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SHOW PREVIEW ISSUE

Coverage Starts on p. 14

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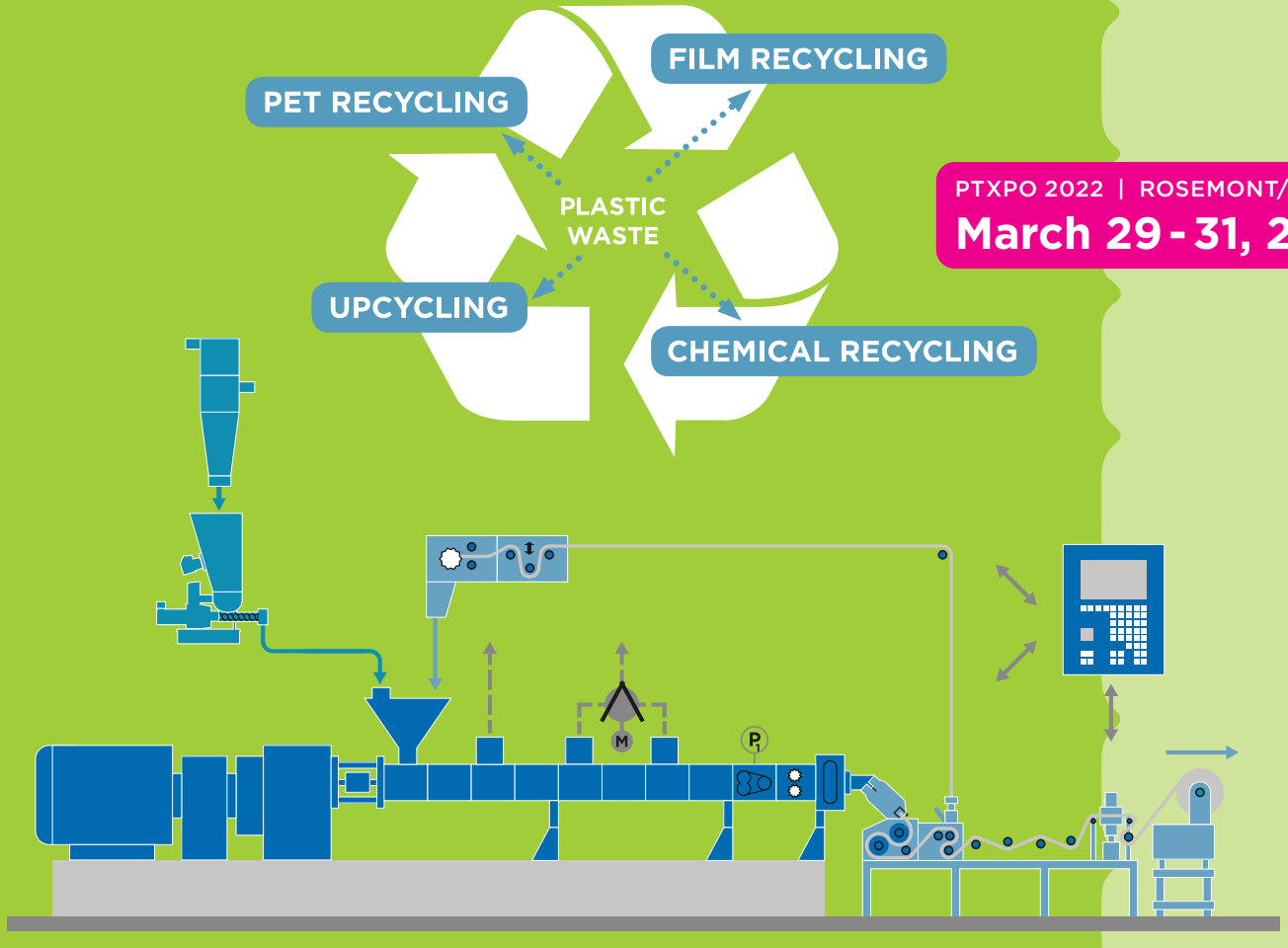

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PT Plastics Technology

On-Site

Ray Products Focuses on Pressure Forming for Crisp Aesthetics, Part-to-Part Repeatability

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By Lilli Manolis Sherman, Senior Editor

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By Adam Dreiblatt, CPM Extrusion Group

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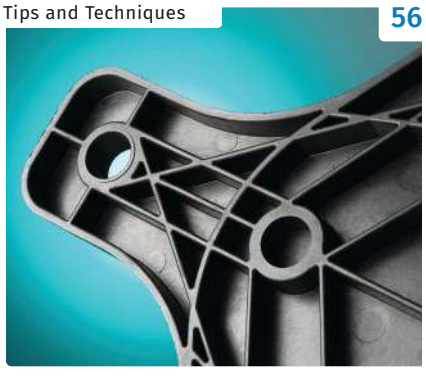
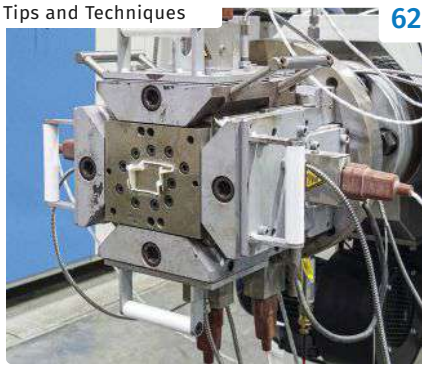


Part 2: The Long and Short of It—Tips for Molding Short-Fiber Reinforced Polymers

Following on a similar guide for long-fiber reinforced compounds, here are practical tips on designing and injection molding parts utilizing short-fiber reinforcements.

By Zachary Alderman, Avient Corp.

Tips and Techniques



Is Your Profile Die the Problem? Or Is It the Heaters?

When a profile is not being extruded to the tolerances of previous runs, the die is often suspect—but the real problem may be the heaters. Learn the five heater-band principles before you do any profile die work.

By Tim Groth, Extrusion Solutions North LLC

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Computed Tomography in Metrology: Measure Quickly and Accurately

Wednesday, April 13th @11:00 AM ET

PRESENTED BY: ZEISS Seeing beyond

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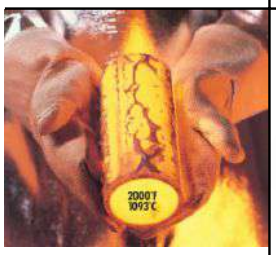 SUPER HOT	 LEATHER PALM	 DOUBLE PALM	 STANDARD 24 OZ.	 GRIPPY GLOVES
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Curtain to Rise This Month on PTXPO

It's showtime, folks. Register now for the first-ever PTXPO and check out our coverage in this issue of new technology that will be on display March 29-31 in Rosemont, Ill.

Have you registered yet to attend the inaugural Plastics Technology Expo? Let me make it easy on you: Point your smartphone camera at the QR code on this page and it will direct you right to the registration page.

Jim Callari
Editorial Director

But please don't dawdle. The first-ever PTXPO is taking place later this month—March 29-31—at the Donald E. Stephens Convention Center in Rosemont, Ill. Supported by research among our subscribers, this event connects buyers and sellers across the entire North American plastics-processing, mold-manufacturing and 3D-printing industries. Thousands of attendees from shop floors to front offices across North America will be represented at the expo.

Exhibitors and attendees will have the opportunity to meet and connect with the entire supply-chain ecosystem, including manufacturing managers, supervisors, engineers, and technicians, as well as engineers and technical managers at OEMs and brand owners.

PTXPO
PLASTICS TECHNOLOGY EXPO 2022

Over the past few months, we have signed up trade groups to help urge their members to attend or exhibit. These include the Plastics Industry Association (PLASTICS), the Manufacturers' Association for Plastics Processors (MAPP), the American Mold Builders Association (AMBA), the Canadian Association of Moldmakers (CAMM), the Society of Plastics Engineers (SPE) Extrusion Division and Chicago Section.

The exhibit area at PTXPO is organized into pavilions for major process and product categories, making it easy for you to plan your show experience and find the technology that's right for you. Separate exhibit areas are devoted to molding, extrusion, auxiliary equipment, recycling, 3D printing/additive manufacturing, moldmaking and materials.

There are also educational opportunities for attendees right on the show floor. There will be live demonstrations of machinery in action at several booths, as well as a series of "Tech Talks" on plastics processing and moldmaking.

When was the last time you walked a trade show, saw what was new on a first-hand basis, met and engaged with your suppliers? It's time.

We began our pre-show coverage of PTXPO in the February issue (see Keeping Up with Technology section). In this month's issue, if you turn to p. 14, you'll get a preview of new technology you will be seeing in injection molding. There is also a schedule of live demos (p. 16) and Tech Talk presentations (p. 18). In this month's Keeping Up section, beginning on p. 64, you'll see new products in extrusion, compounding, auxiliary equipment, and more—identified by the PTXPO logo.

Scan to register for PTXPO.

These are busy times for our industry. Opportunities beckon as OEMs and brand owners are looking hard at shortening their supply chains. That could mean more projects for you. And when was the last time you walked a trade show, saw what was new on a first-hand basis, met and engaged with your suppliers? It's time. PT

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Plastics Technology's 2022 Top Shops Benchmarking Survey Now Open

Plastics Technology magazine and its publisher, Gardner Business Media, have opened up their annual Top Shops Benchmarking survey of injection molders. Responses to the online survey will be accepted until March 31, 2022. Results from the free, anonymous survey will be reported in the October 2022 issue of *Plastics Technology*, and molders who complete the questionnaire will receive a customized report compiled by Gardner Business Media's Gardner Intelligence unit. These reports will show the participants how their facility ranked against the collective survey results.

Now in its sixth year, the benchmarking survey of injection molders queries participants on demographic data, performance indicators, and business and process strategies. A selection of those performance metrics are then scored, with the highest scoring companies named Top Shops for 2022 based on their 2021 operations.

Those Top Shops can then opt to be included in the October 2022 *Plastics Technology* article highlighting their performance and summarizing results of the survey. The survey is available online (***research.net/r/MWNFL8H***) and need not be completed in one sitting. The survey will be open until March 31, 2022.

Tool Storage and Handling System Supplier Names Globeius as North American Distributor

Rack-Storage Ltd., an English supplier of racking systems for heavy-duty and light-duty tool storage and handling, has named Globeius Inc. as its exclusive distributor in North America. The custom-designed storage systems are available in various widths and heights. Individual pull-out racks accept unit loads up to 4,400 lb, or 22,000 lb with electric actuator.

Globeius says a properly designed storage system can help an injection molder realize significant financial benefits through space efficiency and reduced mold-change times, while opening up the possibility of eliminating wood pallets and forklifts. Taking a recent customer as an example, Globeius reported that a Pull-Out Racking and Storage system allowed this injection molder to store more than 4,000 tools of varying sizes, including 30 molds in a 6-ft² space, and eliminated forklifts from the shop floor.

Arkema to Boost Production of Pebax TPEs

Through an investment at its plant in Serquigny, France, Arkema plans to increase its global manufacturing capacity for Pebax polyether-block-amide TPEs by approximately 25% to meet increased market demand in sports and consumer goods. This investment will also enable increased production of the partially biobased Pebax Rnew (from castor oil), as well as standard Pebax grades.

This new capacity, due on stream in mid-2023, will produce a variety of highly specialized grades for soles of running shoes, ski boots and technical textiles, as well as smartphones, flexible screens and medical equipment.

NatureWorks to Open New Headquarters and Advanced Biopolymers R&D Facility

Biopolymer producer NatureWorks will open a new headquarters and advanced R&D facility in Plymouth, Minn., in 2024. The company says this is in response to rapid growth in the market for sustainable biomaterials. The new R&D center's laboratory will support research into the full circular lifecyle of Ingeo PLA biopolymers from next-generation fermentation technology to new applications, to resins with increased functionality. The same year the new facility is due to open, NatureWorks will bring on stream a 165-million-lb, fully integrated Ingeo PLA manufacturing complex in Thailand.

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Honeywell and Avangard to Build Advanced Recycling Plant in Texas

Honeywell and recycler Avangard Innovative will partner in building an advanced recycling plant in Texas. The facility will use Honeywell's recently announced UpCycle Process Technology to transform end-of-life plastic waste into polymer feedstock that can be used to create new plastics.

Houston-based Avangard Innovative is the largest plastics recycler in the Americas and will be the first to deploy the UpCycle Process Technology in the U.S. Honeywell and Avangard intend to form a joint venture to co-own and operate a facility within Avangard's NaturaPCR complex in Waller, Texas. The plant is expected to transform 66 million lb/yr of mixed plastics waste into recycled polymer feedstock. Production is anticipated to begin in 2023.

"The UpCycle Process Technology expands the types of plastics that can be recycled to include waste plastic that would otherwise go unrecycled," says Vimal Kapur, president and CEO of Honeywell Performance Materials and Technologies.

Honeywell recently announced that it would form a joint venture with Sacyr to build a 66-million-lb/yr UpCycle advanced recycling plant in Andalucía, Spain.

Ensinger Acquires Ineos Styrolution's StyLight Thermoplastic Composite Business

Germany's Ensinger Group (U.S. office in Anaheim, Calif.) has acquired the StyLight thermoplastic composite business from Ineos Styrolution. The acquisition adds an exclusive SAN-based product range to Ensinger's comprehensive thermoplastic composite portfolio. SAN based composites with carbon, glass and natural (flax) fibers can have applications in aesthetic, semi-structural and overmolding applications.

Ineos Styrolution launched StyLight in 2016. Ensinger has renamed StyLight to its Tecatec thermoplastic composite materials brand.

Rethinking the Radiator Grille: Award-Winning Part Combines Processes

Electrification of vehicles has allowed OEMs to make dramatic changes to more than just drivetrains as the functional requirements of battery-operated vehicles allow long-standing components to be reimagined.

In the case of BMW, its conversion of a traditional radiator grille into a multi-functional "badge" for the iX sport utility garnered the 2021 Grand Award from the International Society for Plastics Technology (SPE Central Europe).

Molded in a cleanroom atmosphere, the kidney-shaped badge serves an obvious cosmetic function; but on a functional basis, it also protects cameras and several sensors for assisted driving and future autonomous operation.

Produced in an integrated process, the component consists of a functional film that is back-molded with PC and then flood-coated with clear, scratch-resistant liquid PUR through a combination of technologies offered under Engel's clearmelt portfolio.

While this suite of technologies has previously been applied to interior components, the BMW iX's badge marks the first commercial use of back-injected film with PUR flood coating on functional exterior components, which are subject to greater environmental stresses.

Engel acted as the system supplier for the project, responsible for the complete production cell at BMW's Landshut, Germany, production campus. The cell is built around an Engel duo Combi M injection molding machine with a horizontal rotary table. Two large articulated robot arms handle the films and molded parts. Other components are a film-cleaning system, inline QC station, and a two-component PUR metering/dispensing system from Hennecke.

The molding machine's clamping unit and the robots are enclosed in an ISO Class 7 cleanroom more than 6 meters (20 ft) long and over 4 meters (13 ft) high, supplied by Petek Reinraumtechnik of Germany. Engel notes that the cleanroom environment is necessary to avoid any dust on surfaces, which would be visible under the high-gloss PUR coating.

When it comes time to change the mold or do any other work in the clamp area, a sliding ceiling in the cleanroom enclosure above the clamping unit opens up, allowing access to the tool. Within the cleanroom space, all process steps are fully automated, including unpacking the films, inserting films into the tool, and part removal. Adjoining the cleanroom is an ISO Class 8 greyroom, which acts as a work area for personnel to transfer the functional films, which are enclosed in airtight boxes, into the cleanroom, as well as transfer packed parts for downstream processing.

When Engel began quoting the first-of-its-kind cell to the automaker, it didn't have an existing real-world system to show how it would function, so it turned to virtual reality. Engel created a 3D simulation of the production cell to show BMW how the machine and robots would interact and to help assess ergonomic and other aspects of production, before construction of the cell began.

Vertellus Acquires Polyscope Polymers

Indianapolis-based Vertellus has acquired The Netherlands' Polyscope Polymers B.V. (U.S. office in Novi, Mich.), a global leader in SMA copolymers for applications ranging from automotive and electronics to specialty coatings and inks. With the addition of Polyscope's complementary product portfolio and manufacturing capabilities, Vertellus supplements its current slate of proprietary multi-purpose modifiers, compatibilizers and chain extenders for virgin and recycled thermoplastics.

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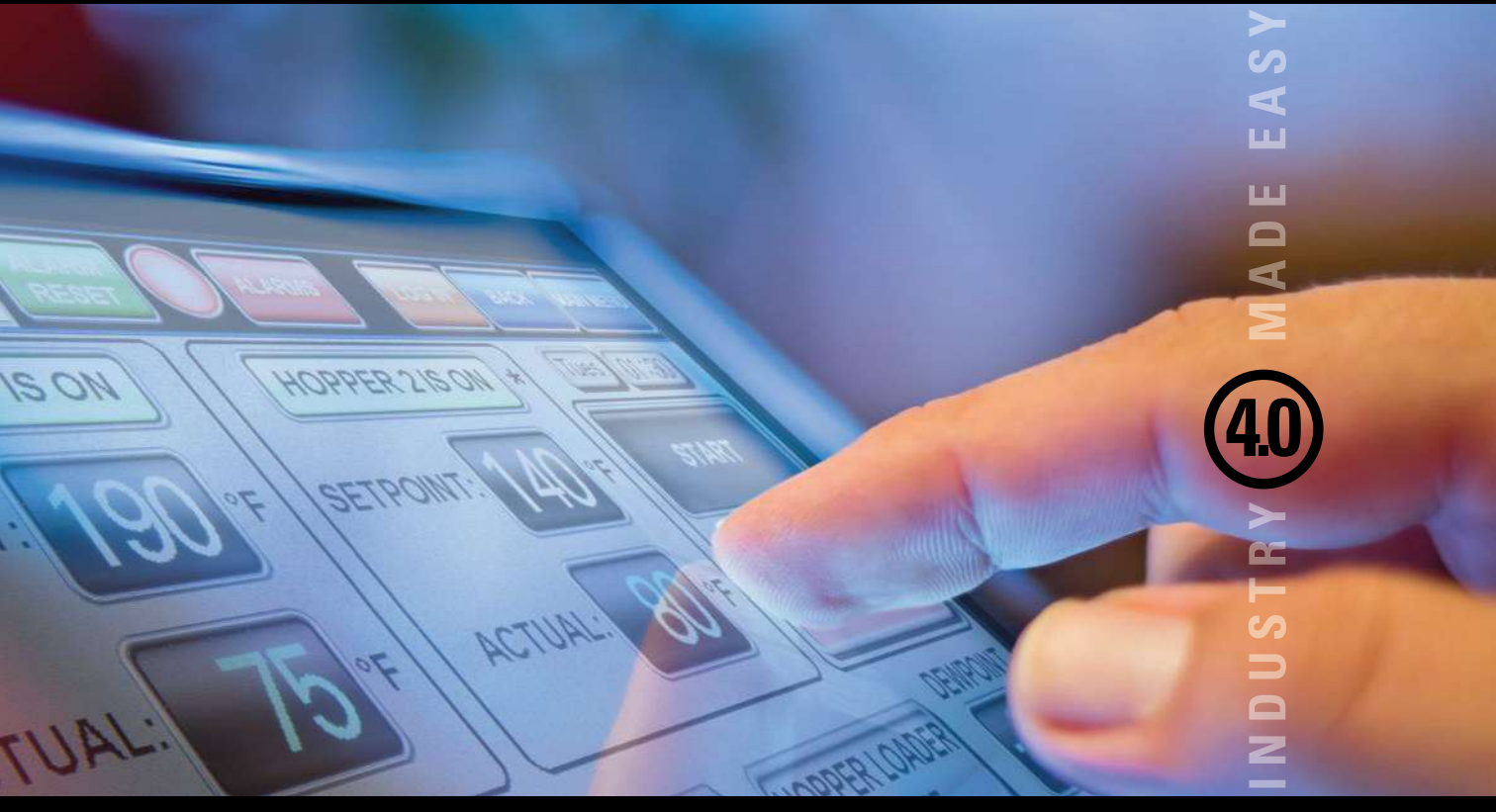

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Packaging Project Combines Thin Walls, Recycled Content and High Speeds

The Thin Wall Integra project combines the technical acumen of Arburg France; Collomb, a French toolmaker focused on thin-walled containers; Pagès Group, a packaging robotics expert; in-mold label (IML) maker Verstraete; material-handling equipment supplier Koch-Technik; and the resin maker Borealis.

The result, first unveiled last November and shown at a January open house at Collomb, is fully automated molding of a thin-wall IML bucket in a 5-sec cycle from a 290-metric-ton hybrid Allrounder 720 H in a packaging version, running a single-cavity mold. The finished container contains 55% post-consumer recycled material, and thinning the walls to just 0.63 mm with a new design enables material savings of up to 35%.

The injection molding machine was optimized for the fastest possible cycle, and the robotic system's movements were streamlined for high speeds. A side-entry robot with a telescopic arm engages from the rear side of the machine to load the mold with the IML labels. The robot then removes and stacks the labeled buckets, and those stacks are then automatically picked up by another robot for palletizing. The Verstraete labels utilize "HolyGrail 2.0" technology, a low-visibility barcode that makes it easier to identify the resin type for recycling.

Borealis described to *Plastics Technology* the material the company provided—UJ599MO-90—as a compounded polyolefin containing 55% PCR. It has a 70 MFR and is colored white. Part of the container's design is an integrated geometric pattern, which both increases compression strength and limits the vacuum effect when pails are nested by allowing air flow.

Hemp Supplier Heartland & Recycler Ravago in Joint-Development Venture

Industrial hemp materials supplier Heartland Industries and Ravago Americas, one of the world's largest plastic recyclers, compounders and distributors, have formed a joint development effort to help large-volume plastics users reduce cost, weight, and carbon footprint with the aid of Heartland's hemp-based additives.

As previously reported, Heartland is building what it calls America's "first reliable industrial hemp supply chain" to provide additives for manufacturers that use plastics. These additives, supplied as powders or pellets, include hemp fibers and fillers based on the woody cellulose core of the hemp plant. Heartland estimates that its new facility in Holland, Mich., will be able to process over 1 million lb/yr of hemp additives for compounding.

Ravago and Heartland will continue to research and develop products to serve automotive, packaging, building materials, and other markets. With these carbon-negative and renewable additives, Ravago reportedly can offer compounds that are stronger, lighter, cheaper, and more sustainable, along with offering enhanced thermal and acoustic properties.

Heartland is focused on replacing compounds with mineral fillers like talc and calcium carbonate. Heartland works mainly with PP, PE, ABS, nylon 6, PVC, and rubber. There are also small applications in bioresins like PLA, PHA and Bio-PE.

Heartland has found applications in industrial packaging like pallets and totes, as well as consumer packaged goods. The company now aims to break into automotive, marine, and building-material markets by empowering existing manufacturers to make more sustainable products by simply swapping additives. According to Heartland, "It is to our benefit that a lot of minerals are unavailable or expensive right now, leaving customers looking for alternative opportunities for their future products."

Carbon Launches New M-Series 3D Printers

Carbon has introduced its all-new M-Series 3D printers employing the next generation of Digital Light Synthesis (DLS) printing technology. The printers come in two models, the M3 and the M3 Max. The M3 is designed for faster printing, a simpler print experience, expanded design space and a more consistent surface finish. The M3 Max offers these same benefits as well as a "true 4K" light engine that doubles the build area with the same pixel size and density. Both printers have a wide range of high-performance materials tailored for applications across industries such as automotive, life sciences, dental, consumer products, and industrial.

These next-generation printers reportedly can create high-quality prototypes with end-use performance levels quicker and more efficiently than ever before. The company says these new DLS printers create substantially lower forces on the part and introduce closed-loop control of force and temperature, reducing failure modes and simplifying the print experience. In addition to a broader design space and smoother parts, these new DLS printers reportedly reduce variation in parts across a single build by up to 50%.

The M3 printer is now available for order and shipping, and the M3 Max printer is available for order and is expected to ship in the second half of 2022.

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Injection Molding Live Demos to Highlight First-Ever PTXPO

Major suppliers will be running injection machines in the first plastics industry trade show in the Chicago area since 2009.

By Tony Deligio
Executive Editor

The first-ever Plastics Technology Expo (PTXPO), coming March 29-31 at the Donald E. Stephens Convention Center in Rosemont, Ill., will feature an array of injection presses running parts in live demonstrations. The show will also feature new technology in extrusion, blow molding and additives (check out the Keeping Up section in this issue and last month for new products debuting at the show), as well as an educational program in three Tech Talk theaters (see sidebar). Here's what you can expect from the injection molding exhibits, based on information available before showtime:

At this month's PTXPO, Absolute Haitian will debut the third generation of its all-electric machines, the Zeres III.

KraussMaffei (KM) will have an 80-ton, all-electric KM80-250PX injection machine on display. Utilizing the company's APC+ software for dynamic control of the molding process, KM plans to mold coasters from recycled resin with the machine automatically adjusting to changes in resin viscosity. The press will also be equipped with a KM LRX-50 linear robot for part removal.

KM will also demonstrate its production monitoring and process support application called socialProduction, including its cloud-based remote support technologies: remoteAccess and smartAssist.

Absolute Haitian will unveil the Zeres III, the third generation of its all-electric machines, to the U.S. market. Available from 44 to 1551 tons, the Zeres III features improved injection and clamp units, as well as the Sigmatek control, featuring Connectivity Plus for easier integration of auxiliaries and automated processes to create full cells and production lines. The Zeres also has integrated hydraulics to power core pull, ejectors, carriage movement and hot-runner valve gates.

At the show, Absolute Haitian will run a 135-ton ZE1200-300 with a two-cavity, thin-wall cup mold in an anticipated cycle time of 12 sec. Two 0.5-oz cups will be molded from a 35-g shot, with the tool utilizing valve gates powered by the Zeres press' integrated hydraulics.

Sepro Group's Success 11X robot, equipped with Visual 2 controls, will be running at Absolute Haitian's booth.

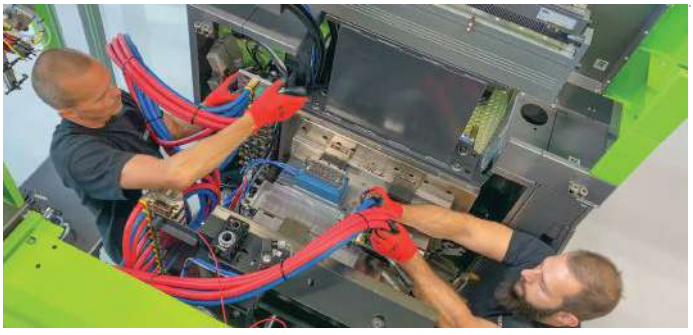
Working in conjunction with the Zeres press will be Sepro Group's Success 11X robot, equipped with Visual 2 controls. Part of the revamped Success Line, the 11X reportedly offers five-axis capabilities at an affordable price. The robot will stack parts on the non-operator side of the machine. Rounding out the machine cell will be a Conair chiller integrated into the Zeres' Sigmatek control.

Engel will feature two molding machines in its PTXPO booth, highlighting fast mold changes and LSR molding, with the assistance of booth collaborators Stäubli and Roembke Mfg. & Design. For the quick-mold-change demonstration, a hydraulic 85-ton victory tiebarless machine will be running two different tools. By utilizing quick-change technology from Staübli, these molds will be swapped out in just 10 min from the last good part from mold "a" to the first good part from mold "b." Both these molds, plus the duckbill valve mold for the LSR machine, were supplied by Roembke.

The quick-change tools will be molding a pair of tongs and a bowl, respectively. The tongs have 30-sec cycle time and are molded from ABS in a 46.2-g shot, with the two parts weighing 23 and 21.1 g, and the remaining resin making up the sprue and runner. The fruit bowl has a cycle time of 31.2 sec and a shot and part weight of 55 g.

iMFLUX will perform a material transition to demonstrate its Auto Viscosity Adjust capability, switching between PPs with different MFIs.

When switching tools, operators utilize Staübli's mold-loading vehicle (MLV), which carries the new tool and receives the old one without the need for an overhead crane. Before sliding the old mold out, operators detach the Staübli quick-coupling water system. The molds and robot EOAT both utilize quick connects and RFID to ensure the proper tool and robot gripper are in place. The machine utilizes Engel's iQ weight control for shot-to-shot consistency, and the parts are demolded and positioned on a conveyor by an Engel viper 12 linear robot.



Engel will have a live demonstration of quick mold changes at its PTXPO booth.

Engel will have two injection molding machines and quick-mold-change technology from Staübli operating at its booth.

The second machine in Engel's booth, also running a Roembke tool, will be a 145-ton, all-electric e-mac 170-145 equipped for processing LSR. The application here is a duckbill valve molded from liquid silicone provided by Shin Etsu with a dosing system from Nexus. The machine is part of Engel's stock program, comprising equipment it keeps at the ready in the U.S. for fast lead times. A viper 20 linear robot handles part removal. The all-electric machine with a compact footprint is suited for cleanroom production.

Plustech will be partnering with Sodick for PTXPO and bringing two injection machines to Rosemont. Plustech is a joint venture between Sodick Co. Ltd. and Yamazen to market Sodick's two-stage plunger injection molding machines. Plustech will be running its 110-ton GL100A-LSR with a 16-cavity LSR mold from M.R. Mold, which has also equipped it with a with a valve-gated cold runner. LSR metering will be handled by a Nexus Servomix X20 system. The X20, which allows molders to swap out material drums in just 5 min, features a maximum feed rate of 1000 cm^3/min and pressure up to 170 bar.

Plustech will also be showing its high-response 22-ton LP20EH3 injection machine from its LP series of micro-molding presses. The machine will run a high-precision mold built by Matrix Tool Inc., reuniting the award-winning combination from *Plastics*

Check Out These Live Demos at PTXPO

Date	Time	Booth	Title	Company
March 29	1:30 PM	106	Fast Mold Changes in Less Than 10 Minutes	Engel
March 29	2:30 PM	425	Yushin IoT: Another Step Closer to "No Robot Downtime"	Yushin
March 29	3:30 PM	407	APC+ Software for Dynamic Control of Injection Molding	KraussMaffei
March 30	10:30 AM	207	The Canon Shuttle Mold System—Challenging the Way We Think About Cooling Time in Injection Molding	Canon Virginia
March 30	11:30 AM	706	Wittmann's New "Quick New" Robot Programming	Wittmann Battenfeld
March 30	1:30 PM	907	What Is Your Most Valuable Asset Doing and Where Is It?	Progressive Components
March 30	2:30 PM	433	Take the Plunge, with Sodick IMM by Plustech Inc.	Plustech Inc.
March 30	3:30 PM	317	Efficient, Affordable Thin-Wall Molding for Packaging	Absolute Haitian
March 31	10:30 AM	330	Eliminating Processing Obstacles	Matsui
March 31	11:30 AM	4309	Model MD-92 Bausano Extruder with Multi Drive System, Industry 4.0 Controls and Smart Energy System Providing an Alternating Electromagnetic Field for Barrel Heating	IMS Tri Mechanical

Technology's inaugural Hot Shots parts competition (see Nov. '21 Close-Up). The machine has an ultrafast 2-3 millisec response time and is capable of injection speeds up to 1300 mm/sec.

On the Sodick metalworking machinery side, the company has recently unveiled iGroove technology for its ALP and ALN wire-EDM machines. iGroove works by rotating the wire so that its entire surface is used during finishing for high-efficiency machining. This function also eliminates the need for taper and reduces wire consumption since it can be fed through at a slower rate.

Sodick will be showcasing an ALN400G iGroove wire-EDM machine and AL60G sinker EDM machine. The AL60G will be dry-run with cut samples on hand. The ALN400G iGroove, or iGE, will execute a hybrid cut where the wire will be cutting on skim passes without being submerged in the water tank, so the iGroove feature is visible.

Tederic will introduce the Neo family of injection machines to North America. All Neo presses offer Keba controls with the option of a 12-, 15-, or 21-in. touchscreen. The new machine series includes six distinct lines: Neo T, E, Ec, H, Mv and Ms. These include servohydraulic toggle, all-electric, hybrid, two-platen and multimaterial machines.

iMFLUX will be showcasing its constant-low-pressure injection technology in collaboration with Japan Steel Works America at the JSW booth in a live machine display, as well as at its own booth. iMFLUX's technology will be displayed on a JSW J-ADS Series medical-grade machine for cleanroom applications. Attendees can see how iMFLUX automatically adapts to shifts in viscosity, compensates for blocked cavities and more.

Canon will introduce a new version of its Shuttle Mold System that supports machine tonnage from 450 to 650 tons.

At the show, iMFLUX will perform a material transition to demonstrate the AVA (Auto Viscosity Adjust) capability, switching from PP (supplied by recycler/compounder/distributor KAL-Polymers) with 10 MFI to one with 40 MFI while maintaining a stable process without operator intervention.

The J-ADS medical machine features stainless-steel rails and rollers for the safety door; bushing-free greaseless tiebars; an added duct on top of the purge cover to exhaust contaminated purge air; white powder coating; J-Mag magnetic platens for easier mold mounting; and stainless-steel covers for high-use areas of the press.

Canon Virginia will introduce a new version of its Shuttle Mold System that supports machine tonnage from 450 to 650 tons. The company notes that this is the first time this size system will be shown publicly. The booth will feature a demonstration of the Shuttle Mold System and will highlight some use cases for the technology. Canon engineers will be on-site to discuss applications and answer questions.

Wittmann Battenfeld will debut its new R9.1 robot controller, featuring the Quick New Wizard programming tool. It will also feature its Innovations Roadshow Truck, which allows attendees to watch live demonstrations of its molding machine control, temperature controller, robots and various auxiliaries.

At PTXPO, Wittmann Battenfeld will introduce the new R9.1 robot controller, featuring the Quick New Wizard programming tool.

Savage Automation, which specializes in full automation cells and 3D-printed robot end-of-arm tooling (EOAT) for high-end injection molding, will show unique EOAT created for a four-cavity medical-device mold. The entire body of the EOAT is 3D printed in nylon 12 and features a vision system that inspects each part to ensure there are no black specks and that dimensions are within tolerance. The entire EOAT weighs just 1 lb, 9 oz.

Beaumont Technologies will introduce a reorganization of its business into three distinct divisions. In January, Beaumont acquired a moldmaking operation in Sugar Grove, Pa., including more than 7000 ft² dedicated to design and development of injection molds. This will act as the hub of Beaumont's new tooling division, giving the company what it calls a one-stop-shop for mold design and build, process validation and production, in addition to quick repairs and improved preventive maintenance for current production tools. ►

Secondly, Beaumont will be opening a new facility in Cranesville, Pa., dedicated to material characterization. The 10,000-ft² facility will offer Moldflow and Thermaflo material characterization and test-specimen molding. Beaumont says the facility, which has room to expand for additional material characterization services, will improve lead times on material reports.

At PTXPO, Beaumont will introduce a new business organization, adding tooling and material characterization units to its traditional training and technology offerings.

Finally, these moves will allow Beaumont's existing headquarters in Erie, Pa., to become dedicated to the production of its injection molding technology products. Doing so will increase production capacity and improve lead times.

In addition, Beaumont's American Injection Molding (AIM) Institute will be offering a new service called Workforce Development, designed to help molders determine an individualized educational pathway that will ensure employees are proficient in their current roles and prepared to take on additional responsibilities in the future. The service is designed to identify and eliminate knowledge gaps within a company's workforce.

Paulson Training will offer PTXPO visitors demonstrations of its new online learning platform—Paulson University. It's said to make training employees seamless, regardless of their geographic location, with the ability to provide plastics-processing education anytime, anywhere and on any internet-enabled device.

Instead of an office being set aside as a dedicated training space with specific sign-up times, the online university allows more flexible learning, including at home. Paulson University allows companies to link into their own in-house learning-management system (LMS), and it includes reporting, progress tracking and bonus training materials. At the show, Paulson will specifically showcase its new PET-ISBM course, which

Tech Talks' Schedule for PTXPO

Date	Time	Title	Company
March 29	11-11:30 AM	Getting Started with Training to Develop a High-Performance Workforce	Paulson Training
March 29	1-1:30 PM	Variable Speed Control—Applications in Process Cooling	Thermal Care, Inc.
March 29	2-2:30 PM	The Canon Shuttle Mold System—Challenging the Way We Think About Cooling Time in Injection Molding	Canon Virginia
March 29	3-3:30 PM	Will Your Team Be Ready to Make a Digital Transformation?	ACS Group
March 30	10-10:30 AM	Supporting the Circular Economy—Solving Challenges of Recycling Laminated Hygroscopic Material Regrind	Processing Technologies International LLC (PTi)
March 30	11-11:30 AM	How to Achieve Stability, Precision and Cost-Efficiency in Manufacturing	KraussMaffei
March 30	1-1:30 PM	Introduction to XP Express Active Gravity Touch (AGT)	Davis-Standard LLC
March 30	2-2:30 PM	Post-Pandemic Manufacturing Challenges: The Role of Technology	Plastics Industry Association
March 30	3-3:30 PM	Manufacturing of Micro Medical Parts Without Cold Runners	Westfall Technik, Inc.
March 31	10-10:30 AM	The Newest Technology of PVC Compounding in a Planetary Extruder	Entex Rust & Mitschke GmbH
March 31	11-11:30 AM	Closed-Loop Water Quality & Treatment	iD Additives
March 31	1-1:30 PM	Innovative Learning Technology for the 21st Century	Kruse Analysis Training
March 31	2-2:30 PM	New Horizons in Automation: Six-Axis Robotics for Injection Molding Manufacturers	Absolute Robot

Paulson will introduce the online Paulson University at PTXPO, offering training anywhere on any web-connected device.

focuses on preform injection molding as well as stretch-blow molding (see last month's Starting Up).

Another computer station at the show will exhibit Paulson's SimTech and SkillBuilder Active Lab Lessons. The custom lab lessons promote active learning so that as students progress through the course, they will solve a set of process problems based on what they've learned via Paulson's simulation tools, SimTech and SkillBuilder. Skillbuilder Lab lessons offer specific guided lessons, and SimTech Lab lessons ask students to solve various setup and optimization problems.

Oerlikon HRSflow will offer information and some physical examples of its comprehensive product line running from small hot-runner nozzles to very large ones with multiple methods of actuation, including hydraulic, pneumatic, servo and servo plate. Newest is the S Series nozzle offering reduced pitch spacing for small components (see last month's Keeping Up).

Progressive Components has added to its plate-sequencing product line, introducing its new Plate Retainer, designed to hold parting lines or retain floating mold plates. When molding machines vibrate, floating plates can drift from their intended location, resulting in stuck parts and mold damage. Progressive says its plate retainer is able to fit into tight spaces and keep plates secure.

Progressive notes the retainer's compact design requires very little machining and no timing or fitting during assembly. The SRT roller within the housing operates smoothly in greaseless applications. When installed, the plate-retainer assembly is flush with the outside of the mold base and does not interfere with the machine's tiebars.

DME will demo its new undercut thread technology and undercut applications featuring the iMold servo-driven units and controllers, as well as "S Cores" technology with collapsible cores as small as 6 mm. PT

Novel LLDPEs Enable Films that Are 'Ahead of Their Time'

ExxonMobil's new Exceed XP 7 series boasts remarkable mechanical performance combined with low density and fractional melt index.

By Lilli Manolis Sherman
Senior Editor

Levels of performance "never seen before" are claimed for a series of hexene LLDPE film resins that ExxonMobil unveiled last fall. Produced with a proprietary metallocene catalyst, Exceed XP 7021 and 7052 are said to deliver remarkable mechanical performance with a combination of low density and fractional melt index that enable the production of innovative new film structures not previously possible. This potential covers a range of applications, including moisture-barrier construction films, stretch-hood, collation shrink and greenhouse films.

The combination of attributes that reportedly have not been previously available in a single resin includes high levels of elasticity and holding force, puncture energy up to 2.3 J/mil and dart impact resistance up to 900 g for a 25.4-micron film. ExxonMobil also says that XP 7021 and XP 7052 offer a combination of fractional MI and low density (0.911-0.912 g/cm³) that has also not been commercially available before, resulting in enhanced bubble stability and creating opportunities for increased output.

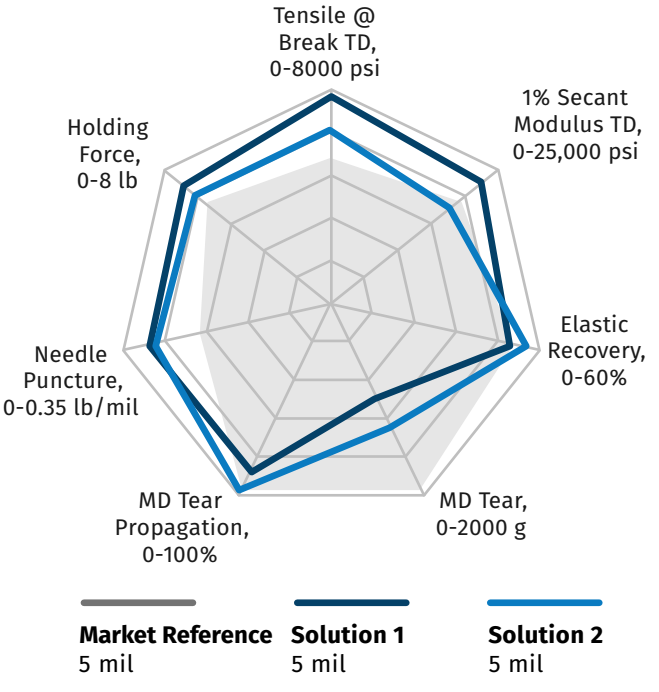
Tex-Trude has been adding new equipment and expects to enter new markets for its stretch-hood films that might not have been possible without the new resin.

The company has been working closely with processors to develop new film formulations that many in the industry say are ahead of their time, according to Tom Miller, Exceed XP 7 PE product manager.

Among these collaborators is Tex-Trude, a 70-yr-old, privately held company based in Channelview, Tex., where it runs three main divisions—for PE blown film, PVC profile extrusion and flexible vinyl compounding—out of one manufacturing plant.

Charlie Nettles III, Tex-Trude's president, says the company is using Exceed XP 7 in new formulations for vapor-barrier construction films designed for use under concrete slabs, as well as stretch-hood packaging films. Based on the excellent results achieved with these products, Nettles anticipates that within a few months, Tex-Trude will use XP 7 in other film-packaging applications, such as lawn & garden, mulch and other chemicals.

Exceed XP 7 for Stretch Hoods



Skins	Exceed XP 1018*	Exceed XP 7052*	Exceed XP 7052*
Core	C8 mLLDPE Vistamaxx 6102	Exceed XP 7052	Exceed XP 7052* Vistamaxx 6102

*Slip and anitblock masterbatch added

The combination of attributes that reportedly have not been previously available in a single resin include high levels of elasticity and holding force, puncture energy, and dart impact resistance. (All images: ExxonMobil)

Tex-Trude is using Exceed XP 7 to produce 10-mil to 20-mil monolayer vapor-barrier construction films designed specifically for use under concrete slabs.

IMPROVED VAPOR BARRIER & STRETCH HOOD FILMS

Tex-Trude extrudes vapor-barrier films in thicknesses from 10 to 20 mils. Nettles notes that the material provides a huge improvement in dart-drop impact consistency—90+% compared with 50-60% achieved with previously used resins.

Nettles also sees a significant improvement in bubble stability. As a result, Tex-Trude replaced a blend of fractional-melt LDPE and a metallocene hexene LLDPE with XP 7 blended as the main component with a butene LLDPE. This has led the firm to switch all of its Xtreme Vapor Barrier product line to the XP 7 formulation. Films in this product line far exceed the ASTM E1745 standards for water-vapor barriers and raise the bar for others in the market, Tex-Trude says. (See Jim Nettles and his team discuss new high-performance vapor-barrier films at ***short.ptonline.com/construct***.)

Tex-Trude is also developing three-layer, 2-mil to 6-mil stretch-hood films in which XP 7 as the main component is blended with other high-performance metallocene hexene LLDPEs. These films provide the snap-back and strength required for this market. Preliminary results are excellent, according to Nettles, with further trials on the way. The company focuses its trials typically on producing mid-gauge films to determine performance prior to producing thinner or thicker films.

Performance achieved in these film trials includes significant improvements in elasticity, dart impact strength, and puncture resistance from a tear perspective that prevents holes forming over corners of pallets during application and transportation. Less "tiger striping" also has been shown. (See the Tex-Trude team discuss new stretch-hood films at ***short.ptonline.com/stretchhood***.) ►

Nettles says Tex-Trude has been adding new equipment and expects to enter new markets for its stretch-hood films that may not have been possible without the new resin.

OTHER PROMISING APPLICATIONS

ExxonMobil has collaborations underway to develop formulations with Exceed XP 7 resins for other applications. According to Miller, these include:

- Collation shrink films that shrink at low temperatures and offer potential energy savings. XP 7 resins enable high shrink speeds at temperatures as low as 120 C/248 F. Such films can protect sensitive products from excessive heat. The removal of cardboard trays is possible in many applications, according to Miller. "Films that exhibit MD and TD shrinkage at low temperatures, and can be processed on traditional blown film lines, are a rarity in the market," he adds.

Films that exhibit MD and TD shrinkage at low temperatures, and can be processed on traditional blown film lines, are a rarity in the market.

- Primary packaging films with low seal-initiation temperatures for fast sealing. Films made with XP 7 can help seal packages at low temperatures without blocking issues. Processors can reduce antiblock levels to improve coefficient-of-friction control and optical properties for better brand promotion. These resins reportedly also enhance packaging toughness with best-in-class flex-crack resistance and extreme dart-impact and puncture resistance, while offering good optical properties.

Says Miller, "Flex-crack resistance is so high, tests undertaken by ExxonMobil resulted in an average of 1 hole/10,000 cycles. The combination of fractional MI and a 0.912 g/cm³ density helps prevent seal thinning without the addition of LDPE, compared with conventional sealing resins."

Under development at Tex-Trude are three-layer, 2-mil to 6-mil stretch-hood films in which XP 7 is the main component.

Collation shrink film is another major application for Exceed XP7 resins, as are primary packaging films and greenhouse films.

- Greenhouse films with remarkable softness and clarity combined with extreme dart and puncture resistance. Greenhouse films that are tough, clear and soft can now be fabricated with XP 7, producing films with reduced risk of failure and premature breakage during installation and use.

"Films made with these new grades offer farmers the opportunity to enjoy longer and better growing conditions for potentially higher crop yields, helping to meet the growing population's need for food," Miller says. PT

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Solvent-Based Inks Boost PET Recycling

Sun Chemical's SunSpectro SolvaWash solvent-based inks allow higher quality and yield of recycled PET from bottles.

Sun Chemical's SolvaWash ink product on the left compared with conventional ink on the right. SolvaWash washable ink releases from the film in a controlled process that generates particles large enough to be easily filtered and removed from the wash solution. (Photos: Sun Chemical)

By Heather Caliendo
Senior Editor

Sun Chemical has launched a recycling-friendly, solvent-based ink that it says will boost recycling rates for PET bottles. Its SunSpectro SolvaWash GR and FL washable/deinkable gravure and flexo-printable inks are designed for reverse printing of crystallizable PET shrink sleeves. The ink has been recognized by the Association of Plastic Recyclers (APR) for its ability to be removed without staining the flake or wash water from post-consumer printed PET packaging during the hot caustic wash step of the recycling process.

According to the EPA, the recycling rate for PET bottles is about 29%, in part because removing inks and labels from the PET bottles during the wash cycle is challenging. As explained by Nicola Juhasz, technical director of sustainability for Sun Chemical, problems arise when conventional inks bleed during the caustic-bath washing process, discoloring the solution and contaminating the plastic in it. The contaminated plastic retains some color and can't be reused in a high-end application, so it's either landfilled or used in lower-end applications.

After being isolated from the bath, the SolvaWash product on the left comes out clean and clear, compared with traditional ink on the right.

HOW IT WORKS

SolvaWash is printed directly on the film without the need for a primer. In a caustic bath, the washable ink releases from the film in a controlled process that generates ink particles large enough to be easily filtered and removed from the wash solution without contaminating the recovered plastic.

SolvaWash is the first generation of products that Sun Chemical has designed for PET container sleeves. It is also developing additional product families that are UV curable and/or water-based for the same applications.

Ink technologies are not limited to PET bottles or container streams, so the company is looking to extend it to a variety of additional plastic packaging applications. They're looking at other streams and ways of using the same concept to enhance recyclability of other types of plastic packaging. PT

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Stretch-Blow 1000-Liter IBCs from PET

Cypet introduces a one-stage ISBM system to provide a clear alternative to HDPE bulk containers.

By Matthew Naitove
Executive Editor

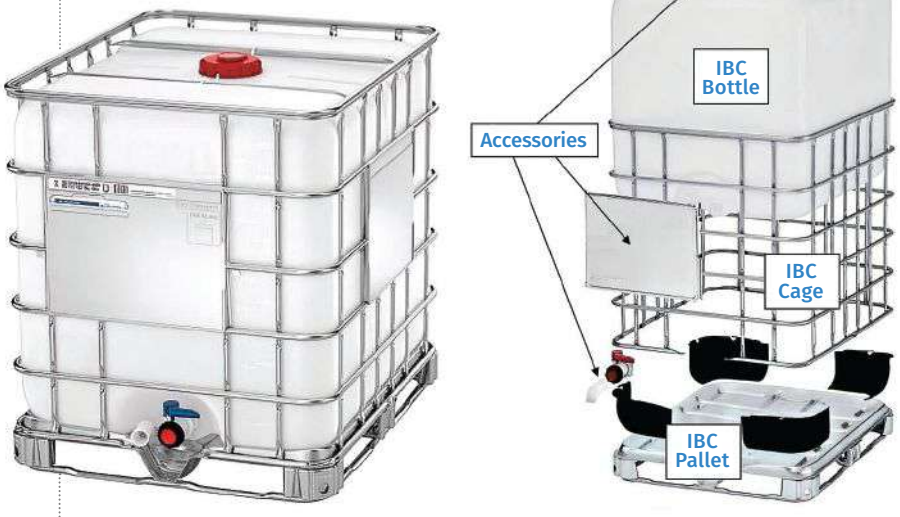
Cypet Technologies, a Cyprus-based producer of PET injection stretch-blow molding (ISBM) machines, has come out with its largest model yet, capable of making 1000-liter (264-gal) intermediate bulk containers (IBCs). Cypet is looking for a strategic partner to cooperate in commercializing PET IBCs globally.

Up to now, the largest of Cypet's single-stage ISBM machines could make up to 120 L PET containers with up to 400-mm necks. These machines are based on a horizontal injection molding machine platform with special tooling and automation. Servohydralic and all-electric models are available. Preform injection and stretch-blowing are accomplished in the same clamp with a special tooling package, in which the preform cavities are located below the blowing cavities. Preforms are molded in a horizontal orientation, while containers are blown in a vertical position. In a typical cycle, when the clamp opens, the preform cavities rotate from horizontal to vertical position, allowing an integrated top-entry linear robot to extract the preforms and transfer them to the blow molds while retaining their vertical orientation. The robot arm also extracts finished containers in the same operation. The clamp closes, and the containers are stretch-blown in the upper molds, while a new set of preforms are injection molded in the lower tooling. See a video of a Cypet machine in action at ***short.ptonline.com/cypet***.

Cypet currently has two of its machines installed in the U.S., and two more are coming to plants in the U.S. and Mexico this year.

Cypet's Michalis Sideris, in charge of business and technical development, says the new IBC machine is different in layout from the smaller models and utilizes upgraded technology, but he declines to provide specific details for the present. He does reveal that the machine output will be about 30 IBCs/hr and the weight will be 8.5 to 9.5 kg (18.7 to 20.9 lb), vs. around 14 kg (30.8 lb) for HDPE. To that roughly 35% weight reduction, add the 40% lower density of PET than HDPE, and you get 45% less plastic usage on a volumetric basis. Note also that the weight reduction

Intermediate Bulk Container, IBC



Conventional HDPE IBCs (shown here) can be replaced with glass-clear PET versions weighing about 35% less. (Photos: Cypet)

QUESTIONS ABOUT BLOW MOLDING?

Learn more at PTonline.com

Click on Blow Molding under the Processes tab at the top of the page.

Until now, the largest container possible with Cypet's ISBM technology was 120 L drums, shown here in PET and HDPE versions.

Cypet one-stage ISBM machines also can produce these 55 L crates.

Another Cypet application is 50 L PET beer kegs.

contributes to lower energy expended for transporting the IBCs.

Sideris notes two further advantages for PET over HDPE. One is glass-like clarity, providing visibility of the container's contents. The other is enhanced recyclability. While both PET and HDPE are widely recycled, PET can be restored more easily to virgin quality, using heat treatment and solid-state polymerization (SSP) to restore I.V. loss (which correlates with molecular weight) from the first processing cycle. Recycling used PET IBCs directly into new IBCs ("bottle-to-bottle") also has a technological head start over HDPE. These advantages make replacement of used PET IBCs with newly recycled containers more cost-effective than washing out used HDPE IBCs, especially for food-contact applications.

PET offers substantial weight savings, glass-clear product visibility, and recycling advantages over incumbent HDPE.

Cypet not only supplies machines, but also offers services for container design, structural simulation, preform design and development, and pilot production. PT

MATERIALS

PART 16

Tracing the History of Polymeric Materials

Beyond PET, PBT and their analogues, development of polyester chemistry led to unsaturated thermosetting resins, copolyester thermoplastic elastomers, liquid-crystal polymers and, most recently, biopolymers.

By Mike Sepe

The versatility of polyester chemistry has been demonstrated over the nine decades since its original introduction. Much of the plastics industry today is focused on thermoplastic materials. However, one of the most important polyester chemistries is unsaturated polyesters and vinyl esters. These materials are created using chemical reactions similar to those already discussed for PET and PBT. However, in this case, a difunctional alcohol such as propylene glycol is reacted with a combination of saturated and unsaturated organic acids or anhydrides with reactive groups that extend in more than two directions. This chemistry allows for the process of crosslinking using a material like styrene monomer or vinyl acetate to create a thermosetting material.

Polyester technologies have proliferated from thermoset unsaturated polyester, used in fiberglass composites like SMC (left), to copolyester TP elastomers like DuPont's Hytrel. (Photos: Dieffenbacher and DuPont)

These chemistries were discovered by Wallace Carothers and his team at DuPont in the early 1930s at the same time that they were investigating the early polyester fiber chemistry. The original thermosetting polymer developed by Carothers used fumaric acid, maleic anhydride, and ethylene glycol. The reaction required a relatively high temperature and resulted in a material of very high viscosity that was difficult to work with and cured very slowly. Like the aliphatic polyesters that DuPont developed at about this same time, these crosslinked versions were not commercialized. But in 1933, Carlton Ellis, an inventor and pioneer in organic chemistry, introduced the vinyl monomer styrene into the process as a crosslinking agent. This resulted in a lower-viscosity resin to which glass fibers could be added prior to curing. Cure rates also increased dramatically with this innovation.

This allowed the production of very large structures with good strength and stiffness. Unfortunately, at the time, styrene was still a specialty chemical with a very high price tag, so commercialization was slow. But with the start of World War II the need for synthetic rubber became a priority and the government financed the construction of multiple plants to produce styrene-butadiene rubber (SBR), making styrene more available and dropping the price to a point where production of unsaturated polyesters at a reasonable cost became feasible. One of the important characteristics of unsaturated polyester is its transparency to radar, an obvious advantage in wartime. Commercialization is generally dated at 1939, a couple of years before the thermoplastic variety was introduced.

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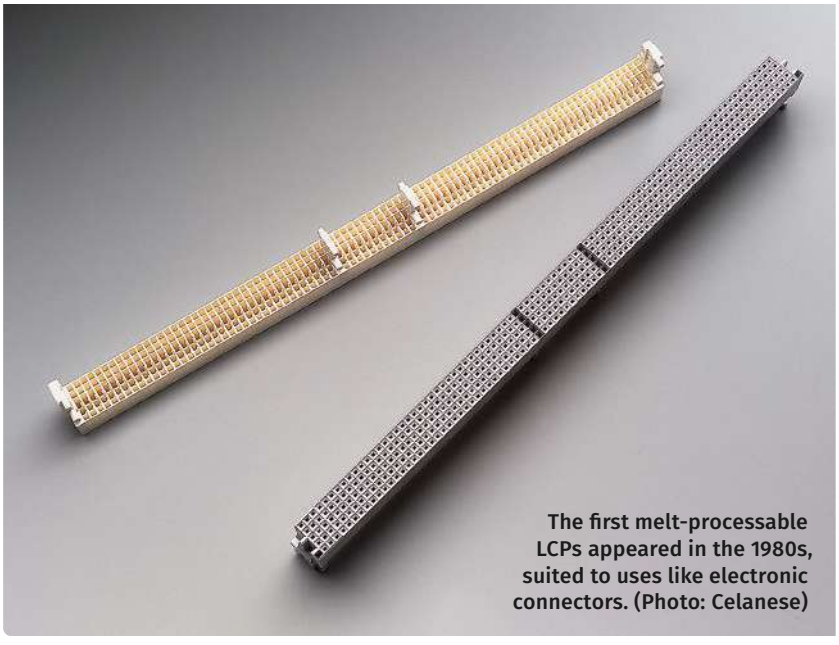
These products, often referred to as "fiberglass," are still used today to make large structures for the marine, building/construction and automotive industries. One of the iconic models of the American automotive industry, the Corvette, introduced in 1953, makes extensive use of these materials in the exterior body panels. Ellis was awarded the first U.S. patent for unsaturated polyester in 1933 and made additional improvements in the product up to the time of his death in 1941 by varying the chemistry of the organic acids, anhydrides, alcohols, and crosslinking agents. He was inducted into the Plastics Hall of Fame in 1974. Today these polymers are used to produce materials known as bulk molding compounds (BMC) and sheet molding compounds (SMC) that can be compression, transfer, or injection molded into products that remain crucial for the automotive, appliance, and electrical industries. Unsaturated polyester can provide a combination of excellent electrical properties and flame suppression that no thermoplastic has been able to replicate, while delivering good mechanical performance and resistance to elevated temperatures. Polymer concrete is also based on unsaturated polyester. A closely related chemistry, polydicyclopentadiene (PDCPD), is also used in larger structures processed through a variety of methods such as reaction injection molding (RIM), resin transfer molding (RTM) and compression molding.



The first melt-processable LCPs appeared in the 1980s, suited to uses like electronic connectors. (Photo: Celanese)

Ellis also has an intersection with the development of the cellulose acetate lacquers created during World War I that we discussed in Part 7 of this series (May '21). These lacquers provided the wood in the airplanes of that time with resistance to moisture and fire. The lacquers were produced by dissolving cellulose acetate polymer in acetone, a chemical that was in limited supply at the time. In 1916, Ellis developed a more efficient method for making isopropanol, which is then converted to acetone. This broke the bottleneck in producing these materials.

In 1970, PBT polyester was incorporated into a new set of compounds that had elastomeric properties. Commercially referred to as copolyester elastomers, these materials consisted of PBT and segments of a longer-chain diol that formed a group referred to as poly tetramethylene oxide (PTMO). ►

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Aliphatic constituents contribute rather modest performance properties to the current crop of biopolymers like PLA, PHA and others. Future development may benefit from incorporation of aromatic chemistries. (Photo: Milliken)

The PBT crystallized to provide the hard structure while the PTMO remained amorphous, providing the flexibility and good low-temperature ductility. The properties could be varied by altering the ratio of PBT and PTMO to produce a range of TP elastomers with different thermal and mechanical properties and surface hardness. These were first introduced by DuPont under the Hytrel trade name and today have several competitors, including grades from Celanese and DSM.

Another fascinating variant on polyester chemistry is liquid-crystal polymers (LCPs). Liquid-crystal forms in small molecules had been studied since the 19th century, but the first well-known commercial example of a liquid-crystal polymer was Kevlar, invented at DuPont in 1965 by chemist Stephanie Kwolek. This was followed in 1967 by Nomex. Both of these materials are based on polyamide chemistry and make extensive used of an aromatic backbone structure. While exhibiting remarkable properties, they have melting points that exceed the degradation temperature of the polymer and therefore can not be melt processed. These are referred to as lyotropic LCPs. Thermotropic LCPs were commercially introduced around 1980 and are based primarily on polyester chemistry. The principal constituent is p-hydroxybenzoic acid. However, homopolymers of this material have melting points above 500 C (932 F), which presents obvious problems for an industry running machines with maximum achievable barrel temperatures of 427 C (800 F).

The first melt-processable LCP product line came from the unlikely source of Dart Industries, which at the time owned Tupperware. The first commercial grades had very high melting points, close to 420 C (788 F) and Dart targeted high-heat cookware, called Ultra 21, as an addition to the Tupperware line. In the late 1980s, I owned several of these items and surprised a friend of mine from GE Plastics when I served lasagna cooked in a pan made from this material. The items were expensive compared with the tradi-

tional polypropylene Tupperware products and the surfaces had to be treated carefully or they scratched easily. But they were a novelty that illustrated the potential of LCP to operate at high temperatures.

A more concerted effort to develop a functional line of LCP products was taken on by Celanese in the mid-1980s with the Vectra line that is still very active today. By introducing other comonomers, the heat resistance of the material could be tailored to hit certain targets, and this is what primarily distinguishes different grades of LCP today. In addition to their excellent thermal properties, LCP materials exhibit very low melt viscosity, enabling production of parts with very thin walls. They also allow for very fast cycle times since the energy barrier between the solid and the liquid state is very small. With the appropriate fiber reinforcement, they can provide exceptional strength and stiffness, although weld-line integrity is a notable problem. Interestingly, DuPont also developed an LCP line somewhat later under the trade name Zenite, but has since sold that line to Celanese.

One other intersection with polyester chemistry is the current offerings in biopolymers. Most biopolymers are derived from starches, sugars, or cellulose. Many of the resulting polymers are polyesters. But at this point, the monomers being used are aliphatic. Therefore, the resulting materials have properties that are comparable to the original aliphatic polyesters developed in the 1930s, which were abandoned due to poor thermal and mechanical performance. This indicates that future development of materials from renewable sources may require aromatic chemistries in order to be considered viable.

In 1970, PBT polyester was first incorporated into a new set of compounds that had elastomeric properties.

Throughout our discussion of nylons and polyesters, the same players keep showing up, and an examination of the chemistry shows that there are many similarities between these two polymers that result in overlaps in applications. This presents challenges in the material-selection process. In our next installment, we will pause our historical treatment to discuss the relative merits of selecting a polyester or a nylon polymer for an application and highlight some notable instances where an industry successfully converted from one to the other. PT

ABOUT THE AUTHOR Mike Sepe is an independent, global materials and processing consultant whose company, Michael P. Sepe, LLC, is based in Sedona, Ariz. He has more than 45 years of experience in the plastics industry and assists clients with material selection, designing for manufacturability, process optimization, troubleshooting, and failure analysis. Contact: *(928) 203-0408 • mike@thematerialanalyst.com*.

INJECTION MOLDING

Revisiting the '5 M's' of Molding

All injection molding ultimately comes down to the "Man, Mold, Machine, Material and Method." But those key aspects can be viewed differently if you're auditing mold changes before startup or troubleshooting changes for an already validated process.

By Garrett MacKenzie

Injection molding can be a real challenge if you don't follow the "Five M's": Man, Mold, Machine, Material and Method. Our goal of 100% efficiency, zero scrap and repeatable processes can sometimes be hindered by poor setups or changes in the molding process.

Over the years, I have developed two separate "5M" systems. One applies to auditing mold changes before startup, while the second applies to troubleshooting changes within a validated process. This article will explain the application of both systems and how they can be used to consistently identify and correct molding problems.

AUDITING A MOLD CHANGE

This 5M configuration is used when auditing a mold change before startup. It serves as an outline for the entire audit process, and if it is repeated every time a mold change is audited, it can help prevent poor setups leading to poor startups. Here are the steps taken for each:

Man: This applies to area setup and notification of the supervisor that the press is about to start. This gives the supervisor time to schedule the operator and get him or her into place when parts start moving down the belt. Cell layout is verified as being correct for the new job. All old packaging, labels and components are verified as removed from area, and all required components are confirmed to be in place.

Mold: It is now time to inspect all stages of the mold setup. The mold should be clean and ready to start. Clamp speeds should be verified.

A service technician measures O-rings while servicing a hydraulic valve stack. (Photo: Garrett MacKenzie)

Mold components should be inspected for damage and proper working condition. Water should be verified as on, and hoses checked for proper placement and flow. Low-pressure close should also be verified. Hot-runner cables should be verified as properly connected, and hot-runner and mold temperature setpoints and actuals should be examined. You must verify core hookups and operation, as well as valve-gate hookup, operating them manually to assure readiness. ►

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Machine: This refers to all mechanicals, including auxiliaries. Verify correct robot end-of-arm-tooling (EOAT), and that the corresponding robot program is loaded. Check all auxiliaries for readiness and proper operation. Verify that the dryer is on and at the correct temperature. Ensure the correct screw tip is installed.

Using the 5M's, we are given a direct path for inspection that is thorough and improves our ability to quickly audit or troubleshoot problems and poor setup practices.

Material: Verify that the correct material has been loaded, and that no other materials are present. Check to see color feeders are set properly and make sure the press has been purged thoroughly and is ready for operation. This includes ensuring that the barrel temperatures are correct and the actuals match the setpoints. Verify that the material purged looks clean and isn't exhibiting any signs of moisture.

Method: This refers to the process, which should be verified as conforming to the setup sheet that was developed when the process was validated. At a minimum, temperatures, shot size, transfer position, hold pressure and injection speeds should be certified as correct.

TROUBLESHOOTING A VALIDATED PROCESS

When troubleshooting, the 5 M's change slightly. Method is exchanged for Maintenance. Why? The first steps of troubleshooting are cleaning/inspecting the mold and verifying that the process (method) is correct. This should be automatic. Once completed, the 5M's again come into play.

The same inspections are performed as noted earlier in the article, only now the processor is looking for what has changed. Is the operator causing a defect? Has something changed with the mold? Could a change have occurred with the material we are using? Is the press functioning properly, or do I need to get maintenance involved?

Using the 5M's, we are given a direct path for inspection that is thorough and improves our ability to quickly audit or troubleshoot problems and poor setup practices. As we develop our approach, our auditing practices become stronger, which reduces downtime and scrap. Tools such as these not only improve our odds of success, but they also boost the profitability of the companies we represent.

ABOUT THE AUTHOR: Garrett MacKenzie is the owner/editor of plastic411.com, as well as a consultant/trainer in plastic injection molding. He has provided process-engineering expertise to many top companies, including Glock, Honda, Johnson Controls and Rubbermaid. Plastic411 Services provides maintenance & training support to Yanfeng Automotive Interior Systems, IAC, Flex-N-Gate and other top automotive suppliers. Contact: *garrett@plastic411.com*.

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EXTRUSION

Why Are There No 'Universal' Screws for All Polymers?

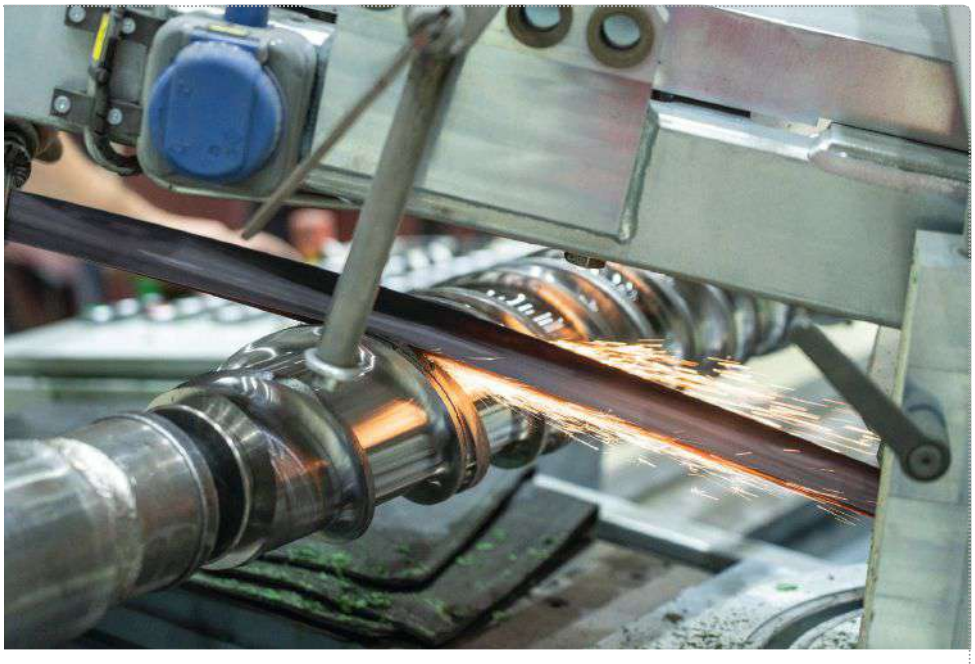
There's a simple answer: Because all plastics are not the same.

Someone recently asked me about "universal" extrusion screws: *"What's the hold-up? Why can't there be one screw design to run all polymers?"* To many people, "plastics" are all the same. But, in fact, different plastic types can have very different processing properties.

By Jim Frankland

A single screw performs three basic functions: solids conveying, melting and metering or pumping. Each of these functions is controlled by the individual properties of the specific polymer, namely its solid and melt density and thermal, viscoelastic and frictional properties. These properties can be so diverse that it's highly unlikely that a universal screw would be able to process them all efficiently. That's not to say that some polymers cannot be processed at all on a particular screw, but not at their optimum efficiency.

For example, let's compare HDPE with HIPS—two of the more commonly used polymers in extrusion—by looking at their specific heats and processing temperatures, which is the amount of energy (hp) required to bring them to their processing temperature. In this case the processing temperatures of HDPE and HIPS are relatively similar. But HDPE has an average specific heat of 0.55 Btu/lb-°F, while HIPS has an average specific heat of 0.40 Btu/lb-°F. That means it will take 37.5% more hp to raise the temperature of a pound of HDPE to its processing temperature compared with HIPS.



Differences in the processing characteristics of two such commonly used resins as HIPS and HDPE show why it is difficult to build a screw that works equally well with both. (Photo: Starlinger)

Moreover, HDPE is a crystalline material, meaning it has a defined melting point, while PS is amorphous with no precise melting point. Overcoming HDPE's crystallinity requires an additional 100 Btu/lb (heat of fusion). So cumulatively, HDPE requires almost 50% more power to reach its processing temperature.

Polymers are also defined by their viscoelastic properties, or how the viscosity changes with changing temperature and shear rate. This is a critical property as it determines how much the shear introduced by the rotation of the screw increases the energy entering the polymer. The power-law

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Polymer Properties for Screw Design

	Density		Specific Heat, Btu/lb-°F	Process Temp., F	Heat of Fusion, Btu/lb	Coefficent of Friction	Power-Law Coefficient, n	Consistency Index, m
	Solid, lb/ft³	Melt, lb/ft³						
HDPE	0.941-0.967	0.48	0.52-0.57	320-450	100	0.2	0.41	20,000
HIPS	1.04-1.10	0.62	0.31-0.48	350-450	N/A	0.28	0.28	28,000
PC	1.2	0.65	0.26-0.28	480-580	N/A	0.31	0.12	9200

coefficient (n) is a measure primarily related to the viscosity as affected by shear rate, and the consistency index (m) is a measure related to the viscosity as affected by temperature. These two properties define the changes in melt viscosity with increasing shear rate and temperature. HIPS has about 50% greater change in viscosity with shear than HDPE (see accompanying table).

HDPE has about 90% of the solid density of polystyrene but only 77% of the melt density. Basically, HDPE breaks down its ordered structure of crystallinity and expands as the melting occurs. This results in a decrease in output (pounds) through the screw; to get equal output/revolution, the screw channels would have to be 38% deeper for HDPE than HIPS. It also requires compensation in the screw compression rate and volume to accommodate the expansion.

As noted above, HIPS has a greater viscosity response to shear rate (power-law coefficient) than HDPE. Therefore, the deeper channels for HDPE to match the lb/hr output of HIPS would result in poor or incomplete melting of HIPS if it were run in the same screw, due to the greater reduction in viscosity and the consequently lower shear melting of the residual HIPS solids.

The feeding rate, which governs the total output of the screw, varies with the physical properties of the feed material, such as the particle shape, density, bulk density, internal (particle-to-particle) friction and external friction of polymer particles to the metal surfaces of the extruder hopper, feed throat and barrel. Studies have shown PS has a 50% greater dynamic coefficient of friction against steel than does HDPE. This affects its feed rate as well as the degree of compaction of solids in the early screw channels and ultimately its efficiency of melting.

Dealing with these differences in polymer properties in the screw design is further complicated by the fact that one difference can offset another. HDPE and PS are certainly not wildly different in the respective properties they provide, yet it's easy to see why it would be difficult to design one screw that can handle both polymers effectively. Now imagine having to design a screw that can also accommodate higher-melting-point polymers such as PC (see table) or polymers that are typically dried before processing.

In these cases, there are some vast differences in processing properties to deal with. Each property variation can affect important requirements for efficient and cost-effective processing. The table shows the same properties for PC just to indicate how very different the values are. Consequently, I think we will continue to need specific screw designs for specific polymers.

Polymer properties can be so diverse that it's highly unlikely that a universal screw would be able to process them all efficiently.

It's important to point out that once a good design is developed for a particular polymer using all this polymer property data, it does not have to be done afresh for each size of the new screw design. Scale-up/down ratios are used to develop other sizes with good results. Except for very large changes in size, that is usually sufficient to produce the necessary performance. PT

ABOUT THE AUTHOR: Jim Frankland is a mechanical engineer who has been involved in all types of extrusion processing for more than 40 years. He is now president of Frankland Plastics Consulting, LLC. Contact *jim.frankland@comcast.net* or *(724)651-9196*.

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TOOLING

How to Know the True Value of Conformally Cooled Injection Molds

What's the return on investing in a new mold with conformal cooling to boost productivity? Will it pay for itself? How soon? Here's an example of how to answer those questions.

By Robert Beard

When evaluating cost-reduction projects in injection molding, the discussion typically centers around cycle-time reduction and the cost to implement the change. This article explores the true value of a conformally cooled injection mold in a very specific case. That case is when the molder can sell more product than it can make on a 24/7 basis. In this pandemic environment, a possible example would be producing home COVID test kits (see photo opposite).

I chose this example because I see many companies struggling to meet the demand for so many healthcare-related plastic products like home test kits and lab testing supplies. I expect that high level of demand to go on for another three to five years. I believe conformal cooling can fill the product pipeline faster than any other technology.

Conformal cooling, in brief, utilizes cooling channels that curve and coil—in two or three dimensions—to conform as closely as possible to the contours of the part, thereby bringing more efficient heat removal than is possible with conventional gun-drilled straight cooling passages. The two main methods of producing such nonlinear cooling channels are additive manufacturing (3D printing) and vacuum brazing of stacked plates.

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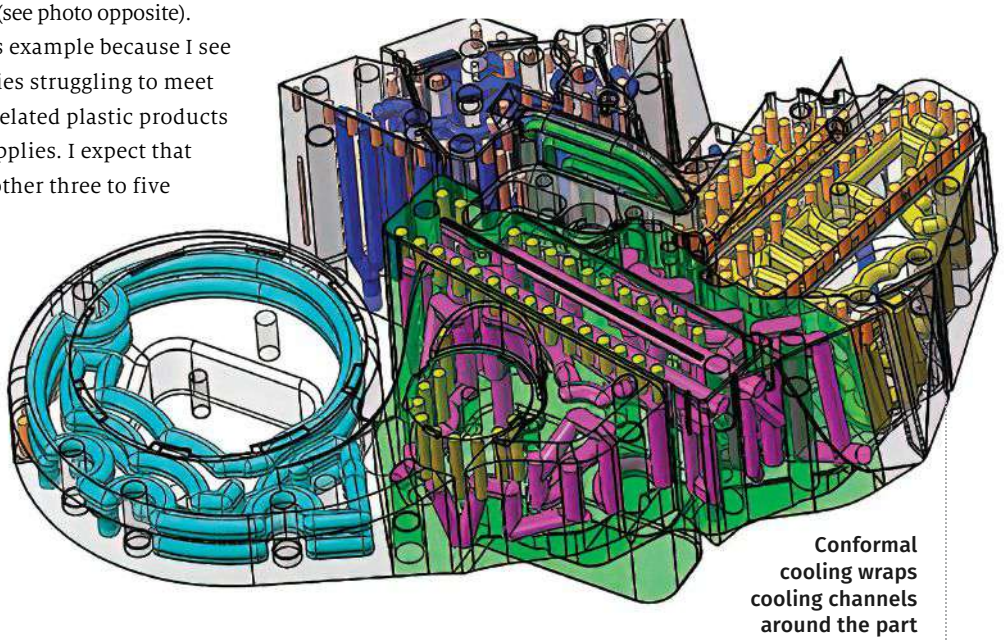
But despite the pressure to produce, many companies are reluctant to try new technologies like conformal cooling or pay the approximately 20% upcharge in mold costs. To ease that transition, I developed the following analysis to measure the return on investment (ROI) over the life of a conformal mold as a function of the increase in sales and profit that it enables. I'll do this in a somewhat simplified fashion, for the sake of clarity, without getting "too deep into the weeds" of cost accounting.



Conformal cooling wraps cooling channels around the part to apply cooling wherever it is needed, unimpeded by complex part geometry. (Images: Contura MTC GmbH)

COST ACCOUNTING FOR CONFORMAL COOLING

Let's say a hypothetical injection molded product (medical or otherwise) has yearly sales of $1 million and a gross margin of 40%, or $400,000. You, the lucky molder, have demand for 35% more units of that

product, and that demand is continuing to grow, but your current mold is running 24/7 and is maxed out. To increase sales to accommodate the demand, you need to order a new mold to run in another press, or you can investigate replacing the current mold with one using conformal cooling to run in your existing press.

A plant running 24/7 and 365 days a year typically operates at 85% to 90% efficiency, allowing for press and mold maintenance, etc. Running at 85% yields 7,446 hr/yr (446,760 min/yr). Assuming a 27-sec cycle, you get about 1 million cycles/yr.

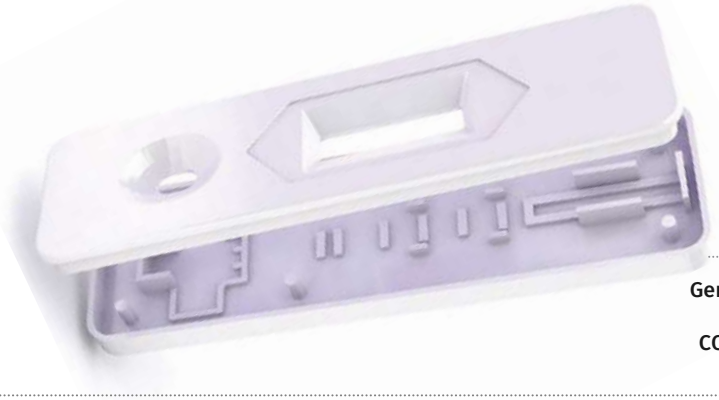
Conformal cooling can reduce the cycle time by 30% to 40%. Assuming a 35% cycle improvement, the new cycle time would be 17.6 sec, producing 1,523,045 cycles/yr, for a 52.3% increase in output. Remember that this is achieved without running a second mold in a second press, which avoids a huge additional cost.

Now, let's look at the increased sales contribution. Your expanded output yields a 52% increase in sales and thus a 52% increase in gross profit.

Assume you started with a gross profit margin of 40% ($400,000). That is increased to 60% ($600,000) gross margin with the conformally cooled mold. The increase of $200,000 in gross margin goes directly into a $200,000 increase in gross profit.

What do you do if you could sell a lot more product than you can make with existing mold technology?

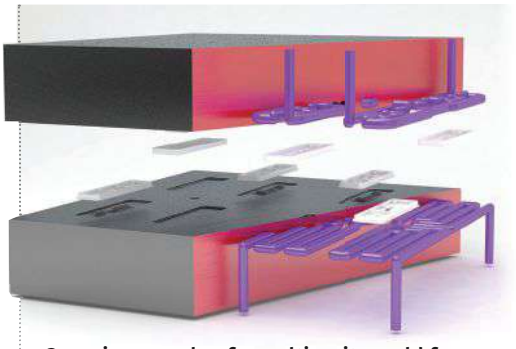
Keep in mind that the 27-sec cycle with the original mold "paid all the bills"—namely, fixed costs and labor costs and resin costs (for the parts made with the 27-sec cycle). Presumably, there would be no additional labor cost with conformal cooling. Since this is a high-volume molding operation, the press is already running without an operator and parts are taken away by a conveyor. The mold goes ►



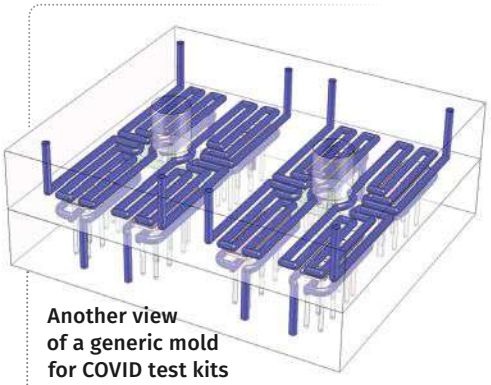
Generic design of a sample COVID test kit.

into the same press as before, so there is no increase in press rate. We'll discuss the costs that do increase later.

What about conformal cooling's contribution to cost reduction? Let's start by asking what is the cost of conformal cooling when building a new mold. If a typical mold for this hypothetical product would cost $100,000 (just to pick a round number), conformal cooling would add around $20,000. Experience with conformal cooling shows that the typical range for payback of this additional investment is two to 12 months. Let's assume a payback of six months. That means this new mold generates $20,000 cost reduction every six months, or $40,000/yr.



Generic example of a multicavity mold for COVID test kits, with conformal cooling.



Another view of a generic mold for COVID test kits with conformal cooling.

Existing technology can build a conformally cooled mold to last for 1 million to 5 million cycles. Let's assume that the new mold runs for 3 yr, or 4.5 million cycles. During that period, the net cost reduction with conformal cooling—after payback of $20,000 in the first six months—is:

2.5 yr × $40,000/yr = $100,000.

Add this to the increased sales contribution to gross profit:

3 yr × $200,000/yr = $600,000

Thus, the conformally cooled mold increases gross profit by a total of $700,000. If you deduct the base cost of the new mold (not including the upcharge for conformal cooling, which has already been paid back), you are left with a handy $600,000 3-yr profit increase.

However, now we have to account for costs that increase due to molding 52% more parts. The most obvious is resin. Resin cost increases by 52%. Remember that the original 27-sec cycle generated a 40% ($400,000) gross profit margin. Let's assume that "inside" that $400,000 is a resin cost of $100,000. We're molding 52% more parts, using 52% more resin, which costs roughly $50,000 a year more, for an additional resin cost around $150,000 for the 3-yr life of the mold. This must be subtracted from the 3-yr saving of $600,000, for a 3-yr net saving of $450,000. Any cost incurred because of the production increase must be subtracted from the 3-yr savings.

Another potential deduction is electricity. The press is running 523,045 (52%) more cycles/yr. There are 52% more press openings and closings, as well as more heating and cooling required. The corresponding increase in electricity cost would need to be accounted for.

Also, the possible effect on power demand for a faster cycle would need to be determined. If the press could not support a faster cycle, higher-wattage barrel heaters could be considered. A more efficient injection screw, designed specifically for the resin being used, could be considered. Even a larger barrel and screw might be in order.

'BUYER BEWARE'

All technologies for building conformally cooled molds are not equal. In a high-volume example like the above, the buyer usually wants to run the mold for 2 yr or longer. We assumed a life of 3 yr for the mold in this generic example. Most of the technologies used to build a conformally cooled mold in the industry today cannot achieve a mold life of 2 million to 5 million cycles. Moldmakers that can achieve such a conformal mold life guarantee their cycle time and warranty the life of the mold in millions of cycles. Look closely into the details of the guarantees and warranties.

Many large corporations in many industries are using conformal cooling technology. You will not see them advertising their cost benefits and profit gains, for obvious reasons. The type of financial analysis modeled here can be used by any corporation to justify a conformally cooled mold. It can also be used by any injection molder to present to a customer. In doing so, the molder demonstrates that it has the best interests of the customer in mind. It also demonstrates that the molder knows how to be the lowest-cost provider, which generates more business. PT

ABOUT THE AUTHOR: Robert Beard, P.E. is president of Robert A. Beard & Associates, Inc. and has over 40 years' experience in plastics. His company provides technical and management expertise to the plastics industry, OEMs and the medical industry. He has been a turnaround general manager for a custom injection molding division, spent 10 years with Abbott Laboratories and was R&D manager for plastic coextrusion at National Can. He founded the Conformal Cooling Conference for Injection Molding, which was held in 2014, 2015 and 2017. Bob has taught thermodynamics, plastics, kinematics, advanced machine design and drafting at the Univ. of Wisconsin, Pennsylvania State Univ. and the State Univ. of N.Y. He is an Honored Fellow in the Society of Plastics Engineers and has been president of the Chicago and Philadelphia sections of SPE. Contact: *info@plastic-solvers.com*.

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By Lilli Manolis Sherman
Senior Editor

Award-Winning Thermoformer:

Ray Products Focuses on Pressure Forming for Crisp Aesthetics, Part-to-Part Repeatability

Ray Products' pressure-forming expertise was recognized in the 2021 SPE Thermoforming Gold Award for its multi-part medical cart made with thermoplastics to replace cast urethane.

For Ray Products, it's all about heavy-gauge thermoforming with pressure and vacuum. This focus helps explain why the Ontario, Calif., processor (***rayplastics.com***) received the 2021 SPE Thermoforming Gold award for pressure forming, using it to replace cast urethane with thermoplastics for a medical cart.

Ray is a 70-yr-old company that since 2003 has been headed up by Brian Ray, who serves as president and represents the third generation of family ownership. The company serves OEMs in medical devices, robotics and transportation, including electric-vehicle charging stations.

Ray operates five rotary and single-station machines that provide pressure-forming capability up to 10 × 6 in. and vacuum forming up to 10 × 18 in.

Says Jason Middleton, v.p. of sales and development, "We develop tight-tolerance, highly aesthetic enclosures and other parts by using state-of-the-art equipment like six-axis robotic CNC trimming centers and temperature-controlled aluminum tooling. Our pressure-forming process can deliver the quality, tolerances and aesthetics typically associated with injection molding at a lower tooling cost and with faster turnaround times."

He adds, "We have capabilities for not just thermoforming, but also in-house painting and contract manufacturing, and we are ISO 9001-2015 certified. We work with our customers very early in the project stages to provide DFM (Design for Manufacturing) feedback, and offer third-party design assistance if needed."

Ray operates five rotary and single-station machines that provide pressure-forming capability up to 10 × 6 in. and vacuum forming up to 10 × 18 in., reportedly the largest vacuum forming machine on the West Coast. The company also has five six-axis robotic trimming centers.

To distinguish itself in the markets it serves, Ray Products uses its expertise to help customers identify new opportunities to use pressure forming to provide the most beneficial process for their needs. The company takes pride in never backing down from complex challenges and always looking to balance the total cost of manufacturing. When forming custom parts, Ray seeks to mold-in cosmetic and functional features, something it says not every thermoformer does, and often uses formed perimeter undercuts to add strength and rigidity.

The company boasts that the parts it pressure forms are so similar to molded parts that the most common question it is asked is, "Is this part injection molded?" At trade shows, Ray Products used its trademarked slogan, "This is NOT Injection Molding." Says Middleton, "This motto pays tribute to the value we bring to the table, as our team can produce a part that not only mimics the aesthetics of an injection molded part, but one that comes at a fraction of the tooling cost and lead time."

Ray Products dates back to the early 1950s and '60s. It started with vacuum forming and fabrication; in response to a demand from customers for improved part detail, Ray added pressure-forming capabilities. The company has invested in new forming equipment that allows for consistent part detail and economical part production. Ray also takes pride in its in-house toolmakers , given the pivotal role tooling plays in the success of pressure-formed parts. The company aligns itself with high-quality sheet suppliers to ensure the best quality parts at competitive prices.

AWARD-WINNING MEDICAL CART

The part that was acknowledged in the SPE contest includes 12 highly aesthetic pressure-formed parts. The assembly includes 10 parts molded in color and two painted parts. The cart was originally manufactured from cast urethane, but pressure forming was able to improve part-to-part repeatability and aesthetics without impacting the overall cart design.

When made by urethane casting, this cart required painting every part and limited the production quantities to 25 pieces at a time. The urethane parts also required 100% inspection using a full assembly check fixture, and approved parts were kitted and shipped together as a unique set. Notes Middleton, "It is not repeatable manufacturing if you must keep a kit of parts together as unique sets."

The 12 pressure-formed parts of this medical cart have no outside attachments, and undercut features are used to secure the side panels. When the side panels are closed, other parts in the assembly overlap to hide any additional attachment hardware. (All photos: Ray Products)

Says Middleton, "Because the urethane process required the customer to purchase complete kits of parts, the customer was always purchasing 25 kits of 12 parts. The customer needed to keep each kit together, with no flexibility of individual parts being interchanged. Urethane, when soft tooled, requires a new tool every 25 pieces, and typically a new master tool every 75 pieces. This is another reason ►

they could only get 25 pieces of each part number at a time."

THE SWITCH TO PRESSURE FORMING

After switching to pressure forming using color-matched acrylic/PVC sheet in thicknesses of 0.187 and 0.250 in., with some parts in metallic color, the medical-device OEM was able to significantly reduce total project costs, improve its manufacturing speed, increase part durability, and guarantee part-to-part repeatability without the need for unique part sets.

Explains Middleton, "The urethane parts were not interchangeable, meaning a set of 12 urethane parts had to stay together and follow the specific chassis until it was completed and ready for shipment by the customer. It was not uncommon for the customer to experience part-to-part fit issues with the urethane parts at different times throughout the assembly process, which would require them to stop the build process on the specific unit, and move to a new unit with a new set of skins. The customer would be required to rework parts on the line in order to keep their production moving.

Ray develops tight-tolerance, highly aesthetic enclosures and utilizes equipment like this six-axis robotic CNC trimming center.

"The repeatable pressure-formed parts produced by Ray Products are received by the customer as individual part numbers, pulled from stock and assembled as required by the customer."

Asked how they came to select the acrylic/PVC sheet for this project, Middleton notes that because the application was a medical cart, they wanted a material that provided superior impact and chemical resistance and was available in lower volumes to support the transition from urethane to pressure forming. Kydex T and Kydex110 sheet extruded by Sekisui Polymer Innovations met the criteria.

Moreover, the switch to color-matched material—including a metallic finish—reduced the total project cost by over 25% when factoring in paint and prep cost, as well as the reduction in finished-part lead time and cosmetic rejects, according to Middleton.

Also, Ray Products was able to increase part durability. Says Middleton, "By utilizing molded-in color options, we eliminated the chipping and scratching of the paint that was problematic with the urethane parts."

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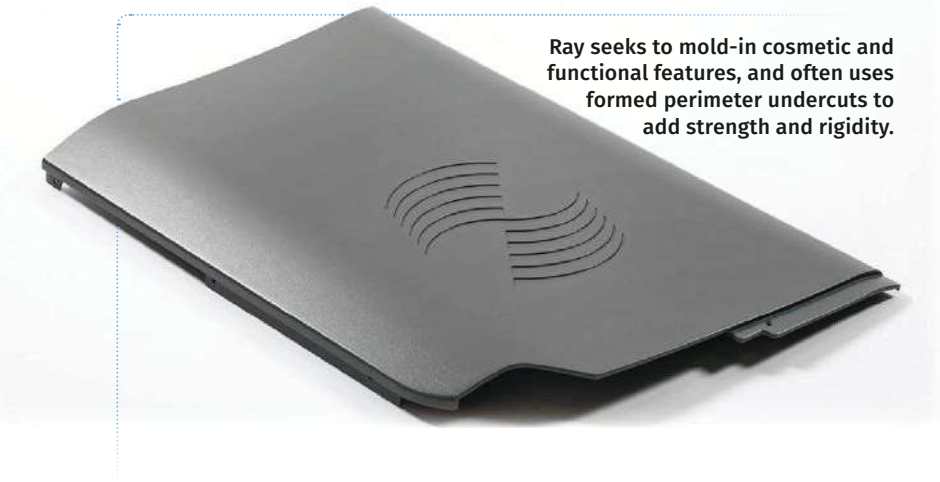
Part-to-part repeatability ensures that a customer can order individual parts whenever they require. Pressure-formed parts are interchangeable, meaning a part number that is ordered today can replace the exact part number that was produced last month, last year or even in the last decade. Parts often get damaged in the field, and Middleton says, "It is crucial that our customers have the confidence that those parts can easily be reproduced to the same tolerances and specifications as all the parts that have been produced previously."



Ray seeks to mold-in cosmetic and functional features, and often uses formed perimeter undercuts to add strength and rigidity.

The pressure-forming process and use of various molded-in features, including several undercuts, allowed Ray Products to significantly reduce the number of purchased components in the assembly.

Says Middleton, "Typically, with medical carts, we work closely with the customer to understand the order of part assembly and the potential field-service requirements and access points. Once we start the design review, we look at all mating surfaces and additional processes that are being utilized. We want to understand all interfaces, whether plastic-to-plastic or plastic-to-sheet-metal. Once we understand how the assembly goes together, we focus on part edges and utilize undercuts to add strength and structure while improving cosmetics by keeping only molded edges visible."

Middleton adds that tight tolerances and aesthetics are required by most of their medical customers, which typically means that all fasteners and attachment points must be hidden. "Since the unit we converted from urethane to pressure forming was already in production, we were not able to change the existing sheet-metal frame, which required us to get creative with attachment points. The pressure-formed parts have no outside attachments, and we use undercut features to secure the side panels. When the side panels are closed, other parts in the assembly overlap to hide any additional attachment hardware. This was done on multiple parts to achieve the same results across the cart. We were able to use the existing sheet-metal frame with minimal modifications, allowing the customer to make a smooth transition from urethane to pressure forming."

Middleton explains that one of the biggest customer complaints on this unit had been part inconsistency, which created various gaps on the assembled units and some parts would not mount correctly. "We utilized various starting gauges for all of these parts that are mated. We have multiple pressure-formed parts that are mating to each other with consistent reveal lines."

He continues, "Even with the different material thicknesses, you can see that all outside mating edges line up. This is a key attribute of pressure forming, as well as the ability to hold tight tolerances."

Middleton adds that with six-axis robotic trimming, Ray is able to minimize or eliminate visibility of trimmed surfaces. The formed undercuts allow Ray to create features like grooves, slots and snap fits that improved the overall cart assembly. In addition, these undercut features allow Ray to eliminate bonded bosses and sheet-metal sections, thus decreasing assembly time and part cost.

The pressure-forming process provided the customer with a total return on investment within the first 50 units produced, and there were no issues about meeting current and future customer demand. PT

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Strategies for Solving Process Problems in Twin-Screw Compounding

When investigating compound quality defects or determining the root cause(s) of processing problems, look for spatial and/or temporal patterns to provide clues. The strategy to identify an assignable cause and cure is to first determine whether the problem is chronic or transient.

By Adam Dreiblatt
CPM Extrusion Group

You can draw a parallel between diagnosis of twin-screw compounding extruders and of the human anatomy. When you go to a physician to diagnose your ailment, the first question is designed to lead the investigation in one of two directions: "How long have you had this problem?" If you respond that the problem started when you were a child, this will lead the doctors down the "disease" pathway, eliminating the possibility that this is a temporary situation. If you reply that the problem started yesterday, this will limit the investigation to your activities within the past 48 hr only.

Chronic compounding problems are like diseases—they are always present, and the cure requires extensive treatment, while transient problems can be thought of as "illnesses." An illness is temporary, and the treatment is relatively simple (e.g., take some medication and rest for 24 hr).

We identify problems in compounding as chronic if the results are the same every time a particular formulation is run.

We identify problems in compounding as "chronic" if the results are the same every time a particular formulation is run—every lot produces the same results: poor physical properties, black specks, strands dropping, die holes freezing, vent ports fouling, etc. In these cases, the problem cannot be the result of a particular lot of raw materials, worn extruder components or any other temporary condition. The symptoms of chronic problems suggest that the process itself is the problem: improper screw/die design and/or operating conditions. For these problems, the treatment requires redesigning the screw configuration or modifying the compounding process. This is the only way to cure such problems.

On the other hand, if a particular compound has been produced successfully in the past, and today it runs differently—this is the symptom of a temporary illness. Now we must determine why the current condition exists and whether it is causing compound quality problems or processing problems. Illnesses

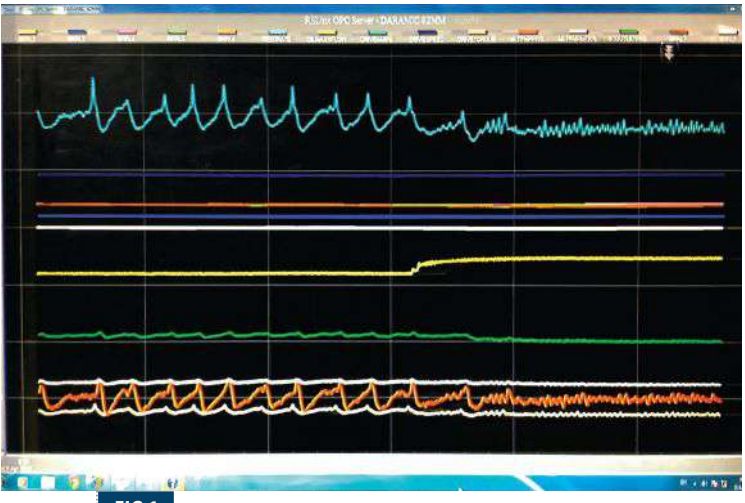

FIG 1

In a "shift," the process changes to a new equilibrium position and remains stable thereafter. (All images: CPM Extrusion Group)

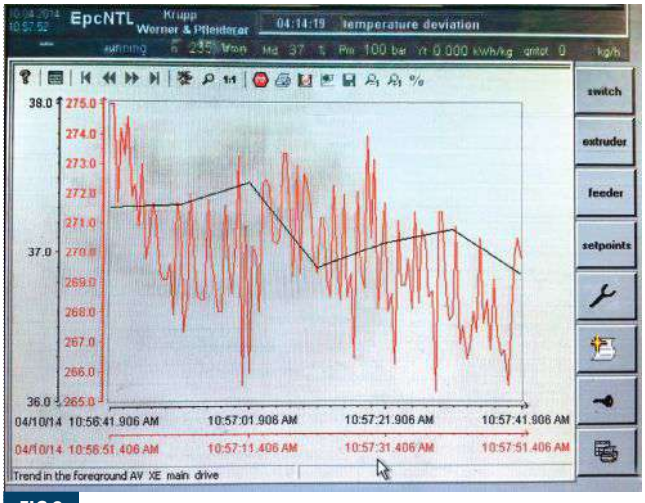

FIG 2

While there are clear signs of variability in a trend, the overall value of the parameter is moving up or down over a larger time scale, similar to the stock market's short-term fluctuation underlying longer-term growth.

are most commonly associated with specific lots of raw materials, mechanical failures (burned-out heater, leaky solenoid valve, etc.), environmental conditions, operator error or machine wear—all of which appear over different time periods.

LOOK FOR PATTERNS

Most modern compounding lines continuously log all the process data, which can be graphically displayed as trend curves over some defined time interval. When viewed in this way, it becomes obvious that there is a pattern to the variation or not. These patterns are not readily seen when viewing numerical information on the extruder control screens. The most common temporal (time-based) and spatial (relative to one specific area) patterns observed during compounding operations are described below with typical root causes.

Nearly every aspect of twin-screw compounding exhibits some degree of short-term variation.

Shift: We describe this first pattern as a "shift"—when the measured parameter moves up or down to a new equilibrium position and remains stable at the new level (Fig. 1). Measured parameters can be any process variable (percentage torque, die pressure, melt temperature, etc.) or any product-quality attribute (melt flow index, percentage ash, color, tensile property, etc.). We should also consider the time frame over which the shift occurs—e.g., gradual change over hours or rapid change within a few minutes—to assist in identifying possible causes.

Which parameters can change like this? Over what time scale? Raw-material lot changes can appear like this, changing the rheology in the extruder as soon as the new lot enters the machine. The process (and product) moves quickly to a new and stable condition. The affected parameters can include motor load (percentage torque), discharge melt temperature and pressure, product melt-flow rate.

Changes in environmental conditions (ambient temperature and/or relative humidity) can influence raw-material temperature, for example, if the resin feedstock is stored in outside silos. Significant changes in ambient temperature can occur within 12 to 24 hr, for example, but generally not in less time than this. As a result, the process will shift gradually over this time frame until reaching a new equilibrium.

Trend: Nearly every aspect of twin-screw compounding exhibits some degree of short-term variation—e.g., barrel temperatures, motor load, die pressure, feeding rate. However, the average value remains constant. In the case of a trend pattern, the average value is increasing or decreasing continuously over some longer time frame (Fig. 2).

We can rule out some variables: For example, raw-material lots do not change in one direction only. Common variables that do tend to trend include barrel temperature caused by cooling-valve failure; pellet size and shape caused by die-hole freeze-off ►

QUESTIONS ABOUT TWIN-SCREW COMPOUNDING?

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Navigate to Compounding under the Processes Tab of the top navigation bar.

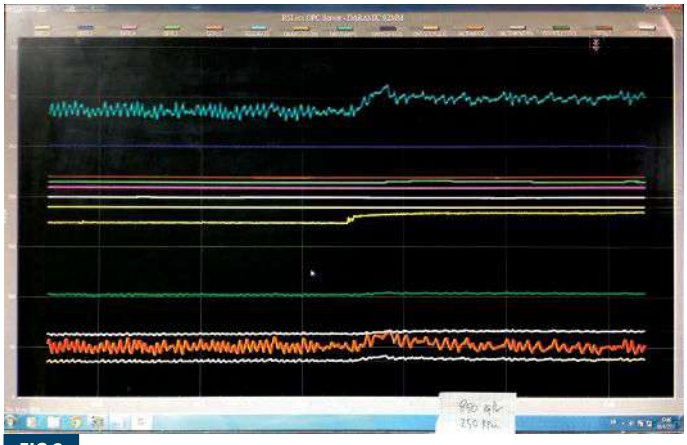


FIG 3 During oscillation, the process parameter or product-quality attribute (e.g., percentage ash) is moving up and down at some regular frequency. How much variation is normal? What is the frequency? What is the root cause of the variation?

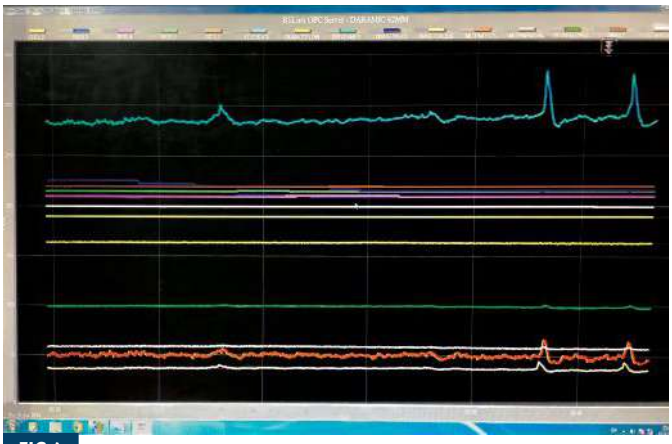


FIG 4 Upset conditions are extremely hard to diagnose since the parameter always returns to the initial equilibrium condition after the upset. There is no pattern or regularity for the time between upset conditions or the amount of deviation during the upset condition.

(e.g., caused by a burned-out heater); product porosity caused by vacuum-system fouling (accumulation of material over time in vacuum piping).

The source of change (e.g., failed component like a cooling solenoid valve) must remain in the failed state throughout the remainder of the production lot for the trend pattern to continue.

As opposed to looking for a trend from a single production lot, we could look at many different lots in sequence to see the trend from screw or barrel wear, as this time scale is months or years.

Oscillation: What is an acceptable amount of variation, for example, for barrel temperature? How much variation in percentage torque or melt pressure is normal?

Regular variation is to be expected for most process parameters and product properties, as there is inherent "noise" in most measurements and also variation associated with PID control loops (Fig. 3). Some acceptable tolerances:

- Temperature control: ±5° C (10° F).
- Motor load/amperage/torque: ±2-3%.
- Feeding rate: ±1-2%.
- Ash content: ±1-2% (should be same as feeding rate).
- Melt pressure: ±2-3%.

For variation greater than "normal," search for the underlying causes. In the case of feeder variation, for example, if the speed of rotation of the metering screw is too slow, that results in surges of material being discharged from the feeder. These surges then induce variation in motor load and melt pressure in the extruder. In the case of barrel-temperature control, look at PID parameter tuning and adjustment of cooling valves (e.g., barrel cooling-water flow-control valve settings). When these manually adjusted cooling valves allow too much water flow, the result is large fluctuation in barrel temperature.

The frequency of fluctuation will depend on the source of variation (e.g., pulsation associated with screw feeders; opening of barrel-cooling solenoid valves) but is typically within seconds or minutes. When looking at longer time scales, we could also see the variation in environmental temperature or humidity from day/night, or even seasonal, changes having some influence on the compounding operation.

Many plant managers see the effect of shift change (e.g., regular variation every 8 to 12 hr), suggesting that the extruder operator influences the process measurements or product quality.

Most common upset conditions are related to accumulation of raw material that eventually avalanches into the extruder, causing torque spikes.

Upset: Upset conditions are extremely hard to diagnose since the parameter always returns to the initial equilibrium condition following the upset (Fig. 4). There is no pattern or regularity for the time between upset conditions or the amount of deviation during the upset condition. Such isolated incidents could be triggered by external influences, like incoming power surges, which must be included in the investigation.

Most common upset conditions are related to accumulation of raw material (e.g., powder buildup in feed hoppers) that eventually avalanches into the extruder, causing torque spikes. There is no regularity to the frequency of occurrence,

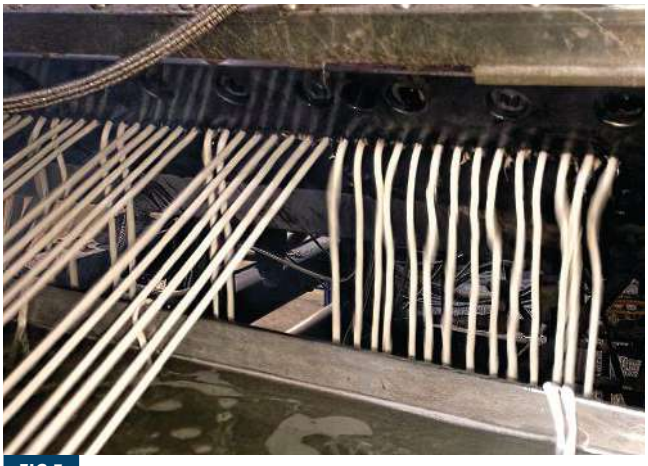


FIG 5 Spatial patterns are associated with product-quality defects as well as processing variables. Why does the product flow differently throughout the die plate? Why is the product hotter in the center of the die?

FIG 6 Are voids in the pellets of different sizes and randomly distributed (suggesting a problem with degassing in the extruder), or are they all the same size and always located in the center of the pellet ("shrink voids" usually associated with insufficient cooling downstream of the extruder)?

and it may be related, for example, to environmental conditions. Consider the case where the accumulation of powder only occurs when a specific filler type is run *and* when there is also high relative humidity.

Identifying the root cause for upset conditions often requires review of multiple lots over a much longer time scale (e.g., months) to determine whether environmental conditions or machine wear has any influence.

Spatial patterns: When a product quality problem appears at a specific location or position (e.g., only on the outer portions of the die), we can isolate the possible causes by considering how the extruder interacts with the die forming operation (Fig. 5).

Most modern compounding lines continuously log all the process data, which can be graphically displayed as trend curves over some defined time interval.

For twin-screw compounding extruders, the melt leaving the screw tips is fairly well mixed prior to arriving at the die entrance. To illustrate this, if you drop one black-colored pellet into a light-colored polymer through the vent port that is typically located at the very end of the extruder, the black color will be well dispersed across the entire die opening. The screws that are usually installed after the vent port are only conveying screws without any mixing elements—yet the color is well mixed throughout. What this implies is that *any* defect in the material exiting the screws will be very well distributed across the entire die; unmixed filler or unmelted polymer will not prefer to flow to one part of the die versus another.

Understanding that there is no mixing after the screw tips, any problems that appear within a specific area of the die cannot be caused by the extruder, such as poor flow from specific die holes, darker strands, or black specks that appear only on certain strands (Fig. 6). In these cases, the problems are created after the screw tips in the adapter, screen changer or die body.

Bottom line: Teach your staff to look at trend curves (a "history" feature is available on most extruder control screens that provides graphs to track specific parameters over time) for patterns that can quickly lead to or eliminate specific root cause(s).

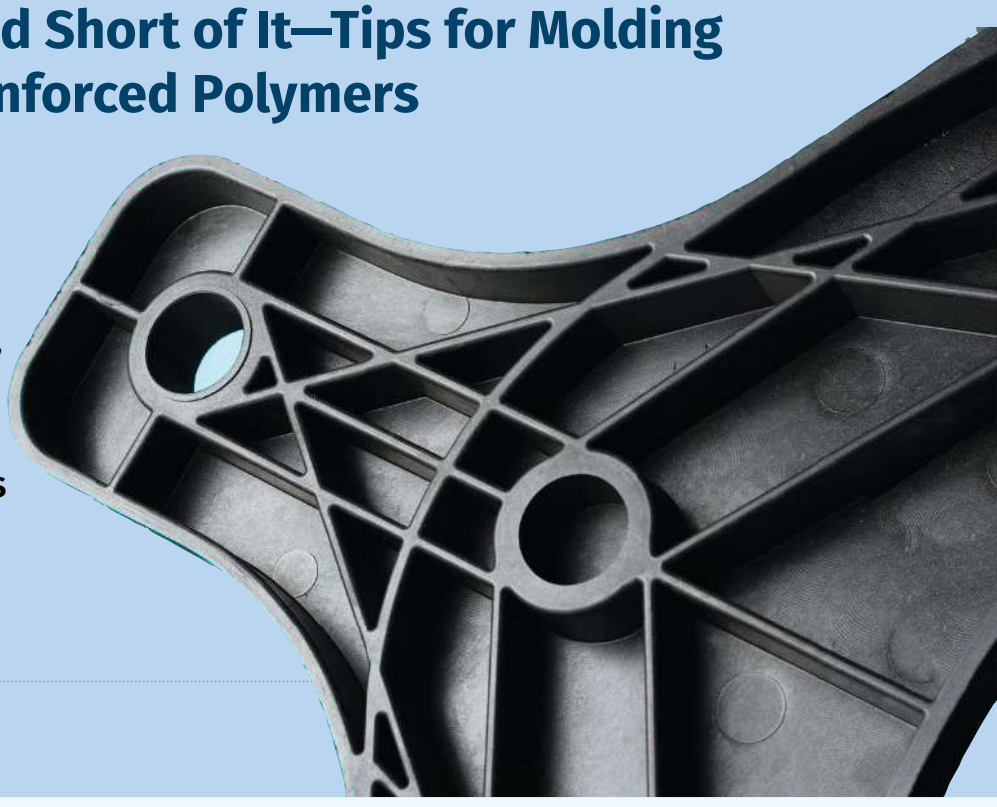
Along with staff training, a good preventive-maintenance program is also required to eliminate some of the "usual suspects" from causing most problems related to mechanical failures. PT

ABOUT THE AUTHOR: Adam Dreiblatt has more than 40 years' experience with twin-screw extrusion as a consultant, teacher and practitioner. He is currently dir. of process technology for CPM Extrusion Group, which supplies compounding extruders and replacement parts. He provides technical support to the global sales organization and customer base. Contact: *(231) 421-6896*; *adam.dreiblatt@cpm.net*; *centuryextrusion.com*.

PART 2

The Long and Short of It—Tips for Molding Short-Fiber Reinforced Polymers

Following on a similar guide for long-fiber reinforced compounds, here are practical tips on designing and injection molding parts utilizing short-fiber reinforcements.



By Zachary Alderman
Avient Corp.

Short glass or carbon-fiber reinforcements can be used in virtually any base polymer to create a compound with an enhanced strength-to-weight ratio and improved mechanical properties, such as better stiffness and wear performance. The improvements in strength result from the weaker polymer transferring load stress to the stronger reinforcing fibers. Strong, lightweight, corrosion-free glass- or carbon-fiber composites are good candidates for metal replacement and for demanding applications in such industries as sporting goods and marine infrastructure.

In Part 1 of this two-part series, we explored the particular benefits and challenges of molding long-fiber reinforced thermoplastics. Short fiber-reinforced polymers, while highly versatile, also present some challenges. They may not be suitable for applications requiring a resin-rich surface and glossy finish, because the fibers create a texture that is particularly evident in nylons such as PA6 and PA66. Furthermore, because the fibers do not absorb colorant, they can adversely affect or limit the appearance of the part. In the case of carbon fiber, which creates a mottled look, color choices for a part are usually restricted to dark gray and black to disguise this effect.

However, the most significant differences between short-fiber reinforced materials and their unreinforced counterparts pertain to processing, primarily due to changes in material properties and molding behavior introduced by the fiber. Part 2 of our series focuses on short-fiber-reinforced polymers, presenting factors to consider when molding these materials and offering practical tips on what to do and not to do.

One of the main differences between molding unmodified resins and running short-fiber reinforced compounds is shrinkage behavior. Fiber alignment during flow can cause anisotropic shrinkage and risk of warpage—a risk that increases with fiber loading and flow length. (All images courtesy of Avient Corp.)

Glass-fiber percentage loading by weight can be up to 60% and carbon-fiber loadings up to 50%, but in both cases, the fibers eventually begin to overwhelm the resin matrix and cause a decrease in properties.

SHORT OVERVIEW OF SHORT FIBERS

Short-fiber-reinforced polymers are produced by melt blending chopped fibers with a resin using a compounding extruder. Glass fibers are typically about 5 mm or 3⁄16 in. long, and carbon fibers are 6 mm or ¼ in. long. The compounded material is then extruded into a strand and pelletized.

This is unlike the process used for long-fiber-reinforced polymers, which are manufactured using pultrusion to produce a continuous-fiber roving that is then chopped to the desired length. Because it is simpler to manufacture short-fiber compounds, they are typically less expensive than their long-fiber counterparts.

Within the short-fiber category, glass fibers are less expensive than carbon fibers, which have a higher price tag thanks to their production costs. Carbon fiber does deliver superior mechanical properties, providing stiffness that is four to five times greater than glass fiber. This is one reason why it is often a top choice for metal-replacement applications when lightweighting is required.

Glass-fiber percentage loading by weight can be higher (up to 60%) than carbon-fiber loadings (up to 50%), but in both cases the fibers eventually begin to overwhelm the resin matrix and cause a decrease in properties. These percentages broadly apply to widely used resins such as polypropylene (PP) and nylon (polyamide or PA). Some materials, including high-temperature resins, will only tolerate lower fiber percentages before performance degradation begins.

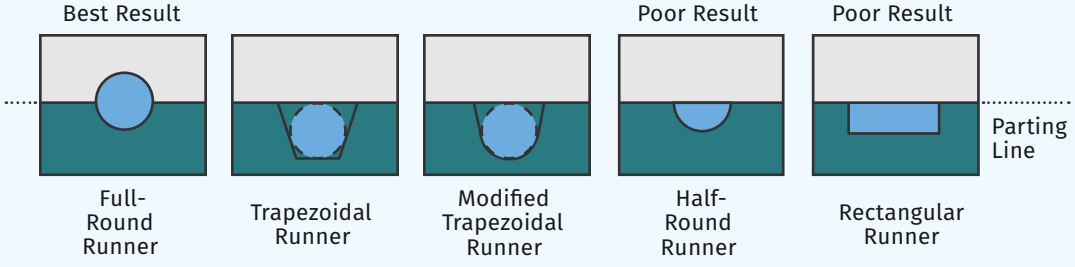
Short-fiber reinforced polymers are suitable for injection molding, compression molding and extrusion. Semi-crystalline materials are more commonly reinforced than amorphous polymers, in part because amorphous resins generally get a lower boost in mechanical properties from the fibers. Popular base resins that can be reinforced with short fibers include nylons, polyolefins and engineering thermoplastics.

CONSIDER THE SHRINKAGE

One of the main differences between molding unmodified resins and running short-fiber reinforced compounds is shrinkage behavior. Although short fibers are randomly distributed within the pellet, when the pellets are melted during the molding process, their fibers line up parallel to each other in the flow direction during mold filling. During cooling, the fibers resist shrinkage in that flow direction but allow it in the cross-flow direction. This anisotropic shrinkage can lead to warpage. The higher the fiber loading and/or the longer the part length, the greater the risk of warpage. In contrast, unreinforced polymers tend to shrink evenly in both directions.

Although tools designed for unreinforced resin can be used for fiber-reinforced materials, changes in processing parameters are usually necessary. For instance, a cooler mold will freeze the orientation of the fibers, not allowing as much shrinkage to occur and resulting in less warpage. A lower mold temperature will also allow the part to be released faster without causing deformation upon ejection. An exception to the process of freezing orientation occurs when the part experiences elevated temperatures after processing. Higher temperatures can allow the polymer chains to relax, which may result in warpage after molding.

FIG 1 **Runner Designs for Short-Fiber Reinforced Thermoplastics**



Some runner shapes are better than others when it comes to molding short-fiber reinforced materials. Full-round runners are best.

Warpage or deformation during cooling is also more common in thin-wall parts, although thick-wall parts are not immune to it. Of course, shrinkage during cooling is necessary to allow parts to be ejected from the mold. This requisite cooling only causes a problem when shrinkage is inconsistent or unplanned. Sometimes parts can be designed to account for warpage. One approach is incorporating "windage" or reverse distortion into the tool so that when warpage occurs the final part shape is corrected.

Alternatively, leaving the part in a hotter mold for a longer period will help reduce warpage by allowing the polymer chains to relax while the part is held in shape by the tooling. However, molders may not choose this method because it increases cycle time.

MOLD MATERIALS & DESIGN

Since reinforcing fibers are abrasive, they will erode the surface of the mold over time. The ends of the short-fiber filaments, which are scattered throughout the pellet, act like needles that impact the steel at different angles. Contrary to popular belief, short fibers are harsher on tool steel than long fibers. That's because there are fewer ends in long fibers with the same weight percentage as short fibers.

Adding glass fibers diminishes weld-line strength because the fibers are unable to cross over between the intersecting flow fronts and provide strength at the point where they meet.

For this reason, when running short-fiber materials, it is recommended to use a harder mold steel, such as H-13, a chromium molybdenum hot-work steel; or P-20, a low-alloy steel. It is also advisable to add some type of hard plating to the cavity surface.

When it comes to tool design, radiused (arc-shaped) runners are advisable to avoid 90° angles that can break the fibers. Sharp, 90° turns without fillets or radii should also be avoided. Furthermore, using a full-round runner eliminates dead flow zones, or areas where a solidified layer of plastic does not permit the full volume of flow. All other runner shapes have these areas.

Gates should be located in areas that will not interfere with fiber orientation, which is crucial for optimizing strength and stiffness. The ideal location for gates is at the end of the part. This is contrary to techniques often employed with unmodified plastics, where a gate might be placed in the center of a part to balance fill. Also, the gates should be sized generously (avoiding pin gates) to accommodate the greater viscosity of the fiber-reinforced resin and ensure complete mold filling. Recommended gate types include fan gates, tab gates and edge gates.

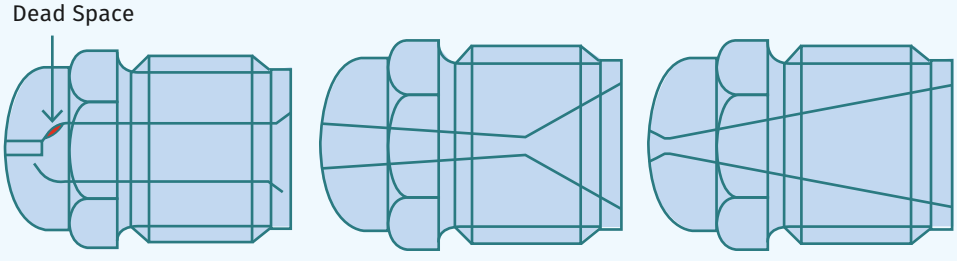
Another key consideration is weld lines. Adding glass fibers diminishes weld-line strength because the fibers are unable to cross over between the intersecting flow fronts and provide strength at the point where they meet. If they simply hit each other without intermingling, mechanical performance will be limited to the properties of the resin matrix. And the higher the fiber loading, the fewer polymer chains are available to entangle at the weld line.

Although many other factors affect the weakness or strength of weld lines, gating once again plays a key role. Gates should be carefully placed to avoid the formation of weld lines at critical structural points, such as areas of high stress during part use. The gate location should enable the two flow fronts to merge easily and continue to flow beyond the weld line.

MOLDING EQUIPMENT

The need to minimize fiber breakage, plus the higher viscosity of materials with high fiber content, require some adjustments to the molding equipment. For example, a larger-than-normal nozzle orifice (7⁄32 or 9⁄32 in.) can ensure unrestricted material flow. Also, a reverse-taper nozzle is better for fiber-reinforced materials. A reverse-taper nozzle does not have the same restrictions as a general-purpose nozzle, so it can help reduce the overall shear force applied to the material. Lower shear helps to maintain the fibers' length and prevents them from turning into a powder. It also helps reduce the chances for polymer degradation from excessive heat.

FIG 2 **Different Styles of Nozzle Tips**



A reverse-taper nozzle tip is recommended for processing short-fiber reinforced materials.

Another approach to lowering shear is using a low-compression screw that turns at a lower rate (50-199 rpm) with lower backpressure (50-200 psi).

A flatter-profile screw creates the highest temperature at the nozzle and will provide less temperature difference along the five heat zones of the screw barrel. Alternatively, the hottest zone of a reverse-profile screw is at the feed location. A reverse-profile design is sometimes used with long fiber-reinforced compounds so the polymer melts from heat instead of from shear forces produced by the screw's rotation. These shear forces cause fiber attrition. Further, this type of screw may be used when excessive drooling occurs at the nozzle.

PROCESSING PARAMETERS

As with all fiber-reinforced compounds, retaining fiber length during processing is essential for maximizing material performance in molded parts. Reductions in fiber length can occur throughout the molding process and are tied to factors such as undersized gates, as mentioned earlier. Unhindered flow can help preserve the integrity of the fibers. A few factors to remember:

Very thin walls can increase shear forces during mold filling and cause fiber breakage. Thin walls can also make the fibers more visible in the finished part.

- **Drying:** Drying requirements depend on the type of resin and whether it readily absorbs moisture.
- **Conveying:** Avoiding sharp corners or impacts while conveying the pellet to the molding equipment can help protect fiber length.
- **Injection speed:** Slower than 25.4 mm (1 in.) per second is ideal for minimizing shear and fiber breakage, although any speed less than 3 in./sec should suffice. On the other hand, injecting too slowly can result in premature freezing-off of the gates or other areas of thin-wall parts, causing a short shot.
- **Mold filling:** Fill the mold to 98% in the injection phase (compared with 95% for most unreinforced resins) and then fill the remaining 2% in the pack phase.

PART DESIGN

Like processing, part design should play to the strengths and avoid the weaknesses of short fiber-reinforced materials. Considerations include wall thickness: Very thin walls can increase shear forces during mold filling and cause fiber breakage. Thin walls can also make the fibers more visible in the finished part. It is advisable to avoid walls thinner than 0.762 mm (0.030 in.), particularly in parts with a longer flow lengths.

GOING LONG ON SHORT FIBERS

Fiber-reinforced polymer compounds are a huge and growing market, with an estimated one-third of polymers compounded with fiber and/or other particulate reinforcing additives, thanks to high demand from the transportation, electrical, electronics, wind-energy, pipe and tank industries. Carbon-fiber reinforced composites are expected to grow at an average rate of more than 8% from 2019 to 2024. Increasing use of carbon-fiber materials by the aerospace and automotive industries is a major factor; however, high cost and limited capacity are working against stronger gains.

The popularity of short-fiber reinforced materials makes it likely that many molders will work with these materials. As a starting point, the material can be processed in existing equipment using standard parameters. The results may be acceptable if the goal is to achieve an increase in mechanical properties. Following the recommendations in this article can help optimize part strength and stiffness.

EDITOR'S NOTE: Part 1 of this series addressed long-fiber processing fundamentals and best practices, including practical tips and guidance on maintaining fiber length and deriving maximum advantages for demanding applications.

ABOUT THE AUTHOR: Zachary Alderman, senior ADTS engineer, Avient Corp., is an experienced application development engineer who provides application engineering support to Avient's West Coast sales team. Skilled in Moldflow and SolidWorks, Alderman has a deep knowledge and understanding of injection molding and plastics materials. Alderman has a bachelor's of engineering (B.E.) in plastics and polymer engineering technology/technician from Pennsylvania State University-Erie.

PLASTICS RECYCLING LATAM

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In this context, 2022 will mark the debut of the **Plastics Recycling LATAM** conference and exhibition, presented by Plastics Technology México magazine, and its publishing house Gardner Business Media (GBM), with the support of **ECOCE**, celebrating 20 years of promoting the environmental education as key to sustainability.

Plastics Recycling LATAM will present knowledge, technologies, and networking opportunities around recycling and the use of post-consumer recycled materials in the value chain of plastics for Mexico and Latin America.

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Is Your Profile Die the Problem? Or Is It the Heaters?

When a profile is not being extruded to the tolerances of previous runs, the die is often suspect—but the real problem may be the heaters. Learn the five heater-band principles before you do any profile die work.

By Tim Groth
Extrusion Solutions North LLC

The profile extrusion process has many variables that processors try to control, and one of the most overlooked is how heat is applied to the profile die via heat transfer from the heater band. Often, a profile cannot be extruded to the same tolerance as the previous run. In response, work is done to the die to compensate for heat not being appropriately applied, or not applied in the same manner as when the tool was hung on the extruder.

Here's a more efficient approach to that problem. There are five principles of heat transfer that processors need to know before proceeding to tooling work.

1. Contact: Heater bands tend to curl up away from the tooling after repeated use. Regardless of the heater system or style the processor uses to keep the heater in contact with the tool, an air pocket will develop at some point along the heater band (Fig. 1). This air pocket will cause the tool to be nonuniform in temperature. The colder tool surface will slow the velocity of the plastic as it goes through this portion of the tool, causing the profile to run out of tolerance compared with the previous run. A gap as narrow as 0.015 in. is enough to cause a temperature variation in that area of the tool.

Heater bands tend to curl up away from the tooling after repeated use.

2. Openings: When more than one heater band is used on the tool, the openings need to be rotated 180° to each other. If the openings are parallel, a cold section will develop on the tool, again causing the material to run at an inconsistent velocity. In Fig. 2, the openings are in parallel, and the side of the tool with those openings will be colder than the other side. When multiple bands are required, mount every other band with the opening on the opposite side of the tool.

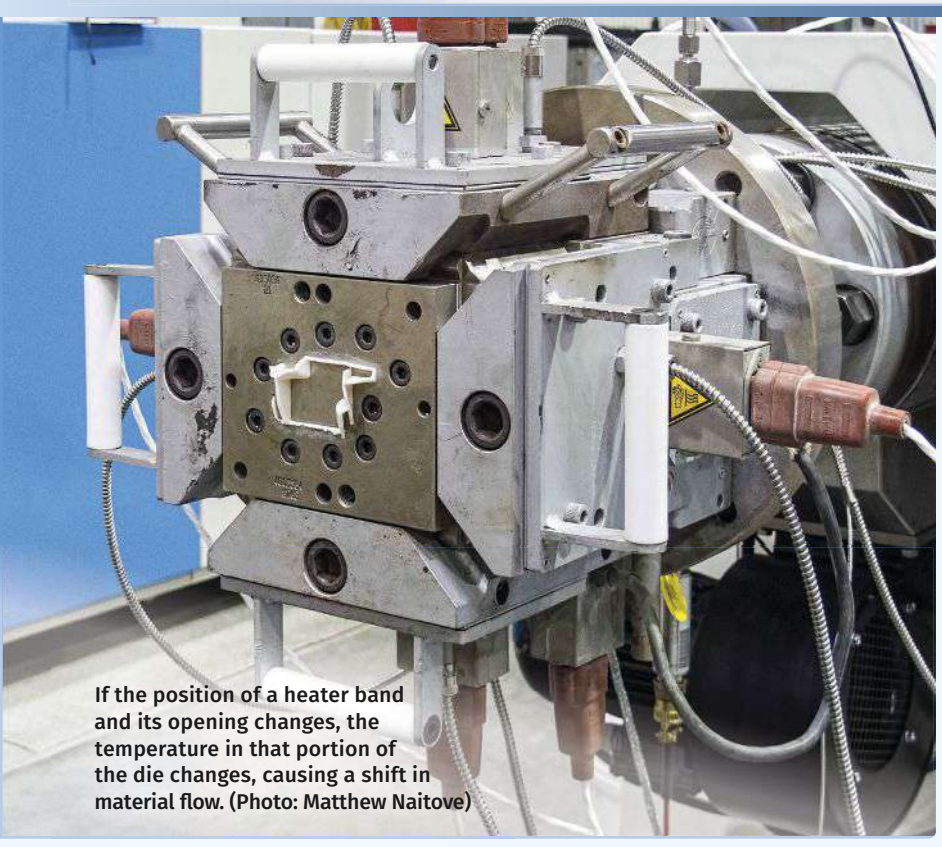
3. Heater Band Style: There are many styles of heater bands. The scope of this article is not to ascertain what style is best but rather to make processors aware that not all styles apply heat equally to the tool. All bands have an opening in which no heat is applied. The heating distance from the opening on the band varies with band style and manufacturer. The band style with a clamp requiring no tools to tighten tends to have a larger area where no heat is applied (Fig. 3). Be aware of the dead space on the band being used.

4. Wattage: Most processors tend to overshoot the wattage required in an effort to speed up the changeover process. Plan

QUESTIONS ABOUT PROFILE EXTRUSION?

Learn more at PTonline.com

Navigate to Extrusion under the Processes Tab on the top navigation bar, then to Pipe, Profile and Tubing Extrusion on the following page.



If the position of a heater band and its opening changes, the temperature in that portion of the die changes, causing a shift in material flow. (Photo: Matthew Naitove)

for 0.035 kw × in.^{2} as a standard. Too high a wattage will overshoot the heat required. Temperature controllers must be auto-tuned to the band wattage. If multiple sizes of bands are used on any one extruder tool, standardize by making a ring to cover the tooling and use one standard size and wattage of band.

5. Location: The band's location on the tooling must be duplicated each time the band is taken off. Ideally, the band opening and position on the die will always be the same to repeat the melt temperature across the extrudate. Use some form of locating system on the die as a stop to how far on the tool the band should go on. Also incorporate some form of location for the opening of the band. When the band's location is changed, the temperature changes, causing a shift in material flow. The velocity of the material will flow toward the path of least resistance, the hottest portion of the tool.

Before starting up the extruder, map the die heat.

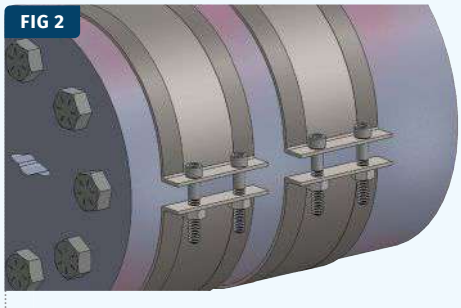
Before starting up the extruder, map the die heat. Using a pyrometer, check the temperature on the final die plate in the four directions: North, East, South, and West. Any variation beyond 2° F will require a recheck of the five heater-band principles cited above. Don't do tooling work until the heat transfer is verified by means of temperature measurement. PT

ABOUT THE AUTHOR: Tim Groth has more than 37 years of hands-on extrusion experience, specializing in design for extrudability, tooling design, troubleshooting, material selection, plant setup, training of engineers and setup technicians, and practicing Lean Manufacturing principles. He is currently dir. of engineering for consulting company Extrusion Solutions North LLC, Hastings, Minn. Contact: *(651) 357-0814; timtgroth@gmail.com.*

FIG 1

At some point an air pocket (shown in red) will develop along the heater band after repeated use. This air pocket will cause the tool to be nonuniform in temperature. (All illustrations: T. Groth)

FIG 2



When more than one heater band is used on the tool, the openings need to be rotated 180° to each other. If the openings are located in parallel as shown above, a cold section will develop on the tool, causing the material to run at an inconsistent velocity.

FIG 3

Band-style heaters have an opening in the back where no heat is applied.

Keeping Up With Technology

PRODUCT FOCUS **Auxiliaries**

MATERIALS HANDLING

‘Touch and Feel’ Auxiliaries

At this months’ PTXPO, Conair will highlight its common control platform, giving attendees a chance to experience it firsthand on the SmartFLX conveying system, dX25 mobile dryer and Thermolator temperature-control unit. Providing users the same look and feel regardless of the equipment involved, the common control places all the buttons in the same place on the HMI, while utilizing the same names and color schemes. Conair says these features not only make the controls easy to operate, but they also minimize the amount of cross-training required for an operator to run different equipment types.

Promising a “hands-on experience,” Conair will allow visitors to operate the controls. For the SmartFLX, attendees can interact with the main control panel, as well as the remote-control panel. Representing Conair’s latest conveying control, the SmartFLX features the new system architecture and a more powerful PLC processor, including an intelligent configurator that simplifies and reduces costs for system design and installation, expansion, and remote diagnostics.

Visitors will also be able to operate Conair’s RFID-equipped resin-selection table. By making connection changes, attendees can see how the table lights direct them to the correct connection and how conveying is disabled until the correct connection is made. A truck-fill line-proofing system, with barcode-based lockout, will also be available for interactive evaluation.

Finally, show visitors will be able to see SmartServices, Conair’s cloud-based Industry 4.0 solution for connecting, monitoring, and managing auxiliary equipment. A dashboard will be connected remotely to operating equipment at Conair facilities in Cranberry Township and Franklin, Pa., to give customers an opportunity to see live demonstrations of all features, including the newest remote machine control, resin reporting, KPI prioritization, and equipment grouping.

FEEDING

Twin-Screw Feeder Delivers Precise Batches

The Model TSF twin-screw feeder from Best Process Solutions is designed for precise batching and weighing. The dual-helix design combines fast, high-volume filling with accurate dribble flow at the end of the cycle. Its compact design is a solution when limited space prohibits multiple individual-screw units.

Two helixes of 1½- or 4-in. diam. are mounted on an 18 × 22 in. hopper. They are rated at 17 ft^3 and 283 ft^3/hr, respectively, at maximum rpm with 100%-efficient conveyable product and no slippage.

FEEDING

Universal Controller for Liquid Color Pumps and Blenders

A next-generation, universal controller with touchscreen technology, enhanced processing power, and WiFi capabilities, will be highlighted at this month’s PTXPO by Riverdale Global. It is designed to support various metering options beyond the company’s liquid-color Pump in a Drum (PIAD), including specific blenders and all peristaltic pumps.

The technology is said to integrate seamlessly with the company’s Return for Refill liquid-color system, which refills empty containers of the same color, maximizing color usage while leaving zero waste for landfills.

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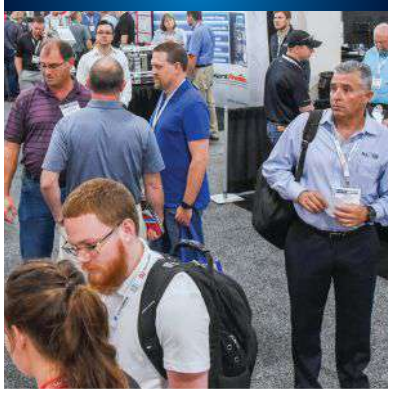


A packed hall floor will showcase companies from every step of the mold manufacturing process, from design to first shot.

NETWORKING

A shop is only as good as it's partners, and the Moldmaking Pavilion @ PTXPO will connect you to the entire mold manufacturing and plastics supply chain.

PTXPO.COM

The plastics market doesn't move without expertly crafted molds. The supply chain starts with molds, and the supply chain connects at the Moldmaking Pavilion @ PTXPO.

FEEDING

Robust Single-Screw Feeder

At the upcoming PTXPO, Coperion K-Tron will debut the ProRate Plus, billed as a robust, reliable and economical single-screw gravimetric feeder for simple applications involving pellets, granules and other free-flowing bulk materials. These continuous gravimetric feeders are available for fast delivery in three sizes handling feed rates from 0.12 up to 400 ft^3/hr, depending on the material. Their space-saving trapezoidal shape allows up to six feeders to be grouped around an extruder inlet within a 5-ft radius. Theoretically, a system with six ProRate Plus-L feeders can feed up to 1017 ft^3/hr within a footprint of only 75 ft^2.

ProRate feeders are highly standardized, minimizing the number of spare parts necessary. Simple access for cleaning and maintenance, even within a cluster, is provided by a patent-pending rail system called "ProClean Rail." This allows retracting the base unit toward the rear of the feeder and rotating it for access to the feeding section and screw element. This allows for maintenance and cleaning while keeping the feeder in position. In addition, the bellows and screw use the latest magnet technology for simple but robust mounting. The magnet connections allow these parts to be released without tools while at the same time providing the required holding force for safe operation.

Each feeder comes equipped with its own pre-wired control module mounted to the feeder stand with adjustable height. There are a basic motor-control unit or an advanced version with integrated user interface, line-control functionality and host communication port (Ethernet IP or Profinet).

HEATING/COOLING

Heating & Cooling Hose Line Upgraded

Hasco says its new Z859PL/ Push-Lok hoses were enhanced to further ease mold setup and teardown. Available in blue and red to clearly denote inlet and outlet lines, the hoses use a "special material blend" to maximize service life of the flexible, twist-free and kink-resistant product. The hoses are temperature-resistant from -40 to 140 C (-40 to 284 F) and require no additional hardware like hose clips and crimps. An identification ring marks the endpoint to ensure reliable mounting of the hose on the coupling. In addition to hoses, the system includes valve and valveless shutoff couplings in a 45° or 90° design, as well as hose-extension nipples for lengthening hoses and a new multi-coupling system.

HEATING/COOLING

High-Temperature Hoses

A new line of mold hoses from Mouldpro ApS of Denmark will be distributed in North America by Globeius Inc. They are designed for high-temperature conveyance of water, oil and chemical media. The T series is designed to work at up to 327 F (164 C), while standard mold water hoses typically operate up to around 212 F (100 C).

The T series hoses are constructed of low-profile, helically convoluted PTFE reinforced with stainless-steel overbraids. Hoses are available with silicone red and blue covers. Globeius says the hoses are in stock at its headquarters in Miami and ready for fast delivery.

HEATING/COOLING

High-Performance Coolant for Extruders, Thermoformers

iD Additives Inc. will feature at this month's PTXPO the latest addition to its Eco-Pro 360 line, which efficiently removes rust and cleans out clogged water lines in injection molds, heat exchangers, chill rolls, and other system components. In addition, new Eco-Pro Cool-Ex coolant is designed to optimize extruder cooling (feed sections, zone coolers, jackets, rails) or any other closed-loop cooling-water systems.

Cool-Ex is used in lieu of facility water, which often contains contaminants responsible for scaling, deposits, and corrosion (photo). Utilizing this coolant reportedly will inhibit mineral scale and fouling and thus prevent unscheduled shutdowns.

TESTING

Offline, Automated Inspection and Analysis Tool

A new purity inspection and analysis tool for raw materials reportedly combines the functionality of a conventional optical light table with automatic evaluation. It will be showcased at this month's PTXPO by Sikora International. Said to be unique to the market, Purity Concept V is designed for laboratory testing or random sample inspection of pellets, flakes and test plates.

The automated light table inspects the test material placed on a sample carrier and evaluates the image recordings quickly for contaminants such as black specks and color deviations down to 50 micron size. These are highlighted on the monitor and marked optically on the sample carrier.

TESTING

New Version of Advanced Metrology Software

MCosmos Version 5.0, the newest version of advanced metrology software for coordinate measuring machines (CMMs) from Mitutoyo America, features numerous upgrades, including the new and simplified graphical user interface, which is said to improve the user experience at any level of knowledge of the product.

These changes include easy-to-use "ribbons" and a much-requested search function, assisting operators in finding specific sections of their measuring process for detailed reports.

Substantial progress reportedly has been made in Mitutoyo's optimization for large CAD files over previous versions of the software, reducing process time and improving the overall operation of MCosmos.

Added in this new version of MCosmos is a 3D topographical view of the geometry and microstructure of technical surfaces, including visualization of tolerance zones. This is especially handy when operators are utilizing noncontact measurement methods. GD&T reporting is another new feature; it is becoming a standard among inspection reports, making it easy to summarize the true positions and tolerancing of workpieces.

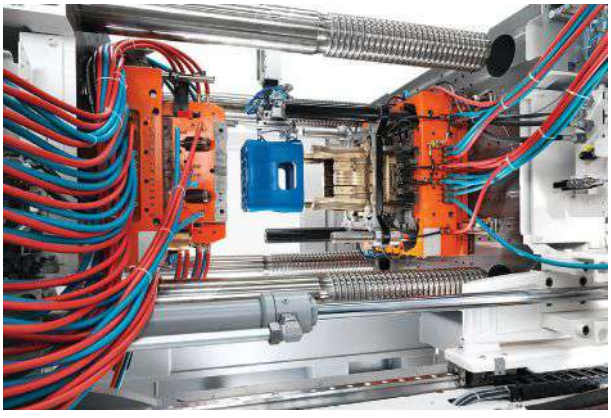
Other new features include point displays that indicate tolerance based on their color, revision management, faster execution, and a Stylus & Fixture Builder.

INJECTION MOLDING

Robot Synchronizes Movement with Machine for Faster Takeout

KraussMaffei (KM) Automation, the company's robotics division, has introduced "synchronous motion," allowing robots to synchronize with the ejector function of a molding machine and enter a mold while the platens are still in motion. In addition to speeding up the molding process, this also reduces the need for pneumatic systems.

Beyond keeping nonproductive time as short as possible, KM notes that this technology can also make it possible to eliminate complicated gripper hardware. Ejector movement can be used for



difficult-to-demold parts with the robot gripping the finished part during the demolding process as the ejector pushes the component onto the gripper. This requires a pneumatic system for the gripper during this "depressurize" step. If, however, the gripper moves along with the ejector, no pneumatic system is required.

KM reports that synchronous motion enables demolding time to be reduced by approximately 35%. In production of trash containers, for example, KM says this reduction in demolding time equates to a 6% reduction in total cycle time.

KM offers synchronous motion both for new machines and as retrofits for the MC6 controls on existing machines. It works with KM's LRX series linear robots and its IR industrial robots.

EXTRUSION

Innovative Film Gauge is 'Ultra-Accurate'

NDC Technologies has taken its Series 9 on-line gauging system one step further with the the Series 9 Converting Gauge. Billed by NDC as "the best-in-class, best-in-value measurement system on the market today," the gauge is said to have a unique set of capabilities for unparalleled measurement performance across a wide range of converting applications.

More specifically, the Series 9 gauge is said to provide:

- **Greater process visibility:** When integrated with NDC's high-performance single-beam scanners, such as the new SlimTrak II, and Pro.Net TDi web-gauging controller, the Series 9 gauge reportedly provides process visibility far beyond that of conventional in-process measurement systems. Users can effectively perform ultra-accurate measurements of moisture, coat weight, degree of cure, and film/layer thickness.
- **Long-term stability:** It delivers ultra-reliable operation with no need for recalibration, systematic monitoring or correction for drift.
- **Advanced diagnostics:** It includes powerful features for preventive maintenance to ensure maximum uptime.

INJECTION MOLDING

Hot-Runner Nozzle Range Maximizes Output, Minimizes Size

Hasco has introduced the Single Shot H6300/ hot-runner nozzles for small and medium-size parts, featuring installation dimensions comparable its Vario Shot nozzles, as well as optimized temperature control and economic design. The Single Shot comes in two sizes with melt-channel diam. of 7 and 9 mm for low-shear mold filling, shot weights up to 800 g, and nozzle lengths up to 179 mm. The shortest depth for the 32-mm diam. nozzle is 73 mm, while the shortest for the 40-mm unit is 90 mm. The line offers a range of torpedo designs and screw-on melt chambers.

Different nozzle variations allow a straight melt feed into a sub-runner or direct gating to the molded part. In addition, various wear parts—including the tips, melt chambers, and thermocouple—are interchangeable, easing their service and maintenance. The heating unit is firmly pressed directly onto the nozzle and has just one control circuit, which Hasco says helps ensure a uniform temperature profile along the full length of the nozzle.

Hasco says strategic placement of the thermocouples and insulating the nozzle body from the surrounding mold enables processing of plastics with a tighter temperature range. A single control circuit and pressed-on heating reportedly reduces nozzle power requirements.

EXTRUSION

Slitter-Rewinder Packed with Safety Features

At the upcoming PTXPO, Parkinson Technologies will be distributing literature on its new Dusenbery MasterSlit DC2 duplex center slitter-rewinder. To address the challenges to operator safety and ergonomics when producing larger finished rolls at higher operating speeds, Dusenbery has incorporated the latest updated safety standards published by the American National Standards Institute (ANSI) and the Plastics Industry Association (PLASTICS). On the material inlet end, a transparent barrier guard remains locked during high-speed operation and provides safe viewing of the process without exposure to the hazards associated with slitting materials at high speeds.

A new control station enables the operator to request safe entry when it's necessary to enter the slitting area for setup or threading material through the machine. Once the request is made, access is declined until the machine reaches the safe speed specified in the newest safety guidelines.

Another new feature provides safe inspection of the winding area with the use of a hold-to-run device. When engaged, this hand-held device slows the machine to a safe speed and initiates a 2-min timer that allows entry into the area while certain functions are temporarily and safely disabled. This feature gives the operator the ability to safely obtain a close-up view of how the material is wound and complete common quality checks such as roll hardness, edge profile, and core alignment. Failure to exit the winding area before the timer runs out, or letting go the hold-to-run button during timer operation, will cause an immediate emergency stop of the machine.

Dusenbery also improved the machine interface with new features such as enhanced diagnostics, component status, and more straightforward navigation to provide intuitive operation.

EXTRUSION

Sheet Roll Stand is Compact, Flexible

PTi will use PTXPO to show its eG-Series Roll Stand for the first time. Developed as a hybrid of the G-Series Configurable Roll Stand, this unit features a unique, compact design for sheet processors with very limited production floor space. It is offered in J-stack or vertical-down configurations, with with small to medium-sized rolls ranging from 36 to 66 in. wide and 12 to 30 in. diam. Other options are available.

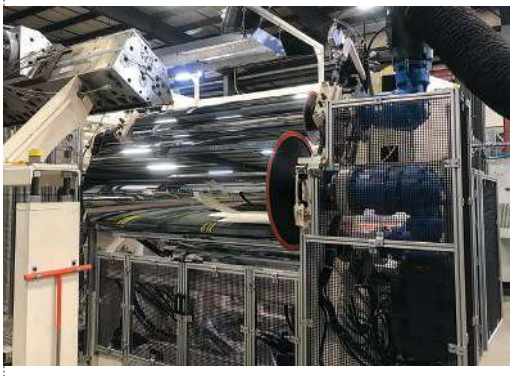
The roll stand is said to enable production of high-quality sheet by offering accurate cooling temperatures, while incorporating design features that simplify the extrusion process. Patented features carried over from earlier eG-Series models include the linear roll-stand traverse, vertical nip-height positioning, chrome-roll safety lockout, and transfer-roll coating.

EXTRUSION

Roll Stand Offers More Automation and Process Control

Applicable to both sheet and cast film, Davis-Standard's new XP Express-AGT (Active Gravity Touch) roll stand reportedly features greater automation and process control for web thicknesses from 8 to 60 mils.

The unique inverted-down, multi-roll design reportedly facilitates improved die-nip management and handling, efficient web cooling and conditioning, precision roll-drive control, and high-performance web-path options. In addition, the XP Express-AGT addresses low-melt-strength resin delivery from die slot to nip, and improves processing of thin gauge sheet.



"The XP Express-AGT is our most versatile and operator-friendly roll stand model yet," explains Steve DeAngelis, Davis-Standard's v.p. of sheet and foam. "It offers more automation and roll control along with smarter ergonomics and a space-saving footprint."

The roll stand is currently available in widths from 36 to 80 in. and for output rates up to 5500 lb/hr. Processors can choose among three AGT roll-stand options, each of which offers a fully automated multi-roll nip gap, individual roll-speed and temperature control, enhanced heat transfer, and an adaptable pull-roll design. This is augmented by four-point Y-axis and traverse X-axis control. Uniform cooling on both sides, double polishing capabilities, reduced web stress, and consistent web orientation and thickness control promote high-quality flat sheets with desired clarity.

DeAngelis will be discussing the features and benefits of the stand in a "Tech Talk" presentation at PTXPO this month (see p. 18).

ADDITIVES

Graphene Nanotube Concentrate Allows Automakers to Boost Efficiency

A new graphene nanotube concentrate reportedly provides targeted conductivity to injection molded ABS, PC, PPS and TPU automotive components at loadings from as little as 0.1 wt.% of nanotubes in the final system. It has been launched by OCSiAl (U.S. office in Columbus, Ohio), said to be the world's largest manufacturer of single-wall carbon/graphene nanotubes. This additive reportedly allows automakers to optimize the painting process and reduce final production cost.

Introducing these nanotubes creates a permanent and homogeneous electrical conductivity without "hot spots," in the range of 10^5–10^9 ohm-cm, while retaining the original key mechanical properties, such as durability and strength. Furthermore, a low working dosage of 0.1-0.3 wt.% of graphene nanotubes has only a limited effect on rheological properties and processability. These characteristics are said to be much superior to those obtainable with higher levels of carbon black.

Said Vladimir Kravchenko, OCSiAl's development and support leader for thermosets, "We already see demand from manufacturers of fuel-system parts including quick connectors, fuel pumps, valves, filter housings, EV-battery caps and other car components."

COMPOUNDING

High-Torque Twin Screw for High Output

ENTEK Extruders will be distributing literature at the upcoming PTXPO on a series of new products aimed at compounders, including a 72-mm co-rotating twin screw that is the first in ENTEK'S HT (high-torque) series. The new extruder reportedly delivers the industry's highest free volume of 1.61 D_o/D_i at 18 Nm/cm^3 torque density, and can operate at rates up to 10,000 lb/hr.

Target markets are high-output commodity and masterbatch compounding, an area that ENTEK previously has not served. These markets typically run medium-to-large batches on a 24/7/365 basis. The machine features an oversized motor and is also said to be well suited for other applications that are torque or power limited.

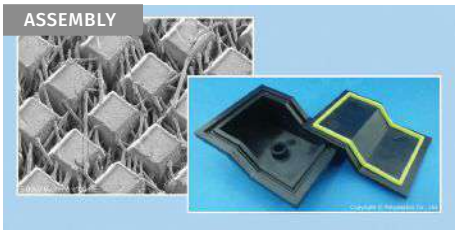
COMPOUNDING

Next-Generation Laboratory Roller Extruders

At PTXPO, Germany's Entex (represented in the U.S. by Triad Sales, Greer, S.C.) will show its new line of Laboratory Roller Extruders (LRE), which covers the entire range of compounding and reaction technology. With its modular design, the processing options are very diverse, especially for mechanically and thermally sensitive materials. Thanks to the multiple configuration variants, even very demanding compounding, mixing and degassing processes reportedly can be realized in a "material-friendly" way.

The adaptable configuration of the kneading elements is said to allow for large free volume. Precise fluid temperature control is achieved through large heat-exchange surfaces and the separation of thermal and mechanical energy. Effective degassing is also provided.

ASSEMBLY



Innovative Technology Bonds Dissimilar Glass-Reinforced Themoplastics

An innovative bonding technology for glass-fiber reinforced thermoplastics from Polyplastics Co. Ltd. is said to be unlike traditional joining methods such as plastics welding or adhesion. Aki-Lock has few restrictions on the materials that can be used and reportedly forms strong, airtight bonds with combinations of different materials for which bonding had previously been difficult.

Called Aki-Lock, the new process uses the glass fibers in reinforced compounds as a physical anchor for bonding. Glass fiber is made bare by laser irradiation, which is applied in a grid pattern. Strong bonds can then be achieved by overmolding with a different resin or by use of a liquid adhesive—for example to bond the plastic to metal. Because the bond is formed by the physical anchors formed by the exposed glass fibers, the overmolded resin or the adhesive need not be compatible with the first resin. Resin or adhesive flooding the grooves formed by the laser reportedly leads to airtight bonding.

Polyplastics also says there is no time limitation from laser treatment until bonding. Masking is unnecessary since the treatment areas can be identified visually. There is no need for chemical etching to roughen the first bonding surface, and no waste liquids or materials are produced.

BLOW MOLDING

Compression Blow Forming Now Available for PET Bottles

At PTXPO 2022 this month in Rosemont, Ill., SACMI won't be exhibiting machines but it will be highlighting its CBF-PET system, an evolution of its Compression Blow Forming process beyond polyolefins to now include PET. The rotary system is offered with 16 or 20 cavities and neck diameters from 53 to 75 mm, bottle diam. of 57 to 77 mm, and max. container height of 220 mm. Output rates are said to be 10,000 bottles/hr with 16 cavities and 13,000 bph with 20 cavities.

In addition, SACMI has integrated its bottle vision system (BVS 360) with the leak tester downstream from the CBF machine as part of a comprehensive inspection system. Fully configurable with up to 12 cameras, the BVS inspects every part of the container—mouth, thread, body, bottom—and is suited to PET, HDPE, PP and PS bottles.

MATERIALS

Biobased PC Copolymer Gets Play in Consumer Electronics

The first biobased PC copolymer from SABIC has been launched to help advance the consumer electronics industry's sustainability goals. LNP Elcrin EXL7414B resin is the first grade in an expanding portfolio to secure the International Sustainability and Carbon Certification Plus (ISCC+) designation. It is formulated with over 50% biobased content from waste materials that do not compete with the food chain. A preliminary SABIC internal assessment indicates that each kilogram of the new biobased resin provides 2 kg of CO_2 reduction compared with the fossil-based alternative.

The Chinese brand *realme* chose LNP Elcrin EXL7414B for the battery cover of its brand-new GT 2 Pro smartphone that launched on Jan. 4 in China. The use of biobased materials is an important selling point for consumers, who increasingly seek out sustainable products. Further, the adoption of LNP Elcrin EXL has enabled *realme* to advance its environmental goals without any compromise in product performance.

Realme was the first consumer electronics brand to adopt the incumbent version of this material, which was used to mold the battery cover of its C25 smartphone, which was previously made of the fossil-based version of the same resin. The two versions reportedly offer the same properties and processing characteristics, enabling a seamless transition for *Realme*.

The excellent processability of the biobased LNP Elcrin EXL7414B is said to enable ultra-thin part designs that save weight and space, and offers opportunities for shorter cycle times and higher throughput vs. standard PC. The new material also provides excellent low-temperature ductility (-40 F) for impact resistance when dropped, and good chemical resistance to withstand UV-cured painting.

MATERIALS

PP Impact Copolymer for Thin-Wall Packaging

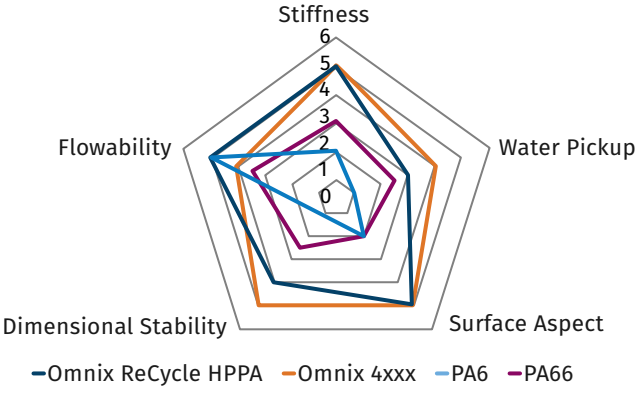
A new PP impact copolymer designed for thin-wall injection molded packaging from Flint Hills Resources combines impact, flow and stiffness thanks to the incorporation of DeltaMax performance modifier from Milliken. New AP5195-LV PP reportedly surpasses incumbent PP materials by delivering superior impact strength, high melt flow and good stiffness simultaneously, without the usual tradeoffs among these properties.

As previously reported, Milliken's DeltaMax is said to be a radical advance in additive technology for PP impact copolymers and recycled PP. It has found uses in consumer, industrial, and automotive markets.

MATERIALS

Reinforced Nylon 6 & 66 with Recycle Content

Solvay has launched a high-performance family of nylon 6 and 66 compounds containing 50% glass reinforcement and a minimum of 33% recycled content. The resin portion is 70% post-industriald and post-consumer recycled material. Omnix ReCycle HPPA (High Performance Polyamide) boasts lower water absorption, improved flowability and best-in-class surface quality vs. virgin high-performance nylons. It is aimed at household appliances and lightweight interior components for automotive and other transportation uses. Omnix ReCycle can be processed on standard injection molding equipment with water-heated molds.



TOOLING

High-Conductivity Core Pins

Regal Components has introduced a line of high-conductivity, beryllium-free copper-alloy core pins for high-volume molding of high-temperature plastics. Regal BFP core pins are made from a C-18000 alloy providing 95-98 Rockwell B (20-25 Rockwell C) hardness. Regal says the alloy offers 10 times better heat conductivity than steel and twice the conductivity of beryllium copper, while also resisting thermal stress and abrasion.

The pins are available in 16 standard diameters from 3/32 to 3/4 in., and in lengths of 3, 6, 14, and 20 in. The pins can also be custom machined. Uniform temperatures throughout these core pins coupled with low-adhesion characteristics help reduce part damage during ejection. The pins are priced from $19.36 each; catalog and complete price list are available on request.

ADDITIVES

High-Chroma Blue-Shade Effect Pigment with Intense Color

New Lumina Royal Sparkling Blue pigment was recently launched by Sun Chemical. This pigment can be used to create vibrant new shades throughout the aqua to violet color areas. It joins the popular Lumina Royal family of pigments, all of which provide strong sparkle. It is suitable across many applications, including automotive, industrial and packaging and is compatible with a broad range of thermoplastics.

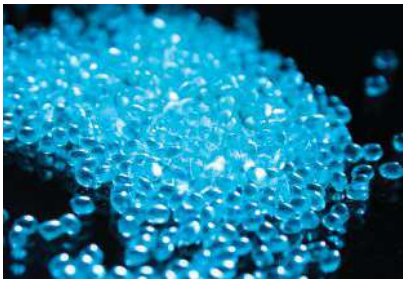
The Lumina Royal family, a result of Sun's acquisition last year of the BASF Colors & Effects pigments business, are included in Sun's PigmentViewer App color library, which is built on virtual renderings that capture the whole appearance potential of a pigment, enabling the designer to evaluate the color panel in a digital format. Visualization of the color from different angles may be achieved by changing the angle of the viewing device relative to the viewer. The viewer needs only to treat the device as if it were a conventional panel or sample, and with regular movement, the digital pigment application creates color travel as one would observe in a real-life physical environment.

ADDITIVES

Light-Stabilizer Masterbatches for Polyolefin Automotive Components

Two new proprietary "premium" light-stabilizing additive concentrates for polyolefin automotive components and other applications are newly available from CAI Performance Additives, the sole North American distributor for China's Starbetter Chemical Materials.

Both masterbatches contain hindered-amine light stabilizers (HALS). Product ST-LST350 contains a single HALS, while ST-LST850 contains two HALS in equal proportions. Both feature an additional, proprietary active ingredient that can enhance polymer compatibility. According to CEO Richard Marshall, the key to these masterbatches is they are *not* made by compounding methods, but produced through a proprietary reactive process, so no heat history is present when used by compounders. They reportedly do not generate VOC or unintended odors.



These additives have been shown to be particularly useful in durable applications like automotive parts that must withstand long periods of light exposure, and have been shown to be highly effective in PP, PE and TPO. Says Marshall, "The simple addition of this masterbatch can add superior resistance to clouding or fading surface qualities. These new ST-LST products can be added straight to the hopper."

Prices Firm for Polyolefins, PS and PET

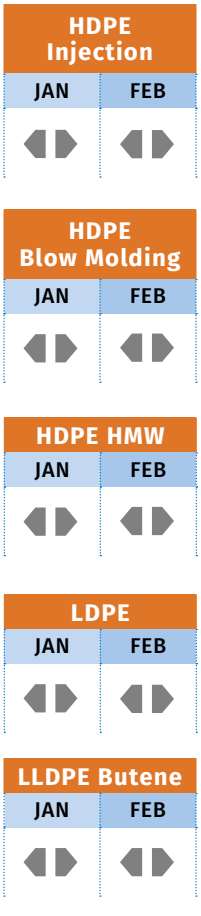
PVC prices have the weakest outlook among commodity resins.

Moving toward the end of the first quarter, the pricing trajectory for the five major commodity resins was a mixed bag, with a potential bottoming-out for PP and PE prices, an upward push for PS and PET, and a downturn for PVC tabs. Key drivers included the continued impact of higher feedstock costs and global logistics issues—including higher feedstock costs, a dearth of truck drivers, container availability, and some Gulf Coast warehouses at full capacity due to export delays.

By Lilli Manolis Sherman
Senior Editor

Those are the views of purchasing consultants from Resin Technology, Inc. (RTi), senior editors from *PetroChemWire (PCW)*, CEO Michael Greenberg of The Plastics Exchange, and Scott Newell, executive v.p. of polyolefins at Spartan Polymers.

Polyethylene Price Trends



PE PRICES FLAT

Polyethylene prices rolled over in January, with suppliers pushing back their 4¢/lb hike to February. However, a new price initiative emerged, averaging an additional 4¢/lb for last month, according to Mike Burns, RTi's v.p. of PE markets, *PCW* senior editor David Barry, and The Plastic Exchange's Greenberg.

Burns ventured that PE prices would hold firm in February as suppliers' price-hike attempts changed the narrative of slumping prices. Still, he forsaw some downward pressure in March and April, noting that supplier inventories are high and new capacity from the SABIC/ExxonMobil joint venture will exacerbate the oversupply that resulted from a drop in exports due to continued logistical problems. Characterizing current domestic demand as "good," he projected that it will not decline, but will level off from the peaks seen in 2021. "The 2022 PE price is approximately 24¢/lb above the pre-pandemic, January 2020 mark. How much of that increase can be given back with the current status of the economy—COVID, wages, supply issues, trucking, employment issues?"

Market Prices Effective Mid-February 2022

Resin Grade	¢/lb
POLYETHYLENE (railcar)	
LDPE, LINER	94-96
LLDPE BUTENE, FILM	83-85
NYMEX 'FINANCIAL' FUTURES	58
MARCH	60
HDPE, G-P INJECTION	87-89
HDPE, BLOW MOLDING	82-84
NYMEX 'FINANCIAL' FUTURES	55
MARCH	55
HDPE, HMW FILM	87-89
POLYPROPYLENE (railcar)	
G-P HOMOPOLYMER, INJECTION	109-111
NYMEX 'FINANCIAL' FUTURES	70
MARCH	71
IMPACT COPOLYMER	112-114
POLYSTYRENE (railcar)	
G-P CRYSTAL	105-108
HIPS	113-117
PVC RESIN (railcar)	
G-P HOMOPOLYMER	102-104
PIPE GRADE	104-106
PET (truckload)	
U.S. BOTTLE GRADE	88.5-90.5

PCW's Barry thought that suppliers could get possibly half of their increases implemented within the first quarter, noting that while market fundamentals do not support price increases, higher crude-oil and ethylene tabs could have an impact.

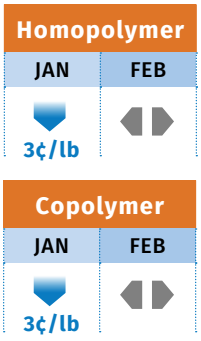
Still, all three industry sources see a slowing of the downward trajectory, and pointed to rising spot prices. Greenberg reported toward the end of January, "As the spot market exhibits firmness and the first signs of prices bottoming out, at least for the moment, it brings current price increase initiatives back to the forefront, and PE producers do have a 4¢/lb price increases on the table for January contracts. When initially nominated during December, it appeared that the increase was pie in the sky, with best hopes to stem the slide in resin prices that eroded 15¢ to 17¢/lb during the fourth quarter. Producers have announced another slew of ►

contract increases for February, which also average 4¢/lb, so there is some additional upward pricing pressure."

PP PRICES BOTTOMED OUT?

Polypropylene prices dropped a few more cents in January, for a total margin give-back from suppliers of 10-13¢/lb since October, despite propylene monomer contract prices rolling over from December, according to Scott Newell at Spartan Polymers, *PCW*'s Barry, and The Plastic Exchange's Greenberg. All three sources ventured that PP prices may have bottomed out, after dropping from their peak in August 2021 by a total of about 40-45¢/lb, from a combination of lower monomer prices and non-monomer supplier price concessions.

Polypropylene Price Trends



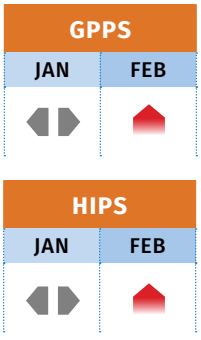
"I think the February-March timeframe will be flat to higher, depending on how PP demand shapes up, which will put pressure on propylene monomer prices and will also coincide with scheduled monomer plant turnarounds," said Newell. Barry noted that domestic PP prices are still higher than in the rest of the world, owing to global logistics issues, though PP spot prices have been as much as 10-20¢/lb lower than contracts. He and Newell described the market as balanced to a bit long, despite PP suppliers throttling back production to a low of 70% of capacity in December.

Greenberg noted that spot-market demand for PP in January was the busiest for The Plastics Exchange since early September 2021, due to more balanced fundamentals and higher energy and feedstock costs, lifting spot prices by 2¢/lb. He detected "the early stages in the potential reversal of the pricing trend, ... with much of the burdensome overhang for PP now gone, following six to seven months of reduced production and a decline of more than 120 million lb from producers' collective resin inventory during December. There have also been six to seven straight months of below-average PP purchases by processors, particularly in the past four months, as they have largely worked down their inventories, expecting even lower prices ahead."

PS PRICES TURNING UPWARD

Polystyrene prices were once again flat in January, but change was underway for February and March, driven solely by rising costs of benzene and ethylene feedstocks. By themselves, supply/demand fundamentals do not support increases, according to *PCW*'s Barry and Robin Chesshier, RTi's v.p. of PE, PS, and nylon 6 markets. Said Chesshier, "Today's PS prices already have the higher feedstock costs built in—aside from future increases—since suppliers never 'gave back' any of their margin when feedstock prices dropped. While suppliers will aim to increase prices based on feedstock costs, buyer resistance will ensue."

Polystyrene Price Trends

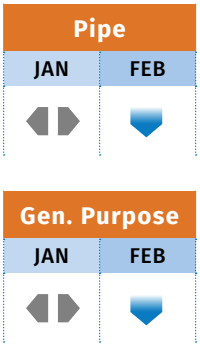


Barry said he would be surprised not to see a price hike emerge for February; and, in fact, TotalEnergies Petrochemicals & Refining announced it would increase PS prices by 5¢/lb on Feb. 1. Barry reported at the end of January that the implied styrene cost based on a 30/70 formula of spot ethylene/benzene was at 46.7 ¢/lb, up from 41.5 ¢/lb four weeks earlier. Despite weak supply/demand fundamentals, both sources did not rule out further upward pressure on PS prices in March, which could result from higher crude oil/benzene prices and scheduled benzene plant maintenance.

PVC PRICES FLAT TO LOWER

PVC prices in January were mostly flat, though there was industry chatter about some price concessions. Meanwhile, Formosa and Westlake issued price increases of 3¢/lb for Feb. 1 and OxyVinyls for March 1 , according to Mark Kallman, RTi's v.p. of PVC and engineering resins, and *PCW* senior editor Donna Todd. Missing was Shintech, which was ramping up its new PVC capacity.

PVC Price Trends

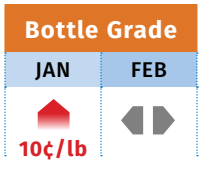


Kallman characterized the price initiative as a "defensive move" to stop any price slippage. Barring an unexpected production outage, he predicted flat or lower prices for February and March. Both sources cited high supplier inventories, and PVC export prices fell as much as 24¢/lb, as exports dipped because of global logistics issues. What could offset this scenario, noted Kallman, is the scheduled plant turnarounds for PVC and feedstocks in this timeframe. Over the course of 2021, PVC prices were hiked nine times for a total of 31.5¢/lb.

PET PRICES UP

PET prices in January were expected to be 10¢/lb higher, driven by costs of feedstocks PTA and MEG, in combination with new contract terms, according to RTi's Kallman. He ventured that February and March could see relatively flat pricing.

PET Price Trends



Meanwhile, imported PET prices also moved up modestly in January—though they continued to be higher than domestic contract prices due to logistical problems. "PET imports will continue to be strong despite the elevated prices, as supply/demand continues to be very tight," said Kallman.

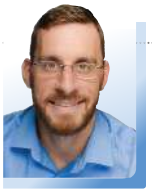
Plastics Processors Start 2022 with Modest Boost

Expansion accelerates in new orders, production, and backlogs.

The Gardner Business Index (GBI) for Plastics Processing started 2022 up more than one point from December to close January at 58.9. The latest gains came thanks to accelerating expansion in new orders, production, and backlogs. A six-point increase in January's supplier deliveries signaled that supply-chain performance remains weak, disrupting the improved readings from Q4 2021. Those business-activity readings that were lower than a month ago included employment and export orders. January's export reading signaled contracting activity for the first time since September. Separately, the decline in employment activity indicated the lowest rate of expansion since late 2020.

By Michael Guckes
Chief Economist/Director of Analytics

Among only custom processors, overall business activity revealed another month of slowing expansion. January's Index reading of 55 was the lowest since October 2020 and extended the trend of slowing expansion in the custom sector that was first observed in May 2021. New orders activity showed no change from the prior month, while production, employment and export orders all registered contracting activity. January's production and employment readings were the weakest since mid-2020; however, recent months of well-above-average backlogs suggest that the industry's primary problem lies with production rather than demand. PT



Michael Guckes is chief economist and director of analytics for Gardner Intelligence, a division of Gardner Business Media, Cincinnati. He has performed economic analysis, modeling and forecasting work for more than 20 years among a wide range of industries. He received his BA in political science and economics from Kenyon College and his MBA from Ohio State University. Contact: *(513) 527-8800; mguckes@gardnerweb.com*. Learn more about the plastics processing Index at *gardnerintelligence.com*.

Gardner Business Index: Plastics Processing

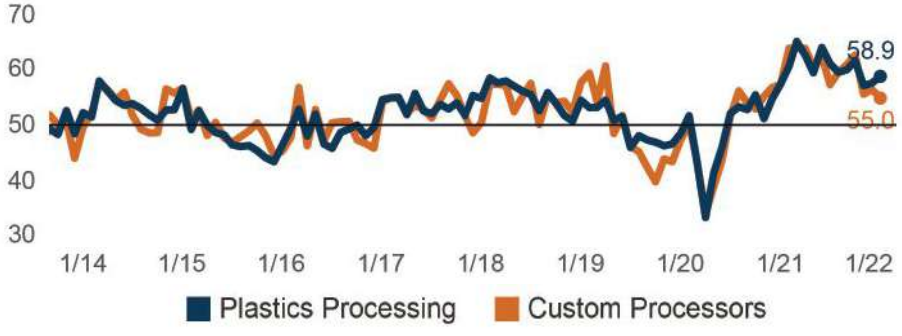


FIG 1

The Plastics Processing Index rose for a second consecutive month to 58.9. January's gains were driven by expanding production, new orders, and backlogs. Custom processors did not benefit from similar gains, resulting in their total activity falling to a one-year low.

Year-End Expansion Driven by Supply Chain and Backlogs

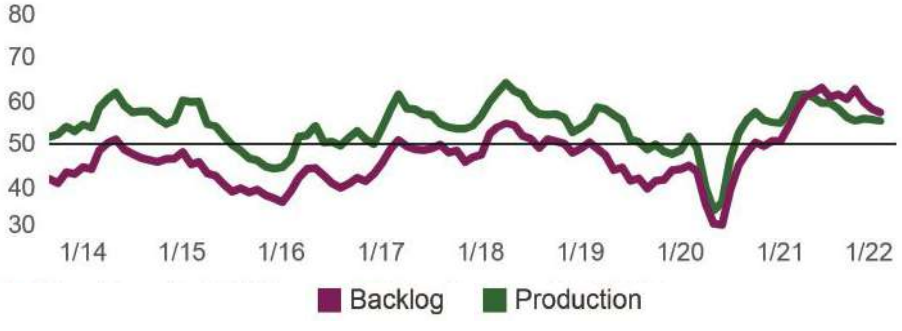


FIG 2

Production activity has slowed over the last year for both plastics and custom processors; however, rising backlogs suggest the problem is not one of demand. Graphs show three-month moving averages.

EXTRUSION AUXILIARY EQUIPMENT

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HELLERMANNTYTON — MILWAUKEE, WIS.

Captive Molder Goes AM Route for Short-Run Project

Pivoting from injection molding to additive manufacturing helped a maker of automotive wire routers save about $1 million in project costs and eight weeks of lead time.

Fast Radius' 3D printing capabilities helped produce a series of wire-routing aids for a new prototype vehicle for a customer of HellermannTyton. (Photo: Fast Radius)

By Heather Caliendo
Senior Editor

When HellermannTyton had about six weeks to produce more than 1000 wire-routing mounts for an automotive application, it turned to additive manufacturing (AM)—commonly referred to as 3D printing—to get the customer the parts it needed when it needed them.

With a U.S. office in Milwaukee, HellermannTyton (***hellermanntyton.us***) designs and manufactures products used to guide wires throughout the interior of vehicles, ensuring cables are safely secured. Typically, these are injection molded in-house by HellermannTyton, but the company ruled out molding here because of the tooling costs involved for such a short run. Instead, it turned to Fast Radius, which has served the automotive industry for many years.

Notes Ethan Fish, project designer at HellermannTyton, "Traditional manufacturing methods like injection molding or CNC machining would have been costly and time-intensive, so we turned to Fast Radius for a better method. Fast Radius' platform helped us quickly evaluate designs and produce high-quality, industrial-grade parts with additive manufacturing, which saved us two months in development time and allowed us to ramp up to full production quickly."

Kyle Huettl, HellermannTyton product manager, says that while AM parts may look more expensive, they are actually cheaper for a project like this. "When customers started to look at that and we started to show them the price differences and the speed and the time that it takes to do this, they were much more open to hearing about it," he notes.

John Nanry, co-founder and chief manufacturing officer for Fast Radius (***fastradius.com***), says the company's Cloud Manufacturing platform integrates design, production and fulfillment operations through a common digital infrastructure. The goal is to make manufacturing easier, more accessible and more sustainable.

"The automotive industry—when you talk about quality and volume requirements—is one of the toughest industries to work with, so we got really excited about taking on that challenge," Nanry notes.

The combination of short lead times, low-volume runs, and complex assembly made additive manufacturing the right choice for production. However, it was important that the technology used to manufacture the routing aids had the right build capacity and materials to meet HellermannTyton's quality requirements.

Fast Radius had the production capacity through both its own fleet of HP Multi-Jet Fusion machines and its network of partners to meet the project's fast timelines. The parts were printed on HP MJF machines using nylon 12. Due to the large size and complexity of these parts, HellermannTyton needed to modify the designs by splitting them into two to four smaller sections that could be produced within the machine's build volume.

Each routing aid is custom-built to match the internal framework of the vehicle. The components have complex geometries that require assembly to the wiring harness. HellermannTyton worked with Fast Radius to print sections with mating geometry that when used in combination with adhesive creates a reliable finished product. Fast Radius' technical team worked closely with HellermannTyton on the post-processing requirements, which included part dyeing, assembly, and specialized shipping. HellermannTyton saved time and costs by using Fast Radius as a one-stop shop for all of their AM needs.

The pivot from traditional manufacturing processes to additive manufacturing enabled HellermannTyton to save approximately $1 million in project costs and eight weeks of lead time. PT

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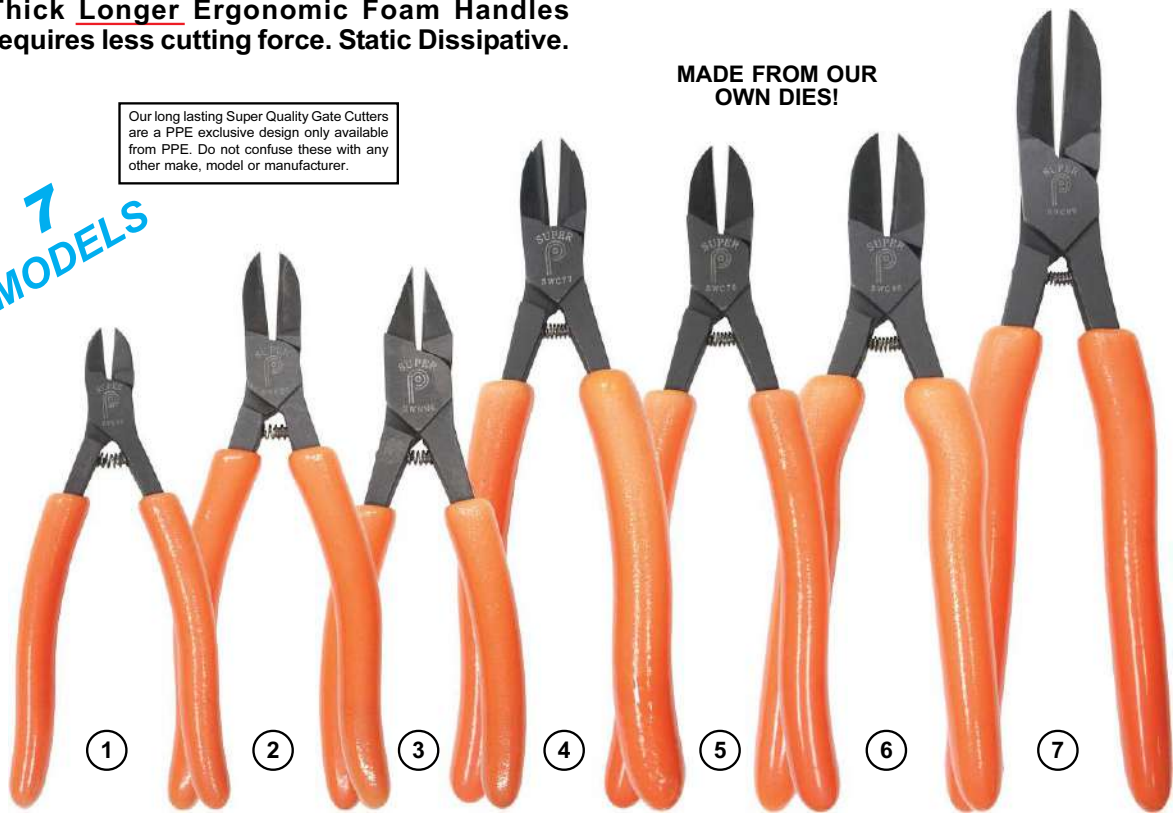
7 MODELS



ITEM	LENGTH	DESCRIPTION ALL HAVE COIL SPRINGS AND BLADE STOPS	PART NO.	QUANTITY PRICES		
				1-11 pair	12-23 pair	24+ pair
1	5-5/8"	FLAT BACK, SLIM BLADE 15°	SWC55	$23.75 ea.	$22.55 ea.	$21.40 ea.
2	6-5/8"	FLAT BACK, SLIM BLADE 15°	SWC66	$26.50 ea.	$24.75 ea.	$23.00 ea.
3	6-3/8"	FLAT BACK, SLIM NEEDLE NOSE 15°	SWNN6	$25.00 ea.	$23.75 ea.	$22.50 ea.
4	8"	FLAT BACK, SLIM DOUBLE GRIND 15°	SWC77	$27.25 ea.	$25.90 ea.	$24.55 ea.
5	8"	FLAT BACK, SLIM BLADE 15°	SWC78	$27.25 ea.	$25.90 ea.	$24.55 ea.
6	8"	FLAT BACK, SLIM BLADE 1-1/8", 15°	SWC88	$26.75 ea.	$25.40 ea.	$24.10 ea.
7	9-7/8"	FLAT BACK, SLIM BLADE 1-1/2", 20°	SWC99	$33.00 ea.	$31.35 ea.	$29.70 ea.

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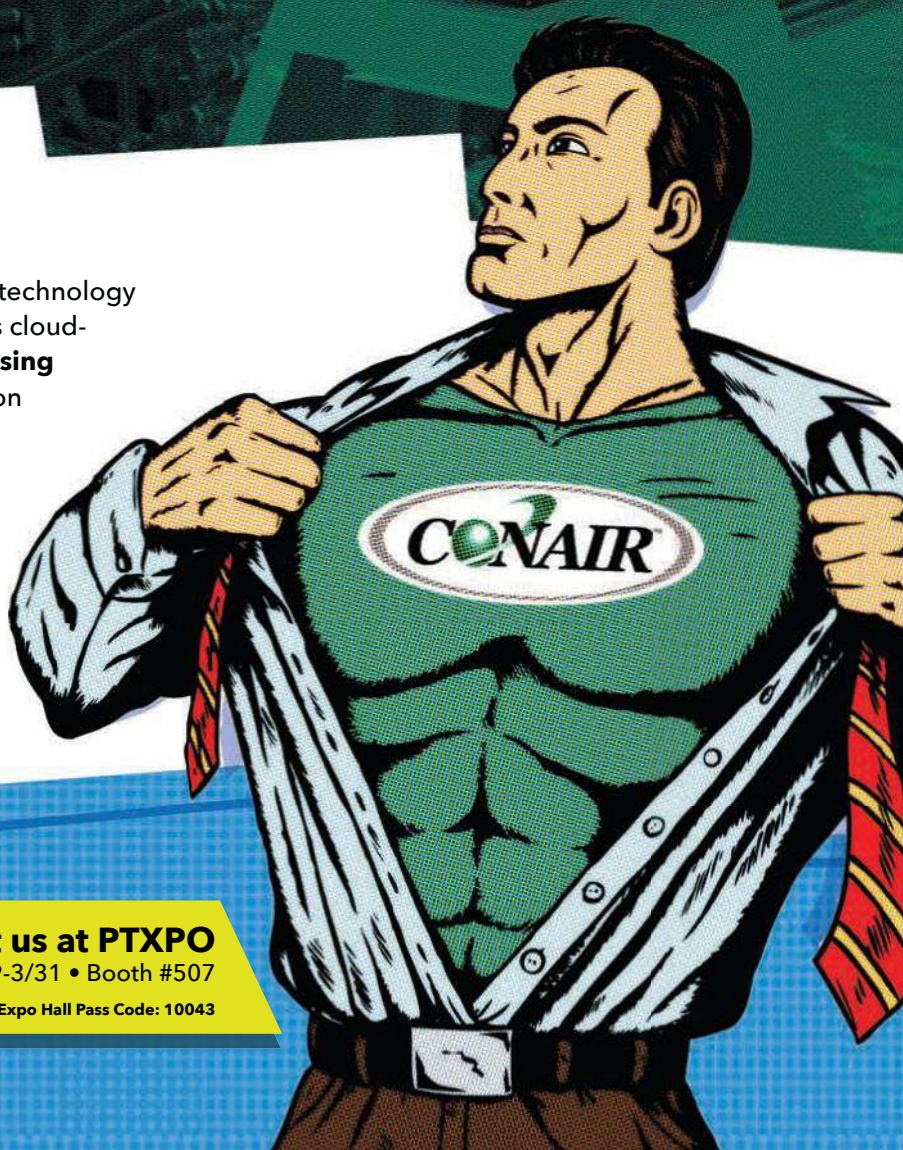

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