemical reaction between the pigment and polymer, he says it will allow any polymer additive package to work, so retaining the desired physical properties for a longer time and exposure.

The WAY range enables a variety of metallic looking colour effects to be developed without the use of metal. Price cites an example in personal transportation, where mass coloured plastics are progressively replacing painted metal parts. "Here the long-term physical strength of the polymer system needs to be retained and WAY technology helps this. In tests exposing samples to real world exposure, pigment based on WAY technology retained physical properties far longer than alternative methods of creating the same effect."

Effect pigments including WAY technology can also have less attenuation and effect on systems used for autonomous driving, such as Radar and Lidar, than metal-based colouring systems, Price claims.

"Another ongoing development, using an innovative inorganic post treatment of effect pigments to reduce UV-instigated polymer decomposition, also has the property that creates mass tone coloured metallic effects without having to add other colorants that may exhibit low light stability," he says.

Sustainable trends

Changing requirements among brand owners and consumers are also highlighted by **Sun Chemical Performance Pigments**. "More sustainable, easier to recycle, identification, more durable, higher loadings, and lower cost are all part of every discussion we have with our customers," says Scott Heitzman, Business Development Manager Plastics.

Sun Chemical has several platforms of pearlescent and metallic pigments. Pearlescents include natural and synthetic mica-based grades – SunMica and SunMica LUX – as well as the SunGem XST glass-based types. The company says these platforms provide a full gamut of whites, interfer-

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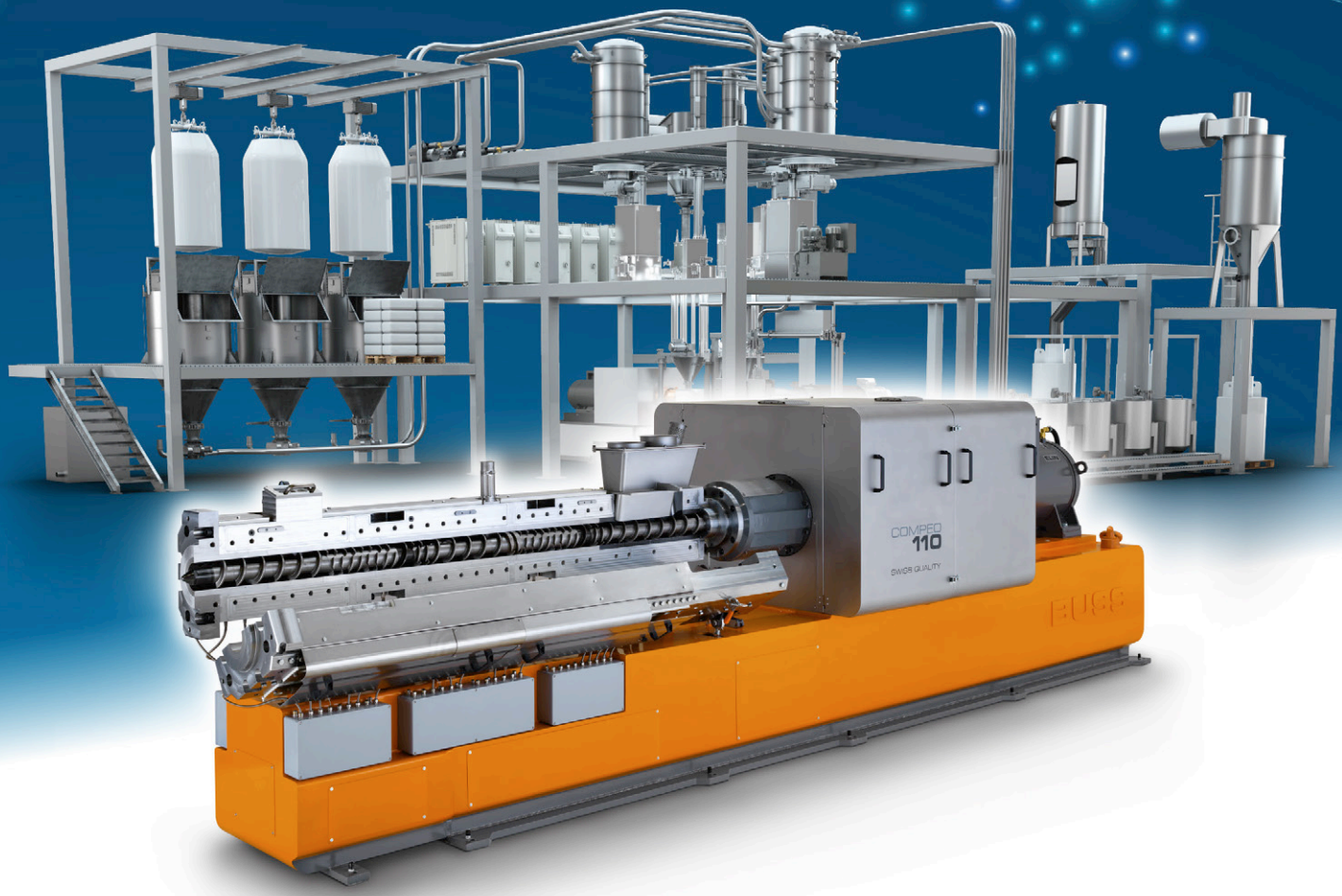

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Above: PET bottles incorporating Ampacet's Modern Mattes pigments

Above: Ampacet's Whispers effect pigments are intended for PET and rPET moulded and extruded applications

ence colours, golds, earthtones, and silver, as well as new black effects.

Heitzman says standout products in the company's range include its new SunMica Fuse Scarlet, which has increased colour purity and brightness over standard russet pearlescents and offers very good colour travel from yellow shade to blue shade red. It is delivered in a non-dusting 65% pigment preparation.

Laser marking additives are also finding increased use in today's market, according to Heitzman. He says Sun Chemical's products in this application sector provide high resolution and are free of other additives that add complexity in formulation. The company currently offers three products for clear or colour applications that mark black, and two products for black and grey that mark grey to white. The product line is supported by different particle sizes as well as substrates of natural, synthetic mica to provide design flexibility.

Heitzman also highlights its SunMica Dark Effects line of silver to black pearlescent pigments, which provide alternative options for applications where metallic pigments are unsuitable. He says they are non-hazardous and provide increased stability, adding that they are "truly unique" in that they do not change hue and maintain their desirable blue-shade silver to black at all angles. "This solves the problems with blends that tend to appear bronze to yellow on the face with a noticeable stronger hue shift," he says.

Sun Chemicals has also extended its line of aluminium-based FDA food contact approved metallic effect additives in particle sizes from 9-250 microns. "We now offer over a dozen grades of our Compal PE pellets. They are 100% solids that provide customers with faster throughput," says Heitzman. The line includes a fine grade with extra hiding power (Benda-Lutz 1249/80 PAO-A) based on a mineral oil paste.

Aiming for PET

Among compounders and masterbatchers using effect pigments, **Ampacet** says mar-resistant matte finishes, textural effects and colour options ranging from vibrant to luminous are among its latest innovations. These include the Modern Mattes and Whispers masterbatch collections, which are intended for injection moulded and extruded PET products.

The Modern Mattes masterbatches "allow-the use of vibrant colours while providing a range of finishes and visual effects, from smooth to textured appearances, as well as delustred and matte finishes," the company says. One grade, called Prima, is said to deliver both surface tactility and improved scuff resistance.

The new Whispers Collection is designed to provide a textural and frosted matte finish for PET applications. "Whispers provides a tactile feel in combination with a visual matte effect. The iced energy of the effect is attained without the added expense of a secondary process or mould change," according to Linda Carroll, Ampacet Director of Global Insight and Innovation. "Whispers Collection colours currently available include Blue Breeze, Calmed Coral, Golden Glimmer, Lucid Lilac, Muted Mauve and Soft Celadon. Colours can be customised for any colour pathway to accurately reflect the targeted brand message."

Both collections are proving popular for personal care, cosmetics, beverages, spirits, automotive, industrial, and home care products, Ampacet says. They can be used in virgin and recycled PET.

A similar philosophy is being followed at **Avient** (formerly PolyOne) with its recently launched "NewÆsthetix by ColorWorks" range of special effect colour masterbatches for PET and rPET. It says that its aim is to develop colour and effect options that deliver original, sought-after aesthetic qualities not normally expected in plastic materials (the ColorWorks brand was acquired when PolyOne took over Clariant's global masterbatch business last year).

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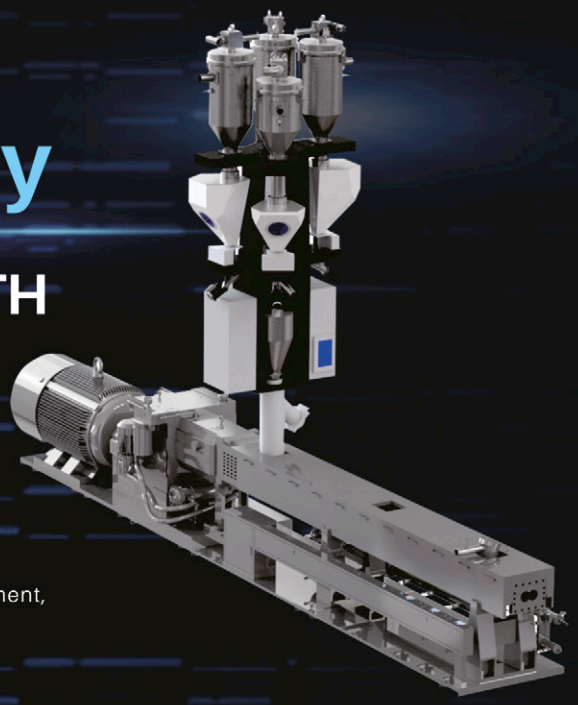

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IMAGE: AVIENT

Right: This satin effect is produced using the latest ColorWorks NewÆsthetix pigments for PET

As an example, Avient highlights a novel chrome colour, which it markets under the name of "Mirror, mirror on the wall…", saying it responds to the growing interest for truly metallic looks.

"Particularly in the consumer electronics and technology sector, designers are focusing on silver and chrome with a liquid feel for their premium products," says Judith van Vliet, ColorWorks Senior Designer. "You see it a lot in glass and that kind of transparency is also very trendy. This new colour concentrate, targeted especially at PET containers, develops a look that is the closest I've seen to a true metallized effect. It does a very good job of bringing those bright qualities to plastics for use in bottles containing prestige products."

The colour is slightly translucent, and so well-suited to applications where it is necessary or desirable for the contents in the bottle to be visible. At the same time, it has the power to overcome slightly off-colour resins, including post-consumer recycled (PCR) rPET. The effect was, in fact, first demonstrated on bottles made of rPET resin.

Brilliant solutions

According to Avient, the secret to achieving the brilliant chrome effect lies in the pigment particle-size distribution and the way it is incorporated into the concentrate. The chrome colour is available in three Renol concentrates of varying tone, softness, and translucency.

Reflectivity is said to be dramatically increased compared to more conventional silver or chrome colours, meaning a 3D look is possible even on very thin sections such as those found in injection-stretch blow moulded PET bottles. Further benefits include a very good reaction to laser marking. "While other colours can turn grey or black and leave a physical, palpable mark on the surface, the chrome pigment simply disappears leaving only the natural transparent polymer behind," Avient says.

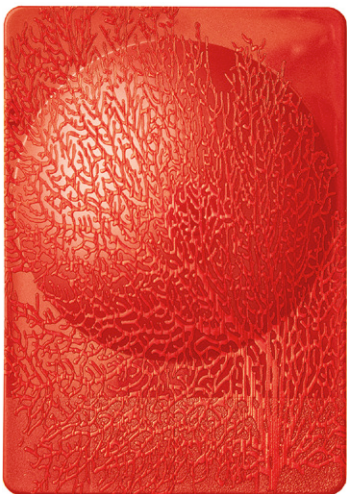

IMAGE: GABRIEL-CHEMIE

IMAGE: GABRIEL-CHEMIE

Gabiel-Chemie's Magic Touch finish (above) combines pigment and laser technology to create enhanced appearance and haptics while the Simply Magic effect (right) combines special effect pigments and laser marking

Another new offering, "Prèstige Satinée" is said to provide new colour takes on a satin effect and is expected to resonate specifically with Asian consumers drawn to the silky, brushed glass of luxury, high-end personal care and cosmetic packaging. It is said to give a brushed-glass look in shades that reflect current consumer preferences for soft, muted colours and those found in nature.

The satin effect, which is created by a proprietary additive that is introduced in masterbatch form during preform moulding "creates an illusion of depth within the container walls, making the bottle appear more like glass," according to Vick Cai, Designer at ColorWorks Asia Pacific. "However, the effect is not only visual. It gives the bottle a softer surface feel."

The growing interest in special effect finishes is a trend also seen at Austrian masterbatch specialist **Gabriel-Chemie**. "We see a continuing demand for special effect pigments to differentiate products at point of sale, especially in the cosmetics industry. Home office may have dampened demand for cosmetics in the short term with 'grunge' and 'tracksuit' look becoming more popular, but we are still involved in a lot of new projects for the future," says Mark Hannah, Head of Corporate Marketing.

Gabriel-Chemie says it is aiming its developments in three main directions: metallics, effect pigments combined with laser additives, and combinations of different effect pigments.

Metallic alternatives

On metallics, Hannah says the trend towards sustainable solutions continues to drive market demand to replace metallic coatings/platings with metallic pigments integrated into compounds. "We are using a new generation of metallic pigments

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IMAGE: GRAFE

Above: Mermaid FX flip-flop pigments from Grafe applied in a 3D print filament

for colouring plastics that get closer than ever at replacing metallic plating with a comparable alternative," he says.

Hannah cites champagne and bronze gold effects among examples of this, as well as a red that he says highlights a new generation of pigments that are capable of giving a depth of colour and shimmer that have not previously been seen in plastics.

Combined trends

"We also see a trend towards not just using effect pigments, but also towards combining the pigments with laser additives and using a laser marker to alter the appearance of the pigments post-production. Magic Touch for instance shows a way to use a laser to create a haptic appearance of coral on a plastic surface," he says.

Another Gabriel-Chemie masterbatch – Simply Magic – uses a combination of effect pigments and laser additives to enable different colours and effects to be produced. "The plastic is all the same base colour, so only one colour needs to be moulded, and the technology enables visual effects such as patterns and designs in monochrome to be realised post-production," says Hannah. "Simply Magic demonstrates this in a camouflage effect that is currently trending in many areas of product design."

Finally, Hannah says effect or colour pigments can be combined to produce marble effects in two, three or more colours. "The pigments themselves need not be new, but the combination of different colours and effects opens up a whole new perspective for existing pigments," he says. The company's Marble Topaz Spirit uses a combination of different coloured plastics to give an individual effect. No two products are the same, providing a means to produce completely individualised products using standard mass-production manufacturing equipment.

Germany's **Grafe Advanced Polymers** introduced its Mermaid flip-flop effect compounds a couple of years ago with high-end products in mind (the company notes that the pigments used are not inexpensive). "It can be implemented well for small production runs, and filament manufacturers for 3D printing have also expressed interest," says Manfred Fischer, Head of Marketing.

The Mermaid products are also said to work well in two-component injection moulding. "Very good results have been shown when combining, for example, re-granulated black ABS as a low-cost carrier with the PMMA-based effect compound as a top layer. Some projects were started in 2019, but then paused for the time being by the Covid-19 pandemic in 2020. However, we expect that this topic will pick up speed again," Fischer says.

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Compounding process simulation tools can save materials, time and money. ***Mark Holmes*** *reports on some developments in computer modelling techniques*

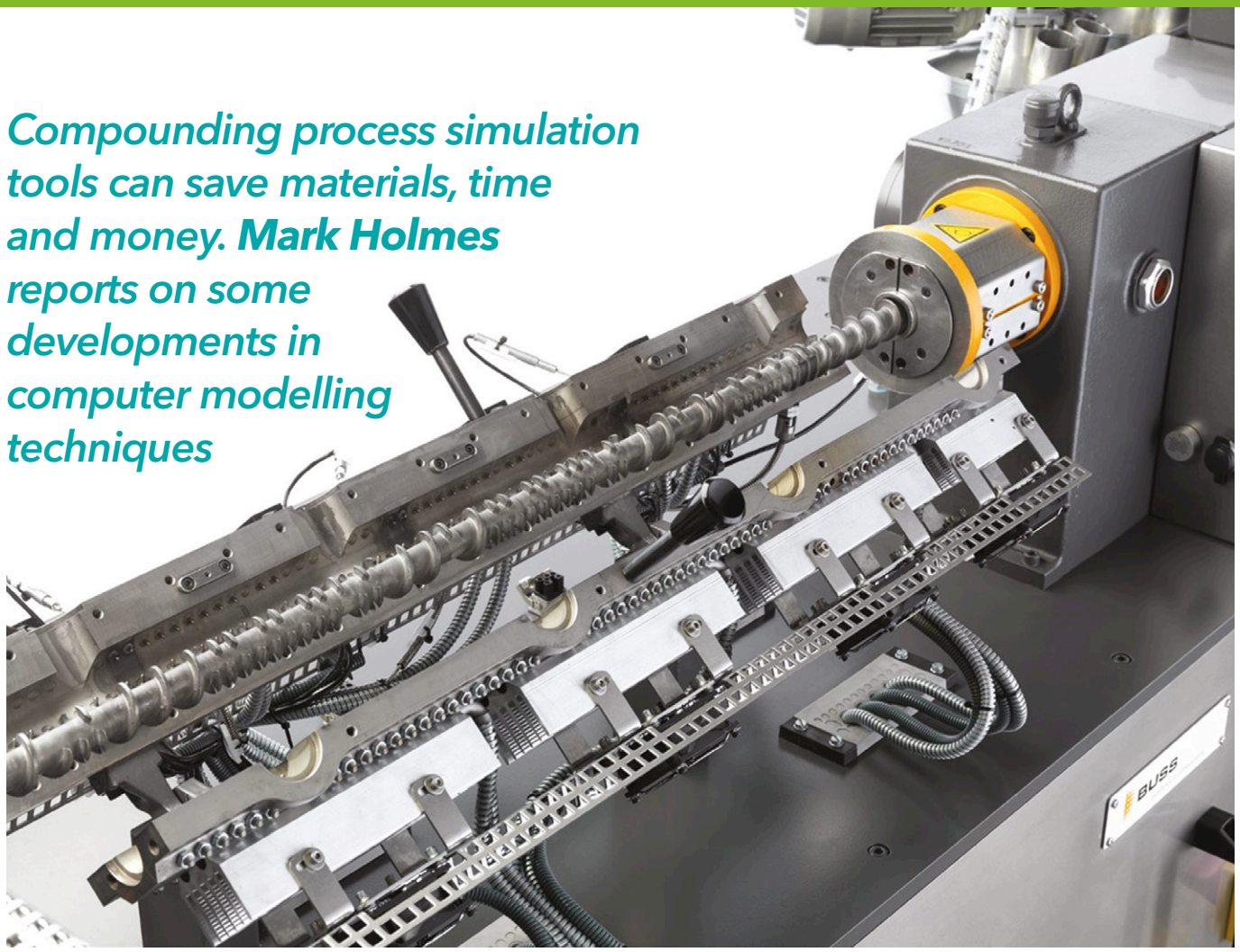


IMAGE: BUSS

Getting inside the process

Optimising the compounding process is a time-consuming task that can result in loss of productivity and output. So doing as much of the analysis and optimisation before committing to production equipment makes absolute sense as it can both save money and improve quality. Widely used in the plastics injection moulding sector, software-based process simulation tools can also play a major role in the plastics compounding industry.

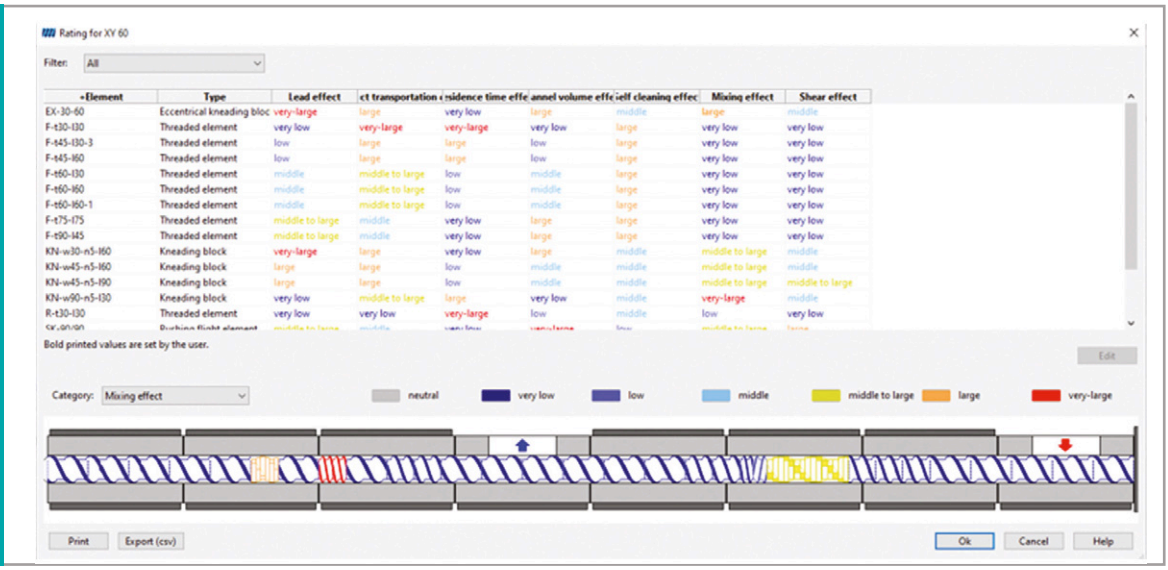
Sigma computer modelling software developer **Kunststofftechnik Paderborn (KTP)**, which is based at the University of Paderborn in Germany, recently commenced its Sigma13 project, which is intended to provide new simulation solutions for increasingly complex compounding applications.

"The main task for process engineers in compounding is screw design based on experience and specific product requirements. Software should support the user in this task and provide a tool for design, including simple screw assembly within the software and evaluation based on reliable simulation results. This can save testing in the laboratory and improve the design process," says Hatice Malatyali, Group Leader Compounding at KTP.

"The plastics industry continues to grow due to various trends, such as lightweight construction, and product requirements are increasing. As a result of these changes, processes are becoming more complex. Software can help to reduce this complexity, as well as support the development of new products," Malatyali says.

According to KTP, numerical simulations are becoming increasingly important because material flow can be calculated much more accurately. The current Sigma3D software solution can be used with numerical simulations to perform individual process analyses for fully filled screw zones, such as the mixing and pressure build-up zones. However, at present only fully-filled zones can be simulated. To get a complete numerical description of the screw, the 3D module must be supplemented by the partly filled screw zones. For this purpose, it is necessary to implement a two-phase model that describes the interaction between the melt and ambient air. ›

Main image: Buss is part of a consortium developing a simulation tool to model the complex co-kneader compounding process



Kunststofftechnik Paderborn is working to improve the screw design tools in its Sigma13 software

Source: Kunststofftechnik Paderborn

Recycling demands

There are also growth areas of plastics compounding where process simulation tools such as Sigma are proving to be of particular value, including processing of plastic recyclates and modification of polymers using carbon fibres and carbon fibre recyclates. "These recyclates accumulate as production residues," says Malatyali. "There is also a steadily growing demand for fibre-reinforced thermoplastics resulting from their significantly improved physical and mechanical properties. In addition, new laws such as the EU Waste Framework Directive and the End-of-Life Vehicle Directive require carbon fibre residues to be recycled."

These new legal requirements will make sustainable recycling methods for fibre composites essential in the future and production of thermoplastic matrix/fibre recyclates can provide such a recycling route. "For this, the incorporation of carbon fibre recyclates into thermoplastics on various compounding extruders has been investigated," Malatyali says. "The initial focus was on the dosing and feeding behaviour according to the fibre type. A model to describe fibre length change during compounding for carbon fibre recyclates was incorporated in Sigma, which takes into account the different input distribution of fibre lengths."

KTP says that the input variables of recycled plastics and fibres vary depending on the supply source. For that reason, the focus of its work in this area has been on validation of the model with different fibre types.

Other areas of development in Sigma13 include development of screw design rules, the influence of processing conditions on molar mass degradation, and an extension of the Sigma3D interface.

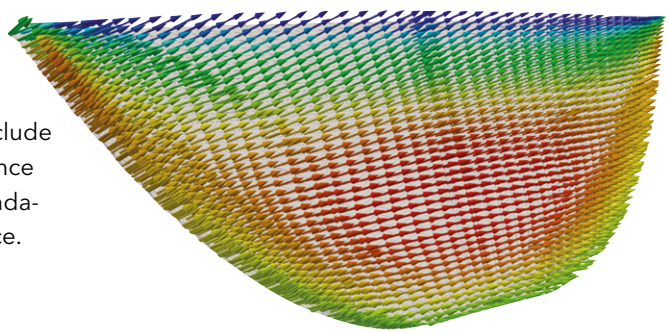
KTP says the screw design rules currently established in the Sigma software contain two major content-related parameters - geometric boundary conditions and process rules. To establish the geometric boundary, a number of properties are determined for all screw elements on the basis of geometric data. This includes conveying effect, residence time behaviour, pitch effect, volume, self-cleaning, mixing effect and shear effect. These characteristics result from the definition of the geometry and not from analytical simulations. These properties of the elements are automatically generated using the screw design rules.

The set of rules is defined so that the designed screw can be checked according to the process zones with the help of the screw design laws. The definition of generally valid process rules is of particular importance because this set of rules can be used to review the design of a process. After the user has designed the screw, a check can be carried out against the design rules. Depending on the result, Sigma13 reports an improvement or an error.

Modelling degradation

Material degradation refers to mechanisms that cause a shortening of the molecular chains of plastics and consequently lead to a decrease in mean molecular weight. These processes lead to a change in the chemical structure and influence

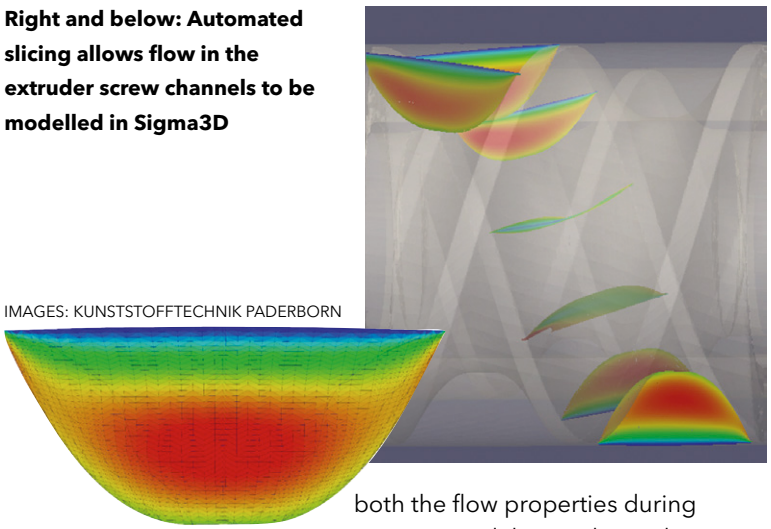
IMAGE: KUNSTSTOFFTECHNIK PADERBORN



Right: Visualisation of velocity profiles in the extruder simulated within Sigma3D software

Right and below: Automated slicing allows flow in the extruder screw channels to be modelled in Sigma3D

IMAGES: KUNSTSTOFFTECHNIK PADERBORN



both the flow properties during processing and the mechanical properties of the final product. With this in mind, KTP plans to investigate and analyse molecular weight degradation during the processing of polypropylene.

Parameters considered for the investigation include shear rate, residence time and temperature, all of which will be varied with different screw and temperature configurations, as well as speeds and throughputs. The intention is to develop the foundations for development of gentle processes, which will also take into account boundary conditions such as high throughput. The work will focus on PP because it is one of the most important industrial mass-consumption plastics. The investigation aims to assess material degradation through the intrinsic viscosity of different PP types that differ with regard to melt flow index.

The Sigma3D interface allows a combination of solutions by numerical one-dimensional process simulation. KTP says that that following the successful introduction of the software, further work now has to be done on development of the Sigma3D module. This will involve the extension of evaluation options for the user.

KTP says that twin-screw extruders are essentially defined by three different geometric zones - channel, intermeshing area, and gap. The first evaluation will obtain further knowledge about the process in relation to these zones for important factors such as flow velocity and shear rate. The second will consider the channel zone in detail. Helixes can be placed next to the front section on the x-axis of the screw elements (slices) in the channel, which will be able to determine conclusions about flow in the channel direction.

One of the long-term goals at KTP is the development of automated process optimisation. "At the moment, evaluation of the designed screw is done by the process engineer," says Malatyali. "This requires a high degree of experience to perform an appropriate evaluation. With these developments in Sigma, we want to give engineers a tool that simplifies the evaluation and speeds up the process of screw design. Using the current investigation on material degradation, an evaluation of the calculation possibilities of molecular weight degradation in the twin-screw process will be carried out. This will serve as a basis for further Sigma projects, which will consider calculation of molecular weight degradation."

Reliable results

The most important requirements for any computer modelling software is the reliability of the model and consequently the accuracy of the results, according to **SC-Consultants**. The French company is the developer of both the XimeX-TSE and Ludovic software for twin screw process analysis.

"The materials that we now need to consider are becoming increasingly different," says Sales Manager Laurent Ratte. "As a consequence, a given model may be suitable for one kind of material, but not be relevant for another. For example, visco-plastic behaviour is well understood and described by current models. However, elasto-plastic behaviour is underestimated, and existing models must be adjusted on a case-by-case basis."

Ratte says that material formulation, process set up and scale up are almost always performed today using the classic trial and error method, which means an important loss in terms of material, time and money. "We estimate that experimental development accounts for one-third of a R&D budget for a compounding company. Replacing this method by using numerical simulation is a

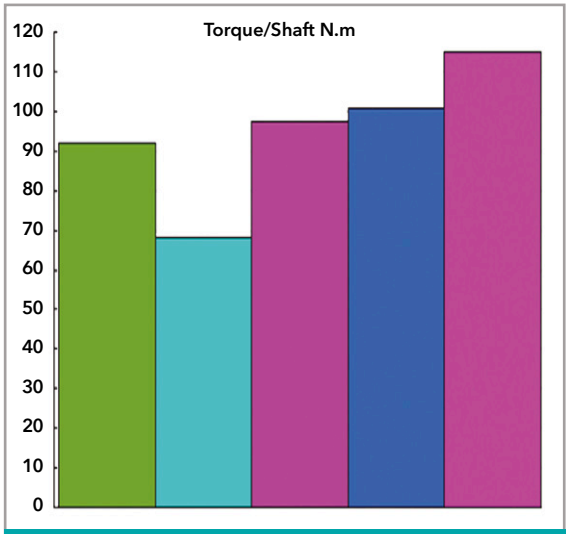


Figure 1: Comparison of torque values for different sets of operating conditions
Image: SC-Consultants

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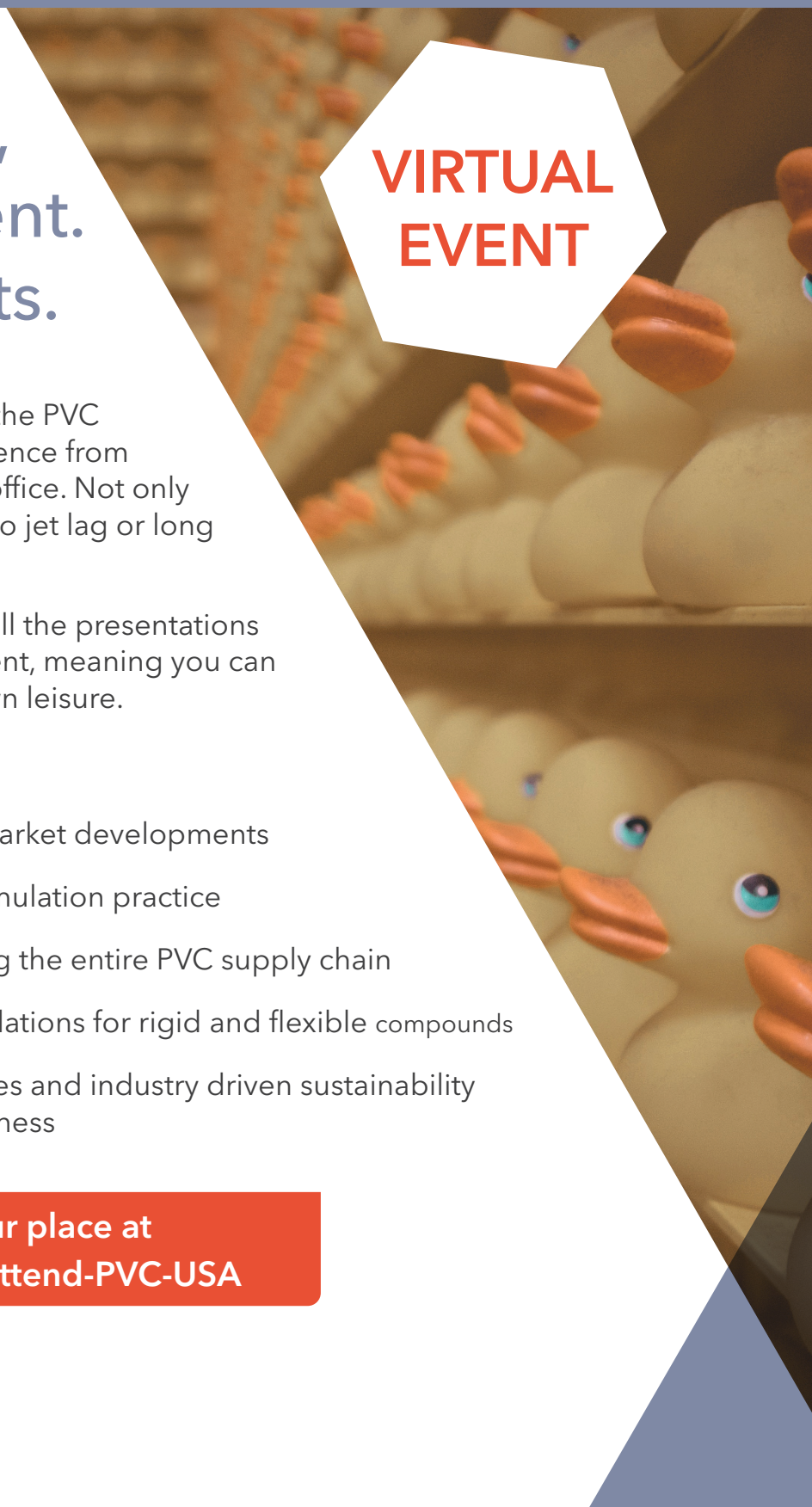

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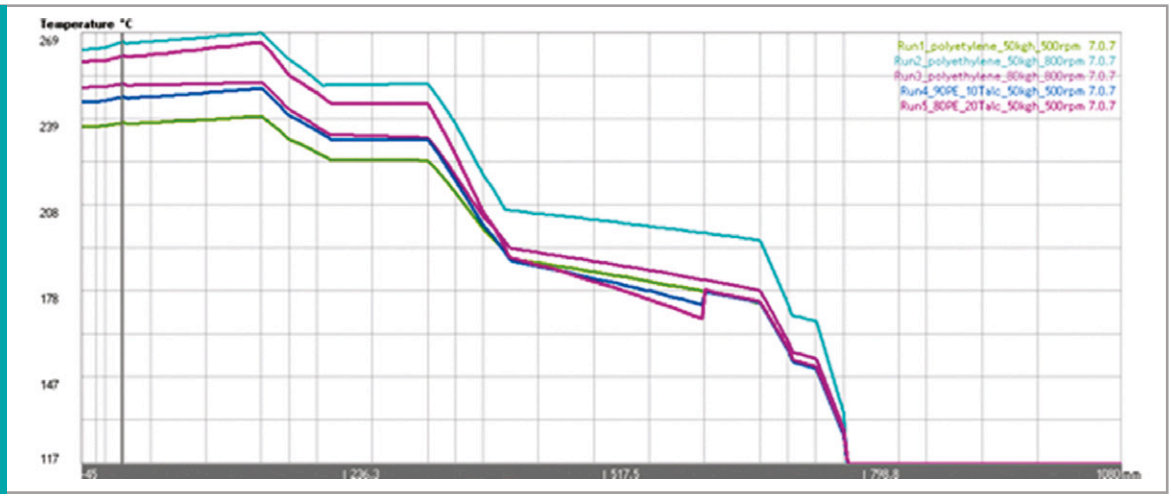

Figure 2: Comparison of different temperature profiles of blends under various operating conditions

Image: SC-Consultants

huge benefit," he says.

"We also estimate that shutting down a production line for just one day of trials in order to perform measurements means a loss of $30-40,000. Whereas simulations are performed in a few minutes, in a 100% virtual way, and without any monetary loss. Therefore, the use of numerical simulation is necessary from both a financial, but also quality point of view. Indeed, numerical simulation can provide the whole thermo-mechanical history of a material, which can highlight areas and parameters to be improved," he says.

SC-Consultants cites two examples where numerical simulation can be of considerable value. Firstly, determining the maximum torque of a twin-screw extruder is important to reach the highest possible level of productivity. Variation of operating conditions allows this to be maximised. Figure 1 shows a comparison of torque values for different sets of operating conditions. The second example is the critical temperature of material, which can often be a limitation in process design. Knowing the temperature profile of the melted material in detail is important and Figure 2 shows a comparison of different temperature profiles of polymer blends under different operating conditions.

Split approaches

Process simulation for compounding is currently split between two different approaches, according to SC-Consultants. "There is general purpose software, mostly in one-dimension aimed at providing quick results, and there is Computational Fluids Dynamics (CFD)," says Ratte. "The first approach is dedicated to practitioners skilled in operating twin-screw extruders. The results are immediately accessible and easily interpreted, which facilitate the development of the material and process in a practical way. The second approach is more suitable for numerical analysts – expert users of CFD code."

He says that the current global economic situation has provided a boost for engineering process simulation and a tool aimed at performing virtual trials is considered to be highly valuable. "All remote or socially distanced tools are currently well appreciated by the market. So, in 2020 we needed to adapt to provide new tools, such as on-line training with recorded video sessions, tutorials on twin-screw simulation tips and webinars for presenting special features and/or applications," Ratte says.

Like many parts of the plastics industry, new developments in process simulation are highly likely to be driven by the recycling market, according to Ratte. "Everywhere in the world, national governments are proposing laws for increasing the ratio of recycled material," he says. "For example, in 2022 Germany will recycle 63% of its plastics packaging compared with 36% now. In France, an ambitious target of 100% by 2025 is envisaged. Recycled plastics will be a fact of life very soon and this will also be the case for compounding. We are looking at new simulation solutions that will anticipate and consider the variable quality and rheology of input material."

According to SC-Consultants, every user of a twin-screw extruder can potentially benefit from the application of numerical simulation. In particular, the company says it is possible to undertake considerable process re-engineering as compounders improve their understanding of their machine capabilities and that this can lead to new developments. It cites addressing of issues with compounding of fibres reinforced compounds as an example.

To keep pace with new demands and requirements it is necessary to continually extend the feature set of process simulation software. "Elastomers require specific investigations, especially to fit to a viscosity behaviour model," says Ratte. "As the viscosity evolution continues and will not be reversed, it is now necessary to add new features to

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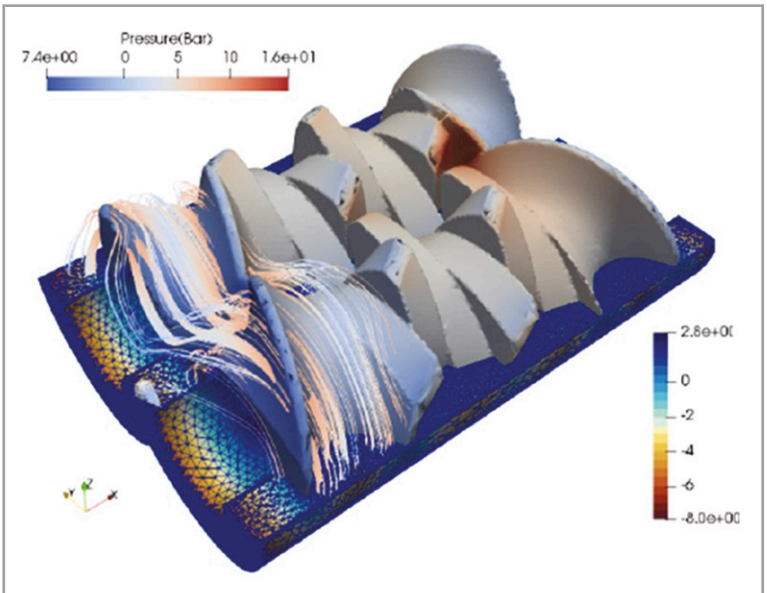

Figure 3: Pressure analysis in a twin-screw extruder determined using XimeX-TSE software *Image: SC-Consultants*

current software. Non-miscible polymers are also an issue. Although it is not always physically possible to mix some specific polymers, compounders are still looking for ways and methods for achieving these special blends. Process simulation software will need to reflect this."

To provide additional accuracy in mixing and process efficiency, SC-Consultants has developed the XimeX-TSE 3D CFD software. The company says this model focuses on a given mixing area within the twin-screw extruder in order to determine mixing with dispersive or distributive properties. XimeX-TSE provides statistical tools for analysing and comparing different screw profiles as part of the optimisation process with regard to material properties and requirements (see Figures 3 and 4).

Cloud computing

Cloud computing is also developing strongly in the simulation market. This year SC-Consultants' subsidiary Sky Computing will extend its offer with a new portfolio that will increase the number of users and expand the software dedicated to physical process modelling.

Other future developments will look at complex physical and chemical reactions, according to the company. "All compounders can now master basic product formulations," says Ratte. "Increasingly, they are now looking at complex products and material characteristics. Key challenges will be in the field of non-miscible polymers, or complex reversible or irreversible reactions in the machine, for example. These are some of the recent requests from our users. We will also continue to target practitioners with computer modelling software that will transfer work away from of the R&D department. New developments will be released soon."

Germany-based **Ianus Simulation** developed its Code Extrud3DPro software around the FeatFlow solver package for incompressible 2D and 3D flow. The company says it can portray and calculate small paths, complex geometries, fast rotatory/translational motions and high viscosities in high-resolution. Extrud3DPro is said to allow fast design of a process and to illustrate all parameters, including temperatures, velocities, viscosities, shear rates and pressures. This allows the determination of influences on geometry, material and process parameters during development, for example rotational speed and barrel temperature profile.

Extrud3DPro is compiled individually for the specific simulation requirement. It can perform flow simulations in single- and twin-screw extruders as well as pumps, mixers and stirrers. Key features include dynamic grid generation, periodic boundary conditions, False-Time-Stepping method and a new temperature model.

Kneader simulation

Swiss kneader extruder maker **Buss** has collaborated with a consortium including the **Institute of Polymer Technology (IKT)** at the University of Stuttgart and the **Kunststoff-Zentrum (SKZ)** in Würzburg, Germany, to take the first steps towards efficiently predicting the mixing behaviour of co-kneaders. The systematic process investigations, both experimental and theoretical, are said to show good agreement and contribute significantly to clarifying the process engineering sequences in the machine.

Kneader extruders are particularly effective for

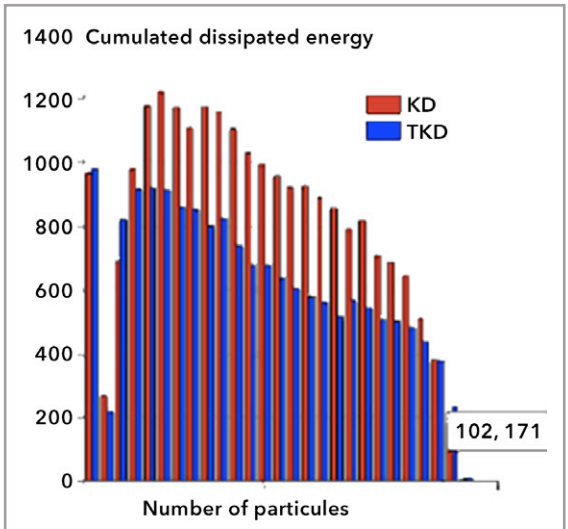

Figure 4: Comparison of particle mixing efficiency between a classic kneading disc (red) and a twisted kneading disc (blue) *Image: SC-Consultants*

the preparation and modification of highly filled, temperature and shear-sensitive plastics, especially formulations with stringent mixing specifications. However, determination of the optimum design and arrangement of the kneading elements in each case is usually based on experience or trials in a pilot plant. Due to the process complexity, Buss says there have only been a few systematic investigations on which to base analytical and numerical models for computer-aided optimisation. The problem, the company says, lies in precisely defining and mathematically modelling the processes taking place in the co-kneader, where longitudinal mixing is axially superimposed on radial mixing due to the combination of oscillating screw movement and spatial interruption of the screw flights.

Validation models

Investigations with two different matrix materials on a Buss laboratory Kneader MX30 served as the basis for the validation of modelling and simulations. Screw elements with different flight geometries were examined, and the number of kneading pins, speeds and throughput varied. To obtain a deeper understanding of the processes involved, melt transport, full fillings, backflow lengths and residence times were recorded using measurements of the local filling level (which influences both dwell time and extruder performance).

Alongside this, numerical flow simulations were used to resolve experimentally undetectable variables, such as flow direction and shear rate. Analytical calculation models delivered process variables, such as temperature and input power along the extruder. Within the scope of numerical modelling, different kneading flight positions were sectioned and simulated, and the superimposed oscillating screw stroke at constant rotary speed was also taken into account. In total, two different kneading elements were simulated for each of two machine types and then compared with regard to the resulting velocity fields and shear rates.

For analytical modelling, the geometry was split into short sections and then described with parameters such as number, height and width of screw channels, number of pins, and width of the interruption between kneading flights. Together with melt material data, these parameters were used to calculate process variables. The model considered several variables relevant to the design, such as dwell time, melt temperature, filling level, power input and pressure over the entire extruder length.

The numerical simulations were evaluated qualitatively based on the velocity field, and quantitatively by calculating the mean shear rate. The assumptions made were said to reflect practical experience, which means that initial tendencies can be predicted using quantitative data.

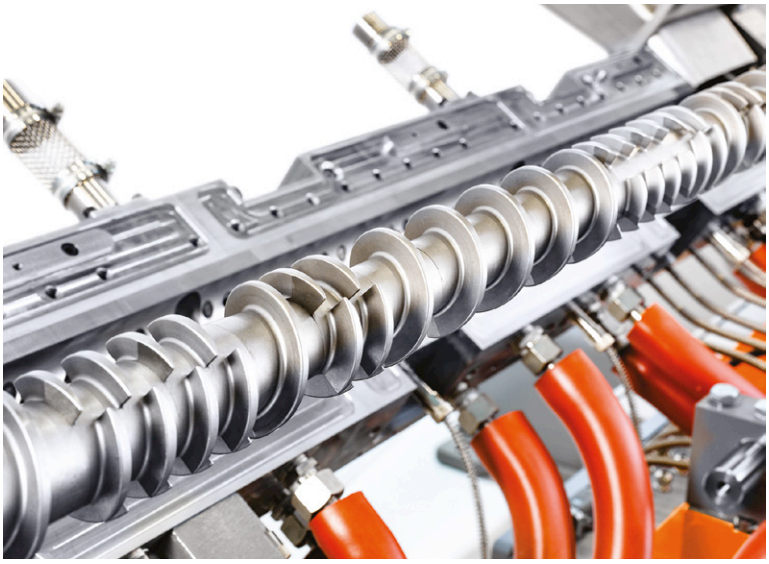

IMAGE: BUSS

Above: Modelling the superimposed combination of longitudinal and radial mixing in a kneader extruder is a challenge

For the analytical calculation, a tool was created that enabled one-dimensional simulations with the developed co-kneader models on the basis of melt material, geometry and processing parameters. Comparing the calculated pressure, filling level and mixing characteristics with the test results showed good agreement. The researchers say that – taking into account the simplifications made for modelling – there was also good agreement between calculation and test data with regard to dwell times, power input and mass temperature.

According to the consortium partners, the investigations enable identification of significant process parameters, thereby clarifying the interactions in the co-kneader between machine configuration, kneading characteristics and materials. The simplified calculation models are able to depict initial tendencies in variation of geometry and influencing factors and, for the first time, their implementation in a simulation tool enables important process variables in the co-kneader to be predicted in a few seconds. Even though only the simulations for the laboratory co-kneader have been validated, results are already said to be enabling the use of simulations for design configuration of co-kneader compounding processes.

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Testing times for odour

*Tackling the problems of odour and VOC emissions from plastics requires a multi-pronged approach that ranges from additives to sophisticated testing. **Mark Holmes** reports*

Bad odour and volatile organic compound (VOC) emissions from plastic compounds can lead to problems in a wide range of applications from food packaging to vehicle interiors. Looking ahead, the increasing use of recycled polymers mean these challenges will only intensify. Fortunately, there are additive solutions available to counter these unwanted odours and testing equipment that can help quantify the problem.

"Emissions from plastic components are generally not desirable," says Jörg Garlinsky, Head of End Use Thermoplastics - Industrial Applications at **Byk**. "To prevent these emissions, adsorbers can be used that bind the VOCs and keep them in the plastic. However, under certain conditions, these compounds may still be released."

Galinsky says the company has taken a different approach in the creation of its latest BYK-P 4200 additive. "As an entrainer, it mixes with the unwanted VOCs and is excreted together with the VOCs during the degassing phase of compounding. The benefit is that substances that are no longer present in the material can no longer be emitted at a later time," Garlinsky explains.

"The additive concept from Byk enables the component of unwanted VOCs and odours to be significantly reduced during compounding," he says. "The fundamental principles of 'entrainers' form the basis for the additive. Its molecular structure is such that it becomes active in the melt at the interface of the granulates during the compounding process, which almost completely separates the VOCs from the granulate. The resulting mix of VOCs and additive carrier substance is separated in the form of steam during the degassing phase of compounding." ›

Main image: Checking and controlling odour in plastics requires both instrumental and organoleptic analysis, according to Austrian masterbatch maker Gabriel-Chemie

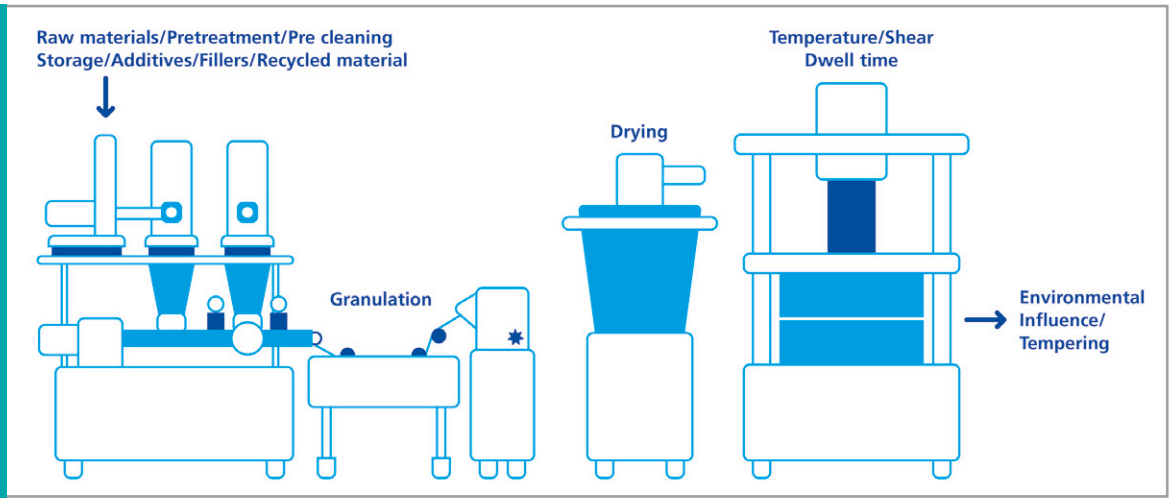

Figure 1: Potential sources of odour and emissions in the plastic processing sequence from compounding to moulding

Source: Byk

Odours and VOCs in the plastic part can be caused by a variety of factors, which Byk says can be broadly assigned to the polymerisation process, processing aids and additives. The company adds that emissions from plastic components are often further determined by environmental influences, with heat and sunlight being major factors. Processing steps that a plastic part undergoes are also relevant (Figure 1). "These include pre-drying procedures and process parameters, such as temperature and dwell times. In addition, the influence of machine specifications, such as screw design, the degassing zones and the available vacuum, cannot be underestimated," says Garlinsky.

State-of-the-art

"Current state-of-the-art processes use microporous materials to adsorb VOCs and odours. The disadvantage of many adsorber products, such as activated carbon or zeolites (aluminosilicate), is that VOCs or odours are bound to the surface by physical forces – Van der Waals forces. Adsorbers can absorb water and other low-molecular substances and release them when heated without the crystal structure of the adsorber being destroyed," he says.

In certain circumstances, Garlinsky says volatile components can be released from the adsober – in summer in vehicle interiors where temperatures exceed 70°C, for example. In such cases, adsorbers can delay, but not rule out, the release of bound substances. They can also result in some impairment of mechanical characteristics.

"Another method for reducing odours and emissions is directly feeding an entrainer in the form of water, nitrogen or carbon dioxide straight into the melt during the extrusion process," he says. "By means of suitable degassing during the extrusion process, which should be carried out primarily via a vacuum, it is possible to remove unwanted odours and VOCs from the process. The disadvantage of this process is that it requires more elaborate technical solutions and, as a result, additional investment in machine technology."

With Byk-P 4200, the company says that it has developed an additive that uses the concept of an entrainer but simplifies the process. The granulated additive is based on a polypropylene carrier and can be added to the extrusion process with relative ease, like a masterbatch, via the main feed or a side feeder. It affects two steps of the extrusion process.

In the first step, the active substance is released during processing by shear and heat in the melt and finely distributed. This results in an intensive exchange between the entrainer additive and the polymer matrix, with the pressure build-up in the process preventing the additive from expanding prematurely. In the second step, the entrainer additive evaporates in the vacuum degassing zone resulting in foaming of the polymer melt. Gas bubbles are formed, which in turn create a large inner surface (phase boundary). Byk says the entrainer significantly reduces the solubility of the volatile components, which can then be extracted during degassing.

Proven results

Byk says it has carried out experimental trials that have determined a significant reduction in odour and VOC in unfilled and talc-filled PP compounds using the additive. In the first, a polypropylene homopolymer with an MVR of 25 cm³/10 min (2.16 kg) was processed on a twin screw extruder (KraussMaffei ZE 25 UT). Vacuum was applied, zeolites were added as an adsorber and BYK-P 4200 was also added to reduce odour and VOCs. At the end of the extrusion process, degassing was carried out via vacuum degassing at approximately 50 mbar. The process was consistently kept at a speed of 600rpm and a throughput of 25kg.

In a second example, 40% of Luzenac 1445 type

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Pressure build-up in the extrusion process leads to degassing of undesirable VOCs during processing

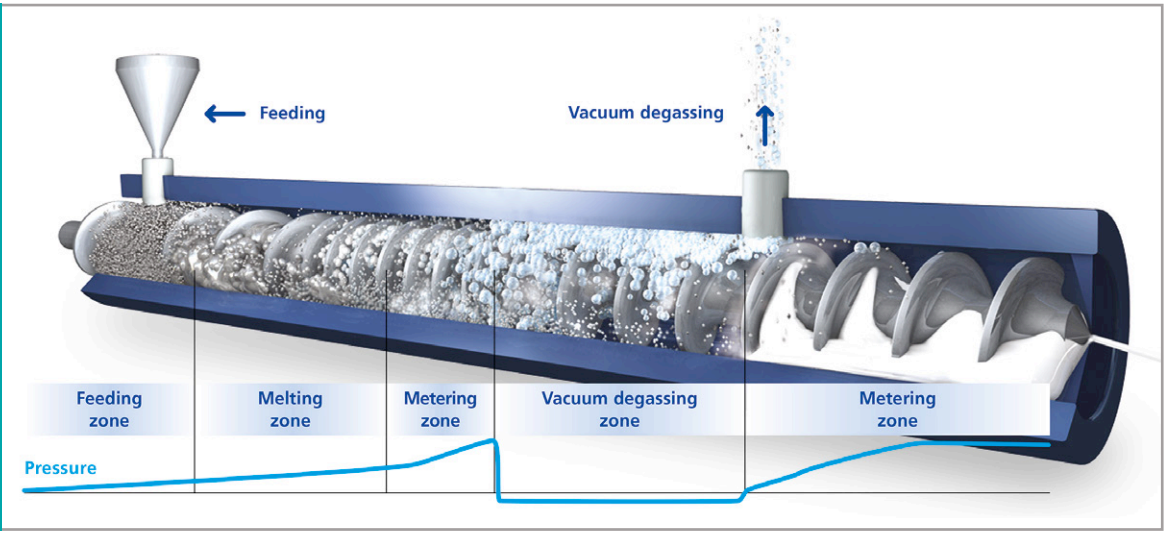

Image: Byk

talc was directly dosed into the melt of the same PP via a side feeder. In this case, the additive was incorporated together with the filler. In addition to vacuum degassing at the end of the extrusion process, atmospheric degassing was applied upstream at the inlet point of the talc.

Sweden's **Nexam Chemical** has developed two odour neutralising products, which it is offering in masterbatch form to enable recycling of polyolefin materials. Nexamod OS01 is an odour scavenging masterbatch designed for use in a wide range of polymer recycling applications, including post-consumer. Typical dosing levels range from 3-10%, with the company claiming a 5% loading in rHDPE improving the olefactory profile from 5.0 to 2.5 on the VDA 270 test scale. Nexamod OS02 offers similar performance but incorporates an antioxidant. Both products are suitable for food contact applications.

Sensitive solutions

Austrian masterbatch specialist **Gabriel-Chemie** says it has developed a solution that focuses on the odours and emissions of sensitive plastic products. "In sensitive products, such as mineral water bottles and caps for example, a consumer would immediately detect a flavour impairment caused by the packaging," says Mark Hannah, Head of Corporate Marketing. "This could lead to consumer complaints and result in product recalls or, in the worst-case scenario, damage to the public reputation of the brand. It is often hard to trace in which part of the value chain the problem was caused – beginning with the raw materials and ending at the consumer."

It developed its PURE service package in combination with plastics converters and leading brands within the food and beverage industry, It is based on two test methods – recognised as standards within the industry – for testing of incoming and outgoing products.

"There is NIAS [Non-Intentionally Added Substance] analysis of incoming raw materials using our in-house headspace gas chromatograph and, where necessary, mass spectrometer," says Hannah. "We have built up a database of molecules that could potentially cause taste or odour impairment together with Fraunhofer IVV and scan incoming raw materials for these molecules. Potential problems can be identified before the raw materials are processed."

With the latest gas chromatography, Gabriel-Chemie says that it is able to test all materials for the presence of volatile, organoleptically relevant NIAS. Concentrations of non-approved substances that are noteworthy in the chromatogram are analysed by means of mass spectrometry. Should a suspicious substance be relevant to the risk assessment, the raw material that led to the introduction of the substance is determined and alternative raw materials are tested. Once all concentrations are below the substance-specific, organoleptically relevant concentration, a certificate including a detailed analysis is issued.

›

IMAGE: GABRIEL-CHEMIE

Below: Gabriel-Chemie's PURE concept aims to tackle both odour and flavour contamination

IMAGE: GABRIEL-CHEMIE

Right: Organoleptic assessment by trained sensory experts is part of the Gabriel-Chemie PURE programme

Expert assessment

The masterbatch is also organoleptically assessed. "Using our specially trained in-house panel of sensory experts, three-way blind testing is carried out on water samples that have been exposed to our masterbatch," Hannah says. "This enables potential taste and odour issues to be identified in our final product."

After successfully passing the NIAS-Evaluation, various raw materials are used to manufacture masterbatch in the test laboratory, from which injection moulded parts are produced. A specially trained sensory panel examines and assesses the injection moulded parts in a complex organoleptic evaluation process lasting several hours. The samples are stored in selected reference liquids, such as still water from a standardised brand, and blind testing is carried out to check for flavour deviations. As a result, processors receive a detailed test report and profile in which the organoleptic suitability of the products is documented. The company says that the initial professional training and certification of the testers, regular development workshops, and the minimum size of the panel, means the testing is recognised as being a relevant and significant industry test method.

"In addition to these two tests, we also provide an SML [specific migration limit] estimate," says Hannah. "We can provide our customers with additional details about the substances in our masterbatch that have the potential to migrate. Customers can then accurately estimate the potential migration in their end products and ensure that this is below the required regulatory threshold."

Gabriel-Chemie says that it aims to keep the number of substances with SML in products as low as possible. However, their presence cannot always be avoided. In order to develop a rough overview of the quantities to be expected, an estimate of concentrations of SML-regulated additives is established in products through cooperation with suppliers. The company says the concentration information supplied goes above and beyond the legal obligation and facilitates easier analysis for customers, which can save both time and money. The analysis includes applicable specific limit values and the maximum permissible quantity that may migrate into food according to the standard method of risk assessment for each substance.

Below: Tosaf claims its emission-optimised masterbatches for POM significantly reduce formaldehyde emissions

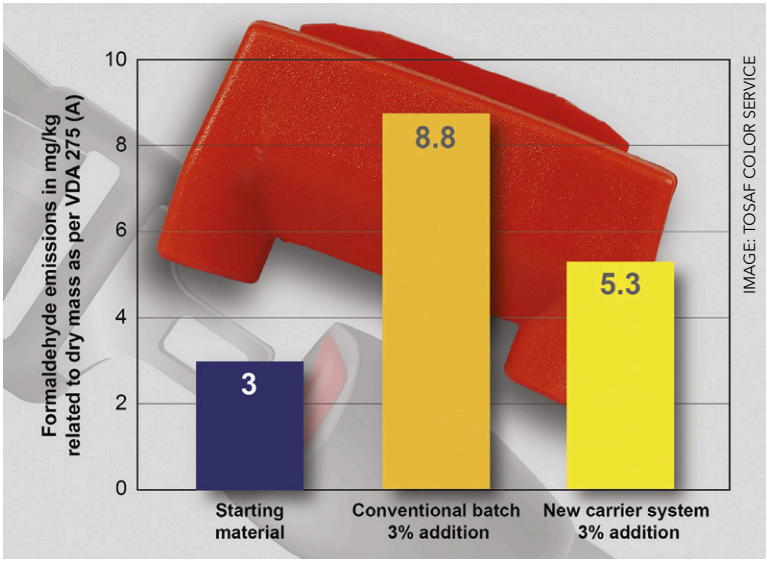

IMAGE: TOSAF COLOR SERVICE

Targeting automotive

Another masterbatch producer responding to demands for lower emissions is **Tosaf**, although the latest developments from its Color Service division are masterbatches aimed primarily at POM applications in the automotive and appliance industries. According to the company, colour masterbatches based on its latest low emission carrier and pigment selection meet the strictest automotive specifications and are suitable for use with all POM grades.

According to the company, tests carried out at an independent institute show that switching from a conventional masterbatch to one formulated using its optimised component materials resulted in a formaldehyde release reduction from 8.8ppm to less than 6ppm.

"Our new low-emission grades are gaining a growing number of authorisations and are also registering the first series applications for car interiors," says Sales Manager Andreas Kruschinski. "Schauenburg Industrietechnik is one of our pilot customers in this area. In addition, we are experiencing growing demand in all typical POM applications in a wide variety of industries."

Tosaf's low-emission POM masterbatches

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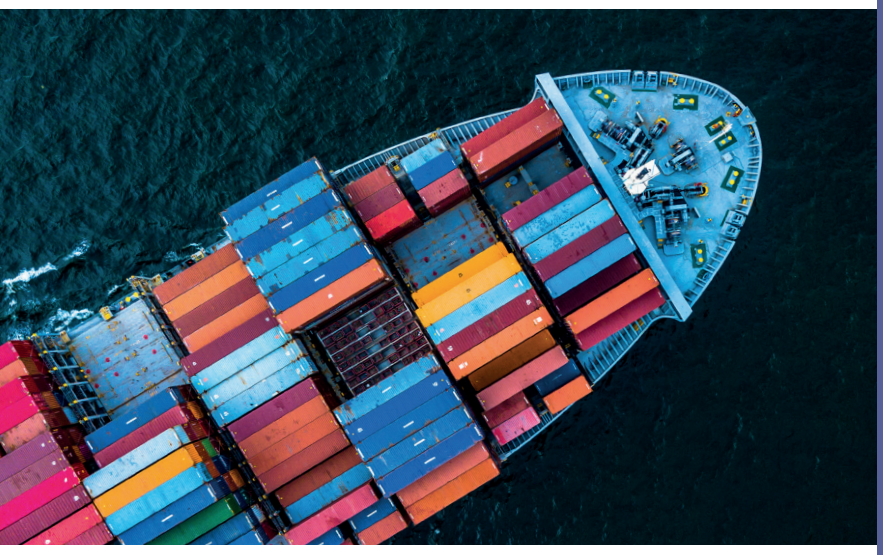

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include standard and customised colors as well as functional and combination packages containing lubricants and UV or heat stabiliers. Typical applications include automotive interior and exterior parts, conveying and gear components, and parts for use in small and large appliances.

Instrumented analysis

Alongside the increasing use of recycled plastics comes a need for fast, reliable and safe means to control emissions and odours, according to **Alpha MOS**, which manufactures analytical instruments for sensory analysis. "In addition, because off-odours are usually caused by trace-level compounds, the analytical technique should show enough sensitivity to be able to detect these molecules at low concentrations," says Marion Bonnefille, Marketing and Communications Manager at the company.

"Analytical times are also an issue. Methods relying on human panel testing are often time-consuming, with long sample preparation phases. In times of Covid, it is even more challenging to gather human panellists together for test sessions. Plastics manufacturers are increasingly turning to analytical techniques that allow assessment of materials without long preparation times to achieve faster results," she says.

"Polymer producers regularly contact us about the need to control the odour quality of the resins and plastic pellets they manufacture. Ensuring that the plastic raw materials are free of any unpleasant odour remains the major concern for the industry, particularly for those involved in the production of food grade packaging," Bonnefille says.

To improve the performance of its solutions, Alpha MOS relies on expertise in data processing and artificial intelligence. "An accurate, sensitive and reproducible measurement of odorous compounds coupled with powerful data processing, allows reliable control of odours in plastics," says Bonnefille. "We have been developing a new and patented data processing method for quality control applications, still based on multivariate statistics, that considers the whole chromatography profile instead of the major peaks separately. In simple terms, this model achieves better tracking of chemical and sensory defects that can occur during plastic pellets production. It is designed for industry users who need to make fast PASS/FAIL decisions."

IMAGE: ALPHA MOS

The Heracles 'electronic nose' from Alpha MOS uses fast GC to automate volatiles analysis

Electronic nose

Alpha MOS says that its Heracles "electronic nose" – which is based on fast gas chromatography technology – detects and analyses volatile compounds emitted by polymers and packaging materials without needing any sample preparation. A small amount of material is weighed in a vial, which is then sealed and heated in the autosampler oven to generate the headspace providing volatile compounds emanating from the product.

A fraction of this headspace is collected through a syringe by the autosampler and injected into the two chromatography columns of the electronic nose after pre-concentration in an embedded trap. The chromatographic data can be processed as a comprehensive odour fingerprint to compare several samples or assess the overall odour conformity against accepted quality standards. Additionally, the chromatograms allow the investigation of the nature of the volatile compounds involved, to explain off-odours or defects, or explain differences.

IMAGE: ALPHA MOS

Below: An Alpha MOS Heracles testing system set up with automated sampler and data station

Using this electronic nose, the company says packaging material can be evaluated in a matter of minutes instead of several days with a panel test. Analytical throughput is high because the instrument is available 24/7. Moreover, the method raises no health or safety issues since no human testing is involved. The instrument also helps identify the molecules entering the chemical composition of the headspace, whereas a sensory panel cannot do this easily.

Most importantly, an instrumented method delivers objective and repeatable evaluation. Aplha MOS says that sensory panel results can lack repeatability due to possible internal variability, as well as the influence of the assessors' mood, state of health or fatigue. The company says it is also difficult to maintain the constant performance of a panel over time: regular training and benchmarking is needed, and results can be influenced by turnover of panel members. The Heracles instrument is claimed to ensure long-term repeatability, without any drift over time.

Using its e-nose and the e-tongue, Alpha MOS has been running studies on the flavour and taste of milk stored in different types of packaging. "This study proved that in one of the packaging samples, the odour and taste of milk stayed much more stable over time than in other ones, while in others many more volatile organic compounds developed," says Bonnefille. "These results allowed the selection of the most suitable type of packaging to preserve milk sensory quality."

Another study focused on a company producing plastic films used for packaging beverages. It aimed to control the odour of films obtained from recycled materials sourced from household waste. The producer wanted to evaluate the recycling process efficiency in removing odours. "The Heracles e-nose was able to provide a quality control tool to determine whether the recycled plastics were conformant or not, based on human panel classification. In addition, the use of the AroChemBase library of chemical compounds and corresponding sensory attributes, allowed the identification of the main molecules responsible for off-odours," Bonnefille says.

IMAGE: FRAUNHOFER IVV

Above: Fraunhofer IVV identified more than 60 odourous substances in plastic sourced from different recycling collection systems in Germany

Addressing future developments, Alpha MOS plans to work on a simpler version of the electronic nose that will show greater robustness and the highest level of consistency when switching between instruments. The aim is to create a solution for global groups needing to ensure consistent quality across different production sites.

Studying waste

As part of a collaborative recycling study conducted with the Chair of Aroma and Smell Research at the Friedrich-Alexander-Universität Erlangen-Nürnberg in Germany and the University of Alicante in Spain, Germany's **Fraunhofer IVV** (Institute for Process Engineering and Packaging) has analysed the sensory properties of post-consumer recycled bags made of LDPE originating from several different collection systems.

Plastics recyclates produced from waste packaging need to meet high sensory requirements to be

IMAGE: AIMPLAS

Above: Researchers at Aimplas hope to develop microorganisms to eliminate odour from waste dairy packaging

used for new products. However, they often exhibit an intense smell, which can be traced back to high contamination of the input material. Elucidation of these off-odours can be extremely challenging. Fraunhofer IVV says that more than 60 odorous substances were identified in its study, using combined chemo-analytical methods, and the information gained will provide a targeted strategy for avoiding off-odours.

Recyclates must have no off-odours if they are to be used as secondary raw materials for the manufacture of high-quality consumer products (necessary to meet the targets of the EU Packaging and Packaging Waste Directive). However, off-odours often prevent a closed cycle for the recycling of plastics packaging materials, particularly in the case of polyolefins.

The Department of Sensory Analytics at Fraunhofer IVV characterises off-odours to help optimise plastics and recyclates. A number of studies concerning odorants in HDPE waste and the recyclates produced from packaging of body care products and detergents have already been conducted. Using various collection systems as part of the current study on post-consumer LDPE bags allows the effect of the collection strategy on the sensory impairment of the waste to be investigated.

Fraunhofer IVV says that identification of the substances causing off-odours is an essential step toward determining measures for odour optimisation. Most of the odorants identified in the study were typical metabolites of microorganisms and many had a cheese-like or faeces-like odour. The odorants included carboxylic acids and sulphur and nitrogen-containing components. Their chemical structures give key insights into their origin and this information can help to identify the pathways into the packaging waste and on via the recycling process into the recyclate. This is of value to system designers as, depending on the specific process steps, targeted measures can be formulated to remove or reduce odorants and/or avoid the formation of new odorants.

Collection matters

The study showed that the way packaging waste is collected has a large bearing on the odour quality of post-consumer LDPE bags. There are significant benefits through the use of Germany's yellow bag separate collection system – the preferred collection method across the country. Waste collected in this way was found to have a significantly lower overall odour. In contrast, the waste fraction collected from general household waste had more intense odours – the higher organic fraction in the general waste favours formation of microbial degradation products. The study also demonstrated that washing the post-consumer LDPE bags from the separate collection system at 60°C on a laboratory scale led to detection of fewer odorants and a reduced overall odour compared to unwashed bags.

Scientists in the Department of Sensory Analytics at Fraunhofer IVV used a combinatory sensory approach to identify the odours. Sensory evaluation of the sample materials was first undertaken by a trained sensory panel, with odorants then identified using comprehensive chemo-analytical methods such as two-dimensional gas chromatography-olfactometry coupled with mass spectrometry. This enabled the chemical structures to be determined and from that the possible formation pathways and sources of the odorants to be identified. These findings will now be used to develop customised solutions for optimisation of the odour of plastic recyclates, starting at the waste collection stage.

Odour in recycled plastics is also one of the targets of the Enzplast programme, which is underway at the Spanish **Aimplas** technical institute. Part of the two-stage project, which is funded by the EU through the Valencia regional authority's ERDF programme, aims to develop a means to exploit microorganisms capable of eliminating odour from dairy packaging waste. According to Aimplas, early results indicate a significant reduction in odour intensity.

CLICK ON THE LINKS FOR MORE INFORMATION:

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- **www.nexamchemical.com**
- **www.gabriel-chemie.com**
- **www.color-service.de (Tosaf)**
- **www.alpha-mos.com**
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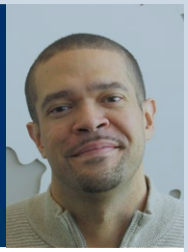

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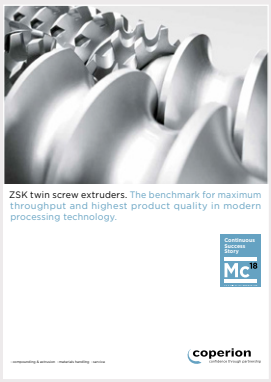
COPERION: ZSK EXTRUDERS



Described as the benchmark for maximum throughput and product quality, the ZSK is Coperion's most flexible and highest performance twin screw extruder series. This 26-page brochure explains the design features and options.

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BUSS: COMPEO KNEADER

The Compeo is the latest generation of kneader extruder from Buss and is designed to provide the utmost flexibility in application. This 12-page brochure details key features and model specifications.

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LEISTRITZ: MASTERBATCH SYSTEMS

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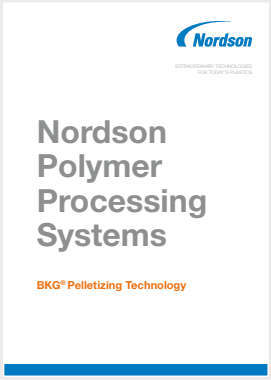
NORDSON: BKG PELLETISERS



The BKG range of pelletisers from Nordson Polymer Processing Technology includes underwater, water-ring and strand systems suitable for almost any thermoplastic pelletising application. Find out more in this six-page brochure.

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STRUKTOL: CREATIVE RECYCLING

Struktol offers a full range of additives to enhance performance of recycled compounds. This brochure details its extensive range of lubricants, PP viscosity modifiers, homogenisers and odour control products.

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If you would like your brochure to be included on this page, please contact Claire Bishop claire.bishop@ami.international. Tel: +44 (0)1732 682948

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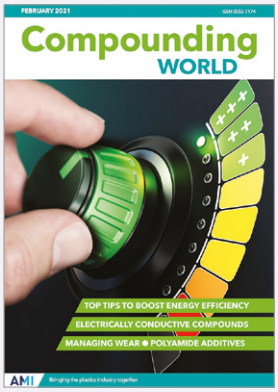

Compounding World February 2021
The February issue of Compounding World provides tips from experts on saving energy in compound production, plus wear management and the latest electrically conductive additives and polyamide developments.

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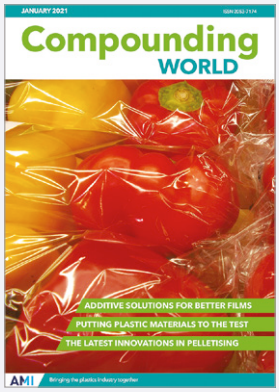

Compounding World January 2021
The first 2021 edition of Compounding World magazine looks at the latest additive developments for film production. It also explores the latest pelletising technologies and reviews new materials testing options.

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Injection World January/February 2021
The January-February issue of Injection World investigates the increase in demand for medical plastics during the Covid-19 pandemic. Plus the latest in thermoplastic composites and new granulator technology for injection moulders.

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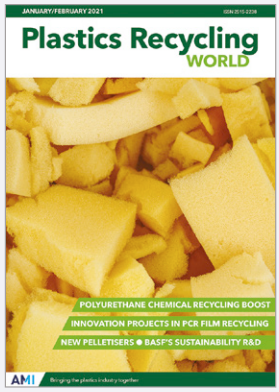

Plastics Recycling World January/February 2021
The January/February edition of Plastics Recycling World looks at how chemical recycling technology could be utilised to recycle polyurethane foams. It also explores some of the latest developments in post-consumer film recycling and pelletising equipment.

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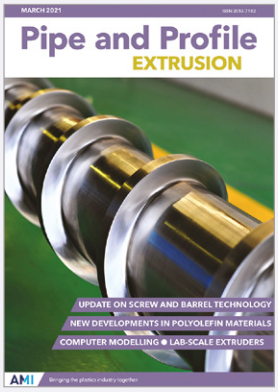

Pipe and Profile March 2021
The March edition of Pipe and Profile Extrusion takes a look at new solutions for extending extrusion screw and barrel lifetimes. It also reviews some of the latest polyolefin pipe applications, laboratory extrusion systems and process modelling software.

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Film and Sheet January/February 2021
The January/February 2021 edition of Film and Sheet Extrusion looks at how some polymer industry players have stepped up to take on the Covid pandemic. It also examines development in bioplastics, polyolefins and materials testing technology.

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GLOBAL EXHIBITION GUIDE

2021

22-26 March	Plastico Brasil, Sao Paulo, Brazil **POSTPONED**	www.plasticobrasil.com.br
23-25 March	ChemPlast Expo, Madrid, Spain **POSTPONED**	www.chemplastexpo.com
13-16 April	Chinaplas 2021, Shenzhen, China	www.chinaplasonline.com
17-21 May	NPE 2021 **CANCELLED**	www.npe.org
1-3 June	JEC 2021, Paris France **POSTPONED**	www.jec-world.events
8-11 June	Moulding Expo, Stuttgart, Germany	www.moulding-expo.de
15-18 June	FIP, Lyon, France **POSTPONED**	www.f-i-p.com
22-25 June	Plast 2021, Milan, Italy **POSTPONED**	www.plastonline.org/en
22-25 June	Colombiaplast, Bogota, Colombia **NEW DATE**	www.colombiaplast.org
10-12 August	Feiplar, Sao Paulo, Brazil **NEW DATE**	www.feiplar.com.br
13-17 September	Plastex, Brno, Czech Republic **POSTPONED**	www.bvv.cz/en/plastex/
12-16 October	Fakuma, Friedrichshafen, Germany	www.fakuma-messe.de
14-18 September	Equiplast, Barcelona, Spain **NEW DATE**	www.equiplast.com
29-30 September	Compounding World Expo Europe, Essen, Germany **NEW DATE**	www.compoundingworldexpo.com/eu/
3-4 November	Compounding World Expo USA, Cleveland, USA **NEW DATE**	www.compoundingworldexpo.com/na/
8-12 November	Plastico Brasil, Sao Paulo, Brazil **NEW DATE**	www.plasticobrasil.com.br
15-18 November	Arabplast, Dubai, UAE **NEW DATE**	www.arabplast.info

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16-18 March	Functional Fillers **VIRTUAL SUMMIT**
20-22 April	PVC Formulation North America **VIRTUAL SUMMIT**
26-29 April	Thermoplastic Concentrates and Masterbatch **VIRTUAL SUMMIT**
4-6 May	Fire retardants in Plastics **VIRTUAL SUMMIT**
22-24 June	Polymers in Cables **VIRTUAL SUMMIT**

For information on all these events and other conferences on film, sheet, pipe and packaging applications, see
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PLASTICS RECYCLING WORLD EXPO

POLYMER TESTING WORLD EXPO

29 - 30 September, 2021
ESSEN, GERMANY

PLASTICS EXTRUSION WORLD EXPO

COMPOUNDING WORLD EXPO

3 - 4 November, 2021
CLEVELAND, OHIO

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