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Plastics Technology®

Compounder in Control

Compounding Solutions relies on technical savvy to drive growth in medical, other markets

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Plastics Technology

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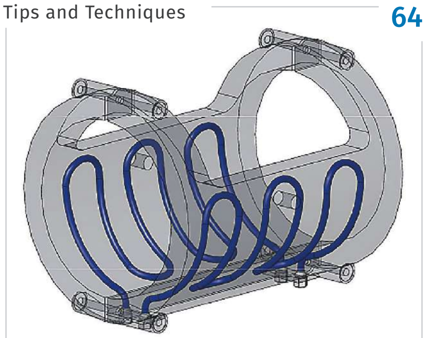
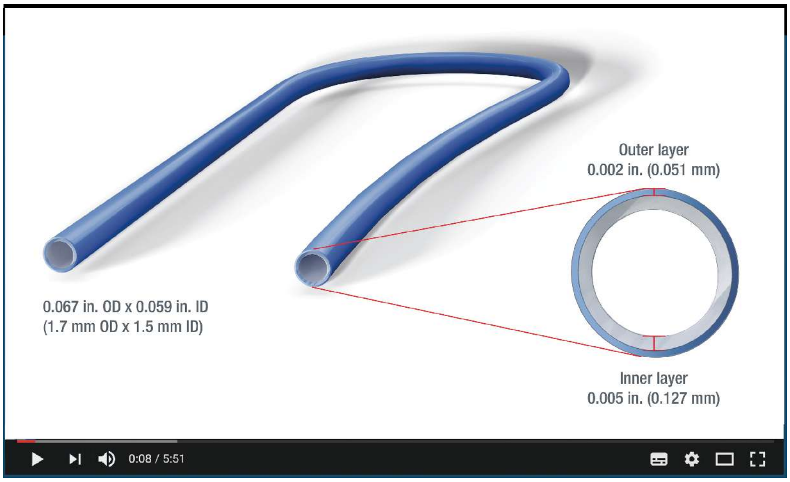
Tips and Techniques



Feature

There's more on the web at *PTonline.com*

California Coextrusion at Plastec West



At last month's Plastec West 2018 in Anaheim, Calif., Conair, Davis-Standard, Leistritz, Zumbach, and Guill Tool demonstrated a coextrusion tubing line that could be applied for adding active pharmaceutical ingredients (API) to a medical product. Watch the line in action at ***PTonline.com***.
youtu.be/PY3NB7aDCvE

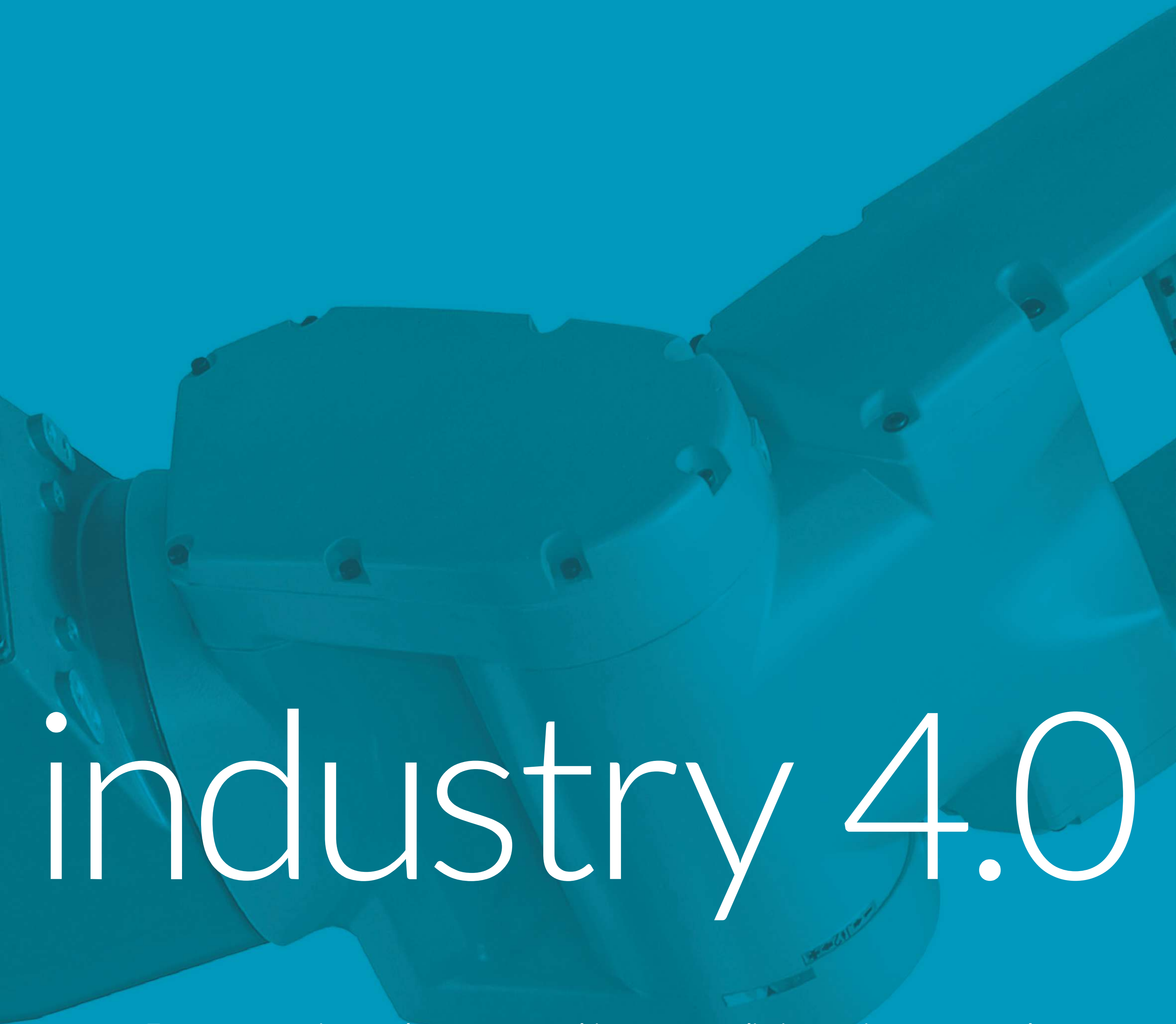
Stay up with our video reports by subscribing to our YouTube Channel: ***short.ptonline.com/yfZBD0uY***

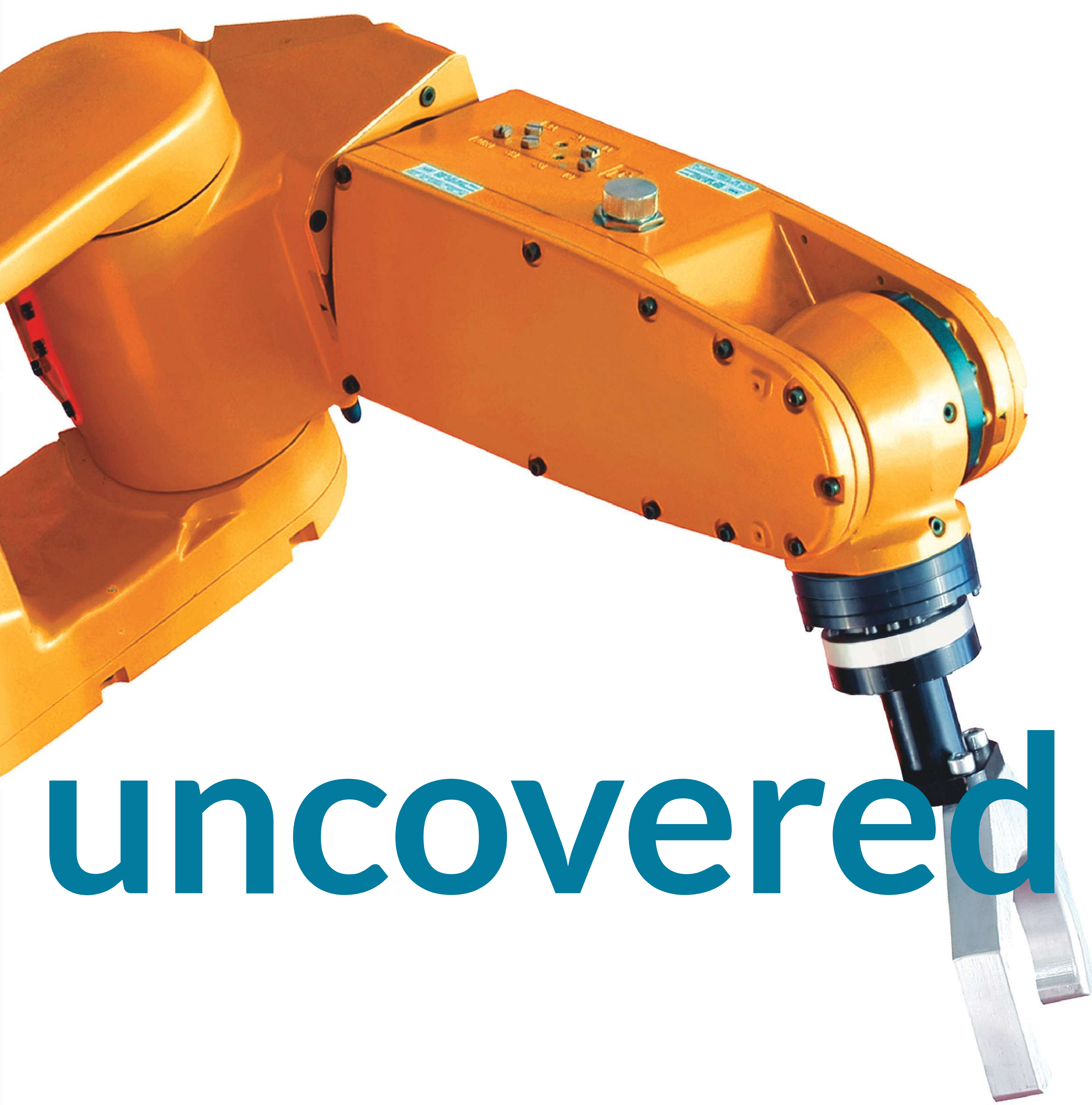
BLOG: Film Review

Film stars in a series of market snapshot blogs from Editorial Director Jim Callari covering film extrusion. In separate posts, Callari breaks down the current status and future outlook for shrink film, stretch film, t-shirt bags and institutional can liners. Learn about the top players, as well as material and technology trends.
short.ptonline.com/PEshrink

Zone in on NPE

Coverage of the upcoming NPE2018 show (May 7-11; Orlando) has begun in earnest at *Plastics Technology*. Head to our special NPE Zone to read about new products to be displayed at the triennial show and keep up on all the latest news about the special event.
ptonline.com/zones/NPE2018


industry 4.0



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CompositesWorld	Products Finishing Mexico
Production Machining	Automotive Design & Production

Examining the Big Themes at NPE2018

Check out the publication that was poly-bagged with this issue to get a big-picture view of what's coming up at the giant show in May. Here's a preview.

With this issue of *Plastics Technology* Magazine, you received a copy of a second publication: the official *NPE2018 Show Preview* Magazine. In this 36-page magazine, the editors of *Plastics Technology* and various sister publications under the Gardner Business Media umbrella wrote about key trends, issues, and themes that will be on display May 7-11 at the Orange County Convention Center in Orlando, Fla.

Jim Callari
Editorial Director

I encourage you to take the time to read this publication. It won't give you much in the way of details on what specific exhibitors will be showing in the way of new technology. But the *NPE2018 Show Preview* magazine does offer a 35,000-ft view on the trends and drivers that will influence what you'll be seeing at individual company booths.

Let's look at a few of these:

Automation: Like most other areas of manufacturing, plastics processors are facing difficulties finding factory workers. But as the lead story by Executive Editor Matt Naitove reveals, advanced robotics have come to the rescue. Robots exhibited at NPE2018 will be faster, smarter, more connected, and, in some cases, more "collaborative."

Industry 4.0: There are going to be a lot of suppliers talking about Industry 4.0, the Internet of Things, and Smart Factories at NPE2018. Naitove reports in that same p. 1 story that new protocols for machine-to-machine and machine-to-central-computer communications are being developed in Europe. It will be interesting to track how North American processors respond to this trend. It's one thing for machines to be wired to communicate with each other. It's another for them to provide so-called "actionable data" that processors can actually use. Which brings us to:

Predictive Maintenance: For all too long, the norm in plastics processing has been to run a machine until, well, it can't run anymore. It's a practice called "run to fail," which many believe has outlived its purpose. As an article written by yours truly on p. 16 of the *NPE2018 Show Preview* magazine reveals, new technology will be on display that will warn you of machinery component problems—and, more importantly, what to do about them—before they shut down your production lines.

Register at npe.org/attend

NPE2018 THE PLASTICS SHOW

SHOW PREVIEW

THE OFFICIAL SHOW DAILY FOR NPE2018: THE PLASTICS SHOW

PRODUCED BY PLASTICS

OFFICIAL MEDIA PARTNER PT Plastics Technology

Robots Are Asked to Do More and to Be Team Players, Too

At NPE2018, key themes will be cell automation and equipment connectivity. Look for more capable robots and forward thinking about Industry 4.0. The "collaborative" niche is also growing.

BY MATT NAITOVE
Executive Editor
Plastics Technology | ptonline.com

Robots exhibited at NPE2018 will be faster, smarter, more connected, and, in some cases, more "collaborative." Interviews with leading robot suppliers showed remarkable unanimity about the overall points of emphasis: new control features to speed cycles, facilitate maintenance, and ease programming; increasing integration of robot and machine controls; and growing industry reliance on automated cells with multiple downstream operations integrated beside the press. This last emphasis is bringing a wider range of robot types to plastics shows—SCARA types, delta or "spider" types, and a growing variety of "collaborative" concepts. Six-axis jointed-arm robots are also likely to be more plentiful than ever at this NPE, but they are facing competition from five-, six-, or seven-axis linear robots sporting servo wrists.

FASTER, STRONGER, SMARTER

Robots overall are becoming faster, carrying heavier loads, and are easier to program. More sophisticated programming is shaving every possible fraction of a second off of cycle time by executing multi-axis movements simultaneously, anticipating the movements of the clamp and ejectors, and establishing optimum standby positions. Smarter robot controls can learn and adjust timing and positions for such automatic cycle optimization. On the other side of the coin, some controls actually slow down the robot when the cycle permits, saving wear and tear by ensuring the robot doesn't move any faster than necessary to get where it is going on time.

The speed, precision, and programmability of servomotors has largely replaced pneumatics on takeout robots—both on the main axes and on wrist rotation. As you'll see at NPE2018, servo sprue pickers are also having their day—becoming, in fact, mini robots. One supplier notes that servo pickers offer benefits for controlling orientation of demolded parts. However, there's general agreement among robot vendors that pneumatics will have a place in simple pick-and-drop applications for some time to come.

The constant pressure to squeeze out higher productivity also means less patience with "flutter" of the robot's vertical axis due to acceleration, deceleration, and machine shock and vibration. Robot suppliers have worked steadily to reduce mass and increase stiffness of robot arms to minimize inherent vibration tendency. They also use software for active vibration suppression—controlling acceleration/deceleration and using small robot counter-motions to dampen vibration (analogous to noise-canceling headphones).

Ease of programming has been a steady trend (see the *Plastics Technology* cover story this past November). Some vendors have approached this, in part, by ensuring a consistent interface among all models in their line; another strategy has been to apply a similar look and continued on page 24 >>

Get in the "Zone" with Specialized Areas on Show Floor

Nearly a dozen "shows within the show" let attendees focus on specific technologies and exhibitors on the sold-out show floor.

BY JIM CALLARI
Editorial Director
Plastics Technology | ptonline.com

Come NPE2018 time—May 7-11 at the Orange County Convention Center, Orlando, Florida—more than 65,000 attendees from all over the world will be able to navigate more than 1 million net square feet (nsf) of operating machinery, new product demos, exciting innovations, and emerging technologies from more than 2,000 leading suppliers of primary processing machinery, auxiliary equipment, tooling, software, materials, additives, and more. This year's show will also feature 10 process-specific Technology Zones—plus International Pavilions and the Industrial Designers Society of America Design Center—to further showcase what's hot in the industry. There are a number of specialized areas, all of which will be located in the South Hall. continued on page 6 >>

Can Widening Skills Gap Be Bridged?

PLASTICS calls for "collaborative response across all levels of government and all manufacturing sectors" to tackle critical issue.

BY TONY DELIGIO
Senior Editor
Plastics Technology | ptonline.com

After years of closely monitoring an increasingly worrisome labor shortage, Plastics Industry Association's (PLASTICS) warnings about the widening gap between the sector's need for skilled workers and the supply of such employees have shifted to full alarm. As stated in PLASTICS' *2017 Size & Impact Study*, "While the skills gap and the decline of a qualified manufacturing workforce have been discussed for many years now, the nation has reached the point where their impacts will begin to be felt more acutely."

In that report, released in December, PLASTICS forecasts that employment in plastics manufacturing will expand 0.9 percent, 0.7 percent and 0.6 percent from 2017 to 2019—rates slower than in the three prior years and in five of the last six going back to 2011. Total employment in 2019 is forecast to reach 735,000, not including captive operations. It stands at 719,000 today. "Employment growth slows as the supply of labor starts to dry up," is how PLASTICS describes the impending scenario in the report.

Plastics is not alone in its search for workers. According to the Manufacturing Institute, 3.5 million manufacturing jobs will need to be filled in the continued on page 28 >>

NPE2018 will feature specialized "zones" for 3D printing and bottle making—which combine in this printed plastic blow mold for a PET bottle.

NPE2018: THE PLASTICS SHOW • REGISTER TODAY AT NPE.ORG

Automotive Lightweighting: On p. 12 of the *NPE2018 Show Preview* magazine, Gary Vasilash, editor-in-chief of *PT*'s sister publication *Automotive Design & Production*, reports on various efforts instituted by Ford to reduce vehicle weight.

Recycling: *Plastics Technology* Senior Editor Heather Caliendo interviewed Kim Holmes, v.p. of sustainability for the Plastics Industry Association (PLASTICS). A key takeaway, courtesy of Holmes: "I believe brand owners and others in the industry are realizing that the traditional mechanical recycling model has limitations. In order to meaningfully drive use of recycled content forward, we need new technologies and methods in our toolbox."

Augmented Reality: As Tony Deligio reports on p. 8 of the *NPE2018 Show Preview* magazine, this technology combines virtual and physical reality environments to allow, for example, tech service to be performed remotely. In a molding plant, augmented reality would use the camera on smart glasses, a smartphone, or a tablet to scan equipment within its view and add digital markers once the machinery is recognized.

3D Printing: Pete Zelinski is editor-in-chief of *Additive Manufacturing* magazine, yet another sister publication of *PT*. In his article on p. 26, he reports on the 10 ways additive manufacturing, also known as 3D printing, is expanding possibilities for production of short-run parts and molds and even production molds. PT

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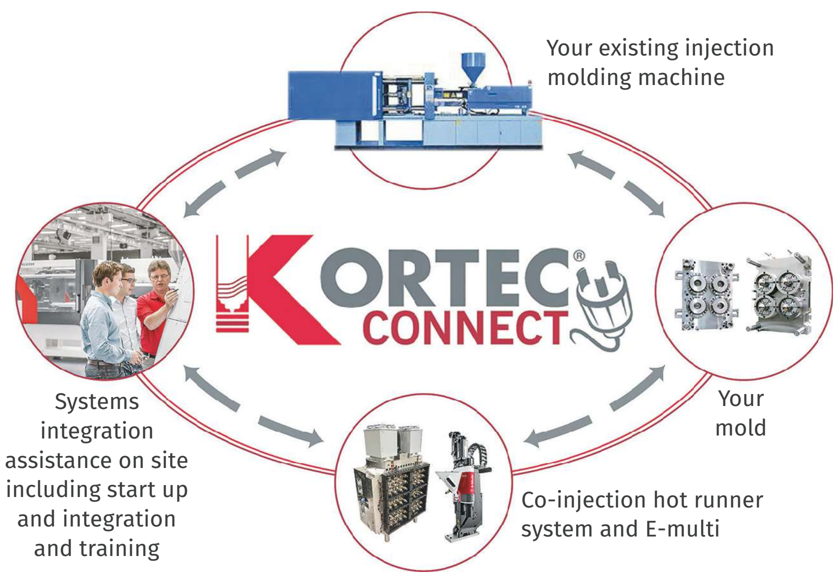
Milacron Broadens Kortec Co-Injection Offering

Milacron Holdings Corp., Cincinnati, is introducing a new way to take advantage of its Kortec co-injection technology for products needing a three-layer barrier sandwich structure. Up to now, Milacron has offered turnkey systems (now branded Kortec Complete) consisting of a two-component injection machine, Kortec hot runner and engineering support—including integration assistance, startup, and training. Now, molders who wish to use an existing injection machine can choose the new Kortec Connect package, which comprises a Kortec hot runner, Mold-Masters E-Multi secondary injection unit as an add-on for the existing press, and the same engineering support.

NPE2018 THE PLASTICS SHOW

Milacron claims 30 years of experience in co-injection, with over 100 systems in the field, producing 12 billion parts in 18 countries. Kortec Connect will be featured at NPE2018 May 7-11 in Orlando, Fla., at booth W2703.

513-536-2000 • milacron.com



Automotive Composites Get A Boost From New Predictive Engineering Tools

Adoption of weight-saving polymer composites in auto body structures will be made easier with new predictive engineering software. The development effort behind it was led by researchers at the U.S. Dept. of Energy's Pacific Northwest National Laboratory in Richland, Wash., along with industry and academia. Other key players were PlastiComp, Winona, Minn., a specialty compounder of long-fiber thermoplastics (LFT); Toyota; modeling software supplier Autodesk; tier one molder Magna; and university researchers from Univ. of Illinois, Purdue, and Virginia Tech.

PlasticComp (***plasticomp.com***) provided 30% long-carbon-fiber PP and nylon 66 materials and molded sample plaques that were used to evaluate fiber orientation and length attrition during injection molding. Also, some of the algorithms used by Autodesk's software (***autodesk.com***) were updated to better model long-carbon-fiber orientation in computer-aided analysis of design concepts to predict performance properties.

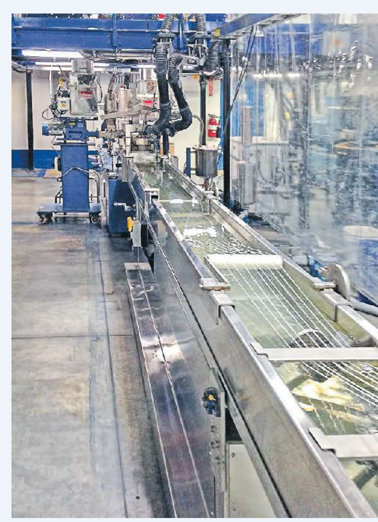
Ube Expanding U.S. Assembly Plant

Ube Machinery Inc. will expand its assembly facility in Ann Arbor, Mich. This will double its annual capacity for assembling mid- to large-size injection molding machines, including its two-platen servo-hydraulic, servo-hydraulic toggle, and all-electric machines. The project started in January and will be completed by September.

734-741-7000 • ubemachinery.com

Clariant Adds Capacity For Medical Compounds

With the startup of a high-throughput twin-screw compounding extruder, Clariant Corp. (U.S. office in Charlotte, N.C.) has completed a multi-year expansion program for its Mevopur medical-grade compounds in Lewiston, Maine. The facility was expanded by 40% and now accommodates additional equipment that enables the plant to more rapidly produce larger batch sizes of Mevopur precolored medical compounds (e.g., 6000 to 12,000 lb or larger). These include compounds based on PE, PP, ABS, SAN, PC/ABS, PC, nylons 6, 66 and 12, COP, and elastomers like EVA, SEBS, TPU and PEBA. A smaller line, installed last year, is configured to meet the rigorous processing requirements of fluoropolymer resins such as FEP, ETFE, and PVDF.



502-295-4106 • Clariant.com

Amcor Launches First Commercial Container Using Its LiquiForm Technology

Thirteen years of R&D effort have reached fruition with the appearance of a PET bottle of hand soap produced by Amcor's "game-changing" LiquiForm technology. That technology uses the liquid contents of the container, rather than compressed air, to simultaneously form and fill stretch-blow molded containers. Amcor, Ann Arbor, Mich., says this approach offers numerous benefits in reduced floor space and costs for separate blowing and filling equipment, as well as eliminating costs of handling, transport, and warehousing of empty containers at a filling plant.

Because water—a major ingredient of most household products and foods—is much less compressible than air, the LiquiForm process also reportedly improves bottle quality and allows for lightweighting through improved material distribution. (For details, see Sept. '14 Starting Up and April '15 cover story.)

For this first commercial launch, Amcor Rigid Plastics' Diversified Products Div. partnered with Greenblendz, Auburn Hills, Mich., a co-packer and developer of private-label consumer products, to develop the 12-oz bottle for Nature's Promise hand soap. The bottle contains 50% post-consumer recycled PET.

Amcor produced the filled containers for Greenblendz using a proprietary machine built by Amcor, which the company says is the first in the industry to successfully use its LiquiForm technology. Amcor plans to set up operations using its LiquiForm machines near the production of the bulk liquid contents—in a brand or co-packer filling site. It plans to partner with customers to create new sites much closer to the retail point of sale, with the goal of reducing freight costs and increasing responsiveness to demand fluctuations.

734-428-9741 • amcor.com

Micro Extruder Can Run Normal-Sized Pellets for 3D Printing

A new micro extruder for 3D printing is believed to be the first machine of its size that can process standard-sized pellets. Developed by Tim Womer of TWWomer & Associates, Edinburg, Pa., the patent-pending TWW Micro Extruder marks the most recent innovation by the well-known extrusion consultant in the area of additive manufacturing. It can also run micropellets.

For the past four years, Womer has been working with Oak Ridge National Laboratory, Oak Ridge, Tenn., and Cincinnati Inc., Harrison, Ohio, to optimize screw technology on Womer's TWW Ultra Lite extruder. The TWW Ultra Lite is larger than the new micro machine, with a throughput rate of 80-100 lb/hr. Roughly 20 TWW Ultra Lite machine are in use on the BAAM (big-area additive manufacturing) machines built by Cincinnati Inc.

The TWW Micro Extruder weighs approximately 15 lb and runs on a standard 120V/15A power source. The unit can be configured for lab use (photo) or mounted on a three-axis gantry for 3D printing. The machine can process a wide range of resins, including PLA and carbon-fiber/ABS, at throughputs to 20 lb/hr.

According to Womer, the new extruder is the first such machine to use a single vertical, conical screw to feed and process standard pellets. This design reportedly reduces the extruder's footprint and weight without sacrificing mixing performance. The screw has a unique helical compression channel to generate pressure and heat. According to Womer, current micro extruders for 3D printing are slow, inefficient and only work with micro pellets.

The extruder is furnished with a nozzle tip that can be sized according to the bead needed to print the part. Besides 3D printing, Womer says the TWW Micro Extruder can be used for materials development, testing and education.

724-355-3311 • twwomer.com

Chinaplas 2018 Plans Array of Concurrent Events

Industry 4.0, plastics in medical, "tech talk" product introductions, and product design all receive heightened focus at Chinaplas 2018. Beyond its 4000 exhibitors and 18 "theme" zones, the big show (April 24-27 in Shanghai) will feature a series of concurrent events focused on a variety of topics, notes show organizer Adsale Exhibition Services Ltd. (***chinaplasonline.com***).

The Industry 4.0 conference, organized with Germany's machinery manufacturing association (VDMA), will take place in the afternoons of April 24-25, with a morning session on April 26. Speakers hail from Arburg, Erema, Kuka, KraussMaffei, RWTH Aachen University, Wittmann Battenfeld and others. Case studies and application discussions will be organized by end markets, including automotive, packaging and electrical/electronics.

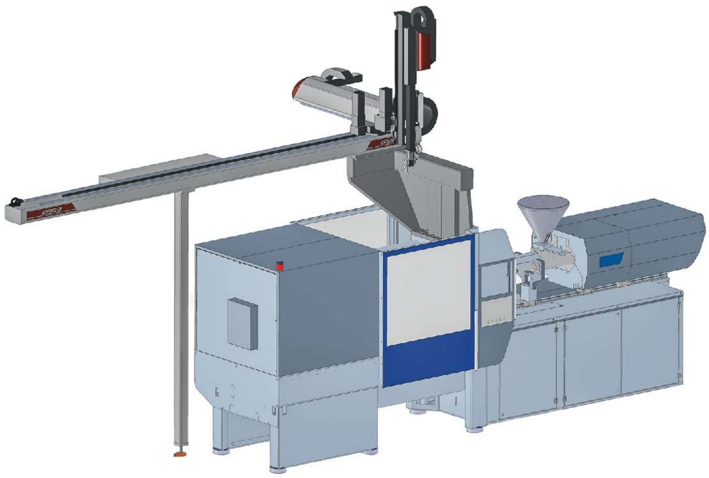
Chinaplas will also feature Tech Talks (photo) on April 24-26, organized around the themes of Smart Manufacturing, Innovative Materials, and Green Solutions. Speakers will cover everything from automation and micromolding to manufacturing execution systems (MES), biodegradable materials, and 3D printing.

The Medical Plastics Connect event features a variety of offerings, including open forums, guidebooks, pop-up kiosks and guided tours. Topics to be covered will include sterilization-resistant materials, pharmaceutical packaging, medical resins, precision tubing, and cleanroom injection molding.

For visitors interested in design, Chinaplas is offering the CMF (Color, Material and Finish) Inspiration for Design x Innovation event. The program consists of the CMF Inspiration Wall, displaying a variety of plastic resources for CMF design; and the CMF Design Forum, to be held on April 26. At the forum, leading plastics suppliers and CMF experts will discuss product innovations and market trends. In addition to these events, Chinaplas 2018 will have more than 80 technical seminars.

Automotive Molder Finds More Floorspace with "L"-Mount Robots

Midwest Molding Inc. in Bartlett, Ill., custom injection molds primarily auto parts in a plant that was built in 2007. By 2015, with business expanding, the family-owned firm knew it had to do something to achieve more efficient space usage. Midwest Molding consulted Wittmann Battenfeld, Inc., Torrington, Conn., which has a tech center in nearby South Elgin, Ill. Midwest Molding has a robot on every press and has used Wittmann robots since 1999. Wittmann and Midwest Molding arrived at a solution to the space restriction. Instead of the traditional mounts for the robots, which track outward from the press and require several extra feet of floorspace, they switched to L-mounts (pictured), which run the robot tighter to the machine, requiring less clearance and allowing machines to sit closer together.



In an L-mount, the robot runs along a beam located close alongside the non-operator side of the press and deposits parts at the end of the injection machine. This occupies less than half the footprint of the standard mounting. Midwest Molding is now running 55 machines with room for up to 25 more.

To ensure the robots would still have the flexibility to take on the toughest jobs, Midwest Molding added the A/C servo flip and rotation wrist to all the new robots they purchased. This helps the robot make the most of its allotted space. What's more, Midwest Molding takes advantage of the control software on the Wittmann robots.

"The programming on these robots is a real advantage," says Mayur Patel, a Midwest Molding manager. "The open architecture allows us to program complex, customized processes; and some of the built-in features like SmartRemoval and EcoMold allow us to ensure efficient, cost-saving usage of the robots. With EcoMode, if we lengthen the cycle time on a machine, the robot will automatically adjust itself to run more slowly and smoothly to save energy as well as wear and tear, and not be needlessly rushing to sit at the mold and wait for it to open. And with SmartRemoval, the robot is tied directly into the machine processes and will enter and exit the mold in the most efficient and timely manner possible without relying on the operator to program that in."

860-496-9603 • wittmann-group.com

Chinaplas Debut for Unusual Approach To Injection Molding Thick Lenses

At Chinaplas last month, Engel Austria presented for the very first time a time- and cost-saving method of injection molding 22-mm-thick PMMA lenses for automotive headlamps. Cooling such thick parts without distortion presents a challenge, which has been overcome in the past by molding the lens in successive layers of the same material. Because injection mold cooling time increases with the square of the wall thickness, several thin layers can cool in less total time than one thick layer, Engel says. Overmolding also compensates for any sink marks in the under-layer. Optical tests reportedly have shown that the boundary between the layers has no effect on optical performance.

Engel (U.S. office in York, Pa.) takes this a step further by pairing up two injection machines—a standard and a two-component unit—and transferring parts from one to the other with a stop for external cooling in between. Cooling in the air takes longer than in the mold, but does not affect the cycle time. Engel bills this as an advance in its optimelt multi-layer lens technology.

At Chinaplas, the lens base body, or thick core of the lens was molded on a 440-ton duo two-platen machine in a four-cavity mold. An Engel easix articulated six-axis robot removed the parts, or "preforms," and placed them in an external cooling station. From there, the robot transfers four already cooled preforms to a 4 + 4 cavity mold of a second duo machine, a 550-ton two-shot model with a rotary table. There, two more PMMA layers are applied successively before the six-axis robot removes the finished lenses. The cycle time is well below 3 min, although the preforms take about 30 min to cool outside the first press.
717-764-6818 • engelglobal.com

Brown Buys Thermoform Tool Maker

Brown Machine Group, Beaverton, Mich., has purchased Freeman Co., a leading manufacturer of thermoform tooling used predominantly for high-volume food packaging. Brown makes thermoforming and automated material-handling machinery under the Brown, Lyle, Nalle Automation Systems, and EPCO brand names. Freeman was founded in 1892 as the Louis G. Freeman Company, and is in Fremont, Ohio. Says Brown CEO Bryan Redman, "The addition of Freeman provides a more complete tooling solution, further establishing Brown's position as a comprehensive solutions provider in thermoforming."
877-702-4142 • brown-machine.com
419-334-9709 • freemancompany.com

Reifenhauser Buys Flat-Die Maker

Reifenhäuser Group of Troisdorf, Germany (U.S. office in Maize, Kan.) has acquired flat-die specialist EDS GmbH in Germany. Reifenhauser is a global supplier of extrusion systems for blown and cast film, sheet and non-wovens. EDS will operate within the Reifenhäuser Group as an independent business unit. Johannes P. Müller, the previous owner, will continue to run EDS, together with Uwe Gaedike, director of operations at Reifenhäuser.
316-260-2122 • reifenhauserinc.com

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Unique Machine Combines Dryer, TCU in Single Footprint

Novel, space-saving device co-developed by Novatec and Advantage Engineering offers a single control designed to reduce setup mistakes.

By Jim Callari
Editorial Director

Two well-known suppliers of auxiliary equipment have combined their wares in a space-saving, first-of-its kind machine that will be displayed at both their booths during NPE2018, May 7-11. Called the DryTemp+, the patent-pending machine combines a portable desiccant-wheel dryer and a fluid temperature-control unit (TCU) in a single footprint. It is the product of a collaborative effort between Novatec Inc., Baltimore, and Advantage Engineering, Greenwood, Ind.

"Processors with dryers typically also have mold-temperature controllers; and dryers require a water connection; so it made sense to both companies to look for ways to integrate the two machines," says Conrad Bessemer, CEO of Novatec (***novatec.com***). "As far as molders are concerned, more molding is being done in cells," he continues. "Space around a molding machine is always at a premium, and the more you can free up the better." According to Bessemer, the DryTemp+ occupies about the same space as a Novatec NovaWheel portable desiccant dryer.

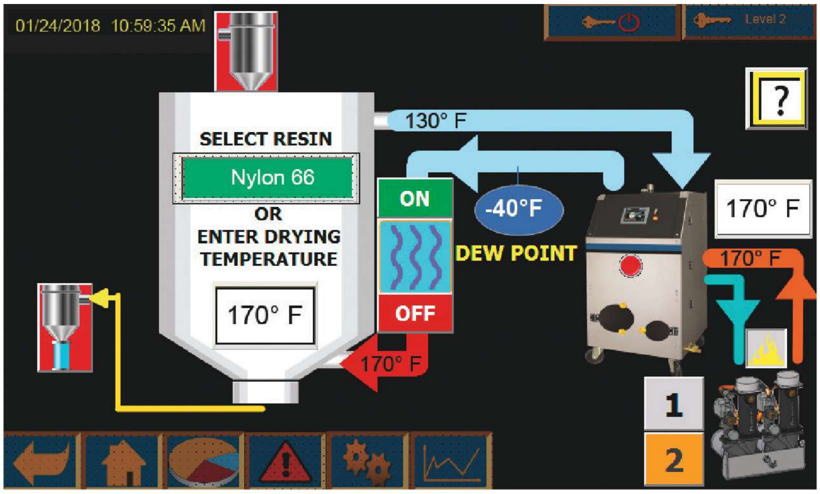
In North America roughly 70% of the drying market is beside the press.

Both Bessemer and Jon Gunderson, president of Advantage (***advantageengineering.com***), agree that the combination unit could potentially appeal to any processor that does not dry centrally. Bessemer estimates that in North America roughly 70% of the drying market is beside the press. Adds Gunderson, "We're seeing a lot of press-side drying in automotive, running high-temperature resins." Gunderson expects NPE2018 will serve as a testing ground for the new technology, perhaps exposing the two suppliers to applications they had not considered. In addition to molding, one possible market is medical-tubing extrusion. Those processors generally run at low throughput rates and have lines typically equipped with both dryers and TCUs, the latter to control the water temperature of their cooling tanks.

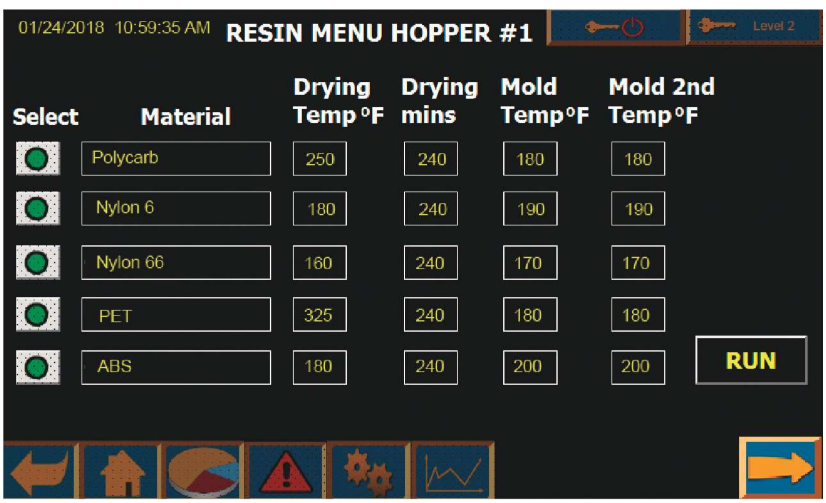
DryTemp+ was designed jointly by the two companies. It will be assembled by Novatec, with Advantage furnishing the pump, heater, modulating control valve, and controls. Advantage patented modulating control technology in the early 1990s and maintains that it provides more precise control over water temperature than more commonly used on-off solenoid valves.

DryTemp+ is a novel dryer/TCU combination unit developed jointly by Novatec and Advantage Engineering. It occupies the same floor space as Novatec's NovaWheel portable dryer. Among its features, TCU components tilt out to facilitate maintenance (inset).

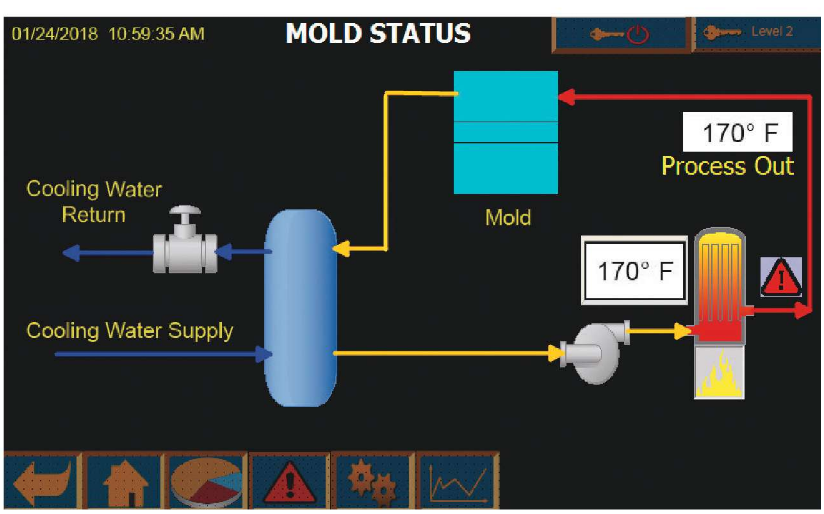
The DryTemp+ will be co-branded and is available from both companies directly or through their third-party sales agents, many of which represent both companies.



The home screen of the DryTemp+ control panel provides easy access to dryer and mold-temperature parameters.



Data-logging feature on DryTemp+ allows pre-programming of desired drying parameters.



TCU screens on DryTemp+ provide mold-temperature status.

ONE CONTROL FOR TWO FUNCTIONS

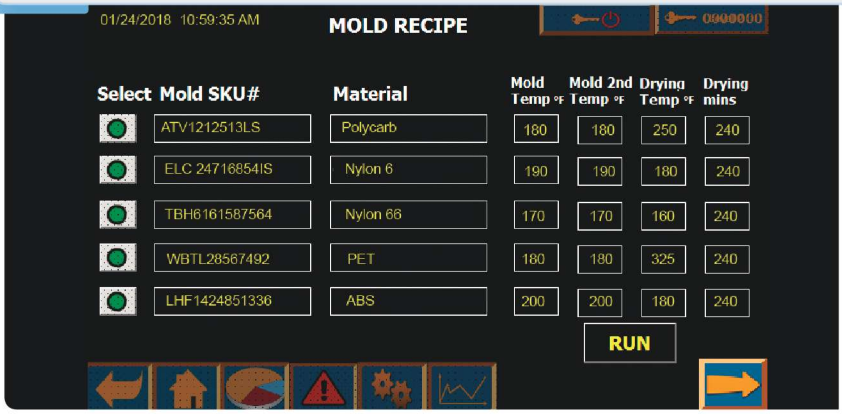
The unit features a 7-in., menu-driven, touchscreen Siemens pendant PLC, from which the user can access both drying and mold-temperature control parameters. The PLC can provide trending and data logging and will be Ethernet equipped so it can be used for QC logging of jobs with resin, mold temperature, and drying parameters recorded. "This will provide great traceability for many molding operations," says Bessemer.

He adds, "What Novatec and Advantage have developed is a total QC system ensuring that drying and temperature parameters are set properly and are recorded as part of an effort to provide mistake-proof molding. Right now, most mold temps are not Ethernet enabled."

> *"Space around a molding machine is always at a premium, and the more you can free up the better."*

The pendant controller features a magnet, allowing it to be mounted on an injection press. The controller will be compatible with barcode readers; a USB barcode device can be used to scan the mold and have drying parameters and mold-temperature zone parameters set automatically. The same barcode device can also scan the resin (for example, a gaylord beside the press) to ensure that the right resin is being used with the mold scan.

The DryTemp+ features a NovaWheel desiccant dryer sized for applications ranging from 25 to 150 lb/hr. The dryer features Novatec's over-dry protection technology (see last month's Close-Up), a central vacuum blower for conveying (DC models), hopper receiver, machine-mount receiver, wand, conveying hose (DC models), cooling coil with plasticizer drain for drying above 225 F, and a vacuum-purge valve with slide-gate discharge.



The controller will be barcode-reader compatible; a USB barcode device (above, right) is used to scan the mold to automatically set drying and mold-temperature zone parameters.

The dryer also features Novatec's intelligent regeneration technology to minimize energy usage, and a dewpoint analyzer with indication alarm.

The TCU is available with one or two circuits, display screen, custom-designed impeller housing and heating and cooling cylinders, ¾-hp pump (2 hp optional), and 10-kW heater. TCU capacity is 30 gpm at 30 psi, with 30-250 F temperature capability. The pump includes a drip-proof motor, seal-flush line, and stainless-steel shaft. The microprocessor controlled, ½-in. modulating cooling valve has a 0-100% aperture range. The TCU's heater is sheathed in stainless steel and controlled by a solid-state relay. Other features include temperature sensors, low-pressure relief valves, over-temperature limit, overpressure relief valves, and mechanical from/to process pressure gauges. TCU components tilt out to facilitate maintenance.

The DryTemp+ also features an automatic phase-rotation detection to facilitate hook-up. It is furnished with a single water supply and drain and power drop. The companies intend to equip the unit with MachineSense predictive-maintenance options in the future.

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Now You Can Injection Mold Unpainted Automotive Soft Skins

New S-TPE for interior trim challenges slush molding and TPV competition.

By Matt Naitove
Executive Editor

There's a new way to make soft skins for automotive interior door panels, instrument panels, and consoles that is said to save considerable cost and weight compared with current methods such as slush molding or injection molding of TPV skins. Kraton Corp., Houston (***kraton.com***) has developed new high-flow SEBS TPE materials that make it possible to injection mold ultra-thin (0.8-1 mm), lightweight soft skins that need no painting. These materials can be processed on existing standard equipment and are suitable for back-foaming or overmolding onto rigid PP substrates.

While Kraton has been presenting this new solution—which it calls injection molded soft-skin (IMSS) technology—to the auto industry for about a year in the form of 4 × 6 in. plaques, the firm took a major step forward in January by inviting automotive OEMs and Tier 1 and 2 molders to a demonstration of injection molding a full-sized instrument-panel (IP) skin, using a tool Kraton commissioned to prove its point. The mold duplicates the A surface of a commercial slush-molded skin for a Ford Fusion. The mold was built by Hi-Tech Mold & Engineering, Rochester Hills, Mich. (***hitechmold.com***), and was run on a 3000-ton Engel press at Hi-Tech's prototyping and tryout facility.

Unpainted soft skins can now be produced by the familiar technology of injection molding in a little over 1 min, rather than waiting 4-5 min for slush molding.

CHALLENGES CURRENT PROCESSES

According to Joe Schulcz, Kraton automotive market manager, the "workhorse" process for molding soft skins today is slush molding of PVC. The first slush-molded Kraton TPE applications are just now approaching commercialization. The biggest limitations of slush molding are that it is a specialized technology that is much less widely distributed than injection molding, and it is relatively slow, with cycle times of 4-5 min and sometimes longer. Kraton demonstrated IP-skin molding in 72 sec, and hopes to get that down below 1 min. The difference translates into a major cost advantage for Kraton IMSS.

IMSS offers cycle times of 72 sec or less, vs. 4-5 min by slush molding.

Another advantage important to the auto industry is weight savings. Slush molded PVC has a density of 1.2 g/cc, vs. 0.9 for S-TPE. That amounts to a 25% weight savings from density alone, which increases to 30% or more when you consider thin-walling, Schulcz notes. Slush molded PVC skins are 1.1-1.2 mm thick, while Kraton IMSS skins potentially could be 1 mm or less. Schulcz considers this to be a major advance: "Achieving 1 mm or thinner walls in parts measuring 25-28 ft^2 is a disruptive technology," he states.

And there's another benefit to consider. A unique aspect of Kraton IMSS is that it achieves high flow with low oil content (<5%). Up to now, such a high-flow S-TPE would require 30-50% oil loadings, which would result in bleeding and visible weld lines (not to mention odor and VOCs). High oil content would require painting to cover such blemishes, as is the case with TPV skins, according to Schulcz. Kraton IMSS eliminates the need for paint and also reportedly improves aging, fogging, VOC and odor performance relative to slush-molded vinyl.

To prove the viability of its new IMSS technology to the automotive market, Kraton built an IP-skin tool mimicking a current slush-molded IP and conducted a molding demonstration in January on a 3000-ton machine at Hi-Tech Mold & Engineering.

All this is made possible by two new high-flow Kraton SEBS resins. Whereas typical SEBS grades have MFIs in the range of 1 to 30, new Kraton MD6951 is 48 MFI and Kraton MD1648 is 200 MFI. Kraton developed IMSS compound recipes with these resins that have 500 MFI at 230 C (446 F). Schulcz says Kraton aims to supply the base SEBS resins to its compounding customers, who will supply fully formulated IMSS compounds to the automotive market.

He adds that his company has some injection molding know-how to offer to customers, too. The materials offer a "reasonably wide process window," Schulcz says, though such very high flow requires some precautions to control flash, for example.

Novel 'Flat' Fiberglass Enhances Injection Molded TP Composites

Higher fiber loadings, better mechanicals, reduced warpage, and better processing are claimed.

By Lilli Manolis Sherman
Senior Editor

Advances in fiberglass reinforcements for thermoplastics have evolved from conventional chopped strand to long-glass fibers to hybrids of long glass and carbon fibers. A key aim is light-weighting while maintaining or enhancing mechanical properties. Key challenges are warpage reduction and ease of processing. Enter a unique family of fiberglass products with a flat rather than round cross-section that may address these issues while offering new benefits.

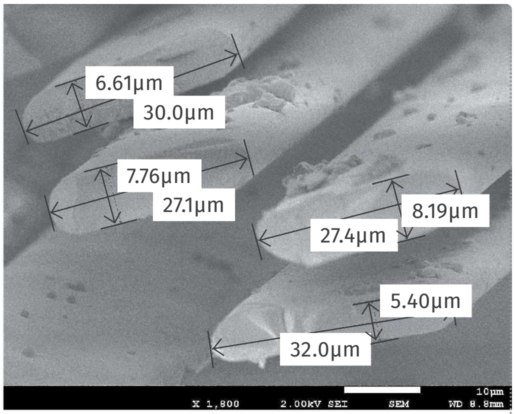
The new glass comes from Chongqing Polycomp International Corp. (CPIC; ***en.cpicfiber.com***), Amsterdam, N.Y., Headquartered in Dadukou, China, CPIC is a subsidiary of YTH Group, a global conglomerate of fiberglass, mineral, composites, textiles, financing and trading companies, and is reportedly the world's third-largest fiberglass manufacturer by installed capacity. CPIC has had U.S. presence since 2012, starting in Rowland Heights, Calif. But in late 2016, the company moved its North American headquarters to the East Coast after acquiring Fiber Glass Industries Inc. (FGI), a 60-year-old privately-held, specialty fiberglass manufacturer in Amsterdam, N.Y. FGI was known for its high level of customer support and rapid deliveries, two features that Zbigniew "Ziggy" Ziobro, former president of FGI and now CPIC's general manager, aims to continue at CPIC's North American organization. Anticipating significant growth in the North American fiberglass market, the company has added several other fiberglass and composites industry veterans to its team. Ziobro noted that the move to its new headquarters puts the customer-service team and management in the same time zone as the majority of the company's North American customers, which is concentrated in the Midwest and on the East Coast.

ADVANTAGES OF 'FLAT' VS. ROUND

The new flat fiberglass is said to facilitate higher fiber loadings and better mechanical properties, including higher impact strength in injection molded thermoplastic composites, while also reducing warpage in thin wall sections.

In addition, the flat glass reportedly enhances thermoplastic processing by providing better fluidity (increased spiral flow), reducing friction, and lowering fiber entanglement and breakage. The flat fibers reportedly tend to flow in planar sheets like mica rather than rolling and tumbling like conventional round glass filaments. In turn, this is said to help provide for a more isotropic dispersion and also allows a higher fiber-volume fraction to be achieved because the fibers pack more

New flat glass fibers are said to exhibit excellent bonding and mechanical properties, reduced warpage, and ease of processing.



The first three grades of flat fiberglass are said to feature unique surface-treatment technology for use in nylon, PPA, PBT, PPS and PC.

closely, as confirmed by scanning-electron micrograph images.

What's more, the new flat glass products are said to help thwart warpage (differential shrinkage and residual stress relaxation) of a plastic or composite part after demolding. Warpage tends to be a function of non-uniform shrinkage between flow and cross-flow directions of a part, which is particularly exacerbated in high-pressure processes like injection molding. This effect is greater when more fibers line up in the direction of polymer flow than in the cross-flow direction, leading to higher shrinkage and warpage in the cross-flow direction.

Flat fiberglass helps reduce warpage significantly in thin-wall parts because its flow properties differ from those of standard round glass.

In the case of thin-wall parts, the cross-flow (through-thickness) direction represents a smaller proportion of the total thickness vs. skins aligned with resin flow, so the effects of non-uniform shrinkage are more pronounced. To some extent, design and gate placements can help reduce warpage, as can process changes such as lowering speeds of fill and/or packing pressures. However, CPIC's flat glass is said to help reduce warpage significantly without any other changes, simply by virtue of how the reinforcement fills parts and how it behaves in conjunction with the resin matrix. Moreover, it helps reduce molding pressures and enables the same part to be molded on smaller injection presses with fewer gates.

Glass-filled semi-crystalline resins using this flat fiber have been molded as thin as 1 mm (0.04 in.) without warpage. The flat fibers are said to exhibit excellent bonding and mechanical properties and are recommended for applications in the automotive and electrical/electronic industries. In all other properties, the flat strands are said to be equivalent to conventional round glass fiber of the same type at the same loading.

Initially, the new flat fiberglass reinforcements are being offered in E-glass (ECT) form with filament width of 24 µm (microns) and thickness of 8 µm, or width of 16 µm and thickness of 5.3 µm. Conventional round glass filaments for chopped strands typically range from 10 to 13 µm in diam. The flat strands are subsequently chopped to either 3.0 mm (0.12 in.) or 4.5 mm (0.18 in.), the most common lengths for short-glass injection grades in Europe and North America, respectively.

Three grades of flat glass fiber are offered in both the 1:3 and 1:4 length/width ratios as well as milled forms. The fibers feature unique surface-treatment (sizing) technology for use in nylon, PPA, PBT, PPS and PC resins. Each product may be purchased in either 55-lb paper bags or 2205-lb supersacks. PT

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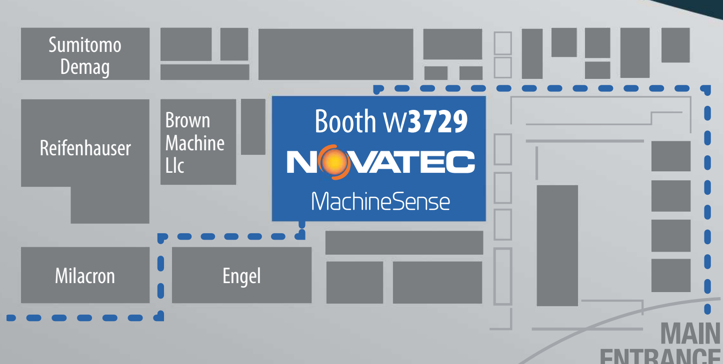

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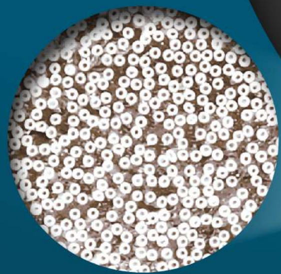

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MATERIALS

PART 3

A Processor's Most Important Job

Processors are often expected to compensate for ill-advised decisions made earlier in the product-development process. In the case of shrinkage, one of the most common 'fixes' is to simply reduce the mold temperature.

By Mike Sepe

A few years ago, I received a call from one of my clients, a processor with a reasonably good understanding of the way plastic materials behave. They had a customer who was upset with them over the way they had "solved" a warpage problem with a part molded in a glass-fiber-reinforced PBT polyester. They had started out with a high mold temperature of 200 F (93 C). The parts came out of the tool and very quickly warped as they cooled. They dealt with this problem the way many molders do: They turned the mold temperature down.

When the mold temperature reached about 95 F (35 C) the parts were straight. Problem solved. Unfortunately, the parts have to operate in their customer's application at 180 F (82 C). So, the customer qualified the parts by putting them into an oven for two hours at 200 F (93 C). When they conducted this test on these parts, they observed that the parts warped to almost the same degree that they did when they came out of the hot mold. The parts were rejected, which my client felt was unfair.

I pointed out to them that they had corrected the warpage problem by suppressing the ability of the PBT to crystallize. Crystallization is accompanied by shrinkage. Crystals are well-ordered domains within the polymer structure and they occupy less space than the amorphous regions. The more a material crystallizes, the more it shrinks. The initial mold temperature was above the glass-transition temperature (T_g) of the polymer and the resin had the opportunity to crystallize to a degree that was reasonably close to the maximum that was achievable. The reduced mold temperature was below the T_g and the degree of crystallinity was correspondingly lower. This reduced the shrinkage of the material.

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Warpage is a symptom of shrinkage that occurs at different rates in different areas of the part. It can have a number of specific causes, such as varying wall thickness, different cooling rates due to uneven heat removal from the part, and different degrees of shrinkage caused by glass-fiber orientation. These are part-design, mold-design, or material-selection issues—not processing issues.

But too often the processor is expected to compensate for ill-advised decisions that are made earlier in the product-development process. And one of the most common "fixes" for excessive shrinkage is to simply reduce the mold temperature. This is also a common strategy for reducing overall shrinkage when the actual shrinkage turns out to be greater than the value that was used to cut the tool. If an outer diameter or an overall length is too small, just turn down the mold temperature and the parts get larger. It seems simple and harmless because the lack of crystallization is not a defect that can be seen by those inspecting the parts.

Warpage is a symptom of shrinkage that occurs at different rates in different areas of the part.

The only way to detect the problem is by doing what my client's customer did, heat the parts to operating conditions and check for dimensional stability. If the parts had crystallized to an appropriate level, the oven exposure would not have created any new crystalline structure, and the part size and shape would have remained essentially the same. But in this case, the as-molded structure and the intended structure were quite different, and when the polymer was exposed to a temperature that re-established the mobility needed to form new crystals, it did what it was intended to do.

If the dimensional changes associated with this additional crystallization occur once the part is in the field, the results can be unpleasant, to say the least. Cracks can occur at attachment points; parts that are designed to move relative to one another can bind; components designed to act as sealing surfaces can allow fluids to leak from a valve or a housing. In this case, the warpage was an indicator that there was a problem that needed to be addressed, not covered up by making an ill-advised process adjustment.

It is important to understand that the cooling rates associated with injection molding will never allow attaining the maximum achievable level of crystallinity. Consider a nylon 66 heated to a melt temperature of 550 F (288 C) entering a mold cavity set at 210 F

FIG 1 **First Heat and Cooling of a Sample from a Molded PP Part**

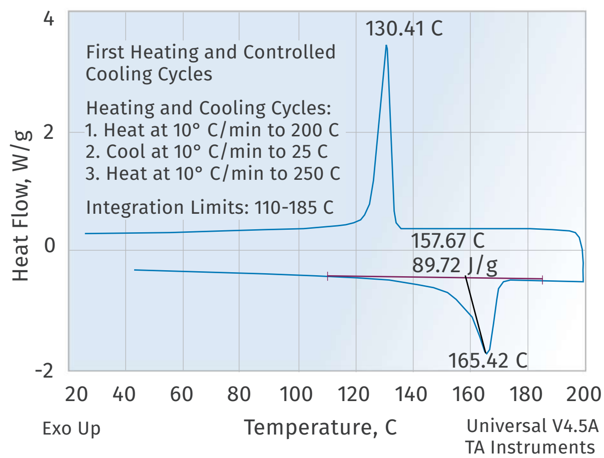
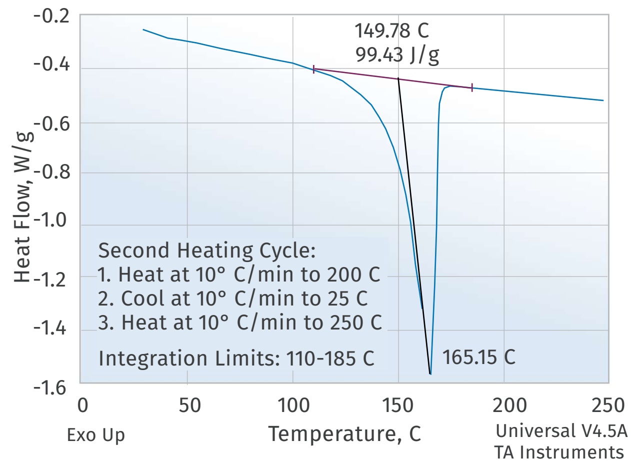


FIG 2 **Second Heating of Sample from PP Molded Part**



In this DSC test, a melted sample of PP is cooled back to the solid state, producing a peak that is a mirror image of the melting event. This is the heat released by crystallization. This heating and cooling erases the thermal imprint of the molding process. When the sample is heated a second time, the heat of fusion is higher (99.43 J/g vs. 89.72 J/g) because the cooling rate in the DSC is much slower than that which the material experienced during molding.

(99 C), a temperature above the T_g of the nylon that will produce a relatively high degree of crystallinity. If the part cools to an ejectable temperature in 30 sec, then the cooling rate for the material is 680° F (378° C)/min! When we test materials under laboratory conditions, we traditionally use heating rates of 10° or 20° C/minute. Therefore, we can achieve a level of perfection in the lab that cannot be attained at the press, even when we do things as well as possible. We also know that the cooling rate at the part surface is faster than in the middle of the wall, unless the nominal wall is very thin. But for processors, the objective is to balance production efficiency with achieving a condition in the polymer that ensures good, but not perfect, stability.

We can perform a test called differential scanning calorimetry (DSC) to check our work. This involves preparing a sample from the molded part and heating it under controlled conditions in the DSC until it melts. The melting event will be observable as a peak that is associated with a property known as the latent heat of fusion. This is a measure of the degree of crystallinity. The greater the heat of fusion, the more crystal structure is present in the molded part.

The melted sample is then cooled back to the solid state, producing a peak that is a mirror image of the melting event. This is the heat released by the process of crystallization. This heating and cooling process erases the thermal imprint of the molding process. When we heat the sample a second time, we should see a new heat of fusion that will be higher than the one we saw on first heat. This is because the cooling rate in the DSC is much slower than that which the material experienced during the molding process. Figures 1 and 2 show the results for this type of DSC test performed on a PP part.

The heat of fusion on first heat is 89.72 J/g, while the second heat of fusion is 99.43 J/g. When we divide the value from first heat by the value from second heat we get 90.2%. That is considered to be the degree of crystallinity that we achieved relative to what was theoretically possible if we could somehow cool the polymer very slowly in the mold and convince our customer that it was acceptable to produce 15 parts/hr. This is the point. In the real world of manufacturing there is a compromise between achieving the perfect structure in a material and making a part at a price that is competitive. A value of 90% is considered to be a good outcome in most cases. It is important to understand that this result does not mean that the polypropylene in the molded part is 90% crystals. The value is a percentage of what was attainable. The absolute degree of crystallinity in this part is actually a little less than 50%, which is quite normal in polypropylene.

Because PP is one of those materials that does not crystallize to a significantly greater degree as mold temperature is increased, there is little danger in running a mold temperature that is relatively low. In this case the mold temperature was 100 F (38 C). But as we will see in subsequent articles, sometimes cooling down the mold causes us to miss the target by a much larger amount. This usually occurs in the high-performance materials.

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INJECTION MOLDING

How to Set Barrel Zone Temps

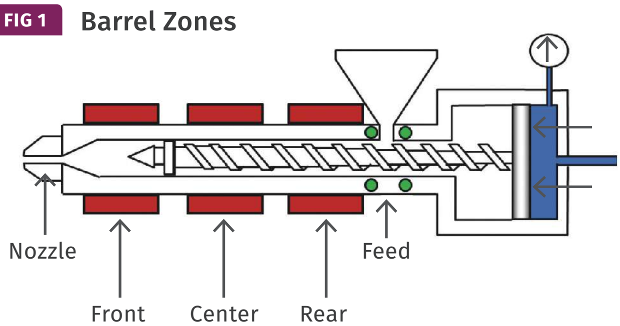
Start by picking a target melt temperature, and double-check data sheets for the resin supplier's recommendations. Now for the rest...

By John Bozzelli

In setting up a new or existing mold, there are a myriad of variables the processor has to deal with, yet one gets immediate attention: setting up the barrel zone temperatures. Operators don't want to waste time waiting for the machine to warm up, so they generally set the zones to the desired temperatures as they set the mold and prepare for production.

But the questions are: What temperature do you want the melt to be, and what temperature profile of the barrel zones will get what you want? Most will agree that having the polymer at the correct melt temperature is a significant factor in making quality parts with stable, trouble-free production. Incorrect temperature settings waste resin and can provide unacceptable parts due dimensional issues, warpage, burning, black specks, degradation, and loss of part performance, to name a few.

FIG 1 **Barrel Zones**



Shown here are the four basic barrel zones on an injection molding machine that must be set up properly, along with the nozzle body and tip.

Machines can have four or more barrel zones, but the basic zones are: feed, rear, middle, and front. You also need to correctly control the nozzle body and tip (Fig. 1). The processor starts by picking a target melt temperature. If it is a resin or grade new to you, check to see what the manufacturer recommends. Even if it's a material you have experience with, double-check data sheets for the resin supplier's recommendations. A mistake at startup will only screw up the rest your day and cost your company money. Usually the resin supplier will provide a range: Let's say it recommends 450-510 F (230-265 C) for a semi-crystalline resin. Pick something near the center, in this case 485 F (250 C). You now have the target temperature for the melt. Next is setting up the barrel zone profile.

This is a bit more complicated. A molder will often consider what backpressure to use in setting up the barrel temperatures. While important, backpressure deserves a separate article. For this discussion, let's assume it is set at 700 psi plastic (not hydraulic) pressure, as this resin is reasonably thermally stable and not glass-filled. Backpressure cannot be stated as 50 or 100 psi, as a hydraulic machine has an intensification ratio that must be known and used to set backpressure correctly if you want to duplicate the process. In my experience, backpressure is stated incorrectly in 95% of resin suppliers' specification sheets.

Before the barrel zone profile is established we need to cover a couple of resin and screw basics. These will help us understand the barrel profile settings. The typical "general-purpose" screw in our industry is best described as having no purpose. In the real world, however, such designs are common.

A screw is composed of three sections (Fig. 2):

1. The feed zone. Often half the screw flight length, this section augers and compacts the granules coming in from the feed throat and perhaps conducts a bit of preheating before the transition zone. Feed-section flights are deep, and as the granules fall in there is air between them. This air needs to be vented out the feed throat or it will cause problems such as splay.

2. The transition/compression zone. This usually comprises 25% of the screw flight length. Here material is melted for the shot.

3. The metering section. This also is typically 25% of the screw flight length. This section pumps the plastic forward and generates the backpressure. ►

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With screw basics completed, let's turn to resin issues that influence how plastics melt. Thermoplastic resins can be amorphous or semi-crystalline. Amorphous materials like ABS and HIPS melt gradually, like butter, and soften easily. Conversely, semi-crystalline resins like polypropylene, polyethylene, and nylon melt like ice, and stay hard until they reach their melting point. They also have a latent heat of fusion, which means they need a certain amount of energy to reach their melting point, and once there they need yet another jolt of energy to get them melted. A semi-crystalline resin will often require twice as much energy to melt as an amorphous resin. For example, PS takes about 160 Btu/lb to melt, whereas PP takes 250-300 Btu/lb. Bottom line: It is harder to properly melt a semi-crystalline resin.

So both screw and resin characteristics must be taken into account when setting up barrel zone temperatures. How does one sort all this out?

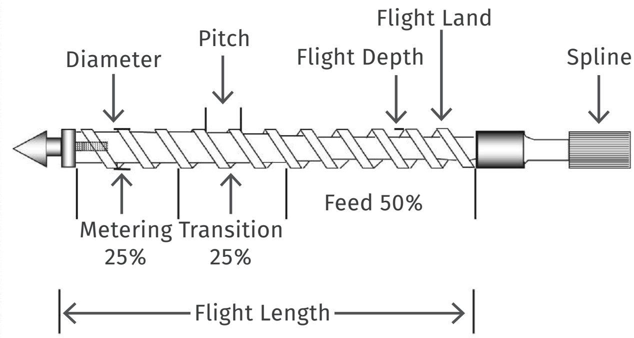
• Setting the feed zone: Starting at the beginning of the melting process, the feed zone has to act as a vent, but you don't want the granules to stick together. It should be PID controlled like the other zones, and for the semi-crystalline resin in this scenario I suggest 140 F (60 C). This is warmer than most would consider, but it provides venting, will not result in condensation of volatiles, is well below the softening point of the resin, and will not cause bridging.

• Setting the rear zone: Remember, in our scenario we are running a semi-crystalline resin, so you must consider shot size. If the shot is greater than roughly 50% of the barrel capacity, keep in mind that the feed section actually shortens because of the large shot size; that is, the time before the resin sees the transition or melting zone shortens. You also have to consider that the transition zone has to pump in a lot of energy and may not be able to get it done. Thus, if the shot is a large portion of the barrel capacity, I set the rear zone high, perhaps 490 F (255 C). If the shot is less than 40% of the barrel, the rear zone would be lower, 465 F (240 C), to ensure there is no melt formed in the feed section to block venting. For an amorphous resin I do not raise the rear zone.

Having the polymer at the correct melt temperature is a significant factor in making quality parts with stable, trouble-free production.

• Setting the center and front zones: To achieve melt uniformity these are both set at the target melt temperature, 485 F (250 C). The goal is to have the front zone at the same temperature as the melt coming out of the metering zone. If the front zone temperature is different there will be a problem with melt uniformity. Review the details of the cycle and you will realize the shot—a cylinder of plastic and reasonably thick—does not reside in the front zone very long—only seconds. If the front zone is a different temperature than the melt, some portion of that cylinder of plastic will be at a different temperature, as plastic is a poor heat conductor.

FIG 2 Screw Components



Typical molding machine screws consist of three sections, as shown here.

The goal is that once you have the plastic melted, keep it at that temperature. The melt does not reside in the front zone, nozzle body, nozzle tip or hot runner long enough to reach melt uniformity if these are at different temperatures than the target. Having the outer layer of the plastic melt at a different temperature will often produce cosmetic issues with your parts. Blush, halos, gloss differential, etc., are problems I have found to be some of the hardest to resolve.

Setting the temperature of the nozzle body and tip is a quagmire. Most have incorrect heater bands, temperature controllers, and insulation, plus poor location of thermocouples and other design issues. All these problems make setting the right temperature nearly impossible.

My recommendation is to first set this up as I discussed in my column in the February 2013 issue (Don't Ignore Nozzle Temperature Control). Then set the temperature at the target, purge a couple of shots, build a shot, and back the injection unit as far as it will go. Working with protective equipment, insert the longest thermocouple into the nozzle tip as far as it will go. Wait until the temperature stabilizes and extract the thermocouple by 2 in. (50 mm) and take another reading. Repeat this until the thermocouple is just inside the nozzle tip. If you see a temperature variation of more than 20° F (10° C), find the problem and repair it. If the temperatures are in the same ballpark, note the difference from the target and adjust the setpoint accordingly.

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EXTRUSION

Understanding Weld Failures

Hard-surfacing failures without evidence of burrs indicate possible weld bond issues.

Photo at top shows a complete failure of a large area of the flight. The pattern on the flight surface where the weld is missing shows the moderate distortion of the weld groove by the welding heat. But it is very smooth, indicating the weld was simply laid on the flight with little or no bond. Photos middle and bottom show a lesser but still catastrophic degree of weld failure. The areas where sections of the weld have fallen out with no sign of galling on either side is again a sure sign of poor weld bond.

By Jim Frankland

Most extrusion screws have hard-surfacing materials welded on the flights to provide longer wear life. When extreme wear occurs in the absence of abrasive fillers, a burr on the flights provides a clue as to what is happening. A burr on the trailing side indicates a very high side force is causing the flights to gall or even weld to the barrel material, literally pulling the two surfaces apart. This is usually due to "wedging," which is caused by the screw momentarily plugging with solid polymer at a radial location. If pressure from the plugged channel is not balanced by a similar force on the other side, the screw is pushed with tremendous force against the barrel.

It's hard to measure this force because it may only last for a fraction of a second. But by calculating the pressure necessary to bend the screw so it can contact the barrel over relatively short lengths, it's been found that the pressure can be momentarily as high as 25,000 psi. Remember, the screw in the compression section is a double-spiral wedge driven by the full torque of the extruder drive, giving it enormous compressive force. Wedging is basically a screw-design issue where the melting rate of the screw is inadequate to match the compression rate.

Before screws are rebuilt it's a good practice to grind the old weld off and check for cracking.

A burr on both sides of the flights usually indicates a barrel alignment issue whereby the barrel is causing the screw to bend with each revolution to conform to the barrel. Again, because of the power of the extruder drive, this crushes the flights and develops galling, resulting in a burr on both sides.

None of the three images that accompany this article show any evidence of a burr, so it's unlikely the weld failure is the result of wedging or barrel alignment. More likely, the weld failure was due to improper weld application, resulting in a poor bond between the hard-surfacing material and the base metal. The photo on the left shows a complete failure of a large area of the flight. The pattern on the flight surface where the weld is missing shows the moderate distortion of the weld groove by the welding heat. But it is very smooth, indicating the weld was simply laid on the flight with little or no bond. The images in the center and right show a lesser— but still catastrophic—degree of weld failure. The areas where sections of the weld have fallen out with no sign of galling on either side is again a sure sign of poor weld bond.

Today almost all screw manufacturers use a technique called plasma transferred arc (PTA) welding to apply hard-surfacing material to the screw flights. PTA is used

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because it has the least effect on the underlying screw material while creating a strong metallurgical bond because of its extremely high temperature. Other welding processes apply heat for a longer period, with a wider heat-affected area at the weld point. This dilutes the hard-surfacing material with base metal and reduces its anti-galling properties by contaminating the hard-surface material with iron.

Most of the nickel/chrome (Ni/Cr) and cobalt-based hard-surfacing materials fuse at about 2000 F, and the plasma "flame" can generate temperatures in excess of 10,000 F. Being much hotter and much more concentrated than most other welding processes reduces the dilution of the hard-surfacing material.

PTA welding is a surprisingly sensitive process and takes constant operator attention; it requires numerous adjustments related to the position of the torch itself and the position of the weld bead on a round surface. Moreover, there are adjustments for the welding arc, shield gas and amperage. Even a little draft on the arc will disturb the shielding gas and plasma gas and cause a reduction in bonding as well as rapid oxidation of the interface area.

PTA welding is a surprisingly sensitive process and takes constant operator attention.

For example, having the PTA torch a mere 1/16-in. too far over center on a small screw will greatly reduce the bond strength. The condition of the base metal before and after welding is also critical. Carbon steel undergoes a phase transformation if held at temperatures below 650 F, which creates a form of steel that is brittle and has a lower density. This results in cracking of the base metal and transfer of the cracks into the hard surface material, setting up areas for weld failure.

To prevent this phase change, the screw must be preheated and held at an elevated temperature through the welding process, and then very slowly cooled to prevent the phase change. Even minor deviations in how the preheating and post-cooling process is handled will cause excessive cracking. Some radial cracking of the hard-surfacing overlay is normal—the overlay usually has a greater coefficient of expansion than the base metal, and upon cooling shrinks more than the base metal, which is relieved by the radial cracking. In fact, if no radial cracking is present with the Ni/Cr alloys it is likely to be in fact some other material.

New screws have the weld applied in a shallow trough before the flights are machined, which helps to reduce the sensitivity of torch position and improves welding rate. The trough dimensions are also critical. However, rebuilt screws are welded on a narrow and round surface. As a result, it's often difficult to obtain the same hardness of the overlay on rebuilt screws, particularly small ones.

Once a screw has been welded with improper preheating and post-cooling, it is difficult to obtain a good rebuild because of the prior cracking and brittleness that extend into the base metal due to the prior phase change. Before screws are rebuilt, it's a good practice to grind the old weld off and check for cracking, using various metallurgical test methods. The practice of putting a layer of softer stainless steel on the screw flights under the hard surfacing is sometimes used to "block off" underlying cracking. However, that results in two welds and, if not done properly, doubles the chances of weld failure.

The important thing to remember is that polymers do not wear screws unless filled with hard, abrasive fillers. Only contact between the barrel and screw flights results in wear. By simply observing the "burr," the cause of wear can generally be determined. Any hard-surfacing failures without evidence of the burr will indicate possible weld-bond issues. PT

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TOOLING

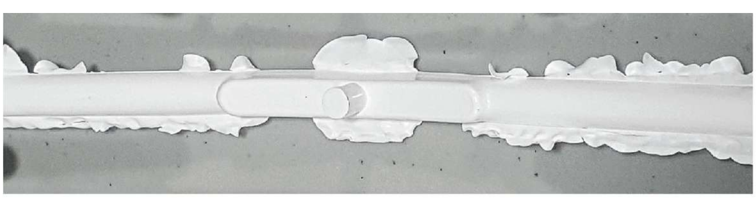
Hot Sprues: Mold a Disk or Not?

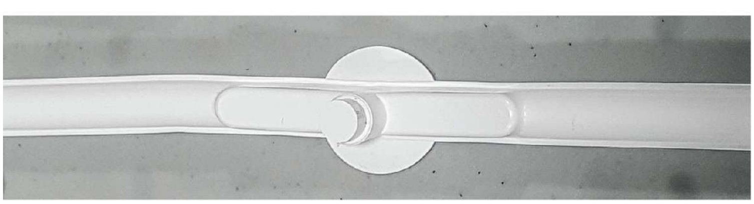
Having a hot sprue shut off against the parting line versus intentionally molding a thin disk has been the subject of controversy for many years.

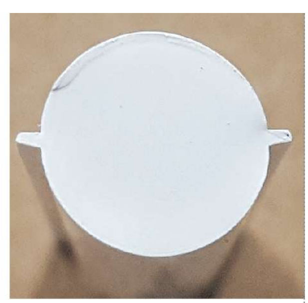
By Jim Fattori

A difference of opinion regarding a particular mold-design preference came up again recently. The conundrum was whether to intentionally leave a space or gap between the end of a hot sprue and the parting line of a cold-runner, two-plate mold. I'm not talking about the space required to compensate for linear thermal expansion. I'm referring to an additional space to mold a thin disk of plastic, about 0.005 to 0.050 in. thick, between the two surfaces.

I decided it was time to see if I could get some closure on the matter—or at least present all the arguments for and against, so that mold designers can make an informed decision about which option suits their needs or application best. Not surprisingly, I couldn't find a single word about this subject on the internet, nor in any of the plastics reference books, seminar handouts, or magazine articles I have collected over the years. So I reached out to several well-respected hot-sprue manufacturers, tool makers, processors and materials-company technical representatives for their thoughts. I was amazed how their steadfast opinions on the preferred design, as well as their reasons, varied from one extreme to the other.







A runner with and without a molded disc and flash trap (cross section, above).

Probably the best argument for leaving a gap and molding a thin disk is that it guarantees the hot sprue will never extend beyond the parting line of the fixed half of the mold. If it did, the face of the hot sprue would quickly hob the moving side. It was also reported that if the tip extends too far, the repetitive impact against the moving half of the mold can cause the tip to slowly unscrew—making the damage that much more severe and often cause the tip to crack near the notch-sensitive threads. That makes sense, considering the threads of a hot-sprue tip are coated with an anti-seize lubricant, as opposed to an anaerobic adhesive, such as Loctite. Those are both very good reasons for wanting to mold a disk.

Several people said they like the molded disk because it acts as a cold well to catch any solidified material residing in the gate of the hot sprue. I don't agree. Plastic flows in the path of least resistance. Unless the disk is very thick, or the material has a very low viscosity, the initial flow of material is going to go right into the wide-open runner—not into a thin disk. In fact, the disk is probably not going to even fill out until the material flow reaches the restrictive gates and the pressure starts to build. Therefore, it's highly unlikely that a molded disk acts as an effective cold well.

However, a disk will function as a "flash trap." That is a thin web of material, usually added down the sides of a runner to prevent flashing. The thin web solidifies prior to the melt-delivery system reaching significant pressure. Therefore, a thin molded disk will help prevent the surrounding area from getting damaged by flash. Another good reason for molding a disk.

One argument against molding a disk is the increased chance of the injection pressure causing the hot sprue to "blow back." Most hot sprues have a standard 1-in. diam. If the peak injection pressure was, for the sake of argument, 14,000 psi of plastic pressure, there will be 11,000 psi trying to push the hot sprue toward the fixed platen.

Molding a thin disk guarantees the hot sprue will never extend beyond the parting line

If the molding machine is small and has an associated small amount of nozzle-touch force, there's a chance the hot sprue will in fact blow back. If the hot sprue is retained by a ¼-20 SHCS, there's a chance the bolt will, over time, fracture from fatigue, and then the hot sprue will blow back. However, this blow-back argument is moot if the hot sprue is retained by a combination flanged and clamp-type locating ring, such as Progressive Components Part LR519. This type of locating ring not only retains the hot sprue, it is fully supported by the fixed platen.

The worst reason I've heard for not molding a disk is, "We always had the sprue tip sit flush with the parting line." That's not a reason; that's old-school resistance to change. As an old-school guy myself, I can confirm that is the way it was always done, and it was never questioned. Back then, if you molded a disk people would ask what happened.

Unless the calculation for linear thermal expansion is off, a hot sprue shouldn't extend beyond the parting line. Calculating that thermal-expansion value is a lot easier said than done. In fact, the chances of being "spot on" are pretty slim. In order to get precisely where you need to be, adjustments typically need to be made when assembling the mold, as well as after the initial try-out.

The formula used to calculate the amount of linear thermal expansion is:

$$\Delta L = La \times (Tp - Ta) \times \alpha$$

ΔL is the increase in length of the hot sprue at the processing temperature.

La is the unsupported length of the hot sprue at ambient temperature; Tp is the processing temperature of the molding material.

Ta is the ambient temperature (typically 68 F); α is the coefficient of thermal expansion of the material—typically steel.

Ta and La are for the most part, fixed values; α is also a fixed value, but are you using the right one? I checked the coefficients of thermal expansion for various types of steels used in injection molds (see Table 1). They ranged from 6.1 to 7.3 × 10^{-6} in./in.-°F. The difference between the highest and lowest values is an extremely small number (0.0000012 in./in.-°F), but it's an important one. If you have a 10-in.-long hot sprue running at 600 F, and your coefficient of thermal expansion is off by just 0.5 × 10^{-6} in./in.-°F, that's a difference of 0.003 in.

Depending on the molding material, that can mean the difference between flashing or hobbing the mold. Using a "generic" expansion coefficient for every type of mold steel is a mistake. These coefficients not only vary from one type of steel to another, they also vary from one supplier to another. If all this isn't confusing enough, it turns out that the coefficient of thermal expansion for tool steel really isn't a fixed value. The value increases as the steel temperature increases. How do you account for that?

And what about the mold base itself? The same formula used to calculate how much the hot sprue will increase in length should also be used for the mold base (Table 2). The amount of thermal expansion is negligible at mold temperatures below 80 F, but higher temperatures are definitely a factor to consider. For example, if you're running PEEK with a mold temperature of 375 F and the hot sprue is 10 in. long, the mold plates over that distance will grow about 0.021 in. If you don't take that into consideration, you're going to mold a disk whether you want one or not.

Instead of pulling your hair out trying to calculate the perfect amount of linear thermal expansion, the easiest way to deal with the problem is to heat the sprue, and if necessary, the mold base, up to the processing temperatures. Measure the distance between the face of the sprue and the parting line and adjust ►

TABLE 1

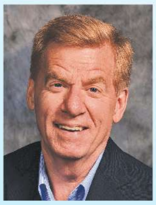
Thermal-Expansion Coefficients Of Mold Materials at 390 F

Material Type	α (in./in.-°F)
420SS	6.10
1045	6.16
P-20	7.00
H-13	7.30
BeCu	9.70

TABLE 2

Mold-Base Expansion Over a 10-in. Length

Mold Base Temperature, F	Mold Base Expansion, Per 10 in.
50	-0.001
75	0.000
80	0.001
100	0.002
125	0.004
150	0.006
250	0.013
375	0.021



accordingly. That will get you very close to being "spot on" without all the mathematical hassle.

If you performed the measurement procedure above, the only thing that can cause a problem is if the processing temperatures change out on the production floor. Unfortunately, the processing temperatures out on the floor almost always differ from what was recommended and designed for.

All molding materials have an acceptable melt-temperature range, as specified by the manufacturer. That range can be as much as 50° F or more. It's not uncommon for a processor to exceed these upper and lower specified temperature limits in order to fill out the cavities or improve the aesthetics or dimensions of a part. It's called "processing around" a part- or mold-design issue. Table 3 shows that unless you have a fairly long hot sprue and a fairly high temperature deviation, the hot sprue really doesn't expand as much as you might think.

With some regularity, problems with a thermocouple or a controller can cause the temperature of the hot sprue to increase—sometimes through the roof. These are the most common reasons:

- The thermocouple does not have proper contact with the steel.
- Incorrect wiring of the thermocouple or heater zones in the electrical connector.
- Frayed thermocouple wires contacting each other.
- A K-Type thermocouple was installed, when a J-Type was required. (Note: In the USA, J-type leads are red and white. Other countries do not follow the same color-coding scheme.)
- A control module fails in the "closed" condition.
- A supervisor detects a thermocouple problem and switches the controller into manual mode at too high a power setting.

A less common reason for temperature override is the quality of the controller itself. I once started up six brand-new hot-runner molds with six brand-new controllers. When we turned the controller on for the first mold, all the zones shot right past their setpoints. The same thing happened to the second mold, and the third, and so on for all six molds. It turned out that a blown-film extruder in an adjoining room had a very large DC motor on the same power line. It was spewing out a massive amount of electrical noise, which affected all the controllers. It took an oscilloscope and a very savvy tech-service rep to solve that one.

A thin molded disk will help prevent the surrounding area from getting damaged by flash

TABLE 3

Thermal Expansion of Hot Sprue Caused by Deviation from Recommended Melt Temperature

Hot Sprue Length, in.	Melt Temp. Deviation, F		
	10	30	50
	Expansion, in.		
2	0.0001	0.0004	0.0007
4	0.0003	0.0008	0.0013
6	0.0004	0.0012	0.0020
8	0.0005	0.0016	0.0027
10	0.0007	0.0020	0.0033
12	0.0008	0.0024	0.0040

So far, I've given you several good reasons to mold a disk, and very few to have the hot sprue "kiss-off" against the B-plate. Now let's discuss what happens to the process with and without a disk.

Some people say that if you don't mold a disk, the face of the hot sprue will contact the B-plate, which will suck the heat out and change the intended heat profile. To some extent, that's true; but, depending on the mold, having the heat sucked out of the face of a hot sprue can either be a good thing or a bad thing.

You may not want to mold a disk if the cycle time is fairly fast, the gate orifice is relatively large, or the material is a type that likes to string, such as ABS. The additional heat transfer helps reduce the damaging strings from forming by increasing the solidification rate. It's the exact reason some molds are designed with water-cooled bushings around a hot-sprue tip. Not molding a disk increases the rate of heat being sucked out of the hot-sprue tip and should reduce the risk of stringing.

Conversely, you may want to mold a disk if the cycle time is fairly slow, the gate orifice is relatively small, or the material is the type that sets up fast, like crystalline nylon. Not molding a disk could suck out too much heat and can cause a cold slug to form behind the gate. Cold slugs require a tremendous amount of pressure to dislodge at the start of injection. I'm sure you've all heard a loud popping sound or felt the injection carriage shake when that happens. To make matters worse, this cold slug needs to get trapped by a cold well or runner overflow before it makes its way to the cavity. Molding a disk will reduce the rate of heat being sucked out of the hot sprue tip. This should reduce the risk of forming a cold slug.

There's a lot of conjecture about just how much heat is or isn't transferred from the face of the hot sprue to the moving half of the mold when you don't mold a disk. If the heat transfer is really that important, and sometimes it really is, then the focus should be more on the outside contact or land area of the hot sprue tip—not the face of the tip. If you don't mold a disk, the face of the tip is only contacting steel for a portion of the molding cycle while the mold is closed. But the land area of the tip is always in contact with the adjoining steel.

Table 4 shows that the amount of possible contact area on the side of a hot-sprue tip can be considerably less or considerably more than that of the face of the tip. The amount of land length in the mold, as specified by hot-sprue manufacturers, varies tremendously. I like to hedge my bets and often increase the land length as much as possible. In fact, for sprues with large orifices, I prefer a shorter nozzle body with ►

an extended nozzle tip, specifically to increase the land length. It's a steel-safe condition that can easily be reduced if there's an issue.

I once helped tweak the process of a high-volume mold running a very fast cycle. Every second meant tens of thousands of dollars per year. We tested tips out of H-13 steel, 420 stainless, and BeCu alloy. We also varied the amount of outside contact of each of those tips. The goal was to get the fastest gate-freeze time to minimize the cycle, but not too fast, which would create cold slugs or cause the mold to be difficult to start up. If the gate-freeze time was too long, it would extend the cycle, or cause stringing. The diameter of the gate orifice was a fixed dimension—just large enough to keep the injection pressures at a reasonable value for the given wall thickness and flow length. The orifice diameter and molding material were the predominant factors in determining which type of metal to use for the hot-sprue tip, and how much land length was needed to obtain the ideal solidification rate to achieve the fastest possible cycle.

TABLE 4

Contact Area of Face & Sides of a Hot-Sprue Tip

1 in. Diameter Hot Sprue Contact Areas, in.^{2}		
Front Face		*0.785
Side Contact or Land Length, in.	0.125	0.393
	0.250	0.785
	0.375	1.178
	0.500	1.571
*Subtract Gate & Runner Area		

Because of this investigation into whether to mold a thin disk, I have reversed my old-school opinion. In all but the most extreme cases, the amount of heat loss from a hot-sprue tip to the moving half of the mold is probably not much of a controlling factor. Therefore, I now suggest intentionally molding a disk with a thickness of roughly 25% of the wall thickness of the part. But don't forget to maximize the land or bearing length of the hot-sprue tip and pay particular attention to the cooling channels near or around the tip. This way, you prevent damage to the parting line of the mold caused by a variety of potential issues, and you maintain the ability to adjust the gate solidification rate by varying the tip's land length and cooling temperature to prevent cold slugs or strings.

Lastly, kudos to those of you who realize that much of what I said here about hot sprues feeding a cold runner in a two-plate mold also applies to a hot sprue in a three-plate mold, and to molds with various other types of hot-feed systems.

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Compounding Solutions LLC • Lewiston, Maine

By Jim Callari
Editorial Director

Technology Is the Solution For This Compounder

Compounding Solutions runs medical formulations in a pristine, climate-controlled, 7600-ft^2 white room equipped with eight extrusion lines, including this 50-mm Leistritz twin screw, notes Scott Neal, company founder, owner, and general manager.

Compounding Solutions has seen its business grow by 20% in each of the last 12 years. That's no accident. The firm has become a mainstay supplier of compounds—primarily for medical—by tapping into its expertise in technology and processing.

If Scott Neal was born with a spoon in his mouth, it was probably plastic. In 1980, at the age of 10, he was running his first extruder. His father, Robert Neal, was a long-time entrepreneur in plastics, and at the time owned Maine Poly Inc., which processed blown and cast film for food and electronics packaging.

In 1990, armed with a degree in economics and business from the University of New Hampshire's Whittemore School of Business and Economics, 22-yr-old Scott, like his dad before him, decided to strike out on his own. He founded PolyColors Inc. in Lewiston, Maine, a compounder of custom color masterbatch serving Northeast blown film, injection molding, and profile extrusion processors. Seven years later, the younger Neal sold his business to Clariant Masterbatches.

After staying on as general manager, Neal's entrepreneurial genes kicked in again. He resigned from Clariant in May of 1999 and founded Compounding Solutions LLC (***compoundingsolutions.net***), also in Lewiston with, he recalls, "two extruders, three employees, and 8000 ft^2 of space." Though armed with expertise in color matching, formulating and compounding, a non-compete clause precluded Neal's new company from entering that business, so—owing to the preponderance of medical OEMs in the Northeast—Neal steered Compounding Solutions to the medical market. By 2004, he had expanded its plant to 20,000 ft^2, added a third extrusion line, and grown to 20 employees.

"When Compounding Solutions was started, there were a lot fewer shoot-and-ship, general-purpose molders in the area than there were just 10 years before," states Neal. "At the same time, we saw the medical market as up-and-coming. And we identified a need among medical-device companies for consistent, high-quality compounds. That's a need we sought to fill."

Today, Compounding Solutions is certified to ISO 9001:2008 and ISO 13485 and sells globally. It runs 14 twin-screw, co-rotating extrusion lines (12 for production, two for R&D) ranging in size from 18 to 50 mm and supplied mostly by Leistritz, Somerville, N.J. The company has expanded its plant to 60,000 ft^2 and at the time of *Plastics Technology*'s visit was putting the finishing touches on a 60,000 ft^2 expansion.

That expansion—a brand-new building adjacent to Compounding Solutions' existing plant—frees up space for up to 10-12 more compounding lines, says Neal. "We will not be moving any equipment from the existing plant to the new one," he states. "At first, we'll be using most of the space for warehousing." That said, one new 50-mm line is on order and due to arrive in June; it will be the first line installed in the expansion. The new building will have a 6400-ft^2, Class 100,000 clean room, expanding Compounding Solutions' ability to create materials with active pharmaceutical ingredients to produce drug-eluting compounds.

Neal is also investigating an entry into the pharmaceutical compounding market. The new building will feature a 3200-ft^2, controlled-environment white room for fluoropolymer compounding; and an 8000-ft^2 area for industrial compounding. The expansion includes plans for two new silos, each with 80,000 lb of capacity.

The medical-device industry accounts for roughly 75% of the compounder's revenue. "Our business has been mostly medical for the past 10 years," says Neal. "It's not our intention to be 100% medical. We supply compounds to processors in food packaging, footwear, sporting/consumer goods, 3D printing, automotive, and others. We even provide toll compounding services. But we're comfortable with medical representing 75% of what we do and tend to focus our marketing and product-development efforts in that area."

On a volume basis, Compounding Solutions runs about 5 million lb/yr. While not comfortable revealing annual sales numbers, Neal divulged that the company has grown by 20% for 12 straight years.

Compounding Solutions' white room is equipped with a HEPA-filtered air exchange with humidity and temperature controls, and epoxy-coated wall surfaces to repel dust and allow for easy cleaning of all surfaces.

FOCUS: TECHNOLOGY

Neal says his client list among medical-device firms includes all the major OEMs. In many cases, material is specified by the OEM, which then directs the compound to be shipped to the molder or extruder for processing. "We may sell to the OEM most often but stay very close to the processors," Neal explains. "We need to know the problems the processor is dealing with in order to solve them." Neal estimates that about 40% of the material he sells into medical is used in production of catheters. Compounding Solutions runs a full slate of materials, including polyolefins, styrenics, polyesters, PC, nylons TPUs, biodegradables. TPEs, and fluoropolymers. It also supplies a range of high-heat compounds and considers PEEK a specialty, while noting that TPU and TPE (notably

PEBA) compounds now represent its biggest growth areas.

Nowadays in particular, with engineering resources at a premium, a lot of compounders rely on their extruder supplier to specify all upstream and downstream components and supply them with a system in a package. Not so for Compounding Solutions: It buys the extruder—paying careful attention to specifying screw design and metallurgy, as well as the controls platform—and all upstream and downstream machinery, and integrates the equipment on its own. That includes desiccant dryers, loss-in-weight feeders, and strand and underwater pelletizers.

In the QC and testing lab, Compounding Solutions has the full gamut of equipment for mechanical, physical, impact, rheological, and visual testing.

"We are very comfortable in our technical knowledge of twin-screw extruders," says Neal, who bought his first Leistritz machine, a counter-rotating twin, while running PolyColors. "We've made it our mission to understand a lot about design and placement of screw elements. In fact, I think we are at the forefront in the development of high-dispersion radiopaque compounds, and a lot of that know-how came from our experience in color dispersion.

The compounder has two manufacturing areas in its current 60,000-ft^2 footprint: one for industrial products and a separate white room specifically for medical products that is furnished with seven extrusion lines—six twins and one single-screw extruder.

Its 7600-ft^2 white room includes an air lock with a positive-pressure environment, sealed and polished concrete floors, a HEPA-filtered air exchange with humidity and temperature controls, and epoxy-coated wall surfaces to repel dust and allow for easy cleaning of all surfaces. Neal says that temperature and humidity control offer substantial benefits for processing conditions, depending on the time of year. "Urethane materials always appreciate the venue due to it is low water-vapor content," he elaborates. "Similar hygroscopic materials are always a challenge to process under high-humidity conditions. The white room provides a step far above typical environmental conditions to further assist with effective processing."

The walls and floors are all sealed and polished so that in the event of contamination the room can be washed from top to bottom. Feeders are all covered and sealed under nitrogen to ensure that nothing is getting into the compound other than what's specified. Downstream of the water baths, changing the water and scrubbing the tanks is standard practice to minimize the number of pyrogens contacting the strands before they are cut and bagged.

White-room compounding is not an industry standard by any means, Neal states. "Unlike other compounding companies, we built our company from the ground up as a medical supplier rather than backing into the market as a side thought."

"The only real differences between our white room and a clean room are the certifications associated with the label," he adds. He says that roughly 90% of the compounds he develops include color, and notes that obtaining and maintaining clean-room certification would be "extraordinarily challenging" due to the extremely fine particle sizes of most colorants and even some radio-opacifiers. "But we do conduct our own air-quality reviews and have found that we meet Class 100,000 standards," Neal notes. "Due to the costs involved in maintaining that level, we have chosen to not take a certification. We believe customers appreciate the savings it passes along as well as the cleanliness of their products without undue extra costs."

Neal notes that the compounder will also dry and package materials with a nitrogen blanket, so they can be dropped into a customer's molding or extrusion machine without requiring pre-conditioning. Leaving no stone unturned, the company packages its materials in plastic pails with sealed lids rather than more typical cardboard boxes, which can generate particulates. "We go the extra mile for both our products and our customers," is how Neal puts it. "Cleanliness and housekeeping are huge considerations when serving the medical market. We always stay on top of those."

Color is a component in about 90% of the compounds formulated by Compounding Solutions.

Throughout the plant, production runs are scheduled based on extruder screw design. Compounding Solutions' average order is 2000 lb; it runs orders anywhere from 25 to 100,000 lb. "Most compounders have 100-lb minimums, but we go down to 25 lb, which in some medical applications can be a year's supply.

Every compound the company makes has a paper trail, a physical file that Compounding Solutions keeps on record after the material has been formulated. The compounder has run sheets stored digitally on its control system so operators can access processing parameters on any product. During *Plastics Technology*'s visit, the firm was in the process of equipping each of its white-room extrusion lines with more advanced production-monitoring controls that will allow it to capture screen shots of process information in real time.

Compounding Solutions' manufacturing operations are supported by a mechanical room, where the company houses its central chilling and nitrogen units and builds its own dies. It also has an in-house team of six dedicated to maintenance. Nearby, the company keeps batch blenders for offline mixing of up to 2000-lb lots, screw-cleaning machines that use blasting media, and ovens for predrying fillers and antimicrobials. It also has a large drum of mineral oil, used for elastomer compounds.

> ***"The white room provides a step far above typical environmental conditions to further assist with effective processing."***

R&D LAB GETS A BOOST

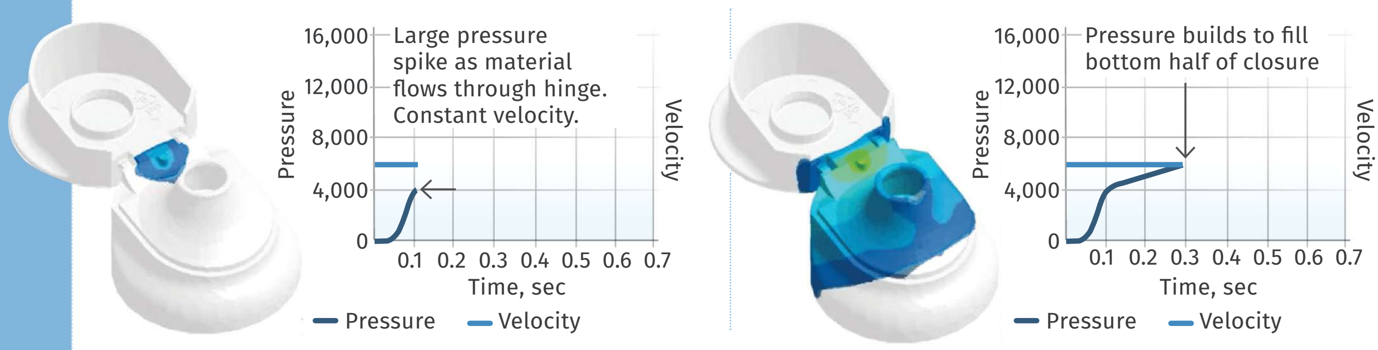
In 2016, Compounding Solutions expanded its R&D efforts with a 2000-ft^2 center—named after long-time employee Pete Goguen—equipped with both production- and lab-sized twin-screw compounding lines; a single-screw extruder; three injection molding machines; a two-roll mill; and dryers and ovens. As Neal explains it, the company works regularly on developing new formulations and processes across all its markets. As an example of the latter, the company developed a reactive extrusion process for compounding a hot-melt adhesive that had been blocking. On another occasion, it developed a proprietary process that allowed for inclusion of weight-reducing hollow glass beads into the compound at high loadings without glass breakage.

Sometimes the company will even engineer its own equipment to solve a problem. On one occasion, it was running a polymer that was hypersensitive to oxygen and water, so it designed a vacuum enclosure that surrounded the polymer in the feed area, pelletizer, and packaging line to keep oxygen and water away from the material.

In the lab, Compounding Solutions has the full gamut of equipment for mechanical, physical, impact, rheological, and visual testing.

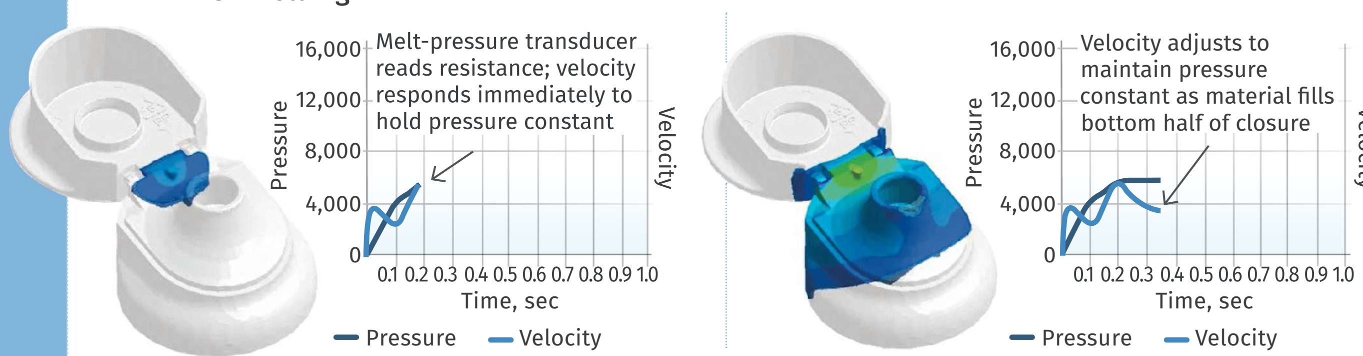
Says Neal: "We embrace technology, and we use it in a way that gives us a quality advantage in the compounds we produce, the speed at which we develop and produce them, and the service we offer customers." PT

FIG 1 Conventional Injection Molding



Conventional injection molding set for constant filling velocity experiences rising pressure and a spike at the end of fill.

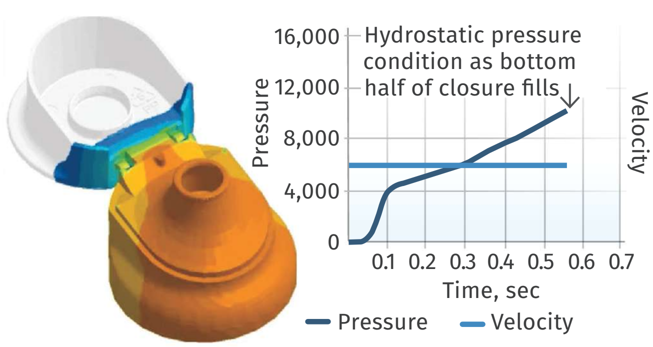
FIG 2 iMFLUX Molding

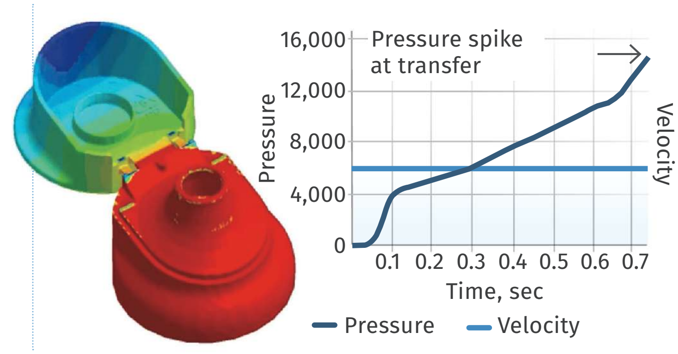


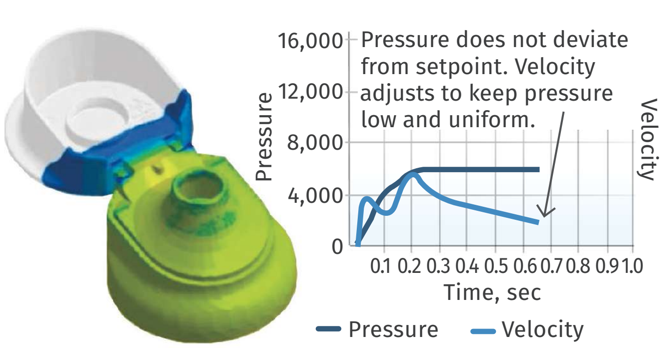
With the iMFLUX process, velocity varies to keep pressure low and uniform. Cavity sensors allow pressure to drop, instead of spike, at end of fill.

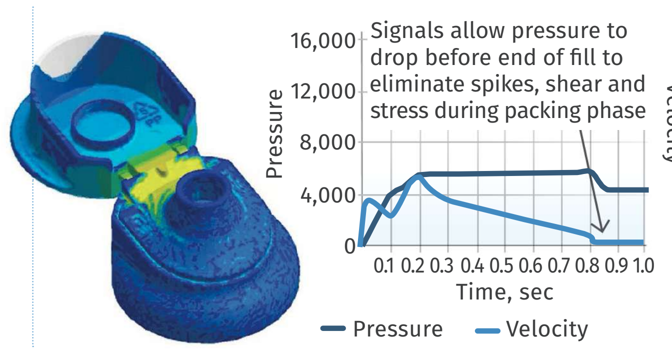
A New Way to Mold Better Parts Faster and Easier

A new injection molding process 'breaks all the rules' by using low, constant pressure to achieve faster cycles and better-quality parts.









By Gene Altonen
iMFLUX

Procter & Gamble is widely known as a consumer-products company but is perhaps less well known for its R&D on improving the technology of plastics processing. P&G is itself a major consumer of injection molded components for packaging, feminine-care products, toothbrushes, razor components, and other products. P&G purchases many components from custom molders, and also manufactures internally within the Oral B toothbrush businesses and the Gillette blades and razors business. P&G continually innovates in this space to provide speed, cost, and design advancements.

Several years ago, P&G recognized the need to reduce the cost and lead time to launch new plastic part designs. The goal was to completely rethink how injection molded parts are made in order to deliver breakthroughs in speed, cost, and quality. A company-wide research effort was launched and involved its injection molding technology experts. After exhaustive research, testing and pilot-scale demonstration, the team developed a breakthrough new technology utilizing low constant injection pressure. This new process enables thinking differently about how parts and molds can be designed. With this new discovery, P&G decided to launch iMFLUX Inc. as a stand-alone, wholly owned subsidiary.

P&G recognized the need to completely rethink how injection molded parts are made in order to deliver breakthroughs in speed, cost and quality.

The new iMFLUX injection molding process involves a specialized controller that enables filling a mold at a lower, defined melt-pressure profile, allowing a variable filling rate that adapts automatically to the part geometry. The advantages include

FIG 3 iMFLUX Packs as It Fills

Comparing short shots: Conventional injection molding (right) shows highly distorted part surfaces when filling is stopped. Since iMFLUX packs as it fills, the part shows fully formed surfaces at any point during mold fill.

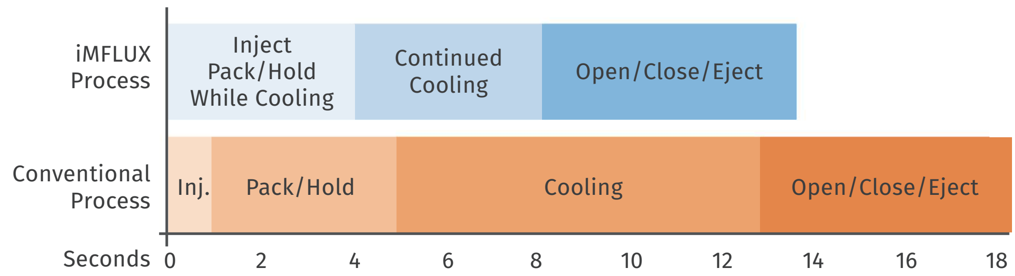
improved part quality, new part and mold design possibilities, sustainability improvements, and reduced capital expenditures. The biggest breakthrough, which was unexpected and highly counterintuitive, was discovering that filling slowly resulted in *faster* cycle times.

ADDRESSES COMMON MOLDING PROBLEMS

The iMFLUX process addresses several challenges raised by the conventional processing philosophy of using the rheology curve to establish an optimal filling velocity. This conventional philosophy generally results in filling the mold very fast, to take advantage of the shear-thinning properties of polymers. However, this approach has several disadvantages, as it generally results in very high molding pressures. Because the process uses a controlled filling velocity, the resulting melt pressure is highly variable across different regions of the molded part. Figure 1 illustrates how pressure varies throughout a typical part injection molded in the conventional manner.

The biggest breakthrough, which was unexpected and highly counterintuitive, was discovering that filling slowly resulted in faster cycle times.

FIG 4 Cycle-Time Comparison Example



iMFLUX essentially eliminates the conventional packing phase, along with some cooling time, because it packs as it fills.

FILLING SLOWER YIELDS *FASTER* CYCLES

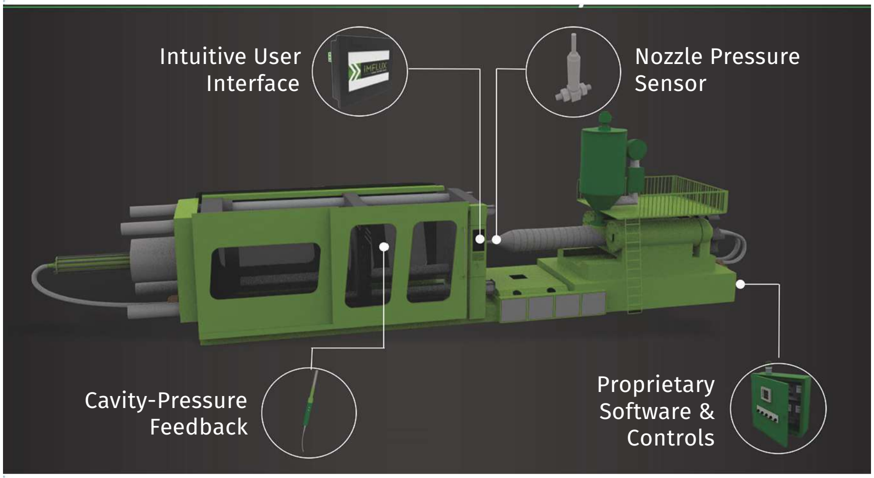
The iMFLUX technology controls the molding process by plastic pressure, rather than the conventional approach of filling a mold according to a volumetric flow rate (also referred to as velocity filling). Controlling the process by plastic melt pressure enables the melt to flow through a melt-delivery system and mold cavity without the potential to stall or hesitate. The constant, non-fluctuating pressure continuously advances the flow front at every point, even where it encounters ribs, bosses, or other features.

The process relies on the cooling of the melt in the mold to create resistance to flow, which in turn allows pressure to stabilize and remain constant in the interior of the flow path and at the flow front. Because the mold is filling very slowly, the ►

These differential pressures inherent in a conventional molding approach result in multiple problems, including differential shrink (or warp), dimensional variations, flash, and the inability to accommodate wall-thickness transitions and part geometry.

The iMFLUX process resolves these issues by using a constant low filling pressure, which results in uniform pressures in the molded part. Rather than using a constant injection speed, the velocity is allowed to vary to maintain constant plastic pressure. Figure 2 shows how velocity varies throughout an iMFLUX process.

FIG 5 iMFLUX Control System



Injection machines of any type can be adapted for iMFLUX with kits available for new machines or for retrofit to existing presses. Key elements include a nozzle pressure sensor, cavity-pressure sensors, and proprietary control software with user interface screens.

polymer is continually cooling and densifying while the mold is being filled. The part actually "packs as it fills."

Figure 3 shows short shots from an iMFLUX process and a typical conventional process. As you can see, the iMFLUX short shots are completely packed no matter where the flow front is stopped, while the conventional parts are not packed and continue to densify behind the flow front.

The iMFLUX process fills slower, but results in a faster molding cycle. There are several contributing factors:

1) Lower filling rates result in less shear heating, which then requires less cooling time.

2) The mold is filled so slowly that the mold is "packed as it fills," thus the material is continuously in contact with the mold walls, providing efficient cooling.

3) When the mold is completely full, the part is already packed, which essentially eliminates the packing phase and reduces the cooling portion of the cycle. The combined effect results in a faster cycle time, as shown in Fig. 4.

HOW TO IMPLEMENT THIS NEW PROCESS

iMFLUX Inc., established in 2013, offers this patented technology, which is available under license. The technology has been vetted at full production scale across hundreds of commercial applications. It is exclusively supplied by iMFLUX Inc., based in Hamilton, Ohio.

A specialized controller is needed for the injection molding machine, enabling the process to be controlled by plastic pressure, rather than by velocity and holding pressure. A pressure sensor is added to the machine nozzle to provide real-time measurement of the plastic pressure entering the material delivery system. The controller uses plastic pressure as its primary control signal throughout the filling of the mold. Sensors are added to the mold, providing indication of pressure in the mold and flow-front progression. Feedback from the mold sensors is essential to provide optimal pressure in the mold and to make real-time adjustments to injection pressure resulting from material, mold or process variations. A user interface is provided to allow entry of process parameters and to monitor the process. Figure 5 shows the elements of the proprietary control system.

The iMFLUX process can be integrated with most machine types, including hydraulic, all-electric and hybrid injection machines. There are many OEM kits for new presses available for this technology from several major machine manufacturers, which provide fast and simple integration. However, iMFLUX can be integrated with existing machines as well.

The process works efficiently with molds designed specifically for iMFLUX and with retrofitted mold and press combinations. This system is in production in multiple industries, including automotive, medical, packaging and consumer goods. Running the process with a closed-loop, low, constant pressure control means that most polymers run better with iMFLUX than in the high-shear environment of a conventional process.

BENEFITS OF THE IMFLUX PROCESS

The benefits the iMFLUX process result from four key differences versus conventional molding:

1) Low, constant-pressure filling;
2) Packing as the mold is filled;
3) Filling with no flow hesitation;
4) How it uses cavity-pressure feedback from the mold.

The table on the previous page summarizes typical benefits that result from these differences.

QUESTIONS ABOUT INJECTION MOLDING?
Learn more at PTonline.com
Visit the Injection Molding Zone.

FOUR CASE STUDIES

Case Study 1: A polycarbonate medical part was converted to the iMFLUX process. The customer was experiencing high scrap rates due to an imbalanced 16-cavity mold with hot-runner valve gates, causing intermittent short shots. iMFLUX reduced scrap rate from more than 10% to less than 0.2% by improving the balance from part to part. This is due to constant-pressure filling. Every part experiences the same pressure and the geometry of the part tells the machine how to continually profile velocity, resulting in consistent packing conditions. On top of eliminating short shots and gaining 48% improvement in cavity balance, the cycle time was reduced by 30%. In this example the existing all-electric injection machine was retrofitted to run the iMFLUX system.

> ***iMFLUX "packs as it fills," saving cycle time by eliminating the normal packing phase.***

Case Study 2: For a PP household-cleaning implement, iMFLUX was brought in during the design phase for new molds and presses. Knowing the benefits of pressure reduction, the mold was designed to maximize the capabilities of the technology. The part previously ran in a servo-hydraulic 500-ton machine with eight cavities and a 52-sec cycle. The new iMFLUX mold and system allowed the use of a conventional hydraulic 400-ton machine, while expanding cavitation by 50% to 12 cavities and reducing the cycle by 21%. Together, that resulted in a 91% throughput improvement. Even with adding four cavities and reducing cycle time, the overall peak injection pressure was 30% lower than with the conventional process. While iMFLUX is effective on retrofitted machines with existing tooling, this case shows there are substantial benefits to designing new molds specifically for the iMFLUX process.

Case Study 3: A PET packaging component was run in a four-cavity mold on a hydraulic press retrofitted with the iMFLUX technology. The new process achieved a 16% throughput increase over the conventional process. On average, retrofitted machines with existing molds achieve 15% to 25% throughput improvement. However, the iMFLUX process also reduced the cavity imbalance from 6% to 0.8%, nearly halved the amount of pressure needed to fill the part (from 1079 bar to 622 bar), and reduced the average part weight by 0.48% while maintaining all dimensional specifications. By packing as the part is filled, pressures can be reduced. Furthermore, while a conventional process fills at a high velocity and then packs the part, iMFLUX's ability to pack while it fills eliminates unnecessary material, reducing part weight. Cycle time was reduced by 13%.

Case Study 4: A PP automotive component was run in an eight-cavity tool on a 550-ton hydraulic machine. It previously ran on a 50-sec cycle, but after the iMFLUX process was integrated to the press, the cycle time was reduced by 8 sec, resulting in a 20% throughput improvement. As described in Case Study #3, simultaneous pack and fill created a 14% pressure reduction and a 1% part-weight reduction. On top of this, iMFLUX's ability to dynamically absorb viscosity changes reduced the scrap rate from 18% to 0.2%. PT

iMFLUX Process Benefits

LOW CONSTANT PRESSURE

- Lower clamp tonnage
- Less retained stress
- Uniform stress (less warp)
- Lower melt temperatures
- Less gate blush
- Less flash
- Less cavity-to-cavity variation in multi-cavity & family molds
- Less material degradation

PACK-AS-IT-FILLS

- Faster cycles
- Fewer sink marks
- Stronger weld lines
- Improved surface finish

NO HESITATION

- Reduced flow lines
- Improved thin-walling
- Higher L/T capability
- Smaller cold runners

CAVITY-PRESSURE RESPONSE

- Lighter parts (1-3%)
- Reduced flash
- Automatic adjustment for viscosity
- Real-time adjustment for blocked cavities
- Actuate sequential valve gates
- Not affected by leaky check ring
- Not affected by worn barrel

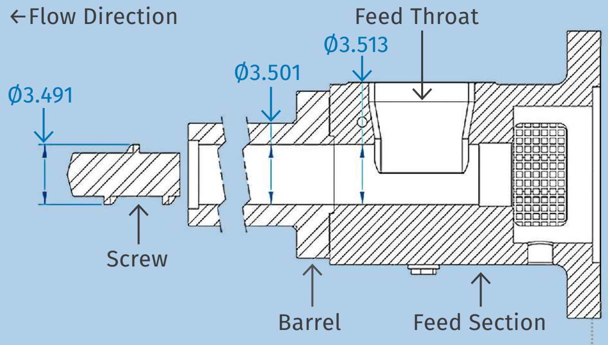
ABOUT THE AUTHOR: Gene Altonen has been the Chief Technology Officer of iMFLUX in Hamilton, Ohio, since 2015. He is the inventor of the iMFLUX core technology, and leads the iMFLUX R&D organization. Gene has spent his entire 27-year Procter & Gamble career developing new packaging solutions, including numerous injection molding technology innovations. Prior to the iMFLUX launch, Gene was a Research Fellow leading major technology developments in the Injection Molding Capability organization within P&G. He holds more than 50 patents and has at least 35 patent applications pending. For more information about iMFLUX contact *info@imflux.com*; *imflux.com*.

Cast vs. Integral: *Which Feed Section Is Best for You?*

Here are seven factors extrusion processors should weigh to help them decide between the two.

FIG 1

Screw, Barrel, and Cast Feed Section



In North America, extruders are typically made with a cast feed section having cooling passages that are molded directly into the casting near the feed throat.

By Steve Maxson
Fermatex Vascular Technologies

Feed-section design plays an important role in the extrusion process and should be carefully considered when specifying a new extruder. Most single-screw extruders operating in North America include a cast feed section with cooling passages that are molded directly into the casting near the feed throat. As shown in Fig. 1, the feed casting is bolted to the upstream side of the barrel. It acts as a thermal barrier, which prevents polymer bridging (early melting) on the feed-throat walls and melt blocks in the feed section of the screw. It also minimizes heat transfer from the barrel to the gear reducer.

Low-melting-point polymers are most susceptible to sticking to the wall of the feed throat.

WHAT YOU WILL LEARN

1. **OUTPUT GAINS:** Research has pointed to 4-5% gains with integral barrel/feedthroat design.
2. **FEEDTHROAT COOLING:** More cooling is needed with integral barrels.
3. **SCREW SWAPS:** Cannot be done among extruders with different barrel designs.
4. **ALIGNMENT ISSUES:** A non-issue with cast-iron feed sections.

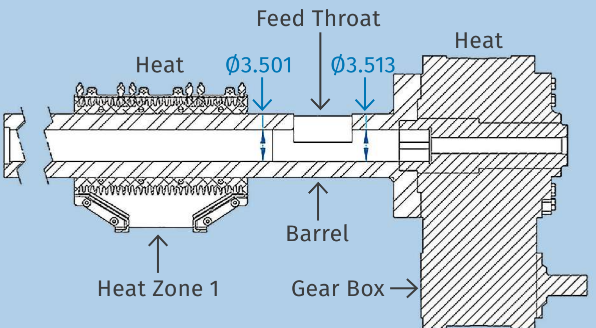
An alternate design offered by some extruder manufacturers is a single-piece barrel with an integral feed port. This design uses a longer barrel, and the feed port is machined directly into the barrel cylinder and liner (see Fig. 2).

Studies have indicated the potential for increased output rate when processing certain polyolefins with this single-piece approach. In a paper delivered at the Society of Plastics Engineers' ANTEC 2007, well-known extrusion consultant Tim Womer and others studied the differences in output rate of 100% PP regrind (2 MI) and 100% HDPE regrind (0.3 MI) on a 3.5-in., 24:1 L/D extruder with either a barrel with integral feed port or a water-cooled, cast-iron feed section. Each test included five different screw speeds, and the integral-feed-throat configuration produced more output at every screw speed than the standard barrel with water-cooled cast feed section. For example, there was an increase in output rate of 5.25% for PP and 3.93% for HDPE when running at 75 rpm screw speed.

Due to the increased output rate, the motor amp draw and melt temperature also increased with the integral configuration compared with the water-cooled cast feed section. The increase in solids conveying and output rate is attributed to the heat migration from using an integral barrel/feed-port configuration that increases the coefficient of friction between the pellet and the barrel wall in the feed section of the screw. The extra heat input to feed zone moves the onset of initial melting back toward the hopper, which is beneficial for certain polymers.

FIG 2

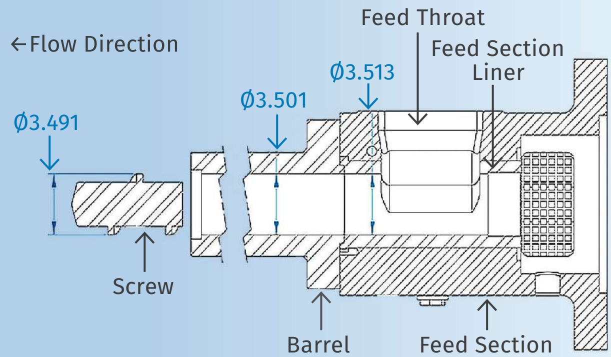
Barrel with Integral Feed Throat Bolted Directly to Gear Reducer



On this extruder, a longer barrel is used, and the feed port is machined directly into the barrel cylinder and liner.

FIG 3

Screw, Barrel, and Cast Feed Section with Replaceable Feed Liner



An optional removable and replaceable feed-section liner in a cast feed section protects against accidental damage or long-term wear and can be swapped out when you want to change feed-throat geometries or replace a damaged feed throat.

Although increased output rates for PP and HDPE may be attractive, there are several risks and downsides when considering the purchase of an extruder with an integral barrel/feed throat, especially when a processor has multiple extruders with the more common water-cooled, cast-iron feed section. Here are the key considerations:

1. An optional removable and replaceable feed-section liner on a separate cast feed section (Fig. 3) protects against accidental damage or long-term wear. With the integral barrel/feed-throat design, you have to swap out the *entire* barrel when you want to change feed-throat geometries or replace a damaged feed throat.

Studies have shown the potential for an increase in output rate when processing certain polyolefins on extruders designed with a single-piece barrel and an integral feed port.

2. A cast feed section, cored for full-surround water cooling (Fig. 4) surrounds the feedscrew to prevent premature melting of the polymer flowing from the hopper. The outside temperature of the casting is typically 90-120 F, or "warm to the touch." The issue with an integral barrel/feed throat is that the barrel acts as a big heat pipe, and heat flows into the feed throat zone. It is harder to effectively control the feed-throat temperature without it being affected by the first barrel zone. The separate cast feed section provides a thermal barrier that results in greatly reduced thermal conduction from the first barrel zone.

With an integral barrel, the area of conduction is much larger, necessitating much more cooling for the feed throat. From a screw-design and extruder-performance standpoint, it would be better to have a separate feed section with a good thermal barrier to control the amount of heat transfer into the feed throat. Excessive heat in the feed throat can cause bridging problems where the pellets traveling down the throat will start to melt prematurely and clump up. Low-melting-point polymers are most susceptible to sticking to the wall of the feed throat. As the pellets build up on the feed-throat walls, material flow is restricted or blocked as it enters the extruder, and gradually there is a decrease in output rate. Cooling of the feed throat is very important to prevent bridging. Removing the partially melted clump of material blocking a feed throat can be difficult and dangerous, and can result in significant downtime.

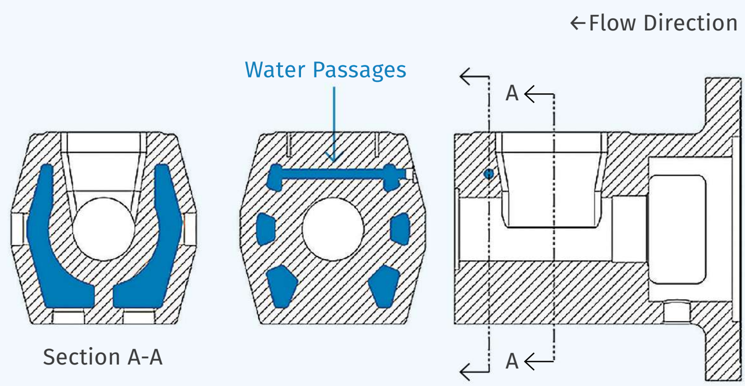
3. It is harder to machine efficient cooling channels in the feed housing. Typically, an aluminum water jacket with cast-in cooling tubes would be used with the integral barrel/feed throat (Fig. 5), which cools the outer surface of the barrel, unlike more efficient internal cooling passages within a cast feed section. Air cooling the feed section with a blower is much less efficient and mostly inadequate, especially as the extruder size increases. The larger the ►

extruder size, the greater the mass of the barrel and the thicker the barrel wall, which increase the heat-removal requirement. Air only has a gentle effect on the barrel; water cooling is better for fast heat removal, and thus water cooling is the most effective method to cool the feed throat. Air cooling would also depend on the ambient temperature, which is apt to differ between summer and winter.

4. Higher feed-zone temperatures increase potential for melt-block problems in the feed section. A melt block is when output rate and motor amps fall due to a loss of solids conveying due to polymer sticking to the screw root in the feed zone. This usually happens when the extruder is stopped—even for a few minutes—with the screw full of polymer. The screw surface under the hopper becomes hot during a screw stoppage. Polymer stuck on the screw root will rotate with the screw, reducing the screw channel area, resulting in flow surging and a loss of output rate. Even small traces of polymer stuck to the screw root can cause flow surging issues.

The fix to a melt-block problem often requires pulling the screw for a full cleanout. With small extruders, the screw can be pulled and cleaned in a few hours. However, pulling and cleaning a large screw by hand may take half a day or longer. Because the integral barrel/feed-throat design does not include a thermal barrier (cooling break) you must have constant water flow to the feed-throat area, especially during a stoppage.

FIG 4 **Cast Feed Section with 'Full Surround' Internal Cooling Passages**



Here, the cast feed section is cored for water cooling that fully surrounds the feedscrew to prevent premature melting of the polymer flowing from the hopper.

5. As mentioned previously, the cast feed section minimizes heat transfer from the "hot" barrel to the extruder gear reducer (Fig. 2). The barrel/screw and gear reducer both generate heat, and the cast feed section acts as a heat sink and absorbs heat between the two devices. The normal operating temperature of common extruder gear reducers is 130-160 F and depends on the gearbox's heat dissipation. Without the thermal barrier of a cast feed section between the barrel and the gear reducer, as in the integral barrel/feed-throat design, heat will migrate to the extruder gear reducer. Excessive heat around the output shaft area of the gear reducer may result in premature failure of the output-shaft radial seal ring. In addition, use of an integral barrel/feed throat bolted directly to the gear reducer may necessitate the need for a cooling coil to be added to the gear reducer, when it would otherwise not be needed with a cast feed section bolted to the gear reducer.

6. If a processor has several extruders with traditional water-cooled, cast-iron feed sections running certain polymers, and then decides to change to an extruder with an integral barrel/feed throat to run the same polymers, then the processor would likely have to modify its barrel-temperature profiles to compensate for the higher melt temperatures associated with the integral barrel/feed throat.

7. The extra heat input into feed zone with the integral barrel/feed throat moves the onset of initial melting back toward the hopper. Similarly, preheating the feedstock results in faster melting because a substantial amount of heat is conducted into the polymer in the hopper. Using an integral barrel/feed throat in conjunction with the preheated feedstock has shown to cause air-entrapment issues while running preheated amorphous PET pellets mixed with a high percentage of preheated, recycled A-PET thin flake.

Flake feedstocks can contain up to 70% air by volume, and air is also between the pellets. The air is squeezed out and flows backward into the hopper from the feed throat as the pellets are compacted into a solid bed along the screw prior to melting. The issue is that thin regrind flake will melt too quickly in the feed zone before compaction is complete, blocking the air from flowing backward to the hopper and trapping air in the melt, resulting in defects in the final product. The early melting phenomenon seen in preheating flake with an integral barrel/feed-throat design would likely not occur with a separate water-cooled cast feed throat.

INTERCHANGEABLE SCREWS?

Processors typically ask if screws are interchangeable between extruders with a cast feed section and ones with an integral barrel/feed throat. The answer is no. Even if the main flight OD, screw shank, and the overall length of the screws are the same, the concept of screw "interchangeability" between the two extruder designs cannot be fulfilled in the context of mechanical design and screw processing performance.

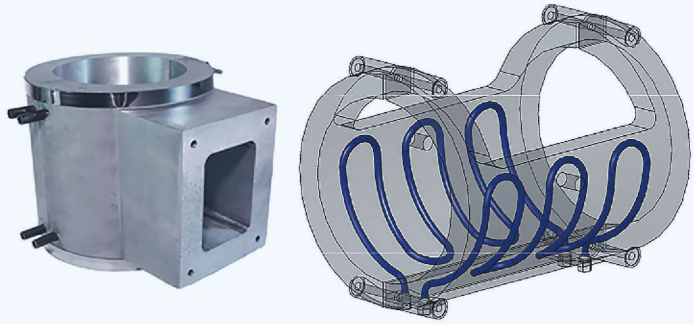
The clearance between the screw and the barrel and feed section is a very important factor in extruder design. Most extruders are designed with a feed screw with full diameter throughout the flighted length and a cast-iron feed section that has a slightly larger bore ID compared with the barrel bore ID, as shown in Fig.1. When the screw and barrel increase in temperature, both the screw and barrel will increase in diameter due to thermal expansion. The clearance between the screw and the barrel and feed section will reduce with increasing temperature. In a running extruder, the screw, barrel and feed section are not at the same temperatures. A large amount of viscous heat is generated as the melt is sheared by screw rotation. When viscous heating is significant, the screw temperature will likely to be higher than the barrel temperature, and the largest difference in temperature will be between the screw and the feed throat.

The feed throat is typically water cooled in the 90-120 F range, and the screw temperature in the feed section will be much higher because the high temperatures in the compression and metering section will raise the temperature of the screw in the feed section due to thermal conduction. If the feed-bore ID and the barrel ID are the same as in an integral barrel/feed throat design, then as the screw heats up it will expand against the "cold" feed-section bore that doesn't expand and binding and galling will likely occur. That is why the cast iron feed section has a slightly larger bore ID compared with the barrel-bore ID; or alternatively, the screw flights in the feed section are undercut. The higher screw temperature will cause the screw to expand much more than the feed throat and the barrel, and therefore there is less chance for catastrophic failures from the screw locking up in the feed section.

> ***"Of the thousands of extruders equipped with a cast-iron feed section, I have not seen any issues with the screw becoming stuck in an extruder barrel due to misalignment."***

The only way to solve this with the integral barrel/feed-throat design is to grind a relief into the inlay of the barrel in the feed area (Fig. 2) or undercut the screw to increase the flight clearance. Grinding a relief in the barrel inlay is not a common practice in the industry, and it is likely that in the future the relief will be mistaken for feed wear. Undercutting the screw in the feed will have an adverse effect on screw performance if the screw is later used in an extruder with a common oversized feed-bore ID, because the clearance between the screw-flight OD and the feed-bore ID will be large enough to allow small feedstock particles such as powder, additives and "fines" to pass over the top of the flights, reducing the ability to convey solids out of the feed section. Even worse, if the standard screw that does not include an undercut in the feed area were to be used in the extruder with an integral barrel/feed throat without a relief in the feed, the screw would almost certainly bind and catastrophically lock up in the feed section.

FIG 5 **Aluminum Water Jackets With Cast-in Cooling Tubes**



With an integral barrel/feed throat, an aluminum water jacket with cast-in cooling tubes would typically be used to cool the outside surface of the barrel.

WHICH DESIGN OFFERS BETTER ALIGNMENT?

Extruder manufacturers that offer the integral barrel/feed throat claim that this design offers improved alignment between the barrel and gearbox. Barrel and feed-section misalignment can cause problems; however, of the thousands of extruders operating around the world equipped with a cast-iron feed section, I have not seen any issues with the screw becoming stuck in an extruder barrel due to misalignment. It is important to remember that the screw is supported and centered in the barrel hydraulically by the internal pressure of the polymer in the screw channels.

Efficient and uniform water cooling of the feed throat is important for many polymers to ensure feeding consistency and to reduce the chances of feed bridging. The integral barrel/feed-throat design is rife with unknowns and potential risks, especially in larger extruders, where it is more difficult to control the temperature of the integral barrel/feed-throat section.

The integral barrel/feed-throat design is a low-cost approach to extruder design that may result in high output rates but not necessarily improve the quality of extrusion. Extensive lab experiments would need to be completed to demonstrate the effectiveness through a range of extruder sizes and with a wide variety of polymers and feedstocks, including powders and recycled material. PT

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Recycling Needs Drive Innovation in Sleeve Labels

Materials suppliers and film processors have been hard at work creating new label offerings compatible with PET bottle recycling.

Eastman got involved in the shrink-film label market in the early 1990s. Its Embrace LV copolyester material is used in this shrink-sleeve label for Method hand soap.

By Heather Caliendo
Senior Editor

Shrink-sleeve labels: You see the eye-catching designs everywhere these days on food, beverages and consumer products. Brand owners love them because they offer plenty of real estate on the container to communicate what the product is and overall messaging on a 360° marketable area of the package. And the trend isn't slowing down—the shrink-label market is expected to grow at a 5.2% annual rate through 2021, reaching $245 million in sales, according to The Freedonia Group's study, *Stretch & Shrink Sleeve Market in the U.S*.

While the labels are a success story for brands, they also present a headache for recyclers. About 20 years ago, PVC had the largest market share of shrink-film labels. But 10 years ago, the industry started shifting away from PVC shrink labels because of environmental concerns.

"It's highly undesirable to have PVC mixed with PET in recycling," says John Standish, technical director of the Association of Plastics Recyclers (APR), Washington, D.C. "One of the most important steps in recycling PET is called 'float and sink' and PVC has a high density and sinks in the water. It gets mixed in with PET and gets trapped in the 'float and sink' step."

The industry started to shift to PETG-based film, but that also created issues for recyclers. According to a 2014 APR report, shrink-sleeve labels that are PVC-based or PETG-based film have a density higher than water and can't be separated from PET flakes during the sink-float separation step of the recycling process, so they contaminate the recycled PET stream and deteriorate the quality of recycled PET (rPET) products.

"Removing shrink-sleeve labels early in the recycling process virtually eliminates misidentification of PET bottles as well as contamination in a sink-float separation process."

With the increased usage of these labels, recyclers were experiencing a rising volume of shrink-labeled PET containers that were not recyclable. It is estimated that PET bales contain approximately 5% shrink-labeled containers. The challenge of removing shrink labels during PET recycling was brought to the industry's attention by APR and the National Association of PET Container Resources (NAPCOR), Florence, Ky., in 2012. APR established guidelines for label manufacturers and an official Critical Guidance Recognition program to encourage development of labels that are more compatible with PET bottle recycling systems.

But the big push came from brand owners: Coca-Cola, PepsiCo, Walmart, and Unilever are among those who have made pledges to use 100% recyclable, reusable or compostable packaging by 2025.

"Labels create a variety of challenges, as they add to the complexity for the PET recycler," Standish says. "But thanks to brand-owner requirements, the recycling aspect is a must-have. We know major brand owners are evaluating the options and we believe that 2018 will be the year we start to see the new options in the marketplace."

DESEAM & RELEASE LABEL ADHESIVE

Eastman Chemical, Kingsport, Tenn., has been in the shrink-film label market since the early 1990s. Early polyester-based shrink labels consisted of blends of several different types of polyester, but in the late 1990s Eastman developed a reactor-grade resin that had very unique shrinkage properties, says Ronnie Little, Eastman's market-development manager, SP-Plastics Packaging. This patented resin has become the industry standard for shrink-film labels. Eastman Embrace LV copolyester (PETG-based) enables differentiated labeling wrapped around highly contoured, complex and thin-walled containers, and it displays 75% ultimate shrinkage.

Little says that shrink labels made from Embrace resins are on some of the most recognizable brands in the world. A few examples include Method soaps and household cleaners, Malibu rum, Jack Daniels, 94Wines and Bayer garden products.

However, there is still the recyclability concern. Eastman has been very vocal about working to find a solution and in 2012, organized a consortium to collaborate on ways to solve this issue. Little says that as result of the work of the consortium, Eastman partnered with ink maker Sun Chemical, Parsippany, N.J., to advance the development of a deseamable adhesive. The result is Sun Chemical's SunLam Deseaming Adhesive. By changing from a traditional solvent to use of SunLam Deseaming Adhesive, shrink labels deseam and release during the bottle-wash step of the wet recycling process.

Little says that for brand owners, this can be done with minimal process changes or additional investment in new equipment. The only change needed is the adhesive. The label removal occurs prior to color, infrared and manual sorting, thus preventing shrink-labeled PET bottles being removed from the rPET stream due to misidentification.

"Eastman's partnership with Sun Chemical to develop

Eastman partnered with Sun Chemical to advance the development of an adhesive that enables shrink labels such as those shown here to deseam and release during the bottle-wash step of the wet recycling process.

deseaming had both companies walking into unchartered territory," Little says. "Eastman and Sun extensively tested SunLam on labels made with Eastman Embrace LV copolyester."

According to Little, they ran thousands of shrink-labeled containers at commercial recycling facilities to determine the effectiveness of label separation. Test variables included time in ►

QUESTIONS ABOUT RECYCLING?

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Visit the Recycling and Scrap Reclaim Zones.

the actual recycling process, temperature of the recycle wash water, and the caustic level of the wash water. This led to optimizing the deseaming adhesive formulation to work efficiently, allowing the shrink label to come off the PET bottle prior to sortation. The result is a label-free PET container ready to be processed into rPET.

SunLam Deseaming Adhesive has received a "Responsible Innovation Acknowledgment" after passing testing outlined by APR. The tests utilized whole-bottle wash equipment at commercial recycling facilities and yielded results of greater than 95% label removal, with results typically exceeding 99%.

"Removing shrink-sleeve labels early in the recycling process virtually eliminates misidentification of PET bottles during sorting, as well as contamination that occurs in the sink-float separation process," Little says. "Not only do labels seamed with SunLam Deseaming Adhesive release during the whole-bottle wash, the adhesive also forms a strong bond on the shrink-sleeve label that lasts through all phases of the PET bottle's life cycle, from the sleeve shrinking, through transporting to store shelves, and consumer use."

Using Topas COC, Taghleef Industries introduced its polyolefin TDS film that is clear and floatable with up to 65% shrinkage.

Topas says its COC enables label manufacturers to make low density, flotation-separable labels that meet APR guidelines.

FLOATABLE SHRINK FILMS

Timothy Kneale, president of Topas Advanced Polymers, Florence, Ky., joined the company in 2004 and said that the company's work in sleeve labels was already taking place with multiple commercial users of labels from various film producers. As the usage of sleeve labels continue to grow each year, Topas became focused on a drop-in option to the current recycling infrastructure.

"We have been working on a solution that enables shrink labels to float, and we're seeing a lot more interest in that as time goes on and consumers and brand owners get more serious about demanding effective recycling solutions," he says. "You see the commitments from big beverage companies and Walmart—the big players are coming together and drawing a line in sand that by 2025, this must be fixed."

Enter Topas' cyclic olefin copolymer (COC) material for shrink applications. These polyolefin film structures will float during the washing stage to facilitate separation of label and bottle materials. Kneale said floatable labels are made by multi-layering COC with PE or PP.

Kneale says that PP has a density around 0.90 g/cc, and LLDPE around 0.92. These are coextruded with COC (1.01 g/cc) so that the final structure is in the 0.95 or lower density range. "This means the labels will float even with ink applied," he says. "We believe the floatable solution is the best; it's universally applicable, and every MRF (Material Recovery Facility) can do this. There's no additional equipment to buy; it's a perfect drop-in for recyclers."

Topas says that COC shrinkage can be as high as that of PVC or PETG, and the Topas COC enables label manufacturers to make low-density, flotation-separable labels that meet the APR guidelines. "The COC brings high shrink, high gloss, great ink adhesion, easy cutting of labels, and high stiffness," Kneale says. "These are all things that ordinary polyolefins (PP, PE) do not do well by themselves."

One processor running Topas COC is Taghleef Industries of Dubai, United Arab Emirates, a supplier of films to the global marketplace. Kneale says that the Taghleef film passed all of APR's flotation tests, which confirms that the label stock will float in water and that the label does not interfere with the color or haze of recycled PET. In 2017, Taghleef introduced its polyolefin TDS label film that is clear and floatable, with up to 65% shrinkage.

"Labels create a variety of challenges, as they add to the complexity for the PET recycler."

Other processors that have developed floatable solutions meeting APR's guidelines include Klöckner Pentaplast, Gordonsville, Va., with its Pentalabel ClearFloat; and UPM Raflatac, Mills River, N.C. UPM Raflatac says that during the recycling process, its RafShrink PO MDO 40 HS film ensures clean separation from clear PET bottles by floating to the top of the caustic washing solution, unlike PVC and PETG labels, which sink with PET bottle material.

"What's exciting now is there's all these different options," APR's Standish says. "The view of PET recycling is that I don't care which one you use —just do something different, get new materials in the market and gain experience, and let's all move forward with recycling." PT

TOOLING

New Developments in Tooling For In-Mold Assembly

A new partnership between French and American toolmakers has facilitated broader access to sophisticated tooling concepts for multi-material overmolding, in-mold assembly, injection-blow molding, and multilayer injection of thick optical lenses. Some recent applications demonstrate the extreme versatility of the system. What's more, these patented tooling capabilities have been enhanced with new developments for LSR and heat/cool molding.

French toolmaker JP Grosfilley SAS, specializing in multi-shot molds (***grosfilley.fr***), has partnered with medical mold builder X-Cell Tool & Mold Inc., Fairview, Pa. (***xctam.com***) as its representative in North America. While some companies have developed rotary-stack, or "cube" molds for multi-component molding, Grosfilley's approach to multi-shot molding is different: It uses rotating Index Plates on a single parting line to permit multiple consecutive functions—such as injection overmolding, cooling, in-mold assembly, injection in "hidden time" and even injection-blow molding—all within a single shot and without extending cycle time.

Grosfilley has built molds with one, two, or even three rotating elements. Those elements not only rotate by 90°, 120°, or 180° on each cycle, but the elements can index out from the mold base before rotating, so as to transfer parts from one rotating component to another for overmolding and in-mold assembly. That way, parts composed of up to six components (and more in development) can pass through up to 10 stations on a single mold face.

Several recent applications are cited by Philippe Gaudin, innovations and R&D manager for Grosfilley. One is a toy car molded with six materials—clear and colored PP, TPO, and styrenic TPE—in nine stations with three rotating elements (see Figs. 1 & 2). Another is a steam iron from Rowenta in Germany, consisting of six materials—PP and TPO in different colors—again with nine stations using three rotating elements (Figs. 3 & 4). That iron formerly required 12 people for assembly, now reduced to three, and a single injection machine. An overall scrap rate of 10% in the past has been reduced to zero with the Grosfilley system. In addition, a double-walled drinking glass utilizes five materials in nine mold stations (Fig. 3).

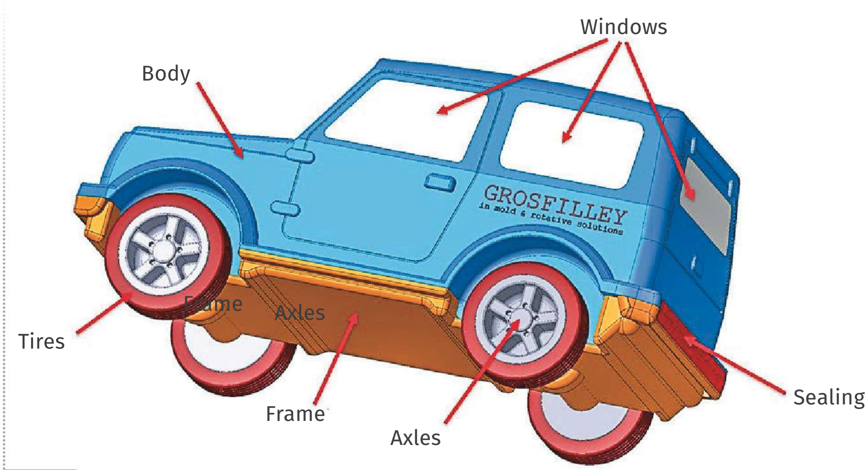


FIG 1 Toy car molded in six materials and assembled in-mold.

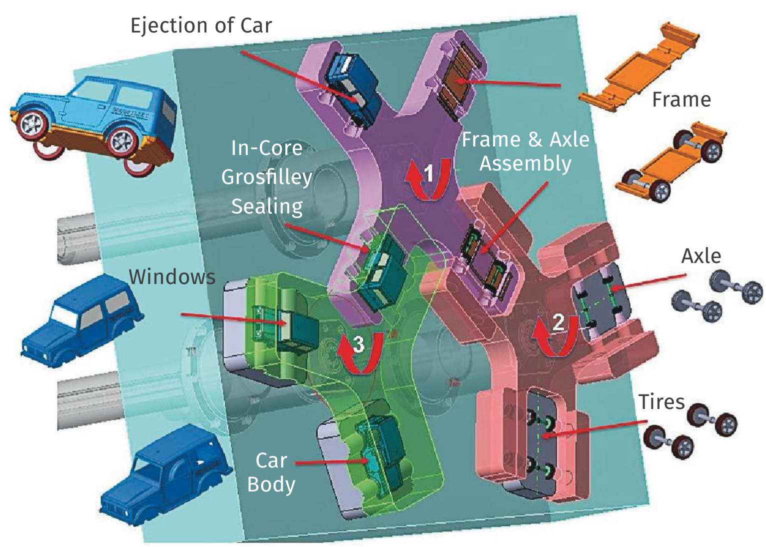


FIG 2 Toy car is molded in nine stations using three rotating elements that hand off parts from one element to another.

Sample Applications in 3-Shaft Multi-Rotation

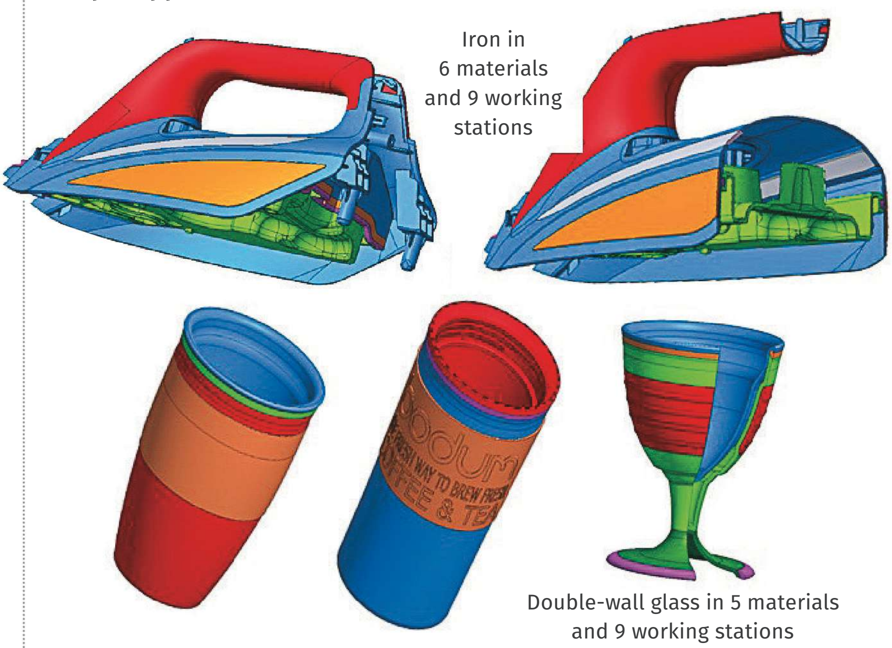


FIG 3 **Examples of commercial parts molded in three-shaft, multi-rotation tools.**

Newer developments from Grosfilley include molding thick optical lenses in multiple shots of the same material, and injection-blow molding on a standard injection machine, with injection and blowing taking place in different stations. This was demonstrated by Wittmann Battenfeld (U.S. office in Torrington, Conn.; ***wittmann-group.com***) on one of its machines at the K 2016 show. In addition, the new "Supercharged" range of Grosfilley Index Plates can rotate cores or cavities weighing up to 12 tons with 0.01° accuracy. The Supercharged range also can handle higher temperatures—up to 200 C/392 F—for overmolding LSR on thermoplastic or vice versa.

Gaudin reports that another new development improves heat/cool molding in larger molds with multiple gates and long flows. The key is electrically conductive ceramic mold inserts positioned a few millimeters behind the cavities. They provide rapid, pinpoint heating control, which is paired with conformal cooling channels close to the cavity as well. One result, Gaudin says, is that the melt stays hotter until the end of flow, so that when flow fronts merge, less of a weld line is produced. Gaudin also notes that Grosfilley can build tools with independent water circuits plumbed through the central shaft of rotating mold components.

X-Cell Tool will exhibit its capabilities for designing and building medical molds at NPE2018 May 7-11 in Orlando, Fla. (Booth S10166).

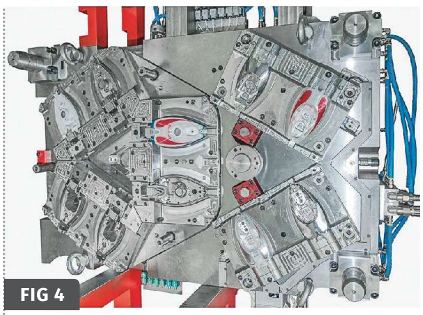


FIG 4 **Multi-rotation tool for six-material iron.**

A Grosfilley mold will run on a new model of injection machine at the booth (W2703) of Cincinnati-based Milacron, Inc. (***milacron.com***), in a system together with a Mold-Masters hot-runner system and E-Multi auxiliary injector. The mold will utilize a G2 index-plate system. The product will be a two-component drinking glass.

TOOLING

Quick Changes for Mold Inserts

Austrian moldmaker Haidlmair (North American office in Concord, Ont.) has a new quick-change system that permits changing injection mold inserts in as little as 3 minutes while the mold is mounted in the press. Called Haiflex, the system was developed for changing venting, engraving, and handle inserts in molds. Only an air hose and a few accessories are required.

905-738-9056 • haidlmair.us

TOOLING

Metal 3D Printer and High-Speed Milling in One Machine

At NPE2018 (booth W782), Plustech Inc., Schaumburg, Ill., will introduce the OPM250 metal 3D printer, which combines laser sintering of metal powder and high-speed milling in the same machine. This can speed production of tooling components such as cores and cavities with conformal cooling channels. Additive manufacturing reportedly can produce in one piece components that would normally be assembled from multiple parts.

847-490-8130 • plustech-inc.com

INJECTION MOLDING

All-Electric Two-Stage Machine Debuts at NPE2018

At the NPE2018 show in Orlando, Fla. (booth W782), Plustech Inc., Schaumburg, Ill., will show off its first Sodick all-electric machine, Sodick model MS100. This 100-ton two-stage model incorporates the company's V-Line two-stage injection system, with an inclined stationary screw mounted over a horizontal plunger. A new toggle design is said to contribute faster cycles and energy savings. It will run a mold with conformal cooling produced on the company's new OPM250 metal 3D printer, also on display at NPE (see separate item below, left).

Also on display will be a 20-ton vertical LP20VRE press with rotary table, designed for micro overmolding; a Sodick 30-ton horizontal GL30A-LP, the company's flagship micromolder; and a 60-ton GL60A "Global Platform" horizontal press. All of these use the V-Line system.

The GL60A will demonstrate the next-generation Meltflipper test tool from Beaumont Technologies, Inc., Erie, Pa. (***beaumontinc.com***). The cavity balance achieved with the Meltflipper will be monitored by Sodick's new cavity-pressure monitoring system.

847-490-8130 • plustech-inc.com

EXTRUSION

System Combines Web Inspection, Thickness/Weight Measurement

The Gemini FWM system from AIS Gauging, Terra Haute, Ind., is a non-traversing x-ray array measurement system that combines web inspection and web gauging into a single platform. It provides full-width, instantaneous, 100% product inspection and measurement without electromechanical scanners that sample just a fraction of the total product. The Gemini system starts measuring at the product's surface and continues through the entire material to construct and analyze a complete picture of quality. Gemini's x-ray technology reportedly can immediately detect, display, and report non-visible defects (less than 1 mm in size) that are embedded within the product.

The system includes quality maps that show data in a video format, including 3D-analysis software, so that defects both on the surface and within the product can be quickly identified. Real-time displays and alarms show defect sizes and their location for easy downstream removal. Defect information is categorized and saved locally and can be exported and archived for further analysis.
812-466 5478 • aisgauging.com

INJECTION MOLDING

Controlled Production Shutdown For PET Preform Molding

In harsh industrial environments, even brief power failures or fluctuations in the grid lasting milliseconds can interrupt the molding cycle, which cannot always be restarted immediately because of the potential presence of short shots in one or more cavities. In PET preform molds with many cavities, removal of short shots can be laborious and carries the risk of damage to the mold.

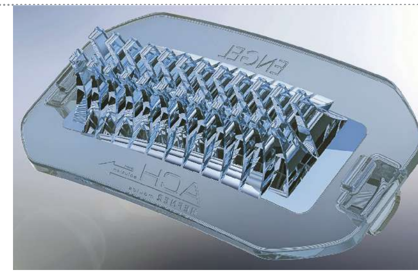
Consequently, Netstal (U.S. office in Florence, Ky.) is offering a new option for its PET-Line preform molding systems. Called CPP, for Controlled Production shutdown during a Power outage, it will provide enough power to complete the current cycle. (This power comes from braking energy recovered by the drive system.) And if the outage lasts longer, then sufficient power is provided to reliably and controllable shut down the process.

After the previous shot is fully injected and demolded, metering of the next shot is stopped and the entire system is brought to a halt. All axes are returned to their end position. As soon as the power returns, production can be started up again.
859-283-0200 • netstal.com

INJECTION MOLDING

LSR Auto Cavity Balancing & High-Speed Cap Molding at Engel's NPE Exhibit

The Austrian parent of Engel Machinery Inc., York, Pa., revealed an early peek at its NPE2018 plans (booth W3303). Though not a complete listing of what will be on display, Engel described these manufacturing cells, the newest of which is described first:



- **LSR auto cavity balancing**: Engel says this is the first time it has molded automotive headlight lenses at a trade show. These products (with light-guide technology) are said to be particularly complex (photo) and require a high degree of precision and stability in molding. They will run on a 120-ton, tiebarless, all-electric e-victory machine with a metering/pumping system and two-cavity mold, both from ACH solution in Austria (***ach-solution.com***). The mold uses a new ServoShot cold-runner valve-gate system from ACH solution, with valves that are pneumatically actuated but the pin strokes are set electrically. All the valve gates open together; varying the pins' open positions adjusts the flow through each valve gate. Parts will be checked via integrated camera inspection and will be weighed individually. The ServoShot software then will adjust the pin openings to balance the fill and equalize the weights in the cavities. The entire cell, including LSR dosing, is handled by the Engel CC300 controller.

- **High-speed cap molding**: Engel is showing off the capabilities of its all-electric e-cap system with a 460-ton model molding 26-mm HDPE beverage caps with tamper-proof bands in a 96-cavity mold on a 2-sec cycle. For historical perspective, two NPE's ago, Engel ran water-bottle caps in 96-cavities on the same size e-cap machine in 2.7 sec.

- **In-mold decorating**: For the first time in North America, Engel will present a fully automated cell for the DecoJect process (also shown at K 2016 in Dusseldorf; see Aug. '16 Close Up.). Aimed at auto interior trim, it involves a thin TPO film, fed from a continuous roll, which is back-injected with PP and punched out of the roll in the mold. A final laser trim occurs after demolding. The film imparts color, gloss, texture, and feel—allowing production of a variety of parts simply by changing films. The cell utilizes an Engel duo 1100-ton two-platen press, an Engel viper linear robot, and Engel easiCell with easix articulated robot and laser-cutting station.

- **Interdental brushes in one shot**: Engel will also demonstrate a tricky piece of molding for the medical arena: eight interdental brushes, each with up to 500 tiny bristles, and a total shot weight of only 1.93 g. A single material (not identified) replaces three components—a grip surface, wire mesh, and the filaments. An all-electric e-motion 121-ton press will use a collection of Engel's latest "intelligent" software: iQ weight control to adjust the process for consistent shot weight, iQ clamp control to automatically set the optimum clamp force, and iQ flow control to optimize mold cooling—which is seeing its North American debut at NPE (more details in a separate item in this section). This cell also ran at K 2016; see Sept. '16 feature.

- **Integrated metal/plastic processing**: For teletronics, Engel will produce thermal switch housings (used to monitor electric motors in cars or home appliances) in a cell that starts with feeding thin brass sheet from a coil through a punch press, where the brass carrier plate also has a thread servo-electrically tapped. The carrier plates, still on a continuous reel, are fed into a vertical, 38.5-ton Engel insert press for overmolding with glass-filled nylon. Camera inspection and high-voltage testing integrated into the tool ensure 100% quality control. Eight finished parts leave the cell every 20 sec. (This cell was also shown at Fakuma 2015.).

717-764-6818 • engelglobal.com

BLOW MOLDING

'Mini' Accumulator-Head Machine Coming to NPE

NPE2015 in May will be the first show appearance of the Mini Hercules accumulator-head blow molder from Graham Engineering Corp., York, Pa. (Booth W2743). This small-shot system (2.5, 5, or 8 lb) also has a small footprint (15 × 11 ft × 15 ft high). It was previewed at NPE2015, and the first several units are now in the field. Graham's XSL Navigator touchscreen control has been adapted for this machine like others in the company's line.

The Mini Hercules comes with single or dual heads and bottom or side discharge. Graham's spiral-flow diverter head is said to allow for color and material changes in 1 hr. The diverter head also provides continuous internal cleaning during production, so there is no need to disassemble the head for cleaning.

717-848-3755 • grahamengineering.com

COMPOUNDING

Multi-Shaft Mixer In New Size

A new 500-gal VersaMix Model VMC-500 multi-shaft mixer from Charles R. Ross & Son Co., Hauppauge, N.Y., is equipped with a custom combination of independently driven agitators. The anchor agitator with helical flights and the screw-auger agitator work in tandem to promote efficient product turnover while bringing air pockets to the surface. Two saw-tooth, high-speed disperser blades impart shear for fast powder wetout and thorough deagglomeration.

This VMC-500 also features air casters for convenient mobility, PLC recipe controls with data-acquisition capabilities, and a purged, explosion-proof operator station.

The Ross VersaMix line is aimed at processing medium to high-viscosity materials of up to several hundred thousand centipoise, including slurries, pastes, gels and suspensions.

800-243-7677 • mixers.com

INJECTION MOLDING

At NPE, U.S. Debut of Arburg's Largest Machine Yet in a Brand-New Design

Arburg's "big reveal" at K 2016 is now coming to NPE2018 as the U.S. launch of its largest machine ever and the first of a brand-new design with a sophisticated new control. The Allrounder 1120H (photo) has a 650-metric-ton clamp (730 U.S. tons, 30% larger than any previous Arburg machine) with 1120 mm tiebar spacing (20% larger than other Allrounders) and 1050 mm stroke. Dry-cycle time is 2.4 sec. This hybrid press has an electric toggle clamp powered by twin servos, plus servo-hydraulic injection with a gas accumulator. Electric ejection is standard, with hydraulic optional. The sleek new design encloses all electric, hydraulic, pneumatic, lubrication, and temperature-control systems within the machine frame. Safety gates and injection unit run on linear guides. Integrated fold-out steps provide access to the mold area.

Its new Gestica controller has a pivoting and height-adjustable operator panel with a smooth glass front that resembles a tablet computer and accepts multitouch/gesture commands. The 15.6-in., full-HD screen has a new EASYslider element that allows fingertip dynamic control of machine movements during setup. Motions can be speeded up or slowed down with the swipe of a finger on the on-screen bar.

The Allrounder 1120H will be molding a PP folding step stool, molded in an eight-cavity family mold and snapped together in an adjoining cell with a pair of six-axis robots. The parts will be demolded by a Multilift V Cartesian robot with 88-lb payload capacity (also introduced at K 2016).

Arburg (U.S. office in Rocky Hill, Conn.) will have a total of nine exhibits at NPE (booth W1325). Among the others will be:

- An electric Allrounder 570A producing wrist straps in LSR with two colors and durometers (70 and 30 Shore A), and assembling complete watch in a robotic cell.
- A dual-durometer LSR/LSR (70 and 30 Shore A) membrane for valves used in medical and automotive applications will be molded on an Allrounder 270A with a 0.1-oz micro-injection unit incorporating a 0.3-in. screw to produce one 0.0018-oz component, which is then overmolded using a servo-electric injector from Kipe Molds, Placentia, Calif. (***kipemolds.com***), which is integrated into the 1 + 1 cavity mold and the Selogica control system.

- A packaging version of the Allrounder 570H designed specifically for thin-wall molding, will produce four IML tubs from PP in a cycle time around 1.9 sec. The finished parts weigh 0.12 oz and have walls 0.0126 in. thick.
- For automotive, long-glass reinforced airbag housings will be molded with "fiber direct compounding" (FDC), whereby continuous glass rovings are fed into the injection barrel downstream of the feed opening. A side feeder with integrated cutter and a special screw and barrel permit customizing the fiber length and concentration. A weight monitor will display the consistency of shot weight.
- Insert encapsulation will be shown on a vertical rotary-table machine. Metal inserts will be fed to a plasma pretreatment station before overmolding with nylon 66.
- In what has become a trademark exhibit for Arburg at major shows, Industry 4.0 networking capability will be demonstrated by molding individualized business-card holders and then barcode labeling them by laser marking, followed by custom decorating with Arburg's Freeformer 3D printer.

860-667-6500 • arburg.us

INJECTION MOLDING

Wittmann's U.S. Debut of Two Machines, New Robots & Auxiliaries at NPE

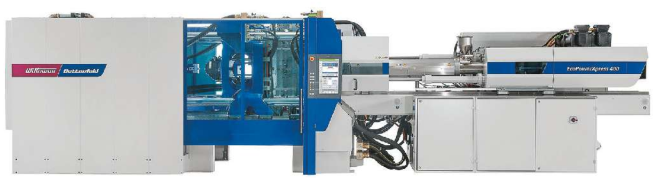
Among six work cells that Wittmann Battenfeld Inc., Torrington, Conn., will display at NPE2018 (booth W3742), two will present new machines that previously debuted in Europe for the first time at a U.S. show. The EcoPower Xpress is the company's newest, high-speed, all-electric machine, aimed at packaging and other thin-wall products (photo). It offers injection speeds up to 600 mm/sec, injection acceleration up to 15,000 mm/sec², and injection pressure to 36,275 psi. Shown in prototype form at K 2016, it became commercial as of Fakuma 2015 last fall. At NPE, a 440-ton model will run a 96-cavity bottle-cap mold; such a mold ran at Fakuma in 2.7 sec.

NPE2018 THE PLASTICS SHOW

Also new is a two-shot model of the MicroPower 15-ton micromolding press, first shown in Europe in 2016. It has two parallel injection units and a rotary disk molding a plug that goes inside the recording head of a vinyl record player. The parts are made of PC and electro-conductive PC. Parts removal will be handled by a Wittmann S8VS4 SCARA robot specially designed for this machine.

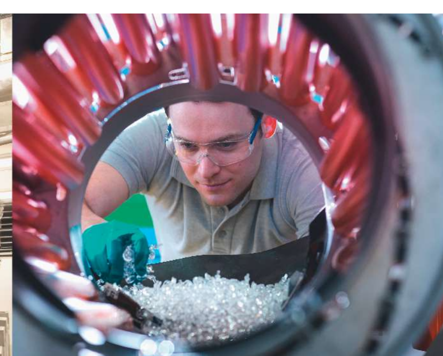
Two robot series will also see their U.S. debut at the show. One is the new X Series, which is basically equivalent to the company's pro series plus the new R9 control. At the opposite end of Wittmann's line is its new Primus line of economical servo robots for relatively simple pick-and-place uses. It also comes with R9 control.

Overall, Wittmann's exhibit emphasizes its Wittmann 4.0 interconnectivity of presses and auxiliaries as a "Pathway to 4.0." This theme will be evident in all the exhibits, including the most complex 4.0 work cell, which interconnects a MacroPower 850 machine producing an automotive spoiler with an HRSflow servo controller for five valve gates, Gammaflux hot-runner temperature controller, and Wittmann robot, TCU, blender, granulator, and Flowcon Plus electronic water-flow controller. The cell also shows off the new CMS Condition Monitoring System for predictive and preventive maintenance.



A number of the molding cells on display make use of the Tempro Plus D mold-temperature controller (TCU) with energy-saving SpeedDrive option introduced at last fall's Fakuma show—a variable-speed pump and the ability to set either motor speed, pump pressure, or differential temperature (ΔT). Some of the working cells also use the new Aton H beside-the-press wheel-type dryer with larger, 7-in. touchscreen and fully integrated 4.0 capabilities. Several cells utilize the Flowcon Plus to continuously monitor and automatically control water flow through each individual mold circuit.

860-496-9603 • wittmann-ct.com



EXTRUSION

Suppliers Team Up On New Extruder Series

Integrated Control Technologies LLC, Coppell, Texas, has partnered with American Kuhne, div. of Graham Engineering, York, Pa., to develop a new line of extruders. Called the Genesis Series, the line will be marketed exclusively through Integrated Control Technologies and its sales channels.

The machines are said to combine the proven extrusion technology of American Kuhne with the system integration capability of Integrated Control Technologies. The extrusion control system consists of an easy-to-use graphical interface requiring minimal training for operators, together with advanced diagnostics and remote monitoring. The Genesis Series will debut at NPE2018 (booth S23103).

Integrated Control Technologies is an aftermarket leader in drive and control upgrades for extruders, with product offerings such as the ACPAK, a pre-engineered AC drive package for extruders through 500 hp, available in as little as 24 hr; and the Tempcon, an advanced extruder control system.

972-906-7445 • integratedcontroltech.com

EXTRUSION

Next-Generation Control System

Davis-Standard LLC, Pawcatuck, Conn., has introduced the next generation of its popular and economical DS-eTPC touch-screen control. Called the DS-eTPC II, the updated controller is engineered with added flexibility to support a broader range of processes and applications. It includes a larger, 15-in. screen with multi-touch capabilities to enable zoom in and out, as well as control for up to three extruders and real-time and historical data trending. Other enhancements include an increase of heat-only zones from four to eight, with an option for up to 20; two auxiliary drives; a remote setpoint; and speed trim via discrete inputs from gauging equipment.

D-S says the controller's modular

design will improve control capabilities and application flexibility while maintaining an attractive price point. What's more, extrusion processors will be able to control up to three extruders from one main operator station. They will also have the option for local control of coextruders while maintaining line control from the primary operator station. For wire and cable processes, there are optional modes for auto on/off and manual control, along with an option for capstan control.

Standard features on the DS-eTPC II include historical data collection, real-time and historical data trending, web interface, alarm log, and an auxiliary local operator station. The new control is also equipped to handle melt pumps for each extruder and auxiliary functions such as vacuum pumps. On-screen diagnostics and Davis-Standard's ReACT (remote-access support) are said to make this system the most capable touchscreen control in its class.

860-599-1010 • davis-standard.com

MATERIALS HANDLING

IBC Discharger for Low Headroom

A new Bulk-Out low-profile discharger from Flexicon Corp, Bethlehem, Pa., positions Intermediate Bulk Containers (IBCs) weighing up to 3200 lb in the frame using an electric hoist and trolley, discharges bulk solid materials into a surge hopper, and conveys the material to a downstream process dust-free.

The surge hopper is available with an integral flexible screw conveyor, tubular cable conveyor, or pneumatic conveying system also produced by the company. The stainless-steel IBC hopper frame measures 36 in.^{2} × 38 in. high and includes four casters with brakes.

888-353-9426 • flexicon.com

MATERIALS HANDLING

Control for Bowl Feeder Gives Energy Savings, Gentler Feeding

Spirol International Corp., Danielson, Conn., has enhanced its Series 2000 bowl feeder with the new Mark VI controller having a 7-in. touchscreen, 50-recipe storage capacity, and Ethernet interface for remote access and control. This feeder is said to be well suited to handling fragile, tactile, or slippery parts in assembly processes.

A key new feature of the controller is the reportedly unique ability to continuously adjust the output drive frequency to match the natural resonant frequency of the drive unit. The feeder's natural resonant frequency must be tuned at or near the frequency of the power source in order to achieve the greatest amplitude of vibration for a given power input. This tuning is done mechanically during initial setup of the feeder; however, the resonant frequency changes as the product mass in the bowl changes and as the springs relax from use. In conventional units, the feeder's performance is thus adversely affected.

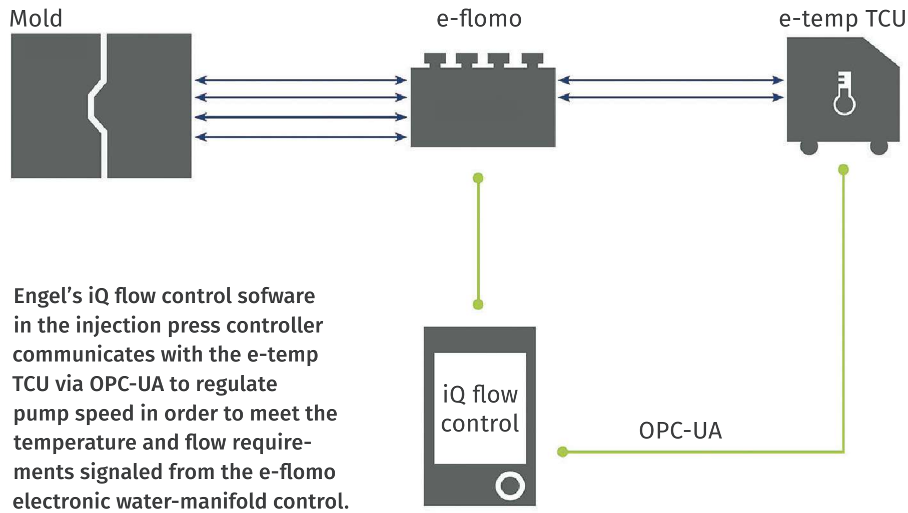
But the new control automatically senses the natural resonant frequency of the feeding system and continuously generates an optimal drive frequency to maximize efficiency. Variable frequency eliminates mechanical bowl tuning, allowing use of interchangeable bowls with a single drive. The result is lower average operating frequencies, which reduce part damage, bowl wear, and noise, as well as providing energy savings.

The controller also contains an internal capacitor bank that stores the discharge energy and recycles it back to the circuit on the next charge cycle. In conventional systems, all the discharge energy is lost to the line source. The result is that the Series 2000 feeder with Mark VI control uses 80% less amperage than conventional units, according to Spirol.

The Series 2000 also has independent horizontal and vertical axes of motion, which result in an elliptical movement of the bowl, providing smoother, gentler feeding with less part damage and noise. The Mark VI provides both variable amplitude and variable angle of motion, allowing for speeds up to 2.5 times greater than other feeders without excessive bouncing and noise.

860-774-8571 • spirol.com

HEATING/COOLING



Engel's iQ flow control sofware in the injection press controller communicates with the e-temp TCU via OPC-UA to regulate pump speed in order to meet the temperature and flow requirements signaled from the e-flomo electronic water-manifold control.

Energy-Saving Mold-Temperature Control Comes to NPE

NPE2018 will see the North American launch of the newest module of iQ intelligent control software from Engel Machinery Inc., York, Pa. (booth W3303). "Most rejects in injection molding are the result of temperature-control errors," says Joachim Kragl, director of Advanced Molding Systems and Processing. "This explains why processors' focus is increasingly shifting to mold-temperature control." It also explains the development of Engel's iQ flow control, which is integrated into its CC300 machine control and communicates with other intelligent peripherals in a machine cell.

Engel began this development at K 2010 with its flomo electronic temperature-controlled water-manifold system, which replaces older maintenance-intensive water distributors and can monitor and document each individual cooling circuit. Partial or complete blockages due to water-borne debris or scale buildup no longer go undetected. Then at NPE2015, Engel launched e-flomo, which added the ability to actively control either the flow rates or in/out temperature difference (ΔT) in all individual cooling circuits. The advantage of ΔT control is that it automatically sets the required flow rate for each circuit to produce the desired ΔT.

K 2016 saw the next step with the introduction of iQ flow control. This software networks the temperature-control units (TCUs) and the injection machine to create a single unit that, based on the measured values determined by e-flomo, controls the pump speed in the TCU to provide the required flow. While e-flomo increases process stability and reduces rejects, automatic pump-speed adjustment with iQ flow control ensures that the pump works no harder than necessary and thus minimizes energy usage for mold-temperature control. Since the pump operates on demand, rather than at maximum output all the time, wear and tear is reduced and pump maintenance is reduced.

A key element of this system is a TCU with variable-speed pump developed by HB-Therm of Switzerland in collaboration with Engel, which sells this unit under the name Engel e-temp (photo). It is networked with the injection machine via the OPC-UA communication protocol, which is becoming a standard of Industry 4.0 networks, which Engel calls inject 4.0.

717-764-6818 • engelglobal.com

AUXILIARY EQUIPMENT

Cleaning Cube for Trays, Parts

The RPT Cleaning Cube from Simco-Ion, Hatfield, Pa., reportedly combines the power of recirculated airflow, HEPA filtration, and static neutralization to effectively clean trays and parts without the need for compressed air.
Dual blowers located inside an acoustically insulated blower box force the recirculated air to the top plenum. The air passes through a HEPA filter and two static-neutralization bars before reaching the large cleaning chamber via 128 high-force jets. Operating at less than 70 dB, themachine requires only a standard wall outlet. The adjustable-height stand provides portability and reduces the need for bench space.

Other features include an optical sensor for automatic operation, UV and white light to assist in thorough inspection, and a flexible air wand for pinpoint cleaning. The RPT Cleaning Cube also captures particulates.

215-997-3449 • simco-ion.com

ADDITIVES

Liquid Additives For PET, PVC

New additions to a broad range of liquid additives and colorants for beverage and industrial applications from Italy's REPI LLC (U.S. office in Dallas, N.C.) will be showcased at NPE 2018 (Booth S19103). For the beverage sector, these include new Anti-Yellow and IV Enhancers for R-PET processing, and UV stabilizers and barrier whites for UHT milk bottles.

For industrial applications, REPI will showcase its broad portfolio of liquid processing additives for PC, PMMA, PVC, HDPE, PP and ABS, as well as its new Xpansor liquid foaming agent for PVC that is said result in a lighter foamed sheet with a perfectly smooth surface.

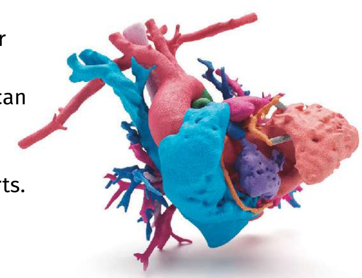
704-648-0252 • repic.com

ADDITIVE MANUFACTURING

HP Announces Lower-Cost Jet Fusion 3D Printers for Prototyping—in Full Color

Last month, HP Inc., Palo Alto, Calif., added to its growing line of 3D printers using its exclusive Multi Jet Fusion process with four new, smaller and lower-cost models aimed at design, product development and prototyping. Available in the second half of this year, the new Jet Fusion 300/500 series is designed to produce up to 52 parts of 30-cc volume in 15 hr, while the company's production-oriented Jet Fusion 3200/4200/4210 models are aimed at volume needs from 130 to 1000 parts/week. The new units have a build volume of up to 7.5 × 13.1 × 9.8 in. vs. up to 15 × 111.2 × 15 in. for the production models. The 300/500 series is also more compact, embodying a one-piece integrated design, while the production models require three separate pieces of equipment for materials and parts handling and cooling. The new units are priced from the "low $50,000s" to the "low $100,000s" range, while the 4200 series starts at around $300,000 for a full system, since most users purchase at least two processing stations in addition to the printer.

The new units have the same degree of precision as the production models (layer thickness of 0.08 mm/0.0031 in.), which means that they can build prototypes that represent exactly the properties of production parts. Two models in the 300/500 series also offer a brand-new capability—full-color printing ("millions of colors") in addition to standard black or white. There's a new grade of High Reusability nylon 12 powder tailored for the new printers that's said to offer the same mechanical properties and surface finish as the grade used on the larger printers.



877-468-8369 • hp.com

TESTING & MEASURING

Versatile Non-Contact Imaging Spectrophotometer

A new non-contact imaging spectrophotometer is said to meet the needs of the plastics and coatings industries. The MetaVue VS3200 from X-Rite Inc., Grand Rapids, Mich., is reportedly the first non-contact instrument for industrial applications that combines color imaging with spectrophotometry to characterize today's most complex materials. It is suited to lab or quality-control operations and is said to offer unmatched color accuracy for measurement of plastic samples, liquids, powders and gels. It will be featured at NPE2018 (booth S19037).

The VS3200 includes an on-board camera allowing precise digital targeting of the sample, including odd shapes. The ability to measure difficult samples helps plastics compounders and processors eliminate color errors in formulation. This device features an adjustable aperture size from 2 to 12 mm, enabling measurement of a wide range of samples without contaminating the instrument or damaging the sample.

888-800-9580 • xrite.com

TESTING & MEASURING

Lower-Cost CT Scanner For Smaller Molding Shops

The use of CT (computed tomography) scanning to measure and inspect plastic parts has drawn increasing interest among injection molders, yet has been hampered by very high cost ($500K-750K). Now, a lower-cost unit has been introduced by Werth, Inc., Saybrook, Conn., which has been a pioneer in industrial 360º CT scanning since 2005. The new TomoScope XS, which will make its debut at NPE2018 (booth S30079), is aimed at small to medium-size molding shops, with a starting price of about $200,000, weight of 1800 lb (a fraction of some previous units), and a compact footprint of 51.2 in. wide × 53.9 in. high × 22.9 in. deep. It boasts features found in much larger units, including an x-ray sensor with resolution of 2940 × 2304 (5 in. diam. × 3.85 in. high). It can perform rapid measurements at high resolution.

It is designed for use in first-article inspection and mold validation, where it reportedly can save a substantial amount of time. Werth's patented CT OnTheFly technology can reduce scan time tenfold, explains v.p. of marketing & sales Robert Kozlowski. "It can be used for production molding to evaluate a part in real time and also has optional tool-correction software," he says, noting that this technology is being used primarily for medical devices and automotive connectors, where good resolution and repeatability are required.

Its unique monoblock design combines the source, voltage generator and vacuum pump into a single serviceable unit, which is said to result in both long maintenance intervals and a virtually unlimited service life. The unit's air-bearing rotary axis is said to position the workpiece with the highest precision to ensure low measurement uncertainty. The company's WinWerth measurement software for the overall measurement process enables traceability of the measurement results. The company is said to be the first manufacturer to guarantee reliable and traceable measurement results by calibrating all CT machines according to standards, including DAkkS certification.

860-399-2445 • werthinc.com

MATERIALS

Fast-Cycling Nylon for Fasteners

What is dubbed a next-generation nylon 66 compound reportedly overcomes cycle-time limitations of earlier workhorse grades, allowing injection molders of fasteners and similar parts to meet product performance requirements while increasing productivity. Chemlon 102HI BK001 from Teknor Apex Co., Pawtucket, R.I., is the first of a new suite of nylon compounds for fastener applications and will make its debut at NPE2018 (Booth S22045).

The new compound boasts the same performance properties as established workhorse grade Chemlon 104H; but in gate-freeze tests, 102HI BK001 showed a 15% improvement vs. industry benchmarks in achieving constant weight, and it did so without any impact on surface aesthetics during demolding. Moreover, in a customer's commercial-scale production using high-cavitation tooling, Chemlon 102HI BK001 demonstrated accelerated rates of crystallization. After long periods of runtime, the new material consistently out-performed competitive products. According to Teknor, some customers have reported up to 9% increase in part production by switching to the new material.

800-237-3167 • teknorapex.com

MATERIALS

High-Temperature Engineering Resins For Medical/Dental Devices

A new range of high-heat, medical-grade engineering resins has been introduced to the North American medical and dental device manufacturers by PolyOne Corp., Avon Lake, Ohio. These FDA-compliant specialty polymers are already well established in Europe, and appear on the approved list of several OEMs. The Comptek line is the result of PolyOne's 2016 acquisition of Germany's Comptek, a specialist in formulations based on highly heat-resistant polymers such as PEEK, PES, PEI, PPS, PSU and PPSU. Properties that can be achieved with these materials include transparency, electrical and/or thermal conductivity, laser markability and X-ray opacity.

866-765-9663 • polyone.com

ADDITIVES

Scratch/Mar Resistance for PMMA

A new anti-scratch additive for PMMA, said to deliver superior scratch/mar resistance while minimizing any negative effects on optical properties, is newly available from TenasiTech (U.S. office in Boston). Solid-FS is the company's second patented organoclay with special organic surface treatment that helps maximize the disassociation of the clays when compounded into thermoplastics (see Dec. '16 feature), and offers an affordable alternative to hard coating.

The first product, Solid-TT, has received good commercial acceptance in PMMA and nylon 6, and looks promising for PET and PVC/PMMA compounds. According to CEO Richard Marshall, the new Solid-FS grade sports both a different surface treatment and different particle size (much smaller agglomerates), and is ideal for high-gloss applications. Moreover, Solid-FS is effective in PMMA at much lower addition rates—0.25% vs. 1% for Solid-TT.

The additive has been shown to deliver up to 7H pencil hardness, compared with 3H for virgin PMMA. Resulting compounds boast superior optical properties, with only 5% haze and a drop of only 2% in gloss. The additive reportedly does not adversely affect other key properties such as impact strength, elastic modulus or resistance to weathering. Moreover, it cannot be rubbed off, and the final product can be thermoformed. No secondary hard-coating steps are needed.

518-572-8572 • tenasitech.com

ADDITIVES

Expanded Portfolio of Healthcare Colorants & Additives

A broader range of colorants and additives for healthcare was introduced by PolyOne Corp., Avon Lake, Ohio, at MD&M West 2018. The expanded line of OnColor HC Plus colorants and OnCap HC Plus additives for healthcare is pre-certified to meet USP Class VI or ISO 10993 specs.

Customers now have expanded resin family choices—including nylon, TPVs and PS—that incorporate biocompatible functional additives in both masterbatch and compounded forms. Functional performance additives that are now tested and certified for biocompatibility include antimicrobials, surface-energy modifiers, content-protection additives, laser-marking pigments, and dimensional and physical-property modifiers.

866-765-9663 • polyone.com

DRYING

Vacuum Drying Line Extended

Maguire Products Inc., Aston, Pa., will introduce the VBD-600 vacuum drying system at NPE2018 (Booth W5747). With 600 lb/hr of drying capacity, the model is an intermediate size in a range from 30 to 1000 lb/hr. Like all Maguire equipment, the new VBD-600 dryer comes with a five-year warranty.

Maguire will also introduce at NPE2018 an energy-monitoring capability that will be available with all VBD models. The VBD-600 on exhibit will include a new touchscreen controller (photo) that enables processors to track energy consumption over time. Energy efficiency is a key feature for the VBD line, according to Maguire, which points out that drying can account for as much as 15% of the total process energy cost for a molding operation. In comparison with desiccant dryers, Maguire says its VBD vacuum dryers consume up to 80% less energy, while drying resin in one-sixth the time.

888-459-2412 • maguire.com

Higher Prices for Commodity Resins

Only PP is facing a downward correction.

Prices of PP and PET moved up in January, while PE, PS, and PVC held even. But rising prices were projected for February, March and into the second quarter for all resins but PP. The latter was heading into a downward correction after prices spiked significantly in step with propylene monomer. Factors behind the overall upward movement include higher oil prices and export demand for resins, planned and unplanned polymer and feedstock plant outages, and expected strong demand in the second quarter.

By Lilli Manolis Sherman
Senior Editor

Those are the views of purchasing consultants at Resin Technology, Inc. (RTi), Fort Worth, Texas (***rtiglobal.com***); Michael Greenberg, CEO of the Plastics Exchange in Chicago (***theplasticsexchange.com***); and Houston-based ***PetroChemWire*** (*PCW*, ***petrochemwire.com***).

PE PRICES HEADED UP

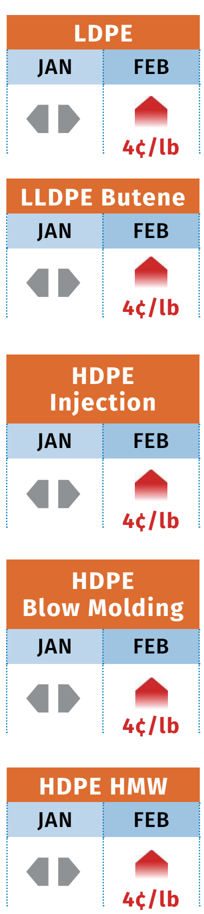
Polyethylene prices were flat in January after most processors saw at least a 3¢/lb reduction in December, according to Mike Burns, RTi's v.p. of client services for PE. However, suppliers announced a 4¢/lb price increase for Feb. 1 and at least three of them issued an additional hike of 3¢/lb for March 1.

Said Burns, "Export markets are very strong and oil prices are very high. Unless these factors change drastically, processors ought not expect any more PE price reductions."

Greenberg reported a slowed PE spot market as spot prices rose by as much as 9¢/lb in January—swinging from a discount to contract level. *PCW* characterized spot PE prices as flat to higher in early February amid balanced-to-tight supply. *PCW* cited strong consumer sentiment as boosting domestic resin consumption, while a combination of planned and unplanned outages kept output in check, despite the ongoing ramp-up of new capacity.

PCW reported that DowDuPont is expected to start up its new 772-million-lb/yr tubular LDPE plant in Plaquemine, La., by the end of the first quarter. Westlake maintained its *force majeure* on LDPE homopolymers, while Formosa PE units in Point Comfort, Texas, were running at reduced rates due to the outage of its Olefins 1 unit. ExxonMobil was heading into a one-month turnaround of its Baton Rouge HDPE/LDPE facilities, while Nova Chemical's Corunna, Ont., ethylene cracker was unexpectedly shut down in late January.

Polyethylene Price Trends



Market Prices Effective Mid-February 2018

Resin Grade	¢/lb
POLYETHYLENE (railcar)	
LDPE, LINER	97-99
LLDPE BUTENE, FILM	83-85
NYMEX 'FINANCIAL' FUTURES	48
MARCH	48
HDPE, G-P INJECTION	99-101
HDPE, BLOW MOLDING	89-91
NYMEX 'FINANCIAL' FUTURES	50
MARCH	50
HDPE, HMW FILM	106-108
POLYPROPYLENE (railcar)	
G-P HOMOPOLYMER, INJECTION	89-91
NYMEX 'FINANCIAL' FUTURES	59
MARCH	57
IMPACT COPOLYMER	91-93
POLYSTYRENE (railcar)	
G-P CRYSTAL	109-111
HIPS	115-117
PVC RESIN (railcar)	
G-P HOMOPOLYMER	80-82
PIPE GRADE	79-81
PET (truckload)	
U.S. BOTTLE GRADE	71

PP PRICES TURNING BACK DOWN

Polypropylene prices moved up 9¢/lb in January, in step with propylene monomer contracts, after a 2¢/lb increase in November and December. But a reversal appeared to be taking place before January's end, with spot monomer prices dropping by as much as 13¢/lb, according to Scott Newell, RTi's v.p. of PP markets.

Newell characterized the January increase as "all cost-push, driven by propylene monomer due to shortages." Full ramp-up of the new Enterprise Product Partners propylene production unit was delayed into January; Dow's propylene unit was still out after an unplanned shutdown; and other minor monomer production outages were cropping up.

Both Newell and *PCW* described the market as very volatile—pushing prices of both monomer and PP way above the rest of the world. Both also reported that the result was significant demand destruction, both domestic and foreign, due to high U.S. PP prices. *PCW* referred to reports of downstream customers pulling orders for a variety of finished PP goods, preferring to wait until prices moderate.

Newell foresaw a turnaround taking place—predicting PP prices to be flat to down for February, based on lower monomer contract prices as supply improved. While the price volatility is difficult to gauge, he anticipated a correction for both monomer and PP by this month and did not expect PP suppliers to attempt margin expansions. In early February, Greenberg reported that spot PP prices dropped 4¢/lb on average, following a sharp drop in spot monomer prices down to 52¢/lb, after peaking at 68¢/lb. Monomer price forecasts for the spring months were even lower.

Polypropylene Price Trends

Homopolymer	
JAN	FEB
▲ 9¢/lb	▼

Copolymer	
JAN	FEB
▲ 9¢/lb	▼

PS PRICES MOVING UP

Polystyrene prices were flat in January, as benzene contract prices dropped by 11¢/gal, which represents a 1¢/lb decrease in PS production costs. However, PS suppliers issued price hikes of 2-7¢/lb for Feb. 1, attributing their action to a substantial rise in spot styrene monomer prices. This was due to a number of planned and unplanned global monomer outages, according to Mark Kallman, RTi's v.p. of client services for engineering resins, PS and PVC, who ventured that PS prices would move up last month, but on the lower end of the increases being sought. "There is a lot of negotiation taking place due to downward pressure from benzene but upward pressure from styrene," Kallman said.

PCW also reported that the 7¢/lb target for price increases was expected to be revised downward. It also reported that Total Petrochemicals notified customers in early February that it had sufficient styrene monomer supplies to restart the two smaller PS lines at its Carville, La., plant that were shut down after severe winter weather. Initially, the company reduced rates on its two larger PS units and idled the two smaller units as it evaluated the extent of styrene monomer production loss at the adjacent Cosmar plant. RTi's Kallman predicted that PS prices in March would be flat, particularly if benzene prices dropped further, as monomer production issues were resolved. While the first quarter continued to reflect the slow season for PS, demand is expected to be strong in the second quarter.

Polystyrene Price Trends

GPPS	
JAN	FEB
◀▶	▲ 2-7¢/lb

HIPS	
JAN	FEB
◀▶	▲ 2-7¢/lb

PVC PRICES INCREASE; MORE UNDERWAY?

PVC prices were flat in January, but suppliers issued a 3¢/lb price increase for Feb. 1, followed by a 4¢/lb increase for March 1, according to RTi's Kallman and *PCW*. The latter reported that some suppliers were warning of an April price hike, as well. Among the contributing factors cited by suppliers, according to *PCW* , is that too much margin was lost as a result of the December 1¢/lb decrease, 2-3¢/lb resets in fourth-quarter 2017 contract negotiations, and financial losses during Hurricane Harvey.

Kallman noted that overseas demand was very good as global prices rose, so that U.S. export prices have been increasing, putting pressure on domestic prices. But he added, "There are opposing forces at work—a substantial decrease in February ethylene prices is expected, which will yield a discount off the 3¢/lb increase." While he ventured that suppliers would implement 1-2¢ of the February increase, he expected that it would be delayed to this month along with the March increase—allowing suppliers to implement 4-5¢/lb by April, the start of the construction season, which is anticipated to be strong this year.

PVC Price Trends

Pipe	
JAN	FEB
◀▶	▲ 1-3¢/lb

Gen. Purpose	
JAN	FEB
◀▶	▲ 1-3¢/lb

PET PRICES UP

PCW reported that domestic bottle-grade PET resin ended January at 71¢/lb for bulk-truck shipments delivered to the Midwest, up 2¢/lb from December. Supply was limited due to M&G Chemicals idling PET plants in Apple Grove, W. Va., and Altamira, Mexico, in October when M&G subsidiaries filed for bankruptcy protection. One of Altamira's two production units was restarted in mid-January. Meanwhile, imported PET with an IV of 78 or higher was at 65¢/lb, delivered duty-paid (DDP) to the West Coast, and 67-70¢/lb DDP to the East Coast and Chicago area, plus 2-5¢/lb for inland freight, up 1-2¢/lb from early January.

PET Price Trends

Bottle Grade	
JAN	FEB
▲ 2¢/lb	◀▶

Cost of North American PET feedstocks—PTA, MEG and PX, averaged 58.4¢/lb in January, down from 73¢/lb in December. However, *PCW* ventures that PET prices will likely rise in March as anti-dumping duties go into effect (March 5) on U.S. PET imports from five countries—South Korea, Brazil, Indonesia, Taiwan, and Pakistan—which account for about 40% of all U.S. imports. *PCW* projects PET prices will likely rise from the current level of 70-71¢/lb to the mid-70¢/lb range for domestically produced PET resin in truckload and bulk-truck spot business, and 2-4¢/lb lower for bulk-truck and railcar business tied to published PET feedstock indexes. Imports of PET from the five countries started to drop in December 2017. *PCW* expects import prices to rise 2-4¢/lb above the levels noted above.

Plastics Processing Continues Expansion

Business is poised for additional growth this year.

By Michael Guckes
Chief Economist

In January the Gardner Business Index (GBI): Plastics Processing started off 2018 on the same steady growth trend it followed throughout 2017. Processors are well positioned for additional growth in 2018, as new orders and production in the current and recent months have been the greatest drivers of the index. The index is calculated based on survey responses from subscribers of *Plastics Technology* magazine. Index values over 50 indicate expansion, under 50 indicate contraction, and 50 equals no change.

For the fifth month in a row, new orders growth has exceeded production. Reviewing past trends from the Gardner Business Indices reveals that when new orders growth exceeds production growth it is typical for manufacturers to experience additional growth in future months as they adjust to increased demand. The outpacing of new orders over production typically results in significant increases in backlogs; however, this has yet to occur, as recent backlog readings indicate only mild increases.

The GBI reading among only custom processors in January grew slightly. During the month, custom processors experienced a faster rate of production but a slightly slower rate of new orders. Surprisingly, backlog, exports, and employment readings all contracted during the month and supplier deliveries recorded no change.

Michael Guckes is the chief economist for Gardner Intelligence, a division of Gardner Business Media, Cincinnati. He has performed economic analysis, modeling, and forecasting work for nearly 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*.

GBI: All Processors vs. Custom Processors

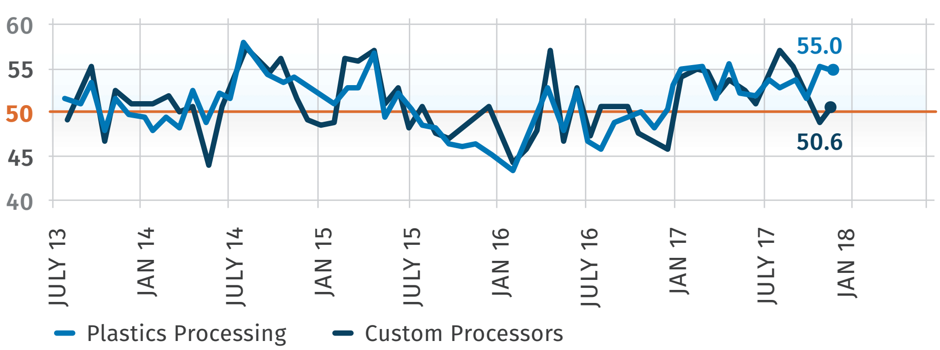


FIG 1

The Plastics Processing Index started the year where it left off 2017, with modest growth powered by new orders and production. Custom processors grew slightly in January.

GBI: Plastics Processing–New Orders & Exports

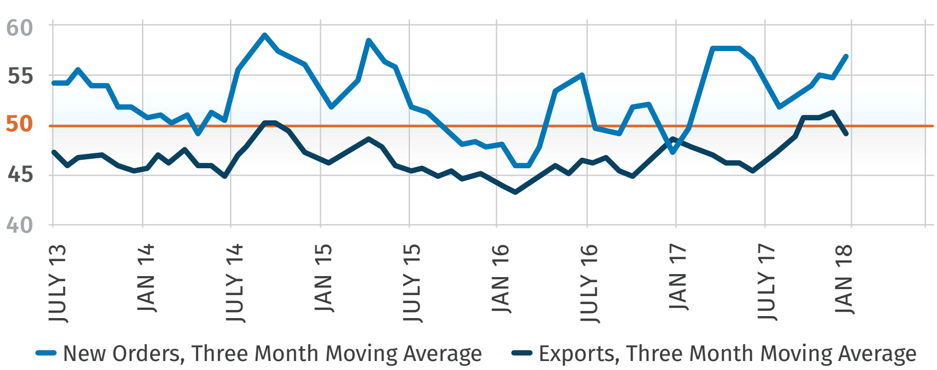


FIG 2

New orders have been a critical driver of the GBI Plastics Processing Index. New orders growth is coming from both domestic and international consumers of manufactured plastic products.

Electronics OEMs Face Slower Growth

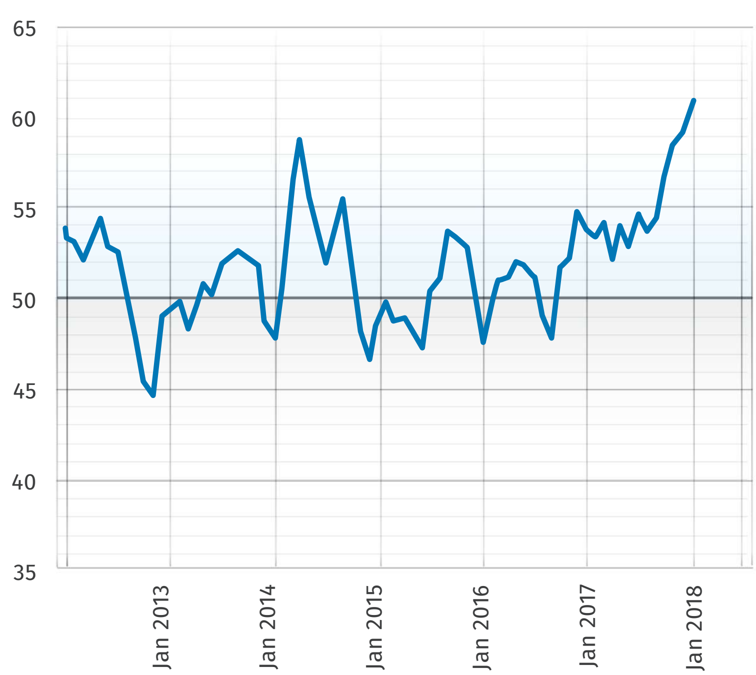
Strong 2017 created overcapacity, which is expected to balance out this year, as demand increases.

By Michael Guckes
Chief Economist

Growth in the electronics industry is projected to slow in 2018, according to Gardner Intelligence, a division of Gardner Business Media, publishers of *Plastics Technology*. Gardner based its projection on the historical results of more than 230 publicly traded electronics-industry and industry-related firms, along with Wall Street analyst projections pertaining to these firms (where available).

The industry's robust expansion during 2017 created overcapacity, which will be balanced by increased demand during 2018. According to IC Insights, Scottsdale, Ariz., a leading semiconductor market-research company, growth of logic and memory integrated circuits is expected to come in at 10.8% and 60.1%, respectively, for 2017 once the final numbers are tabulated. By comparison, growth in both areas in 2016 was a respective 0.8% and -0.6%.

GBI: Suppliers to Electronics OEMs



Firms that supply parts and components to electronics OEMs saw strong expansion in production, new orders, and supplier deliveries.

Data from the Gardner Business Index (GBI) corroborates this view. In 2017, the GBI for electronics was 55.2, compared with 51.5 in 2016. That jump represented the fastest average annual expansion rate in electronics since at least 2012. An index value of 50 indicates no change; values above 50 indicate industry expansion, while values above 50 indicate contraction. The farther the value is from 50, the faster the rate of expansion or contraction.

The average electronics industry fourth-quarter 2017 reading of 59.1 was the fastest rate of expansion for the electronics industry during a single quarter in the history of the index.

Among firms that supply the electronics industry and participate in the GBI, our fourth-quarter 2017 data reveal strong expansion in production, new orders, and supplier deliveries. These three factors were the primary drivers of Gardner's overall index of the electronics industry over the first three quarters of 2017. For Q4 2017, an index of 59.1 was the fastest rate of expansion for the electronics industry during a single quarter in the history of the index. Looking forward, news of new capital investment by consumer and industrial electronics manufacturers during the early weeks of 2018 imply that capital spending and growth of the electronics industry may have additional room for expansion.

ABOUT THE AUTHOR: Michael Guckes is the chief economist for Gardner Business Intelligence, a division of Gardner Business Media (Cincinnati, OH US). He has performed economic analysis, modeling and forecasting work for nearly 20 years among a wide range of industries. Michael received his BA in political science and economics from Kenyon College and his MBA from The Ohio State University.
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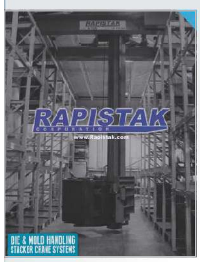

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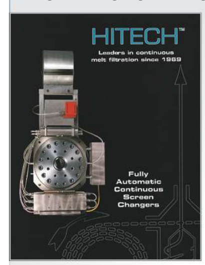

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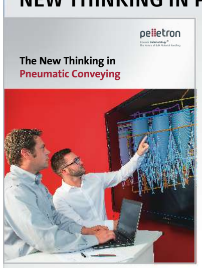

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GW PLASTICS — BETHEL, VT.

GW Plastics Bets on Metal 3D Printing

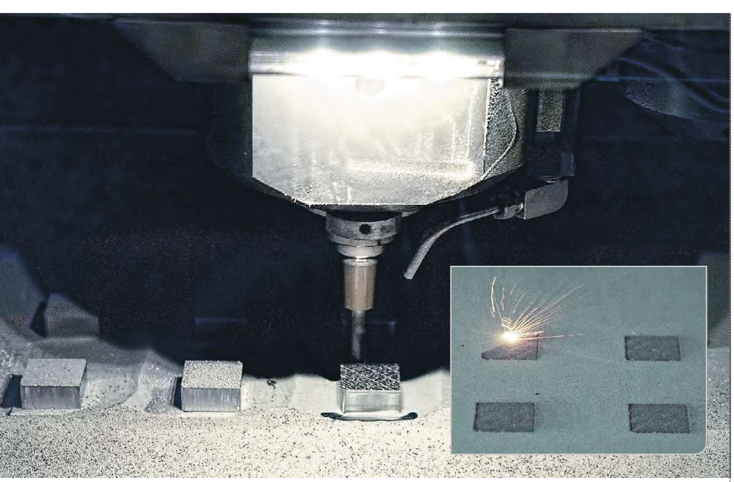
Conformal cooling is goal of big investment at U.S. mold facility.

By Matt Naitove
Executive Editor

In response to growing demand in its global medical-device and drug-delivery business, precision custom molder GW Plastics, Bethel, Vt., has made a substantial investment in 3D metal printing at its Royalton, Vt., captive moldmaking facility. The purpose is to build injection molds with conformal cooling for faster cycles.

GW (*gwplastics.com*) is one of only a handful of precision mold builders that have invested in this technology. "We are in the precision molding business, and cycle time is paramount. We see it as in our best interest to lead the charge into 3D metal printing and conformal cooling," says Timothy Holmes, v.p. of engineering. "That means faster cycles and better part quality through more predictable part shrinkage and warpage, so we won't have to design molds with deliberate distortions to counteract shrink and warp. Ultimately, that will mean faster time to market for our customers."

GW Plastics has invested over $2 million in its Royalton mold facility over the last 12 months to support R&D and expand capacity. About half that amount went into a "hybrid" machine that both laser sinters metal powders and performs finish machining—"as good as any CNC," says Holmes—as well



GW Plastics "grows" mold components by laser sintering metal powder (inset) to incorporate conformal cooling channels. Integrated high-speed milling yields nearly finished parts that require only minor post-processing steps.

as an environmentally enclosed room for the machine that has controlled humidity and protects the valuable metal powder—which is reused after every part build—from contamination.

"Our vision for metal 3D printing," says Holmes, "is selective use of this technology for geometry-dependent conformal cooling." GW Plastics previously used an outside supplier to produce 3D printed metal mold components with conformal cooling, which it has tested for up to 100,000 cycles to establish their durability under injection molding pressures. Cycle-time savings with these test molds averaged 25-30%, according to Holmes.

Other advantages of 3D printing are parts consolidation in mold building. Optimizing cooling in conventionally machined molds, Holmes explains, can require assembly of multiple components using o-ring seals and special high-conductivity mold materials. Metal 3D printing can eliminate all that. What's more, Holmes points out, 3D printing eliminates drilling holes for cooling, ejectors, etc., which can be one of the more expensive operations in mold building.

Holmes also notes that in the last five years he has seen a "vast improvement in steel selection for 3D printing," including grades that provide a higher-quality finish than before. And more are coming, he adds, such as improved grades of stainless steel.

Despite all these advantages of metal 3D printing, Holmes states, "I wouldn't want to use it for everything." Rather than "grow" entire cores and cavities from sintered metal powder, he targets the technology for inserts in critical areas. The reason, he says, is that metal 3D printing is "a little more expensive than conventional machining, but the payback is certainly worth it."

One factor is the metal powders, which cost more than conventional mold steels. Another factor is the additional engineering analysis required—"a lot more flow and cooling analysis"—to design metal printed mold components. Although the time to "grow" the laser-sintered metal part and machine it to a rough finish is about the same as for conventional machining, Holmes notes, what adds time and cost are secondary operations on the printed metal parts, such as removing support structures. The net result is 20-25% additional manufacturing time for printed metal parts.

"We've only had the metal 3D printing machine for a few months, and this is still something of an R&D project," Holmes says. There's a lot to learn, such as being able to predict precisely the shrinkage and distortion of printed metal parts. Long-term durability in molding also has yet to be established, but Holmes is confident that printed metal parts will be able to hit the million-cycle benchmark. In any case, printed metal inserts can be replaced by growing new ones.

GW Plastics also recently purchased a 3D plastic printer. Although it is now used mainly to produce "show and tell" parts for product development, Holmes can foresee printing plastic cavities and cores to mold hundreds of parts for prototyping. PT

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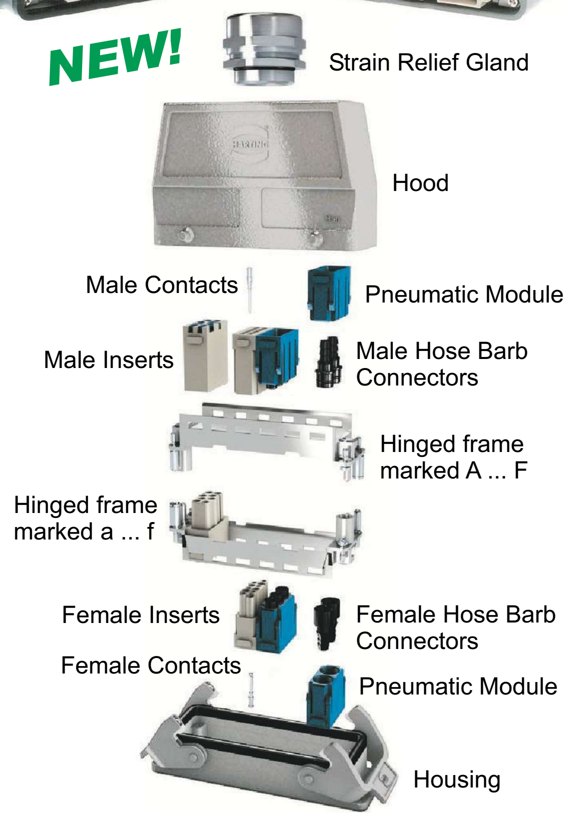

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