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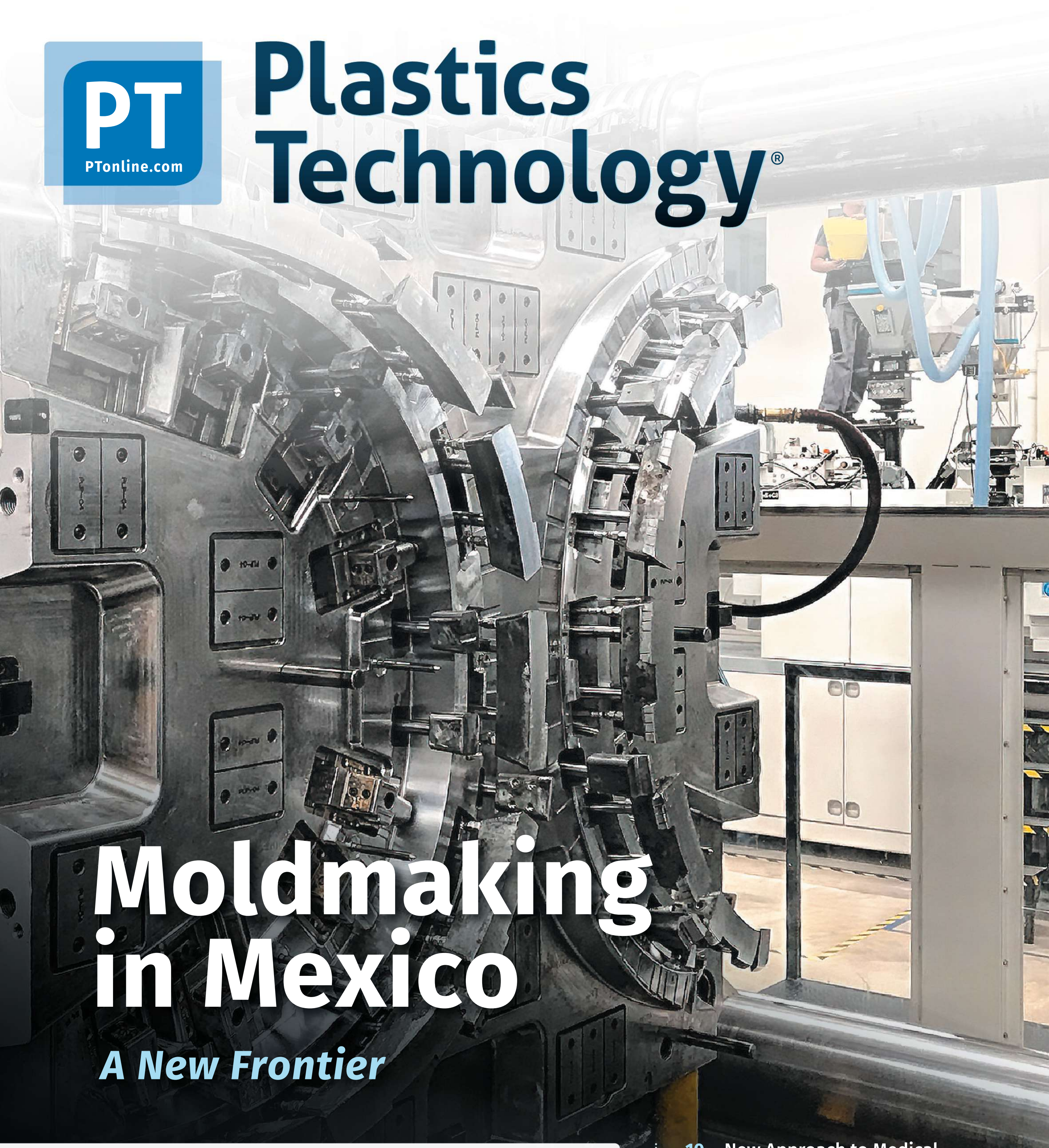

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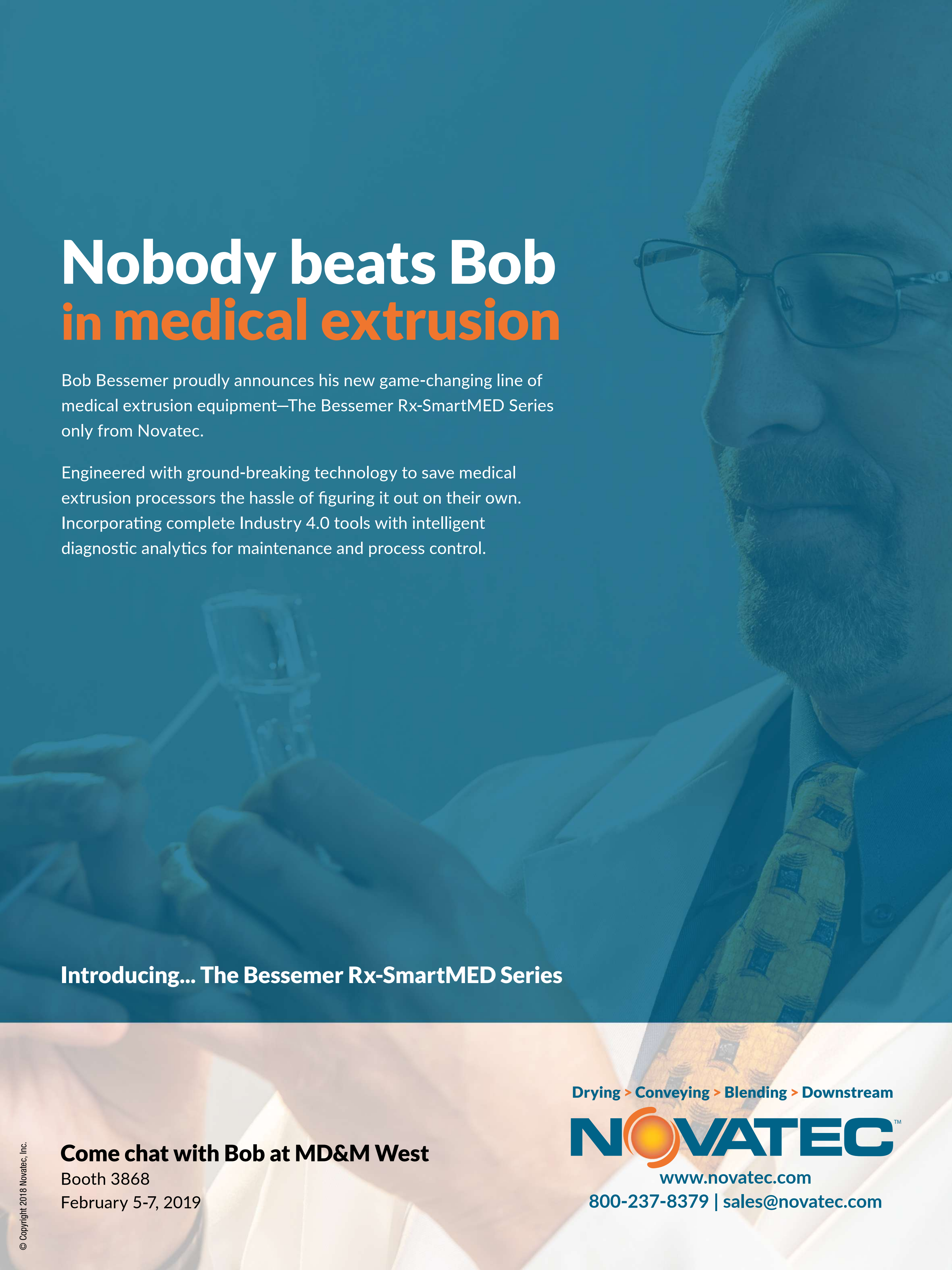
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Bob Bessemer proudly announces his new game-changing line of medical extrusion equipment—The Bessemer Rx-SmartMED Series only from Novatec.
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Plastics Technology

PT Web Exclusives

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

BLOG: Querétaro Makes Mark on Molding Map

Integrity Tool and Mold, featured on page 38, is part of a growing injection molding and tooling scene in the Mexican city of Querétaro—that scene will now include a new event. In 2017 and 2018, *PT*'s sister publication, *Plastics Technology México,* hosted an injection molding conference in the city. This November, it launches a new conference and show catering specifically to tooling and injection molding—Meximold.
short.ptonline.com/Meximold

BLOG: Tip for Measuring Mold Coolant Flow

Every month, *Plastics Technology*'s Processor's Edge feature at the back of the book offers a snapshot of how resourceful processors apply technology to give themselves an edge. This month Executive Editor Matt Naitove checks in with EVCO Plastics. On the blog, EVCO shares a clever hack for measuring mold coolant flow.
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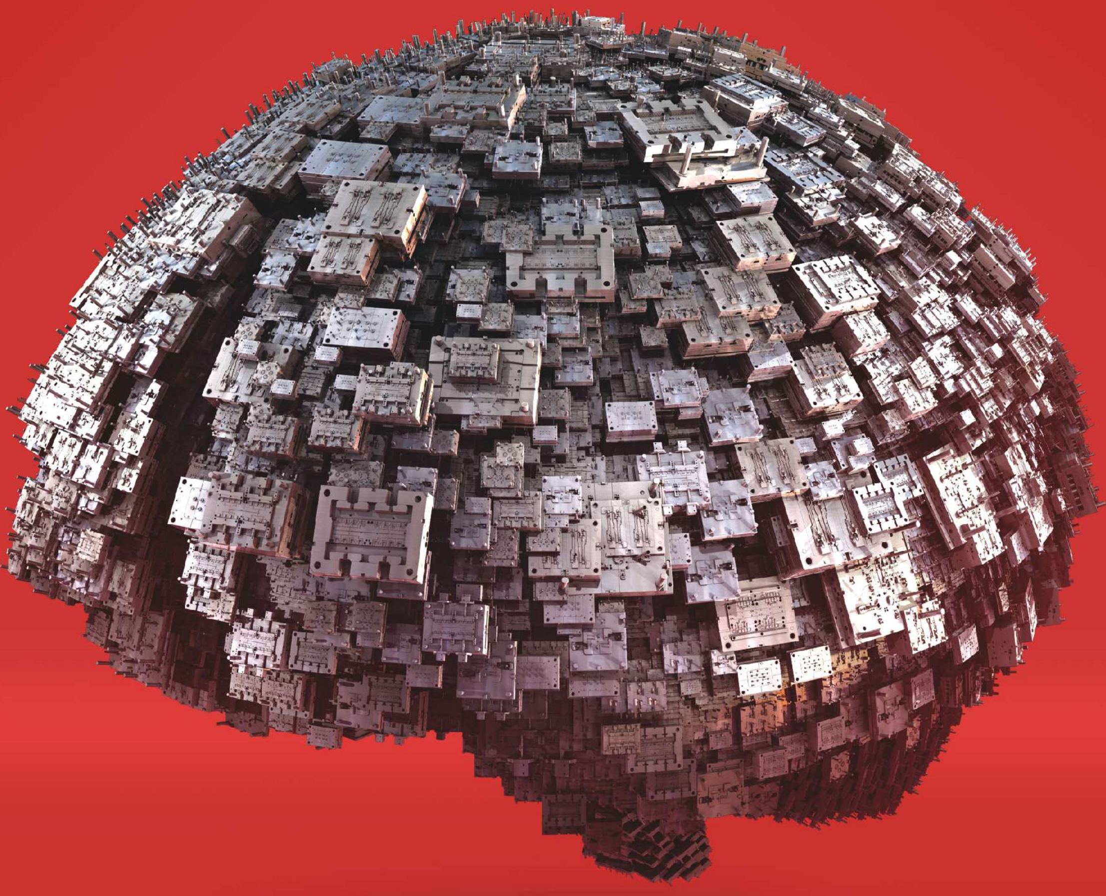

Best of Best Practices in Injection Molding

Fifty expert speakers at *Plastics Technology*'s annual Molding Conference will offer their insights to help you optimize your process.

If I were an injection molder and was told I had the opportunity to mingle with the likes of John Bozzelli, Don Paulson, Suhas Kulkarni, Robert Gattshall, Steve Johnson, and 40+ other top technical minds in the industry, I'd say "Sign me up."

Jim Callari
Editorial Director

Well, you have the opportunity, right now. Molding 2019—the 29th annual Molding Conference—will take place in Indianapolis, March 19-21, at the Hyatt Regency Indianapolis. As usual, it will offer attendees expert viewpoints on new and emerging technologies. But this year's conference, more than ever, is emphasizing presentations exploring "Best Practices" in the most important aspects of the molding process. Two of my colleagues on the *Plastics Technology* editorial team—Executive Editor Matt Naitove and Senior Editor Tony Deligio—have put together a lineup of speakers capable of delivering the goods. This magazine focuses on best practices in each issue—online and in print. Think of the Molding 2019 Conference as the pages of *Plastics Technology* coming to life.

Each morning of the two-and-a-half-day conference, expert speakers will be presenting topics of concern to all injection molders, regardless of the markets they serve or the type of presses they run. These broad-and-deep General Sessions kick off on Tuesday, March 21 with *Best Practices: Molding for Consistent Quality and Optimum Productivity*. On Wednesday, the General Session focus shifts to automation with *Best Practices: Applying Robots & Automation*. On the final half-day of the event, the General Session will cover the mold and temperature control with *Best Practices: Tooling and Cooling*.

This magazine focuses on best practices in each issue—online and in print. Think of the Molding 2019 Conference as the pages of Plastics Technology coming to life.

These general sessions will be preceded by keynote presentations each day. On Tuesday, the focus will be on "tomorrow's smart molding plant," while on Wednesday the discussion will shift to the hot topic of additive manufacturing (3D printing), specifically on the difference between design for AM and for injection molding. On the final half-day, we'll start off with strategies for getting a mold commissioned faster.

In addition to the keynotes, special lunch presentations are planned, including a discussion on changes to R&D tax credits and what they mean for molders, as well as a new metal additive manufacturing technology that promises "the fastest way to hardest parts."

Beyond the general sessions, Molding 2019 will break into focused concurrent tracks in the afternoons, based on technology, end markets and special focus areas. These include:

- Medical, Packaging & Precision Molding;
- Medium & Large Parts Molding for Mechanical Performance & Aesthetics;
- LSR Molding
- Technology for Today's Molders;
- Preparing for the New Era of Digital Manufacturing.

Molding 2019
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PT A Plastics Technology Event

In addition to the technical program, attendees will be able to mingle with more than 50 suppliers in the tabletop exhibit area.

A special discounted nightly rate of $169 plus taxes has been secured at the Hyatt Regency Indianapolis for conference attendees. Attendees who register before February 15 will receive an early-bird discount, saving $200 on conference registration fees.

Learn more about this one-of-a-kind event at ***moldingconference.com***.

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Bill Carteaux Passes Away

Early on the morning of December 10, William R. (Bill) Carteaux, president and CEO of the Plastics Industry Association (PLASTICS), passed away due to complications from acute myeloid leukemia (AML). He was 59. The PLASTICS board has asked CEO Patty Long to step in as interim President & CEO.

Carteaux was diagnosed with AML in 2016 and underwent multiple rounds of chemotherapy and a bone-marrow transplant. The disease went into remission, before recurring in July 2017 and again last November.

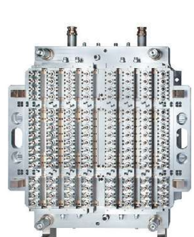
Carteaux took charge of PLASTICS in February 2005. Under his direction, PLASTICS and its biggest event, NPE, underwent tremendous change, including a name change from the Society of the Plastics Industry, and the decision to move NPE from Chicago—its home since 1971—to Orlando, Fla., in 2012.

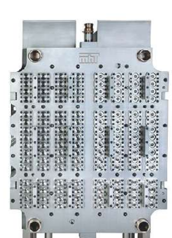
Carteaux also sought to raise PLASTICS' stature as an advocate for the industry, pulling together different groups and companies within the industry to collaborate on combatting anti-plastics information and legislation, including work against bag bans and efforts to curb plastics debris in the oceans. He also sought to bring national plastics associations together for the benefit of the global plastics industry, most recently working alongside Canada's and Mexico's trade associations to present a united front on the renegotiation of NAFTA.

Prior to leading PLASTICS, Carteaux held leadership positions at multiple plastics machinery manufacturers, including as president and CEO of Demag Plastics Group (1998-2005) and president of Autojectors (1990-1998). Carteaux earned a BS from Purdue University in 1984 and an MBA from Indiana Wesleyan. Carteaux also served on the boards of The Leukemia & Lymphoma Society and the National Association of Manufacturers.

Krones Acquires MHT for PET Tooling

Krones, a major supplier of PET bottle blowing, filling, capping, labeling, handling and packaging systems, has broadened its turnkey capabilities with two recent acquisitions. In April 2018, Krones purchased a 70% interest in Integrated Plastics Systems AG of Switzerland, which provides preform and bottle design and acts as a system integrator for PET preform injection molding systems for the beverage industry. Then, this past November, Krones bought MHT Holding AG of Germany, the parent of MHT Mold & Hotrunner Technology, which builds PET preform injection molds and hot-runner systems.





Newcomer Nyltec Polymers Offers Novel Recycled PET/ Nylon Resin

An engineering compound of a proprietary nylon mixed with 90% recycled PET is newly available from startup company Nyltec Polymers, Marietta, Ga. (***nyltecpolymers.com***). Called NyLester, it reportedly matches the physical properties of nylon 6. It boasts excellent surface appearance and is reportedly suitable for injection or blow molding, extrusion, thermoforming and rotomolding. One customer is running trials in 3D printing. Says company president Patrick Patin, "We blend our proprietary and patent-pending mix of nylons directly with recycled or virgin PET to make NyLester with no additives or chemical processes (just dry hoppers and an extruder). However, NyLester will accept additives, just like nylon 6, for reinforcement etc."

Nyltec is working with an injection molder in China who will feed PET and NyLester masterbatch directly into an injection molding machine, saving time and money. Nyltec aims to sell NyLester to most buyers for $1.35/lb, which is much less than nylon 6.

Austrian LSR Tooling & Systems Supplier Now Represented in U.S.

ACH Solution USA Inc., Sarasota, Fla. (***ach-solution.com***), is the new exclusive North American representative for ACH Solution GmbH of Austria. General manager of the U.S. company is Steven Broadbent, who has over 25 years in the rubber industry, including more than 10 years as technical sales engineer for thermoset molding systems at Engel Machinery Inc.

ACH Solution builds LSR molds with cold-runner valve-gate systems, including the company's ServoShot system that allows digital setting of different pin-opening positions for flow control (see March Keeping Up for details). ACH Solution also makes automation solutions for LSR molding and secondary operations; it also supplies MiniMix and MaxiMix dosing pumps and complete turnkey LSR molding systems.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R&B Expands Blow Molding Portfolio

R&B Plastics Machinery is broadening its range of blow molding machinery through an alliance with firms in Taiwan and South Africa. R&B already supplies shuttle, wheel and reciprocating-screw extrusion blow molders as well as injection-blow machines. Now it is offering for the first time all-electric shuttle machines (pictured) and hydraulic accumulator-head models, both built by Sika Machinery Co. in Taiwan, incorporating designs from Seecor Blow Moulding Solutions (***seecor.com***) in South Africa. Sika is a custom machine builder that has been making machines for Seecor for some time. Machines for North America incorporate R&B technology and engineering.

Sika produces systems and components for the new R&B Sika Shuttle line (RBS Series) and accumulator machines (RBA Series) and ships them to R&B in Saline, Mich., for assembly and customer trials. R&B maintains all detailed drawings of the machines and provides service and spare parts in North America. R&B has already sold several all-electric shuttles in the U.S. They come in single- and double-sided models with strokes from 350 to 1250 mm. Hydraulic and hybrid versions are also available. Accumulator models can mold parts from 5 to 500 gal.

Continuous Compression Molding Challenges Injection for Optical Parts

It's not just for bottle caps anymore. Besides a recent move into single-serve coffee capsules, the continuous compression molding (CCM) process from SACMI of Italy is now being developed for optical parts such as lighting lenses, advanced instrumentation and automotive parts. SACMI is working with Polyoptics, a German producer of plastic optical systems and components, and the German research institute KIMW in Lüdenscheid. The project reportedly has yielded excellent lab samples in cycle times significantly shorter than with injection molding, says SACMI.

SACMI builds CCM systems in which a plastic profile is continuously extruded and cut off into blanks that are automatically deposited into individual compression molds that move continuously on a conveyor. This process offers independent control of each mold and flexibility in number of molds being run. Lab tests have shown that CCM can use the same polymers—PMMA and PC—used by Polyoptics for injection molding optical parts.

Software Offers Three New Capabilities for 3D Printing

Three new software products offer MES capabilities, process simulation, and economic feasibility analysis for additive manufacturing (AM), also called 3D printing:

• Agile Manufacturing Execution System is an MES (manufacturing execution system) product designed specifically for AM. It automatically recommends production schedules in direct integration with parts orders. Using delivery dates and production specs, the system classifies parts for jobs based on production priority and machine availability. It comes from 3YourMind in Germany (U.S. office in San Francisco; ***3yourmind.com***).

• Another new product from 3YourMind is AM Part Identifier software that automatically checks a parts economic potential for 3D printing. AMPI searches large databases of existing AM parts to detect whether a new design is technically and economically suitable for AM based on material selection, quality and production requirements, and/or CAD specifications.

• New Simcenter 3D AM Process Simulation from Siemens PLM Software (U.S.office in Alameda, Calif.; ***plm.automation.siemens.com***) helps predict distortion and shrinkage during 3D printing of metals and helps avoid these issues by automatically generating a compensated CAD model. The new program is fully integrated within Siemens' NX CAD software and is based on the powder-bed fusion process for metal printing.

Sidel Acquires PET Packaging Designer & Moldmaker

Sidel Group of France has acquired PET Engineering Srl of Italy, which designs and prototypes PET preforms and bottles and also builds PET blow molds. Sidel says this acquisition diversifies its packaging services portfolio. Adds PET Engineering CEO Moreno Barel, "PET Engineering is perfectly established to help Sidel expand its packaging offering—especially regarding design of containers for water, soft drinks, liquid dairy products and beer."

Davis-Standard Buys Thermoforming Machine Builder TSL

Extrusion machinery maker Davis-Standard LLC (D-S) now can offer sheet processors a turnkey system that includes thermoforming, since D-S acquired Thermoforming Systems LLC (TSL) of Yakima, Wash. TSL builds thermoforming machinery for food packaging.

OnRobot Opens U.S. Office In Dallas

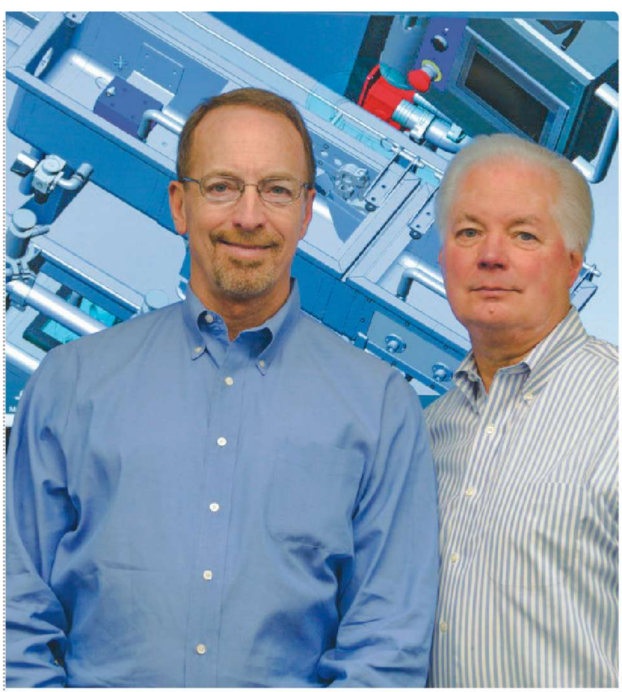
OnRobot, a Danish manufacturer of electric grippers for collaborative robots, has opened its first U.S. headquarters in Dallas. The company (***onrobot.com***) supplies hardware and software for cobots from Universal Robots, Kuka, Fanuc and Yaskawa (see April Keeping Up). OnRobot recently acquired another Danish maker of cobot EOAT, Purple Robotics (see July Keeping Up).

Downstream System 'Rewrites the Rules' for Medical Tubing Extrusion

Extrusion downstream expert Bob Bessemer joins Novatec to enter medical tubing market with innovative line of tanks and puller/cutters.

By Jim Callari
Editorial Director

At next month's MD&M West Show in Anaheim, Calif., Novatec will take the wraps off a new line of downstream machinery aimed at tight-tolerance, microbore medical tubing. Water tanks, vacuum tanks, and puller/cutters feature an array of altogether new features that will be offered as standard and priced competitively. Novatec will be exhibiting its new product offerings in Booth 3868 in the Plastec West section of the show, to be held Feb. 5-7 at the Anaheim Convention Center.



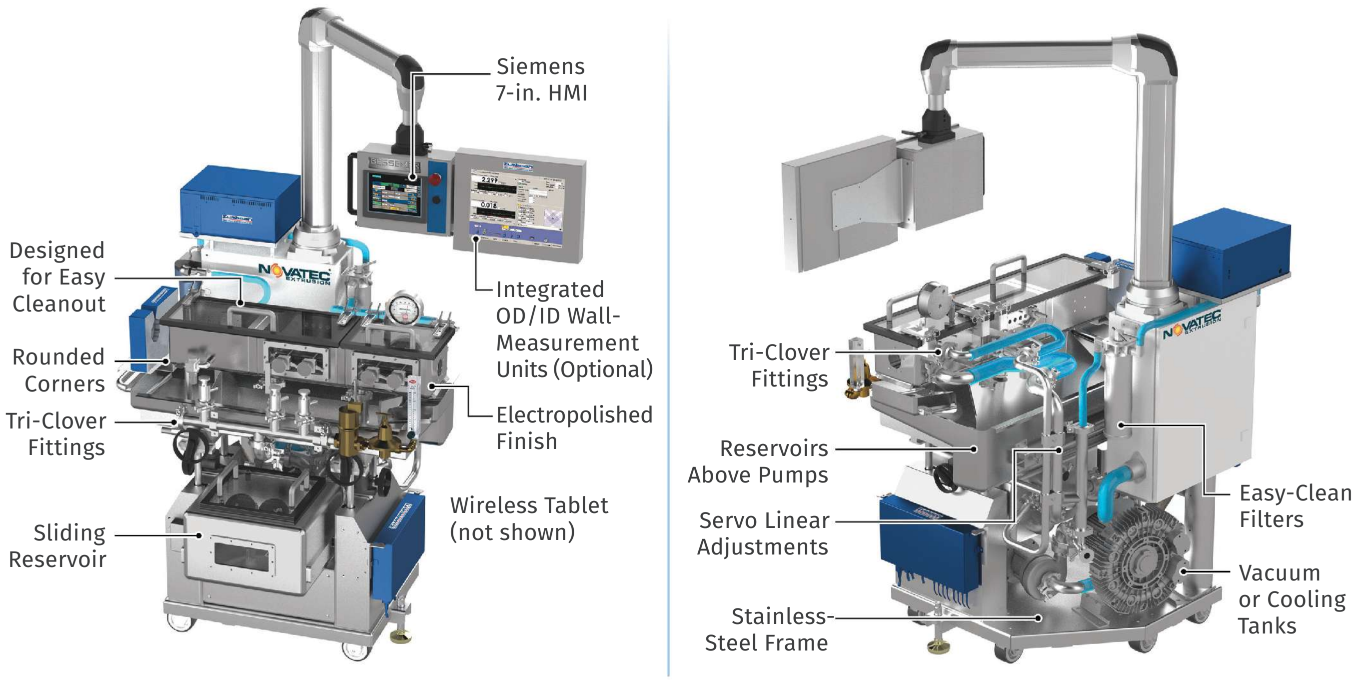
Bessemer brothers Bob (l) and Conrad lead Novatec's charge into downstream systems for medical tubing.

With roots in downstream extrusion technology that go back to the late 1970s, Novatec president and CEO Conrad Bessemer diversified the firm—known mainly for conveying, drying and predictive-maintenance technology—into the business of downstream extrusion machinery in 2012. Since then, the company's Bessemer Series has targeted primarily non-medical pipe, profile and tubing applications. Novatec's foray into medical was spearheaded by the appointment in August of Bob Bessemer as v.p. of extrusion technology. Bob, the younger of the Bessemer brothers, has a long career innovating downstream systems for medical and other markets. One example was the introduction of the first-ever servomotor-controlled cutter. Bob Bessemer joined Novatec following a 25-yr stint at Conair, where he was most recently senior technical advisor for downstream extrusion. By spring of this year, the younger Bessemer says Novatec will have a fully operational extrusion/development lab at its Baltimore headquarters for both internal equipment and process development and customer trials.

"Tri-clover fittings and valves are standard in the wine, beer, and dairy industries, but not for tanks that produce catheters for the heart and brain."

"We felt it was about time to rewrite the rules that have governed downstream extrusion systems for medical tubing," says Bob Bessemer. "There have certainly been incremental improvements made to this equipment over the years, but what we are bringing to the market are game-changing ideas that are intended to replace a lot of the 'black art' I see regularly with science. I've been out in the field in the 36 years I've been in this business, and I've seen lots of customers with the same kinds of problems. So, I started with a clean slate, considered the problems and issues I have seen at medical-tubing plants over the years, and set out to engineer the very best tank, puller, and cutter for medical tubing that address these issues. We're offering many brand-new features as standard because we think they are vital to the process. You can't get into this market in a meaningful way with a product line that is 'as good' as what's already out there. It will be our plan—starting with this series—to be dramatically better, and at a better price."

Throughout the product-development cycle Bessemer consulted regularly with "elite" processors such as Larry Alpert,



New line of Bessemer Rx-SmartMED Series tanks (front and back views) for medical tubing include a range of new features. The tanks are built of 304-L stainless steel, with all contact surfaces electropolished to reduce biofilm formation. Tank corners are rounded, and all water-contact surfaces are TIG welded.

a long-time medical-tubing executive who now runs his own consulting company, Med1Extrusion. Says Alpert, "Bob has been at the forefront of a lot of developments in this area, but I've been bugging him awhile about things I felt were necessary improvements that needed to be made from the aspect of the user."

Dubbed the Bessemer Rx-SmartMED Series, the new line includes water and vacuum tanks that will be available initially in 3-, 5-, and 8-ft lengths. The tanks will be built using 304-L stainless steel, with all contact surfaces electropolished to reduce formation of biofilms. To facilitate cleaning, the corners of the tank will be rounded, even on inside chamber bulkhead plates. All water-contact surfaces will be TIG welded, the preferred welding method for food and beverage applications. Threads exposed to the process water have been "almost completely" eliminated, says Bessemer, by the use of 316 stainless steel tri-clover fittings and valves. "These fittings and valves are a standard in the wine, beer, and dairy industries, but not for tanks that produce catheters for the heart and brain? That didn't make sense to us, so these will be standard on the Novatec tanks."

"You can't get into this market in a meaningful way with a product line that is 'as good' as what's already out there.'"

In fact, Bessemer adds, he has seen cases over the last three years where a medical tubing processor bought a tank, only to disassemble it and add tri-clover fittings on its own.

Water input to the tank has been improved to allow proper water circulation while minimizing water turbulence. A new diffuser has been developed to improve the water entry. All threads have been removed from the rotary water-level device.

The roller system has been designed without threads exposed to the process water while allowing external adjustment of roller height. The rollers can be mounted without need of tools and can be adjusted to either roll or be fixed, as needed.

A reservoir system is designed for ease of draining/flushing, which is very common for medical tanks. This reservoir has been incorporated into the full-length splash tray, again with all rounded corners to ease cleaning. Situating the reservoir above the water pump is said to improve the speed of tank cleaning/flushing. Notes Bessemer, "Typically, tapwater tanks have the water tested on a weekly, if not daily, basis. And tanks with deionized water are typically tested on a monthly basis. In either case, if they fail the water testing, the tanks must go through a bleaching/chorine-flushing procedure. That is very time consuming, taking many hours to perform. In fact, this painfully slow process is even why some medical-tubing processors avoid vacuum systems,

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because they have twice as many hoses as a regular tank and take even longer to clean. With our new system, you turn on the water pump, open the tri-clover three-way valve, and use the water pump to drain the water from the entire system."

The water pump is made of 316 stainless steel—another standard feature—and can be taken apart and cleaned with ease during flushing. The water pump is mounted on vibration dampers to minimize tank vibration. It's positioned below all reservoirs to enable total draining while eliminating cavitation. An inverter is supplied as standard, allowing the pump to run at half speed, which keeps it always operational, to minimize water stagnation and thus further extend the time between flushing procedures. A three-way valve enables the water pump to empty the system entirely to enhance the flushing procedure.

> ***"Operators measure the hot gap and typically have used a hand-wheel to move the tank back and forth. We've made all of that unnecessary with the tablet."***

Filtration is provided in series with 5, 2, and 0.5 microns, and a UV filter is furnished standard.

The base frame also comes standard in stainless steel to make cleaning/wipe-down easier. Stainless-steel casters with non-marking urethane wheels make it easier to move the tank in a cleanroom.

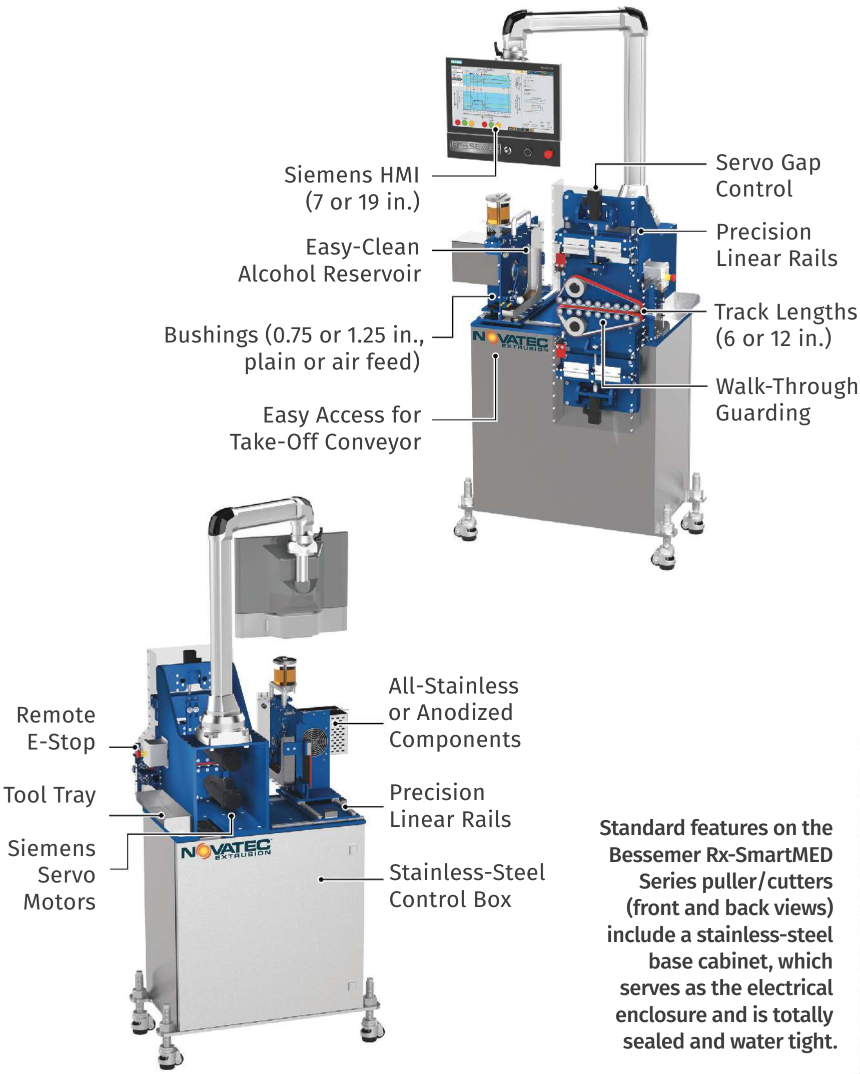
VACUUM OPTION

With the addition of a vacuum system, these tanks can be used for non-contact or contact vacuum calibration with vacuum levels up to 130 in. of water as standard. The regenerative vacuum unit operates below 75 db even at maximum vacuum levels. The standard closed-loop system controls vacuum to 0.01 in. of water with a fully automatic vent-valve system to maintain the vacuum pump within its optimum CFM curve, thus optimizing performance and vacuum stability. With this precision vacuum stability, water drool can be eliminated (if necessary) to optimize tubing concentricity and/or ovality. Customized tooling will be available to further enhance this process with a new tool-less and thread-less mounting system.

The controls even incorporate a servo-driven linear actuator to enhance repeatability of the gap between the hot die and tank. A handheld, wireless tablet is used for this operation, which includes a recipe to record previous settings. "The distance from the hot face of the die to where the tube first enters the tank—known as the hot gap—is a validation point," Bessemer explains. "Operators measure that and typically have used a hand-wheel to move the tank back and forth. We've made all of that unnecessary with the tablet." A digital water-temperature readout is also available as standard. An optional water-temperature control unit can be added to allow control within 1° F.

MICRO MEDICAL PULLER/CUTTERS

Downstream of the tank, the new puller/cutters represent what Bessemer calls "an attempt to enhance the operation and update features to what we believe should be the standard for processing of medical tubes, especially for heart and brain devices and difficult-to-process materials with extremely thin walls." The units will be offered with either a 6- or 12-in.-long puller assembly. The cutter with be available in either a 0.75-in. or 1.25-in. OD bushing size. Standard features include a stainless-steel base cabinet, which also serves as the electrical enclosure and is totally sealed and water tight. Urethane non-marking casters are said to be ideal for use in a cleanroom and come furnished with an integrated locking device to improve ease of moving from line to line without need to raise and lower the unit to transport it.



Standard features on the Bessemer Rx-SmartMED Series puller/cutters (front and back views) include a stainless-steel base cabinet, which serves as the electrical enclosure and is totally sealed and water tight.

Also standard on the puller is a servo-actuated belt-gap system, which Bessemer believes will eliminate the operator variable of manually adjusting belt gap, and the variable slippage that ensues. This unit has been designed for use in a cleanroom; its bearings require no grease or lubrication to help minimize particulate generation, Bessemer notes. Linear slide bearings ensure that the upper and lower belts are perfectly parallel, which is especially critical when processing thin-wall medical tubing, instead of typical round bushings and shaft assemblies. The belts are precision flat belts, which Bessemer maintains are far more accurate than typical Poly V belts or any timing belts, including herringbone style.

"Flat belts not only run with far less heat, but also generate no particulates and require no flanges," Bessemer explains. A precision tensioning and tracking system has been designed to offer precision tracking plus ease of belt changes. These units will come with three different belt-covering materials as (three sets of belts) as standard, which will allow processors to use the most appropriate belt per application. The pullers are all dual-servo driven, with in-line planetary reducers offering the most precise speed control possible. All plates in the puller and cutter are anodized aluminum with all stainless-steel shafting and hardware to eliminate corrosion.

The cutter is designed to enhance blade surface speed with the proper cutting radius, achieving on-demand maximum blade speeds up to 1500 rpm. This will ensure minimal cutting interruption and allow slicing blades to be used to cut even the smallest, lowest-durometer, thin-wall medical tubing.

The cutting chamber is made of clear polycarbonate, making it easier for operators to see blade wear and particulates while facilitating blade gapping. The bushing has been moved to a 45° angle—instead of directly under the servomotor—to make it easier for operators to see the cut tube while allowing utilization of a stainless-steel drip tray. Moreover, the blade guard slides to the rear and does not need to be fully removed, making it easier for the drip tray to be regularly cleaned. An air-feed cutter bushing will also come standard. Cutter bushings are bolted together as a standard feature to eliminate the possibility that the operator will improperly gap them.

NOVEL SOFTWARE PACKAGE

Novatec is offering as an option a taper/bubble tube package developed by Larry Alpert. The software is designed to take all the guesswork out of selecting the proper die size to produce the desired tapered tube. Using a 19-in. touchscreen computer that communicates with Siemens PLCs, operators are guided through a series of dropdown menus where they can select material type (12 choices), durometer, extruder size, die size (if available), desired throughput, tube dimensions and shape (symmetrical or asymmetrical), number of lumens (up to eight) and more. From there, the software will advise the operator if the die size selected can make the tapered tube and will make suggestions if it cannot. Operators can also pick from a number of pre-programmed velocity profiles (linear, various "S" curves, and others) or create their own. Due to the large screen, the graphs will display the profiles as they are being tested. Notes Alpert, "I've always been a proponent of what I call the 'technician's cockpit.' That's why I suggested the large-screen PC. A medical-tubing line is compact, and all controls must be within arm's length of an operator so they don't have to move their feet, and must have the right ergonomics.

"A medical-tubing line is compact, and all controls must be within arm's length of an operator."

Bessemer describes this product launch as "Phase 1," noting that Novatec plans to introduce new products every quarter.

Why Blow Molders Are Switching to EPET

High clarity, easy incorporation of handles, and recycling resin code No. 1 are the principal drivers for converting to EPET resins for extrusion blow molding.

Key early successes for EPET bottles are in orange juice, such as Simply Orange, converted from PETG for superior recyclability; and Tropicana, converted from HDPE for superior clarity.

By Lilli Manolis Sherman & Matt Naitove
Senior Editor & Executive Editor

A shifting market preference for extrudable PET (EPET) versus PETG copolyester in order to make extrusion blow molded (EBM) clear bottles that can be recycled with the standard PET stream appears to be gaining momentum. The recycling issue was given a major push by the State of California in October 2017, with the passing of Assembly Bill 906, which revised the state's definition of PET to exclude PETG—essentially barring products made from the glycol-modified copolyester from using ASTM resin identification code (RIC) No.1 ("PETE 1"), in order to prevent contamination of the post-consumer recycle (PCR) PET stream.

The bill, which could have broad impact beyond California's borders, officially went into effect Oct. 1, 2018, with PETG products now falling under RIC No.7, defined as "Other," which includes materials made with more than one resin from categories 1-6.

Another contributing factor is the growing popularity of clear handleware containers, especially for orange and other juices, as well as ready-to-drink (RTD) teas. EBM can mold integral through-handles, unlike stretch-blow molding of conventional PET.

Large handleware containers, particularly for dishwashing and laundry detergent, are targeted market segments, according to DAK Americas.

"Extrusion blow molding of clear bottles integrating a true through-handle and that can carry the 'PETE #1' resin symbol for recycling with PET has long been a packaging goal for consumer-products groups," says Joe Slenk, applications engineer at EBM machine builder Bekum America.

One recent success story for EPET has been orange juice, such as Simply Orange, a Coca-Cola Co. brand, which converted from PETG for recyclability. The first big EPET conversion was the 89-oz Tropicana orange-juice jug from Pepsi, which converted, not from PETG, but from white opaque HDPE several years ago in order to take advantage of the crystal clarity of PET. Industry sources also point to EPET conversions from PVC in non-beverage products for improved recyclability.

The resulting market shift has been assisted by the two main domestic suppliers of EPET resin, DAK Americas and Indorama Ventures. They have developed high-melt-viscosity EPET grades for EBM with hang strength, toughness, and reduced crystallization rates.

High-viscosity EPET grades have been developed with hang strength, toughness, and crystallization rates suitable for EBM.

The inherent challenge of parison formation with PET's poor melt strength (or "hang strength" in EBM) originally resulted in the development of EBM-grade copolyester resins, such as PETG, first introduced over 30 years ago. "Unfortunately, copolyester materials are not readily managed in the established PET recycle infrastructure due to their lower drying and melting temperatures," says Bekum's Slenk.

George Rollend, technical fellow at DAK Americas in technical marketing development, notes that over the years, container recyclers have had major processing issues with a relatively small percentage content of PETG present in the bottle recycling stream. "This is due to the substantially lower melt point of PETG vs PET," he explains.

"During recycle processing, the lower-melting amorphous PETG begins to stick to the conventional bottle-grade PET within the recycle stream, causing agglomeration and clumping of the total stream. This causes interruptions in the process, and makes it impossible to achieve a quality recycle product. As a result, PETG is considered a contaminant by recyclers, and there is a movement to eliminate PETG from carrying the No. 1 recycle code on containers." ►

Traditionally, bottle-grade PET lacked the melt strength and slow crystallization necessary for use in EBM applications. Within the last six years or so, improved EPET resins hit the market. One example is DAK's Array EBM with enhanced melt strength. Another is Polyclear EBM from Indorama, described by new-business development manager Frank Ebbs as designed for clear, high-gloss EBM containers with or without handles that offer improved drop performance and can be recycled with the clear PET PCR stream with no detrimental effect.

Similarly, Eastman Chemical, a major PETG producer, launched Aspira One for EBM in late 2012. It is a proprietary copolyester designed specifically for compatibility with recycling code No. 1 PET. When asked to comment on industry rumors that Eastman may exit the EBM resin business, the company's global business manager, Brad Potter, told *Plastics Technology*, "Eastman remains committed to the EBM container market and to meeting the industry's evolving requirements. PETG continues to provide unmatched performance in terms of quality, design flexibility and processability and does not require brands to lower their performance standards. At the same time, we recognize the importance of sustainability to our customers—and to their customers—and so we are actively exploring a range of approaches, including but not limited to mechanical recycling, that will allow them to meet both their performance and sustainability objectives."

Non-handled, wide-mouth jars of various sizes and shapes are being commercialized with DAK's Array EBM resins.

Availability of adequate EPET material to support growing demand does not appear to be an issue. Rollend says, "We think the supply of EPET is more than sufficient to meet the current demand at this point in time." Indorama's Ebbs agrees.

HOW BIG IS EPET'S POTENTIAL?

DAK's Rollend pegs the current EPET market size in the range of 100 million lb/yr. He sees opportunities in large handleware (greater than 60 fl oz), particularly in dishwashing and laundry detergents. Agricultural chemicals and automotive fluids also beckon. Non-handleware applications include wide-mouth jars and some narrow-neck bottles. "Non-handled, wide-mouth jars of various shapes and sizes are being commercialized with DAK's Array EBM resins. These include jars for jams and jellies; liquor flasks of 100, 200, and 375 ml; and tall wide-mouth jars." He also points to future opportunities in personal care (health and beauty aids), nutritional supplements, pharmaceuticals, and niche food and beverage products.

Indorama's Ebbs anticipates that EPET will win market shares in juice, tea, nectar, water, olive oil and laundry detergents. He says the initial applications were juice and tea in containers with handles. "The newer applications are household, food and water packaging."

Rollend cites a number of factors in favor of EPET over PETG for consumer packaging. One is its relatively low cost: "DAK Americas' Array EBM product was developed as an EPET formulation with significantly more melt viscosity at affordable costs." Another is greater tolerance for recycle. He says that most PETG polymers cannot meet the rigors of a 25% and 50% recycle loading, as called for in the "Critical Guidance" document from the Association of Plastic Recyclers (APR), whereas DAK's EPET is optimized for regrind use up to 50% or more. Moreover, Rollend notes that machine builders have learned how to deal with the idiosyncrasies of higher-viscosity EPET materials on existing EBM wheel and shuttle machines.

Notes Bekum's Slenk, "We have been developing the technology to run EPET for years and now have over a dozen machines currently running fully automated, round-the-clock production of PET handleware bottles. This trend is continuing, as we have several new machine orders for EPET applications."

Other points cited by Rollend:

- Brands have begun to encourage EPET use by reducing their performance specs—notably in drop impact. If you have a secure handle, the container is less likely to drop.
- EPET has melting properties similar to stretch-blow PET resins.
- EPET crystallizes, so it can be reprocessed in standard PET crystallizing and drying equipment.
- EBM tooling is typically less expensive than preform injection and blow tooling for the PET stretch-blow molding process.

HOW DOES PROCESSING EPET COMPARE WITH PETG?

Sources at EBM machine builders—such as Slenk at Bekum; Bill Farrant, president of Kautex Machines; and Bob Jackson, president of Jackson Machinery, which represents Hesta Blasformtechnik of Germany—are in substantial agreement on the processing similarities and differences between EPET and PETG, and the consequent implications for machinery selection. Processing temperatures for EPET are much higher—over 500 F, vs. around 400 F for PETG. At the same time, it's important to keep EPET melt temperatures as low as possible to maintain melt strength. According to Slenk, "Hang strength is a challenge with this material, and parison formation becomes difficult if it's too hot."

One answer, machine suppliers agree, is to limit screw rpm and thus shear heating. That can limit throughput, so an EPET EBM machine could benefit from a larger extruder or one with longer L/D than a PETG machine. Hesta, for example, offers both 24:1 and 32:1 screws for its machines. Head design is also important to prevent overshearing the melt, Slenk points out. DAK's Rollend adds that screw design is most critical in processing EPET with high levels of regrind, in order to prevent surging and consequent tail-length variation that has a strong influence on overall container wall-thickness control.

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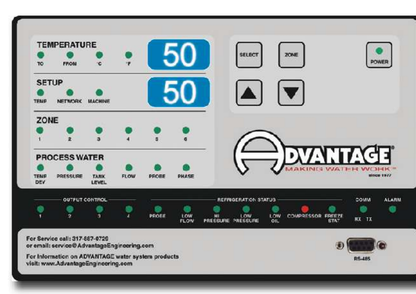

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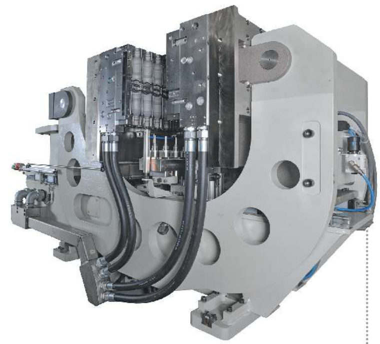
Despite higher melt temperature than PETG, cycle times with EPET are said to be similar because it sets up faster.

Another key consideration, several sources agree, is a need for higher clamp force for EPET in order to get a good pinch-off. Exactly how much more force may be required appears to be a subject of debate, though a ballpark of 20% was suggested by one machinery OEM. Jackson notes this is influenced the boosting of clamp force from 32 tons to 44 tons on Hesta's newest and largest all-electric EBM machine, the Hesta 900.



Higher clamp force and uniform force distribution are important to achieve a good pinch-off in EPET extrusion blow molding. Bekum's C-clamp, shown here, has been successful in this application.

Slenk says uniformity of clamp-force distribution is perhaps equally important, and cites that as one reason the C-Frame clamps on Bekum machines have been very successful in EPET applications.

EPET may not be a drop-in for PETG with regard to tooling. Some modifications for sharper pinch-off may be required. Rollend suggests that EPET molds may benefit from deeper flash pockets, sharper knives, prouder edges, and steeper angles.

He adds that drying requirements for EPET are very similar to those for standard bottle-grade PET, which typically are more intensive than those for PETG.

Equipment suppliers point out that all of the above considerations assume even greater importance when it comes to converting from non-polyester resins, such as HDPE or PVC, to EPET.

2019

MATERIALS

PART 1 Heat Deflection Temperature vs. Dynamic Mechanical Analysis

Does the industry need a better way of reporting the temperature-dependent behavior of plastics? With DMA, it already has one. But it's been glacially slow to catch on.

By Mike Sepe

Twenty years ago, a session at the Society of Plastics Engineer's annual technical conference (ANTEC) was devoted to reviewing standard methods used to measure plastic properties that are customarily provided on a material data sheet. The objective of the session was to scrutinize the way we have always done things and propose alternative approaches where appropriate. The proceedings were published as a standalone work and the presentations made the rounds during that year to other organizations, including the Society of Automotive Engineers (SAE).

I made a presentation in that session devoted to the property of deflection temperature under load (DTUL), also known in the industry as the heat deflection temperature (HDT). In that paper I suggested that the industry needed a better way of reporting the temperature-dependent behavior of plastic materials. The alternative method I proposed is known as dynamic mechanical analysis (DMA).

Twenty years later, questions are still being posted on various industry sites about the relative utility of HDT vs. DMA. Most of the answers to these questions suggest a lack of familiarity with DMA and a comfort level with the way we have always done things—which, given the stakes, is somewhat disturbing. The test for HDT was developed in the early years of plastic testing and it is not difficult to see how it would have been considered useful 40 or 50 years ago. If there is an interest in identifying a temperature range where a material might fail, placing a beam of that material under some type of load and then raising the temperature until the material softens or melts appears to make sense.

Little was expected of plastic materials at that time. The concept of plastics as engineering materials was just beginning to enter the conversation within the industry and the general public still thought of these materials as suitable only for toys, straws, and low-end housewares, despite the fact that nylon and polyester were well established and polymers like acetal, polycarbonate and polysulfone were coming into their own. Today we make parts for medical devices, cars and trucks, and the aerospace industry. Metal replacement occurs often; and even applications that were pioneered in the 1960s, such as plastic gears, are achieving greater precision and higher power ratings than were considered achievable even 10 years ago.

> ***What possible relevance can measurements of elevated-temperature performance have when they are made at stresses that are less than 10% of those at which we plan to use our parts?***

With this increased sophistication, it would be expected that engineers and designers would need a more complete picture of the temperature-dependent behavior of plastic materials. But almost all the information available on the effects of elevated temperatures remains limited to a measurement of HDT. The problem with this narrow view of polymer behavior is that very few engineers and designers understand what this test is measuring.

I once received a part drawing that called out a particular grade of flame-retardant ABS. A note on the drawing stipulated that the part was to withstand continuous exposure to a temperature of 190 F (87 C). The requirement was unrealistic, particularly because the time frame associated with "continuous" was not defined, and the number looked suspiciously familiar. A check of the data sheet showed that this temperature was the published HDT. It took a long conversation to explain to the ►

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engineer who had written the requirement that the HDT could not be treated as a representation of long-term elevated-temperature performance.

Like most properties provided on a datasheet, HDT defines what does not work; it tells us nothing about what a material can do. This was stated very plainly by a representative from a material supplier many years ago when he told attendees at a technical session, “Just remember, if there is a number on the data sheet, something bad happened at that point.” Tensile strength is quoted at yield or at break, outcomes that we never want to experience in the real world. Impact resistance provides the energy needed to break the test specimen. And HDT defines the temperature at which a molded test specimen of a very specific geometry undergoes a certain degree of bending when placed under a given stress.

Dynamic mechanical analysis (DMA) has been proposed as a more valid alternative to HDT for at least 20 years. Today’s more critical engineering applications for plastics make a change all the more urgent. (Photo: DMA 850 from TA Instruments)

The stresses used under the ASTM protocol are so low as to be laughable: 66 psi (0.455 MPa) and 264 psi (1.82 MPa). A few months ago, I received a call from a university professor who had been asked by a client to perform the HDT test. He was unfamiliar with the procedure and when he calculated the amount of force that would be needed to achieve the required stress, the value he obtained was so low that he was convinced he had made an error. But he had not made a mistake; the stresses associated with the test are ridiculously low. I routinely see finite-element analysis (FEA) plots that show maximum stresses of 3000-5000 psi (20-35 MPa). What possible relevance can measurements of elevated-temperature performance have when they are made at stresses that are less than 10% of those at which we plan to use our parts? What would we obtain from an HDT test performed at these higher stress levels?

Almost all the information available on the effects of elevated temperatures remains limited to a measurement of heat deflection temperature.

The folks at ISO have attempted to inject a little reality into the test. ISO 75, the method that corresponds to ASTM D 648, calls out a third stress level of 1160 psi (8.00 MPa). However, it has been slow to catch on. It is not hard to see that as the stress level associated with the HDT test increases, the temperature at which failure occurs will decrease. The magnitude of this decrease will depend greatly upon the material being tested, for reasons that will become evident as we fill in the picture with additional data. But as an example, the HDT of a 15% glass-fiber reinforced nylon 6 is measured at approximately 400 F (205 C) under a stress of 264 psi. At 1160 psi the value will decline to approximately 175 F (80 C).

There is an obvious reluctance on the part of material suppliers to start publishing the lower values, particularly since they know that many people who read data sheets do not look at the fine print that defines the test conditions. In addition, almost all unfilled materials would fail at *room temperature* under this higher stress. If a test designed to measure elevated-temperature performance produces immediate failure at room temperature in thousands of materials when realistic stresses are applied, it raises questions about the utility of the test in general.

So why do we continue to use it? The simplest answer is that we have always done it that way. Or perhaps the industry is unsure of what to replace the test with. As is the case with almost all of the values on a data sheet, they represent points on a curve. Tensile yield strength is a point on a tensile stress-strain curve. Impact resistance is a point on a plot of collected energy over the duration of the impact test. And the HDT is a point at which the modulus of the material being tested declines to a specific point. In an era when we aspire to replace aluminum and steel, the obvious question is: Why not just provide the curve and let the engineers find the point that is of interest to them for their applications? In our next article we will do just that.

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INJECTION MOLDING

PART 2 The Importance of Consistent Fill Time

To make identical parts, you need to keep fill time constant. In part one we covered the why. Here's the how.

Last month, in the first part of this two-part installment, we focused on the reasons viscosity can change during injection molding.

By John Bozzelli

Because viscosity is a variable, keeping fill time constant minimizes the influence of these variations and provides a more stable process and more consistent parts. If driven to the same shear rate, viscosity variations can be minimized to provide a more consistent process. Run to run, shot to shot, summer to winter, and machine to machine—keep fill time the same and your process will be more consistent.

Once you find a fill time that makes good parts, use that fill time for the life of the mold. So how do you maintain that fill time? There are differences of opinion in the industry. Some processors feel it is their job to adjust for viscosity changes. However, is it really possible, plausible—or the right strategy—to expect an operator to stand at the machine adjusting for viscosity variations? I prefer the strategy where the machine automatically adjusts for changes in viscosity, something like a car on cruise control. If you set up a machine correctly, it will provide consistent fill time. For most processes and machines, I target less than ±0.04 sec of variation. This does not apply if you have a fill time of 0.06 sec or a long fill time, so use common sense in establishing this range. Dare I say it: Do a DOE!

Run-to-run, shot-to-shot, summer-to-winter, machine-to-machine, keep fill time the same and your process will be more consistent.

Any machine—open- or closed-loop, electric or hydraulic—will keep fill time constant, provided that it is set up with an appropriate Delta P. Delta P is the difference between the set first-stage pressure available and the peak pressure during injection or first stage. This, in combination with the required "load-compensation" circuit, will attenuate viscosity changes.

To find the appropriate Delta P for each machine (yes, they do vary), you need to find how much higher the set or available pressure for first stage should be than the actual peak pressure

Delta P Data for an Hydraulic Injection Molding Machine

Shot No.	Set Pressure psi or bar	Fill Time sec	Peak Pressure psi or bar	Delta P psi	
1	1200	1.50	1156	44	Bad
2	1300	1.39	1229	71	Bad
3	1400	1.38	1244	156	Bad
4	1500	1.24	1355	145	Bad
5	1600	1.25	1376	224	Bad
6	1700	1.22	1453	247	Bad
7	1800	1.22	1467	333	Bingo
8	1930	1.22	1460	470	Too Much

during injection. The principle is the same for electric or hydraulic machines. The set or available pressure must be set higher than the peak (not transfer) pressure during injection. Peak pressure can be the same as the pressure at transfer but sometimes it is not, especially if you profile injection. For this procedure you must be able to read peak pressure during fill or first stage. The question is how much higher the allowable or set pressure should be than the peak pressure to allow the machine to control fill time.

THE DELTA P PROCEDURE

A caveat before we get into the nitty-gritty: Do not try this without proper at-the-press training. There are safety concerns for personnel and the possibility of damaging the mold or machine if one does not understand the procedure correctly. This procedure involves using high temperatures and pressures. If at any time, you are unsure of what will happen, stop and seek help.

- Bring the machine to steady-state operating conditions while molding parts and following all appropriate safety practices associated with the operation of the mold and machine selected. Ensure that you can read the peak hydraulic pressure during first stage. This may not be the pressure at transfer, especially if you are profiling injection speeds. Location of the pressure-measuring device, gauge or transducer, should be after the flow-control valve or directly on ►


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the hydraulic injection cylinder (*not* near the pump). For electric machines, use the injection pressure displayed on the appropriate screen. Also, ensure you can measure the time from "injection-start" to when the screw reaches its cutoff (also known as transfer or switchover) position. This time is the fill time. This timer should count up and read to at least 0.01 sec. Ensure the machine is set to transfer from first to second stage via screw position.

- Ensure that the part will not stick if you make a short shot. Make sure the part is not filling during screw rotate. This can happen if the gate-seal time is long and the backpressure is high enough to push plastic into the mold during screw rotate. If a short shot sticks, use mold release or whatever is necessary to allow for easy part removal. Shorts will be made during the entire procedure. This is a maintenance task, not a process-development task.

- Take second stage (pack and hold pressure) off. That is, set second-stage pressure very low—for example, at 15 psi (1 bar) hydraulic or 100 psi (7 bar) plastic pressure. Do *not* set hold time to zero unless necessary. Taking second stage off by removing time on the timer may cause tool damage when you put time back on the second-stage or hold timer.

- Adjust the first-stage allowable timer for at least 3 sec longer than current fill time. This ensures there is always enough time on this timer for the screw to reach its cutoff position *before* this timer times out. For this step and the entire experiment, note: It is critical that *all shots are short,* and you are not bottoming the screw. Damage to the mold, machine and/or operator could result if you do not ensure making short shots with some cushion.

- Note peak pressure during first stage and compare it to the set first-stage pressure limit.

- Decrease the first set pressure limit until you significantly change (increase) the fill time. I target about 1 sec longer if it is not a thin-wall part. Normally this will be about 400 psi (28 bar) below peak pressure noted for the shot in Step 5 for hydraulic machines and about 2500 psi (172 bar) below peak for electrics. Shots will be short, so make sure they can be ejected. In this step, you are purposely running "pressure limited." Note: Some machines significantly overshoot the set first-stage limit or available pressure. That is, the set limit on the controller screen is lower than the actual peak pressure.

- Record first-stage set pressure limit, fill time and peak pressure during injection. See accompanying table.

- Once you are running pressure-limited, increase first-stage pressure limit by 100 to 200 psi (7–14 bar) for hydraulic machines, or 500 to 1000 psi (35 – 70 bar) for electric machines.

Perform a series of short shots to determine the appropriate Delta P for a particular injection machine. Setting that Delta P is the secret to consistent fill time.

- Repeat Step 8 until two criteria are met as you increase first-stage set or allowable pressure: A) Fill time stops dropping and becomes constant; and B) peak pressure stops trending up. That's the appropriate Delta P for that particular machine. Please note that you may not find the correct Delta P, as the machine may not have enough injection pressure available to establish a Delta P. Reminder: For each shot, make sure you are making a short shot with some cushion!

Develop a data table similar to the one here. The shot labeled "Bingo" shows the *minimum* Delta P required for this hydraulic machine. Note that the 333 hydraulic pressure is significantly higher than the typical 10% higher often recommended. In this case it's well over 25%. Moreover, do not get into the habit of ignoring this Delta P by just setting the set or allowable pressure to the machine's maximum. Why? If set pressure is at the maximum or significantly higher than peak pressure on a multicavity tool, and a cavity accidentally plugs due to a cold slug, what will happen? The machine will overpack the remaining cavities, flash a slide, or at a minimum you will have flash to clean up.

Once you have established the required Delta P for a machine, put a note on the controller stating what it is. This makes it easier for the processors. Expecting them to remember Delta Ps for 10, 20 or more machines is insane. Also, you have to check the load-compensation circuit: Check out the end of a column I wrote in 2010 (***short.ptonline.com/evaluate***).

Bottom line: Keep fill time constant to run identical parts. Accomplish this using an appropriate Delta P and having a working load-compensation circuit. Let the machine do the adjusting to keep fill time the same. It is designed to do this, but the machine must be set up properly.

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EXTRUSION

Unraveling the Complexity of Single-Screw Scale-Up

Variables such as shear rates, melting rate, residence time and conductive heating are all influenced in the scale-up.

Scale-up of single screws can be a surprisingly complex issue when you consider all the variables and their interactions. One of the first scale-up rules was defined by Carley and McKelvey in a 1953 article published in the journal, *Industrial and Engineering Chemistry*. They showed that output and power consumption varied with the ratio of the square of the screw diameters $(D_1/D_2)^2$ when at the same screw rpm and channel depth for screws having the same geometry (channel width and flight width).

By Jim Frankland

However, shear rate is determined by the peripheral screw speed rather than the rpm. When compared at the same peripheral speed and the same channel depth, the outputs scale up as the simple ratio of the screw diameters.

The squaring effect of the output comes from the change in channel volume. In the accompanying illustration, a 2-in. and a 4-in. screw have the same channel depth. As the screw size increases, the channel volume increases by the square of the ratio of the diameters. In this case, the volume of one turn of the 4-in. screw was calculated to be exactly four times the volume of one turn of the 2-in. screw.

Maddock...determined that the 0.7 power of the ratio of the screw diameters was a better factor for determining channel depth then the square root of the ratio of the screw diameters.

As a result, the diameter scale-up $(D_1/D_2)^2$ holds true for the same channel depth and screw rpm.

In a 2006 issue of *Polymer Engineering and Science*, an article by Chris Rauwendaal provided a very thorough analysis for all aspects of scale-up, including shear rate, melt conveying rate, residence time, shear, conductive and dissipative melting capacity, solids conveying rate, power consumption, heat transfer, mixing, and specific energy consumption, for a total of 14 different scale-up factors. It's a very comprehensive and accurate analysis but requires an expert to resolve the best balance between scale-up factors.

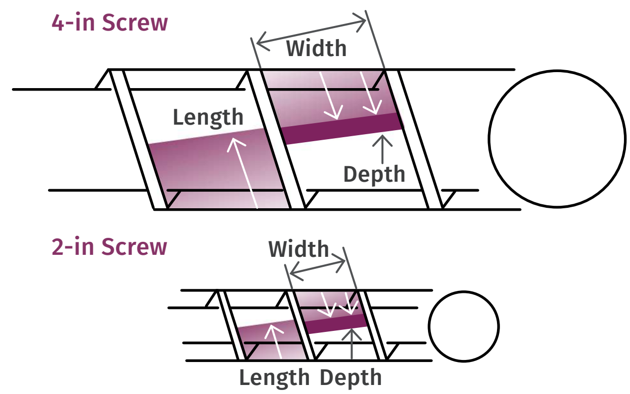
In 1974 I was fortunate to be given a two-week individual training course by Bruce Maddock at Union Carbide's Bound Brook, N.J., development lab. It was common practice at that time to scale up the channel depth using the inverse or the square root of the diameters: $(D_1/D_2)^{0.5}$. Maddock was at that time finalizing a technical paper in which he taught that scale-up of channel depths was more closely represented by the ratio of the diameters to the 0.7 power. That ratio, $(D_1/D_2)^{0.7}$, was representative of maintaining similar melt temperatures and melt quality across two extruder sizes that were geometrically similar in flight lead, flight width and so forth.

At that time, Carbide had one of the largest development programs in the industry—with extruders up to 4.5 in. for testing—so that there was quite a bit of actual data to support the calculation. Additionally, the data was collected making blown film, so melt quality was clearly demonstrated. I have used that same approach for sizing the metering depth for hundreds of screws with the same lead angle and proportional configuration. I have added a small correction for polymers with strong shear-thinning behavior, which becomes important when the screws are to be run at vastly different peripheral screw speeds.

The shear rate, melting rate, residence time and conductive heating are all influenced in the scale-up. Shear rate in the screw channel is described as $(\pi\ D\ N/h)$ where:

D is the diameter to the first power;
N is the revolutions/sec;

The 'Squaring Effect' of Output



As screw size increases the volume in the channel increases by the square of the ratio of the diameters. Here, the volume of one turn of the 4-in. screw was calculated to be exactly four times the volume of one turn of the 2-in. screw.

h is the channel depth.

It's clear, then, that the use of the same channel depth with an increase in screw size will produce a much different shear rate and result in differing melt quality and melt temperature. It's also clear that there is more consistency between the square of the diameter ratio to 0.7 power than the 0.5 power, compared with the first power of the diameter used in calculating the shear rate.

Maddock and others determined that the 0.7 power of the ratio of the screw diameters was a better factor for determining channel depth then the square root of the ratio of the screw diameters, as it takes more fully into account the heat-transfer distances, increased shear heating over the flights due to higher peripheral speed, flight-length ratio, and increased leakage flow over the flights due to the larger flight clearances as the diameter is scaled up. Additionally, heat removal through barrel cooling is reduced because of the ratio of barrel area to output. The use of $(D_1/D_2)^{0.7}$ generates a greater channel depth in the scale-up and reduced shear rate to counter those effects.

In conclusion, the use of $(D_1/D_2)^{0.7}$ as a scale-up factor for the metering depth of screws with similar geometry and L/D has been found to be a very satisfactory general approach. C.I. Chung, in his 2000 book, *Extrusion of Polymers*, arrived at the same scale-up factor as a "balanced" basis for overall scale-up.

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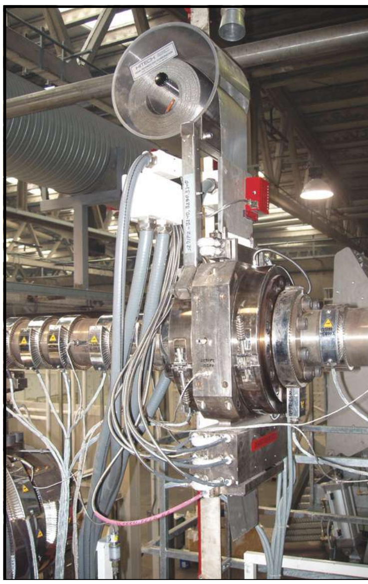

TOOLING

PART 2

Tricks of the Trade on RTOs, RSOs

They have a lot more to offer than shutting off a cavity. Let's take a look at what else they can provide.

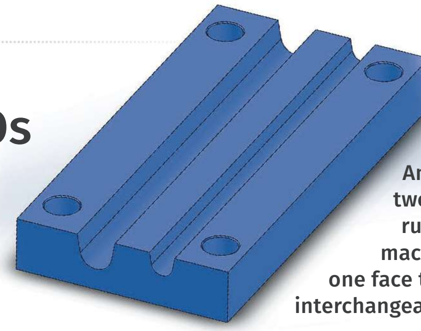

FIG 1

An RSO with two different runner sizes machined into one face to balance interchangeable molds.

By Jim Fattori

Most people think runner shutoffs (RSOs) are needed only for family molds. That's not true. Many people use them in dedicated high-cavitation molds. Let's say you have a four- or eight-cavity mold, and one of the cavities has a problem. Sometimes it's advantageous to be able to quickly and temporarily block off that cavity—in the press—and continue molding. Your profit margin just dropped by 12% to 25%, but you are still able to fulfill a promised delivery date to your customer.

I cannot stress how important it is in this situation to have the mold repaired at the end of the production run, so as not to have a cavity blocked off at the start of the next run. In addition to the loss of profit margin and extended time to make the production quantity, you also expose yourself to potential mold damage. Most molders have a process setup sheet for every mold. That sheet is based on using all the cavities in the mold. So, what happens when you dial in the shot size for eight cavities, but only six or seven are open? Flash, overpacked parts stuck in the cavity, broken ejector pins, or a cracked cavity insert are just a few of the problems you might encounter when you accidentally mold a "pancake."

FIG 2A

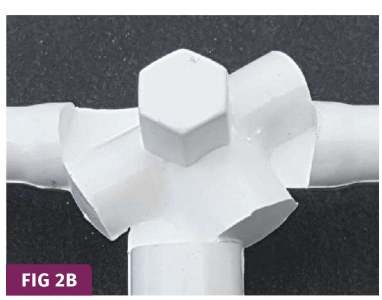

FIG 2B

RTOs often rotate during production.

RSOs can do a lot more than just shut off a cavity or divert material flow. Quite often, when a cavity in a family mold is blocked off, the material flow and fill pattern change, as do the packing pressures to the other cavities. The same change in flow and fill can occur if the mold is used to run more than one type of thermoplastic material—especially if they have very different viscosities. An RSO can be deployed to change the gate location to the open cavities to overcome a flow issue. Changing the gate location can potentially improve or eliminate things like an undesirable weld-line location, excessive sink, or trapped gas. I had one mold that required some parts to be run in acrylic and others in rigid PVC. The acrylic parts were no problem, but the process became pressure-limited when running the more viscous PVC. An RSO was added to the mold in order to open a second flow channel, which led to a second gate to feed the part.

RTOs don't take up a lot of room, and they are not very expensive to make or buy.

Say you have a two-cavity family mold, and one of the cavities is an interchangeable insert that makes a different part. The mold has an RTO to run one cavity or the other, but usually both cavities are run at the same time. When you debug the mold using one of the interchangeable cavity inserts, everything is fine; but when you install the other cavity insert, the balance is way off because the part volume, wall thickness or flow length of the new part is considerably different. Adjusting the size of the gate to either one of the parts will result in a host of other problems—primarily the gate-seal times and different pack pressures in the cavities.

So instead of using a small round runner turn-off (RTO), a long, rectangular RSO insert could be extremely helpful in this scenario. It will allow you to adjust the flow and associated fill pressure to the gate by changing the runner size. The longer the runner you have to work with, the easier this rebalancing will be. Therefore, if you made two of these RSO inserts, each with a different size runner cut into it, you can now run either of the interchangeable cavities without the original flow-imbalance problem and without having to change the gate diameter. One runner acts as a flow enhancer, and the other acts as a flow restrictor. If you have the real estate in the mold to mount the RSO insert off-center, you can cut both runner sizes in the face of just one insert, as shown in Fig. 1. Use the one runner size for one of the interchangeable cavities. Rotate it 180° to run the other interchangeable cavity. Or flip the RSO over to completely block the flow of material to the cavity. ►

FIG 3A

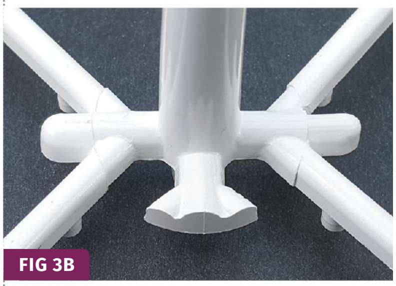

FIG 3B

RTO for feeding two or four cavities.

Let's assume you have a multicavity mold that requires a validated molding process. Murphy's Law says that at some point in time one of the cavities is going to have an issue. That would require you to immediately shut down the press and make the necessary repairs. It's not much of a problem if you have a spare cavity-and-core set sitting on the shelf that you can simply swap out and get back into production. But what if you don't? Can you afford to be down for days, or even weeks? Running anything other than full cavitation is not only a non-validated process, there would most likely be a flow imbalance that could throw some of the other cavities out of specification.

But what if the mold had an RSO like the one in Fig. 1, which can improve the flow balance to the other cavities? During the initial mold sampling to establish the best process to submit for validation, you could intentionally block off a cavity and establish a second process, with less than full cavitation. Both processes could then be submitted for validation up front. Obviously, there would be increased cost to validate two processes instead of just one, but doing so will keep you up and running if there's a problem. Granted, it won't be 100% efficient, but it buys you time to machine the necessary components in order to get back to full cavitation.

I have always preferred RSOs to RTOs. Most RTOs have a spring-loaded ball plunger, an O-ring, a Bellville washer, or some other type of component under their heel to prevent it from rotating as the molten material flows through the runner channel at high velocity and high pressure. Over time, either the spring in the ball plunger fails or the O-ring gets stiff, which allows the RTO to rotate freely (Figs. 2A, 2B). That's when someone on the production floor will grind a point on the end of an old ejector pin and peen a dot between the RTO and the mold plate, to prevent it from rotating. This will elicit bad language from the next person who needs to rotate the RTO to a different position.

Conversely, due to an accumulation of gas and rust around their body, RTOs can become nearly impossible to rotate at all. Despite these shortcomings, RTOs don't take up a lot of room in a mold and they are not very expensive to make or buy. Injection mold supply companies offer various types of standardized RTOs. I couldn't find anyone who offered a standardized RSO. I guess that's because there really is no such thing as a true standard RSO design. Most of them are tailored specifically to the individual mold. The three most common runner configurations machined into an RTO are a "T," "L," or straight-through, but others are possible (Figs. 3A, 3B).

Obviously, at some point in time, an RTO needs to be rotated to a different position. The people on the production floor will use anything at their disposal to do this. I like to reduce their options to just one tool: a hex-key wrench. EDM'ing a hex into the RTO has several benefits (Figs. 4A, 4B). It provides a lot of bearing surface; it's easier to orient the RTO into the proper position; and it minimizes the chance of damage caused to the RTO and the adjoining areas when using some other type of method, such as a steel screwdriver or a pair of gate cutters. If the RTO is opposite the sprue bushing, the hex also functions as the all-important cold well to catch and retain any semi-solidified material residing in the machine nozzle tip.

For full-round runners, the RTO on the cavity side is typically the sprue bushing. I try to avoid this configuration and use two RTOs or RSOs just beyond the sprue bushing. The amount of plastic at the end of a sprue bushing is already massive. The addition of the hex, as well as multiple runner channels, make this location considerably more massive. This extra mass can require the cycle time to be extended by a few seconds to prevent the sprue from breaking away from the runner and sticking in the sprue bushing when the mold opens.

Another reason I try to avoid the configuration cited above is that production personnel often forget to back the machine carriage off before trying to rotate the sprue bushing. The hex can get stripped because the machine's nozzle-touch force prevents it from being rotated. Lastly, the production personnel don't know if there is a dowel pin or a key under the head of the sprue bushing that prevents it from rotating on its own accord. If the bushing is in a mechanically fixed position, any attempt to rotate it in the press with a hex key will be futile.

FIG 4A

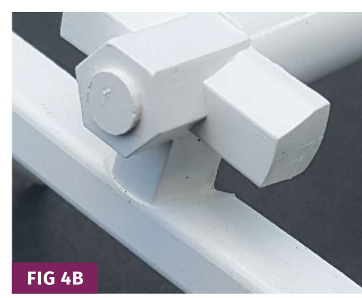

FIG 4B

RTO with a hex EDM'd for a full-round runner (left) and a trapezoidal runner (right).

RSOs are often an afterthought when designing an injection mold. When you understand all they have to offer, the folks in the trenches and in the office will appreciate having them when a problem occurs.

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By Tony Deligio
Senior Editor

Moldmaking in Mexico:

A New Frontier

Advancing beyond repairs and maintenance, there is a growing Mexican moldmaking segment, giving local supply and support to the country's burgeoning automotive sector, among others.

Integrity has more than 170 full-time employees on staff, including approximately 40 mold builders.

Seven years ago, bowing to customer requests and in a bid to better exploit a growing market, Integrity Tool and Mold opened a 20,000-ft^2 facility in Mexico. Initially focused on maintenance and engineering changes for existing molds, the operation in Querétaro generated enough business that after just two years it was doubled to 40,000 ft^2.

Two years later in 2015, still experiencing tremendous growth, including branching into new tool builds, the company faced a decision. Space-restricted at its location, but still sensing the potential to expand, the Windsor, Ont.,-based moldmaker opted to nearly triple its Mexican operation, electing to construct a new greenfield site in Querétaro.

Integrity Tool and Mold's newest operation in Querétaro covers 118,000 ft² and seeks to grow alongside Mexico's growing moldmaking industry.

"We knew we'd already doubled in size at the original plant, and we were landlocked at that point," explains Wayne McLaughlin, plant manager at Integrity Tool and Mold de Mexico. "We saw a lot more opportunity coming, but we were at full capacity. It spawned the idea for this new plant; and at the same time, we were hearing a little bit from customers about better tryout support and the possibility of supporting them with service part runs."

The company broke ground on the 118,000-ft² facility in the third quarter of 2016, and by June 2017, it began moving into the new space. When *Plastics Technology* visited in the fall of 2018, each of the three bays were filled to varying degrees with equipment, while the administrative space, including a cafeteria, neared final completion.

In 2017, Mexico was the second largest market in the world for tools and dies, but only 5% of what the domestic market required was made locally.

"Our capable capacity in Mexico has tripled," McLaughlin says. "We're not to that level yet, but the infrastructure is here to do that."

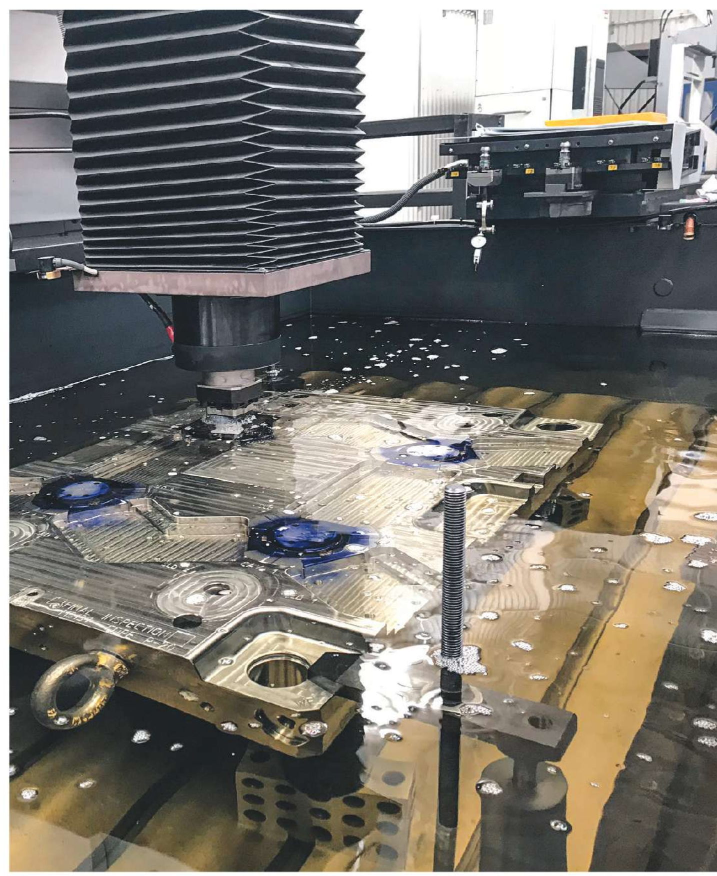
AUTOMOTIVE MARKET ACCELERATES

As automotive OEMs and their tier suppliers set up factories in Mexico, the country's tooling industry is expanding rapidly alongside the burgeoning transportation sector. According to business information source IHS Markit, the 13 OEMs currently making light vehicles in Mexico—including BMW which will open its plant in San Luis Potosi in 2019—will produce just shy of 5 million automobiles in 2021, up 48% from 2015. In terms of part production, IHS Markit forecasts that by that time, Mexico will rank fourth globally, trailing only China, the U.S. and Japan.

Speaking at the Amerimold 2018 conference last June in Novi, Mich. (organized by *PT* parent Gardner Business Media), Eduardo Medrano, president of Mexico's tooling association (AMMMT), said that the $3 billion worth of tools and dies imported by Mexico in 2017 made it the second largest market in the world. Only 5% of what the domestic market required was made locally.

Because of the lack of domestic tool makers, Medrano said that Mexico imported an estimated 5000 plastic injection molds in 2017, supplied mainly from China, the U.S., Canada, South Korea and Germany for larger tools. For smaller molds, the top sources were, in order, the U.S., China, Germany, South Korea and Canada.

According to AMMMT, there are currently 265 mold and die shops in Mexico, including 30 with foreign investment or ownership. These generate an estimated $175 million in sales, employing 3400 workers and running 1000 CNC machines to serve 695 local customers.



Among Integrity's machining capabilities are several large EDM systems from Makino.

BUILDING FOR THE FUTURE

Integrity is banking on continued growth for moldmaking in Mexico, building in specialized capabilities and scale to its new Querétaro site with an eye to future needs. The facility has a ►

The middle of Integrity's three bays is dedicated to mold assembly with 22 separate work cells.

Integrity offers its customers five injection molding machines, ranging in clamp tonnage from 320 to 2300 tons. Show here is a 2300-ton KraussMaffei machine.

50-ton overhead crane to take on extra-large tools, including bumper fascia molds. The first bay, adjacent to the administrative offices, features injection molding capabilities, with five KraussMaffei and Haitian presses ranging in clamp force from 320 to 2300 tons. Integrity has two 2300-ton KraussMaffei presses in this bay, including one capable of running up to four different materials at a time. Beyond mold trials, Integrity says

To support its molding operation, Integrity installed a complete Novatec material-handling and drying system.

its molding capabilities are intended to support customers in emergency production situations. At the back of the bay, Integrity has installed a complete material-handling and drying system from Novatec.

The middle bay houses mold assembly operations, with 22 separate work cells. The final bay is designated for moldmaking, with eight large five-axis CNC machining centers, including Promac and DMG Mori models, as well as EDM machines from Makino. Of the more than 170 full-time employees, between 35 and 40 are moldmakers; and the company is on track to build 130 new tools in 2018.

Compared with Integrity's other operations globally, McLaughlin notes that the new site in Querétaro is roughly twice the size of its factility in Tennessee and just a little smaller than all of its original Canadian factories put together. The Querétaro location puts it very near the geographic center of Mexico, with Mexico City 135 miles south; San Luis Potosi the same distance north; Guadalajara around 200 miles to the west; and Aguascalientes about 180 miles northwest.

"We saw a lot more opportunity coming, but we were at full capacity. It spawned the idea for this new plant."

When Integrity first set up operations in Mexico, McLaughlin said the company identified two primary obstacles: "The first challenge was human-resource availability—skilled help. The second was supply base. Supply base has stepped it up really well over time. We don't even really qualify that as a challenge anymore. Steel suppliers are here; hot-runner systems are here; mold texturing—they're all right here." The human-resource issue, however, is still one that Integrity and others must confront constantly, according to McLaughlin.

There is a labor pool to draw from, but its depth, and the skill set of the individuals within it, differ from what Integrity is used to. "We're hiring some semi-skilled labor that may have come from a machine shop or were in a tool room at a molder," McLaughlin says, "but they really didn't have experience with building new tools."

To address that, Integrity has instituted a comprehensive in-house training program, as well as flying experienced workers from Canada down to Mexico and some Mexican workers up to Windsor. In addition, the company is collaborating with local technical colleges to find new recruits and help those schools build a curriculum that will serve the growing moldmaking industry.

"I think OEMs and Tiers are seeing that there's more ability here. I think Integrity is helping that. Whatever we can do in Canada, we can do here."

"At least here in Querétaro, there is no specialized training for moldmaking," McLaughlin says. "So we're hiring guys that have industrial engineering and mechanical engineering experience. They've proven that they have that mindset, and then we're training them specific to our industry."

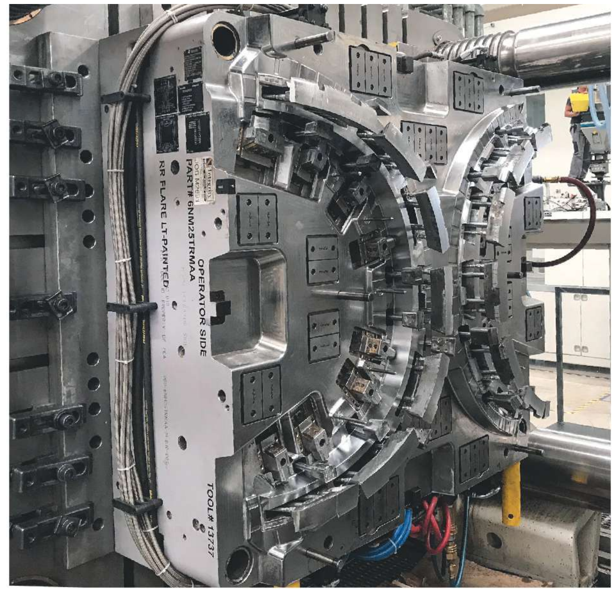
Part of this effort involves a co-op partnership with local technical colleges. On Integrity's shop floor, multiple workers sport yellow shirts that designate them as members of the co-op program. Integrity currently has eight co-op students, spending a portion of their school day at the plant for paid hands-on experience. From the last co-op student group, McLaughlin says Integrity hired all eight, giving the company workers experience not just in moldmaking but in how Integrity makes molds.

"The co-op is appealing to us because we're training them in our processes and techniques and work ethic, which is good," McLaughlin says. "There's a benefit to that—you're investing in a young guy and if he's treated properly, he's going to stay here."

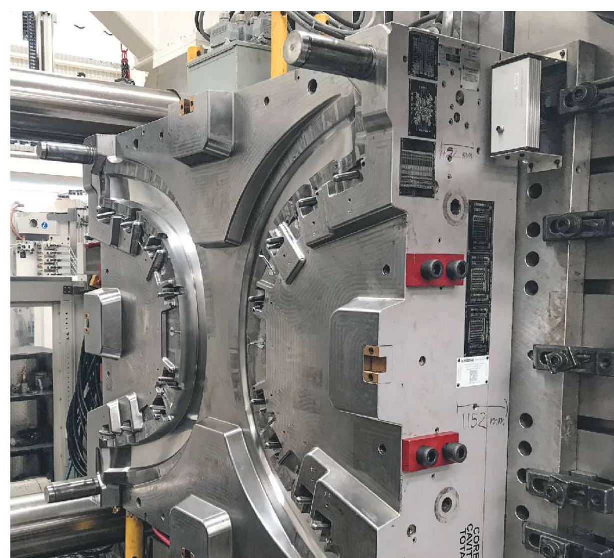
HECHO EN MEXICO (MADE IN MEXICO)

As the nascent moldmaking industry grows in Mexico, its OEM and tier supplier customers are increasingly asking for local tool builds and support, instead of using Mexican shops simply for repairs and engineering changes on molds that were brought in from elsewhere. "We're hearing a lot more about local tooling requests," McLaughlin says. "It seems like it's being mandated by the OEMs or the big Tier Ones—they want to build local now, in Mexico."

When Integrity first came to Mexico, its business was 100% based on repairs, maintenance and engineering changes. Not long after arriving, it moved into building locally, and today, McLaughlin says its business is split 70:30 between new builds and maintenance/repairs. That's the same ratio as at its headquarters in Canada. "I think OEMs and Tiers are seeing that there's more ability here," McLaughlin says. "I'm not bragging, but I think Integrity is helping that. Whatever we can do in Canada, we can do here." PT



Integrity's new operation in Querétaro features two 2300-ton KraussMaffei injection molding machines, providing mold trials for larger tools or emergency production for customers.



Integrity's new facility features a 50-ton overhead crane capable of moving large molds between its two 2300-ton KraussMaffei injection molding machines.

Suhas Kulkarni, president and founder of injection molding consultancy FimmTech, instructs participants during a Design of Experiments (DOE) workshop at custom injection molder Comar's Garden Grove, Calif. plant, held in conjunction with the Molding 2018 Conference.

Process Capability and the 'Hesitation Effect'

Understanding the concepts of pack and hold and applying them during process development is critical for molders to achieve consistent part quality.

By Suhas Kulkarni
Fimmtech

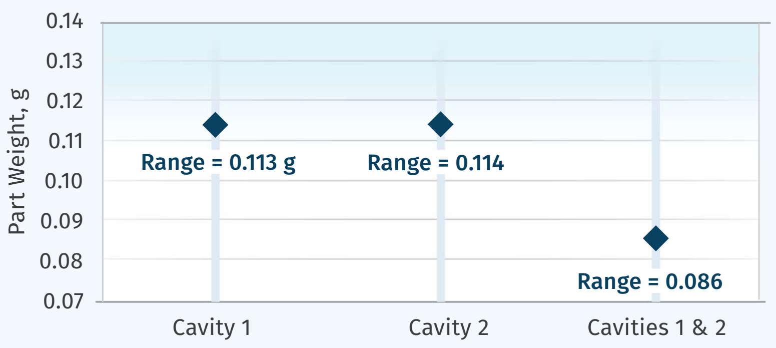
A two-part series on process capability by this author was published in *Plastics Technology* in May 2018 ("Improving Molding Process Capability: Understanding the PVT Graph") and August 2018 ("Improving Molding Process Capability: The Role of the Five Essential Pillars"). The articles were based on studies conducted by the author at his firm's lab in Carlsbad, Calif. Generating the data for these two stories revealed an intriguing phenomenon: The injection molding machine was very consistent in delivery of the melt, but the calculated variation for individual cavities showed large differences. It was puzzling at first, but further investigation uncovered the reason. This article describes the findings and reasons for the process-capability numbers, called the hesitation effect.

What is the hesitation effect? Figure 1 is a schematic of a family mold with two non-identical parts. Part A has a rectangular cross-section and Part B has a cross-section with a thin section. They both have one gate. Figure 1 shows the initial fill pattern of the plastic, where the flow is even. As the flow advances, the plastic reaches the thin section in Part B and therefore the required pressure to push past the thin section increases.

At the same time, the plastic in Part A does not need high pressure to continue filling the part, since the cross-section is thicker than that of the thin section in Part B. Since the required fill pressure is low in Part A, the melt front preferentially flows in part A and the flow front in Part B slows down, increasing the viscosity of the melt and cooling the melt. Once Part A is filled, the plastic now tries to

FIG 2

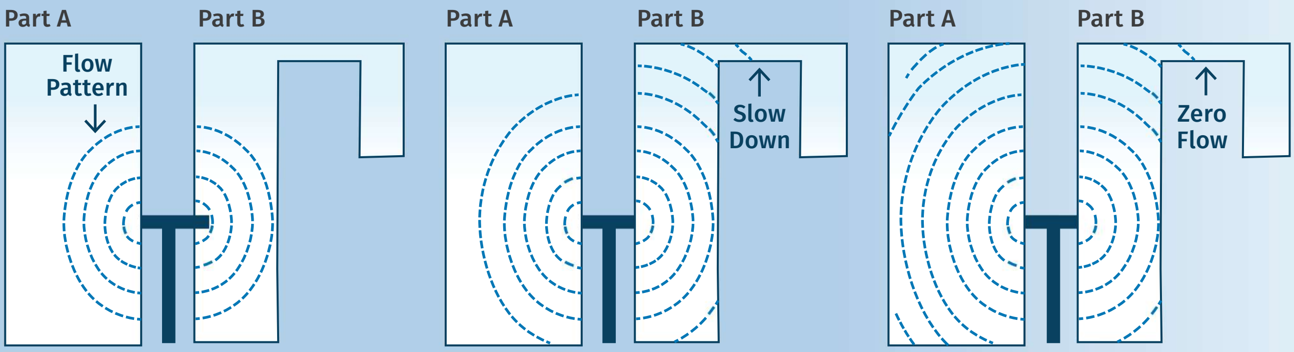
Consistent Machine, Yet Inconsistent Fill



In this experiment, 30 shots were collected, and the weights were recorded for the individual cavities and the runner. The combined range for both cavities was low, but the range for the individual cavities was higher. The low combined range suggests that the machine was consistently delivering an accurate amount of melt from shot to shot. However, if the individual cavities are showing variation, it suggests that there is a hesitation effect in the flow into the cavities, where one is filling preferentially over the other.

FIG 1

Understanding the Hesitation Effect



Even fill in both cavities.

Flow slows down in the thin section as the flow continues in Part A

Part A is filled but the plastic in the thin section has high viscosity resulting is reduced or zero flow

flow in the thin section and may or may not reach the end of fill, depending on the plastic viscosity. The overall flow in Part B can be summarized as follows: The plastic flows at an initial rate, then slows down and/or stops and restarts again. The melt flow is said to hesitate, and this is referred to as the hesitation effect. This effect can cause several cosmetic defects, such as flow marks, sink in thick sections, and dimensional variations.

Process capability is a measure of consistency of part quality. The higher the process-capability number, the better the part consistency. The experiment with the family mold described above was simple: 30 shots were collected, and the weights of the individual cavities and the runner were recorded. The data was then analyzed. Figure 2 shows the part-weight range for the two cavities. The data shows that the range for the runner was 0.008 g. The range for cavity one was 0.113 g, and 0.114 g for cavity two.

When the weights of the two cavities were added together, the range dropped down to 0.086 g. This shows that the combined range for both cavities was low, but the range for the individual cavities was higher. The low combined range suggests that the machine was delivering consistently an accurate amount of melt from shot to shot. However, since the individual cavities showed variation, that suggests that a hesitation effect was occurring in the plastic flow into the cavities, where one was filling preferentially over the other.

A molder may have one of the best machines, but without following a proper process-development procedure using Scientific Molding and Design of Experiments techniques, the molder may end up with low process-capability numbers.

It was observed that it was not one particular cavity that preferred to fill first and that the phenomenon was random. The machine cushion value stayed consistent throughout the run. It was noted that as the packing pressure was increased, the ranges got lower.

Calculating process capability is the norm is many industries. From the above data it is evident that a molder may have one of the best machines on the market, but without following a proper process-development procedure utilizing Scientific Molding and Design of Experiments techniques, the molder may end up with low process-capability numbers. In this case, understanding the concept of pack and hold and applying these during process development would be important to achieve consistency. It is also important that the gate be sealed at the end of the pack and hold phases. This should be part of the mold-qualification procedure. PT

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PT Keeping Up With Technology

PRODUCT FOCUS **Blow Molding**

BLOW MOLDING

Faster Mold Changes For PET ISBM Machine

A new quick-mold-change (QMC) system from SIPA of Italy for its ECS SP single-stage injection stretch-blow molding (ISBM) machines reportedly slashes changeover times by about 25%. New features also include added safety and user-friendliness. These hybrid machines are suited to molding containers for pharmaceuticals, cosmetics, personal-care products, and spirits, especially in sizes from 20 to 50 ml. They come with injection clamps of 55 and 88 tons.

The QMC system involves a new automated procedure for loading/unloading the preform core plates; this incorporates additional sensors to ensure that the mold-opening stroke is adjusted to the preform length. Operations for assembling and disassembling the neck-ring plate have also been modified. A new, patent-pending system now allows the procedure to be carried out safely by one person instead of two.

Changing the blow mold is much easier, too, SIPA says. Addition of roller bearings in critical positions means that once a forklift positions the mold next to the clamp unit, the tool can be pushed into position by hand. Height adjustment of the mold in the clamp is also easier.

Finally, modifications have been made to the sealing plate and stretch rods, and standard screw fittings for the water-cooling system are replaced by quick-fit push/pull fittings.

INJECTION MOLDING

Upgraded PET Preform System Runs Longer Without Maintenance

The XForm 500 PET preform injection molding system from SIPA of Italy has been upgraded again for longer mold life between maintenance cycles. Previously, the Gen3 system cold halves were guaranteed to run for 8 million cycles with no flash over 0. 2 mm. Now, a new surface treatment and durable mold structure with very low deformation allows for a 40% longer guaranteed period—11 million cycles—without maintenance. Since the 500-ton system can run preform molds with up to 180 cavities, it could produce almost 2 billion preforms without mold maintenance.

The system is also said to stand out for its speed (lock-to-lock times below 2.5 sec), versatility (accepting any generation of legacy preform tooling from any major moldmaker), and energy efficiency.

TOOLING

'Eco-Friendly' Rust Remover & Rust Preventative

It's water-based, environmentally safe, EPA tested, nontoxic, non-hazardous, non-flammable and non-aerosol. So says iD Additives about its new Eco-Pro 360, which reportedly removes mill oil, flash rust, and white rust without etching. What's more, it provides a protective coating for long-term rust protection and does not need to be removed before the mold goes back into production.

Eco-Pro 360 is a new product category for iD Additives, a supplier of colorants, foaming agents, UV stabilizers, and purging compounds. It reportedly "cleans, coats and seals" injection molds, blown film dies, and other tooling. It also can be reused many times after filtering out any rust particles.

BLOW MOLDING

Base Inversion Enhances Hot-Fill PET Bottles

Weight savings and design flexibility that allows for "product premium-ization" are promised by the new BoostPrime packaging solution for hot-fill PET bottles from Sidel. It removes the need for restrictive vacuum panels or gas addition to enable bottles to resist hot-filling temperatures up to 85-88 C. The patented solution is aimed at single-serve bottles of up to 1.2 L for juice, nectar, soft drinks, isotonics and tea (JNSDIT).

The final bottle shape is achieved with an "active base inversion" and relies on three key features that are said to have minor impact on the package production line layout:

- The package design requires specific base geometry and specifications.
- The Base Overstroke System (BOSS) allows mechanical forming of the bottle base during blowing.
- An inverter contributes to base inversion, which takes place after filling, capping, tilting and cooling and before labeling. It balances the negative pressure induced by beverage cooling in the bottle from filling to ambient temperature.

In addition, BoostPrime reportedly decreases the weight of current hot-fill bottles by up to 30%, or 3 to 7 g. It also allows producers to save as much as 90% on label material by switching from a sleeve to roll-fed operation. Payback for a new 1L hot-fill PET line can be as little as one year, Sidel says.

The first BoostPrime hot-fill lines are running in Mexico, where a customer has nearly 50 SKUs in production for juice, tea and isotonics. Bottle weight savings are up to 32% for a 237-ml bottle.

INJECTION MOLDING

Simple Robot Cell For Gate Cutting

A custom robotics integrator has come up with a simple, low-cost solution for trimming parts from sprues that is flexible, mobile, and needs no programming knowledge. The O-Cut from Complete Solution Robotics in Loveland, Colo. (***csrobotics.com***), is a self-contained cell based on a small, six-axis FANUC robot and a gate-cutting device ("nipper"). "The system can be rolled to any machine and set up in minutes," says Michael Olson, the firm's founder and owner.

The robot grabs a sprue and attached part or parts from a sprue picker and then presents the parts to the nipper. The parts fall into a bin (or can be placed in a tray) and the sprue is dropped into a grinder. Setup involves a menu-driven recipe on the accompanying touchscreen. The robot is "taught" the operating positions using incremental "jog" commands for each axis, with fine adjustment by by direct entry of numbers. Points can be adjusted in 0.001-mm increments. Recipes can be stored for quick recall and can be shared between different O-Cut units. An operator can move the cell, fine-tune positions, and change cut sequences as needed. Multiple cuts are possible.

The robot has a 4-kg payload capacity and cut repeatability of ±0.02 mm. Hydraulic feet on the cell are adjusted via hand crank. In standard configuration, the sprue grinder, nippers and part bin are supplied by the customer, but options include the grinder and a conveyor with indexing boxes or trays for cut parts. Pricing starts at $50,000 without nippers or grinder.

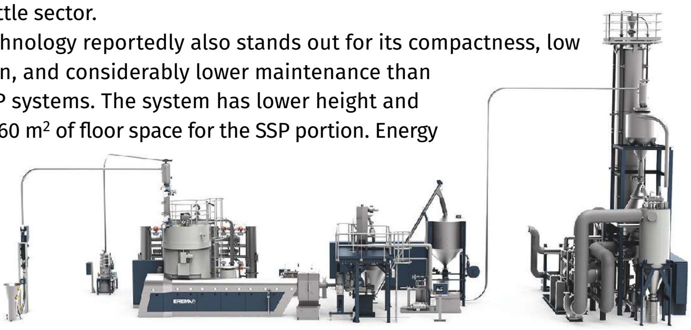
RECYCLING

New Technology Enhances RPET Purity

Austria-based Erema launched its new Vacunite bottle-to-bottle technology at November's PETnology conference in Paris. This technology brings together Erema's Vacurema degassing and decontamination process with newly patented, vacuum-supported solid-state polycondensation (SSP) from Polymetrix in Switzerland.

One unique aspect of this combination is that all thermal process steps take place in nitrogen atmosphere, which largely eliminates flake and pellet discoloration, Erema says, and removes additives that could lead to undesired reactions in the melt. Another reported benefit of Vacunite is the vacuum support cleans the nitrogen, which means it can be reused in the process. Any remaining dust particles are removed from the pellets before filling to avoid preform contamination. "Using vacuum support and nitrogen atmosphere creates RPET recyclates that far exceed all existing food-contact requirements, even those of the major beverage brands," states Christoph Wöss, Erema business-development manager for the bottle sector.

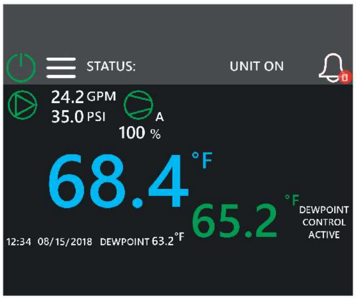
The recycling technology reportedly also stands out for its compactness, low energy consumption, and considerably lower maintenance than current vacuum SSP systems. The system has lower height and occupies only 50 to 60 m^2 of floor space for the SSP portion. Energy consumption for the entire process from flake to final pellets reportedly amounts to 0.35 kWh/kg.



PROCESS COOLING

Chillers Automatically Prevent Mold Condensation

Chiller controls now monitor ambient dewpoint and automatically adjust the cooling-water setpoint temperature at or above the dewpoint to prevent condensation on molds. This new and reportedly unique control feature has been made standard on all chillers from Delta T Systems. By preventing condensation, this feature is said to decrease scrap rates caused by cosmetic defects from water droplets



on the mold face. It also improves housekeeping and lengthens tool life by avoiding rust. Delta T says it is the first to offer such automatic protection as part of the chiller controls.

MIXING

Lab Paddle Blender

A new Laboratory Paddle Blender from Charles R. Ross & Son Co. offers advanced features for more convenient, automated powder blending and liquid spraying operations with recipe management. Shown is the 1 ft^3 model constructed entirely of 304 stainless steel and and driven by a 1-hp motor. Complementing the blender's full vacuum capability, new features include a pneumatic powder charging port and liquid delivery spray system to promote batch-to-batch consistency. Touchscreen PLC recipe controls are housed in a NEMA 4X stainless-steel enclosure allowing for indoor or outdoor use.

For increased versatility, an interchangeable ribbon agitator can be supplied with any new Ross Paddle Blender. Both paddle and ribbon agitators are widely used in the preparation of dry solid-solid mixes and can easily accommodate minor liquid additions.

Volume Resin Prices Enter 2019 on Downward Path

Significant declines in feedstock prices, general year-end slowdown, and resin export/import issues contribute to this trend.

By Lilli Manolis Sherman
Senior Editor

Prices of nearly all volume resins were flat or lower in December, with PP and PE showing the most dramatic declines going into the new year. Even the exception in the group, nylon 66, which saw prices spiking throughout 2018, was stabilizing. A drop in feedstock prices, starting with crude oil, was a contributing factor. And then there was a general seasonal slowdown in demand and, in some cases, a buildup in supplier inventories, as well as competition from lower-priced imports.

These were the views last month of purchasing consultants from Resin Technology, Inc. (RTi), Fort Worth, Texas; senior editors from Houston-based *PetroChemWire* (*PCW*); and CEO Michael Greenberg of The Plastics Exchange in Chicago.

Market Prices Effective Mid-December 2018

Resin Grade	¢/lb
POLYETHYLENE (railcar)	
LDPE, LINER	98-100
LLDPE BUTENE, FILM	81-83
NYMEX 'FINANCIAL' FUTURES	43
JANUARY	43
HDPE, G-P INJECTION	103-105
HDPE, BLOW MOLDING	93-95
NYMEX 'FINANCIAL' FUTURES	48
JANUARY	48
HDPE, HMW FILM	110-112
POLYPROPYLENE (railcar)	
G-P HOMOPOLYMER, INJECTION	82-84
NYMEX 'FINANCIAL' FUTURES	72
JANUARY	72
IMPACT COPOLYMER	84-86
POLYSTYRENE (railcar)	
G-P CRYSTAL	108-110
HIPS	114-116
PVC RESIN (railcar)	
G-P HOMOPOLYMER	83-85
PIPE GRADE	82-84
PET (truckload)	
U.S. BOTTLE GRADE	73-75

PE PRICES DOWN

Polyethylene prices dropped 3¢/lb in November and additional decreases of 2-3¢/lb were being offered to some customers going into December, according to Mike Burns, RTi's v.p. of PE markets. The big change was crude oil dropping from $76 to $50/bbl. Both Burns and *PCW* senior editor David Barry said the North American PE market has to adjust, particularly because of its need to export. Both noted that the spread between domestic and export prices has been significant—for example, exported LLDPE butene grade fell below 40¢/lb—a 10-year low.

Burns noted that PE supplier inventories are 1 billion lb higher than a year ago. Barry added that PE exports typically have been high in December, after which the market tightens up—but this was not the case in 2018. He noted factors such as concern about a slowdown in the global economy, coupled with the huge amount of new North American PE capacity that has come on stream—with more to come, such as Sasol's 1-billion lb/yr LLDPE plant in Lake Charles, La.—in an already saturated market.

The Plastic Exchange's Greenberg characterized much of November's PE spot market as anemic until the end of the month, when the market sprang to life. "Buyers were driven back to the market for different reasons. Some needed to procure minimal spot material to keep their plants running; while others, pleased with the recent price decline, ordered a bit more, both to use and add to their coffers." He, too, saw potential for even lower prices in December.

As for the new year, *PCW*'s Barry noted that first quarter could be like 2018's fourth quarter, with slumping prices unless oil prices turn around and change the PE cost structure globally. But RTi's Burns noted that PE prices will start the year 5-10¢/lb lower than the industry had anticipated, so suppliers would aim to stop any further erosion. He also expected that strong domestic demand growth of over 7% in 2018 would continue through 2019.

Polyethylene Price Trends

	NOV	DEC
LDPE	▼ 3¢/lb	▼
LLDPE Butene	▼ 3¢/lb	▼
HDPE Injection	▼ 3¢/lb	▼
HDPE Blow Molding	▼ 3¢/lb	▼
HDPE HMW	▼ 3¢/lb	▼

PP PRICES DROP BY DOUBLE-DIGITS

Polypropylene prices fell 10¢/lb in November, in step with propylene monomer and with strong potential to drop further in ►

December, according to Scott Newell, RTi's v.p. of PP markets. Moreover, all industry sources anticipated monomer contracts to settle at least 5¢/lb lower in December. While he expected PP prices to follow, Newell noted that PP suppliers had issued margin increases of 3¢/lb for last month. "Our current expectation is that some of that 3¢/lb margin has the potential to go through. We have been the highest priced in the world for both monomer and PP, and demand destruction took place. At the same time, propylene monomer supply has grown significantly—PP prices are now correcting."

Polypropylene Price Trends

Homopolymer	
NOV	DEC
10¢/lb	

Copolymer	
NOV	DEC
10¢/lb	

PCW's Barry said he was on the fence about whether suppliers would be able to get any margin increase, citing plenty of low-cost PP imports and ample spot PP spot material available domestically, contradicting the tightness claimed by suppliers. He ventured that PP prices would be flat to higher in the first quarter, based on historical buying trends, which predict strong demand from processors who managed their year-end inventories, particularly at lower prices.

Newell noted that with domestic PP prices coming down, PP imports will not look as attractive in 2019. "PP prices had the potential to move quite a bit lower than what the industry may have expected due to new market dynamics—oil at $50/bbl, which made heavy feeds like propylene become more attractive to produce, adding to an already built-up monomer supply."

Characterizing PP spot-market activity as very robust going into December, Greenberg reported, "The sharp and swift market correction has shut down the import arbitrage; therefore, we expect much fewer speculative pounds inbound during December, which could eventually lead to a lack of PP supply early in the New Year."

These sources also see the potential for price volatility arising from oil price movements and cold-weather plant disruptions.

PS PRICES DOWN

Polystyrene prices held even in November, but there were industry reports that suppliers were offering price concessions of up to 7¢/lb in December. According to *PCW*'s Barry and Robin Chesshier, RTi's v.p. of PE, PS and nylon 6 markets, price discounts should have been even greater, considering the double-digit price decline of both benzene and butadiene feedstocks, along with a drop of at least 7¢/lb that was expected for styrene monomer.

Polystyrene Price Trends

GPPS	
NOV	DEC

HIPS	
NOV	DEC

Barry reported that based on falling benzene costs, spot prime PS prices were expected to fall at least 5¢/lb in December. Based on a 30/70 formula of spot ethylene and benzene, implied styrene monomer production costs were 26¢/lb in early December, down from 33-34¢ in October. Actual spot monomer prices dropped by 62¢ to 39¢/lb in that time frame. Chesshier anticipated that PS prices in January would be flat, but the first quarter could see some upward pricing pressure driven by feedstock prices rebounding—e.g., benzene is seen as underpriced—along with the ever-present possibility of unplanned feedstock outages.

PVC PRICES FLAT TO DOWN

PVC prices were flat in November, but suppliers called for a 2¢/lb increase for December. Mark Kallman, RTi's v.p. of PVC and engineering resin markets, and *PCW* senior editor Donna Todd both saw this hike as unlikely to succeed.

Todd reported that the price hike was viewed very unfavorably by resin buyers. "For one thing, December price increases—the last of which occurred in December 1988—don't work. Demand is at the lowest point of the year, meaning processors have no incentive to pay more for resin they don't need."

PVC Price Trends

Pipe	
NOV	DEC

Gen. Purpose	
NOV	DEC

Characterizing the price-hike announcement as a "bargaining chip," Kallman did not expect the increase to be realized. While spot ethylene prices rose very slightly in November, ethane prices were dropping, and late-settling November ethylene contracts were expected to remain flat or drop by 1¢/lb or so. "There are no supporting feedstock costs for a PVC price hike, along with falling global ethylene prices due to low crude-oil prices," Kallman said. He ventured that PVC contract prices this month would be flat and more likely down as negotiations concluded. He expected some upward pressure in February and March due to planned plant shutdowns.

PET PRICES HEADING DOWN

Prices for domestic bottle-grade PET were in a wide range of 68¢ to 75¢/lb in early December, for domestic and import, truckload and bulk truckload (48,000 lb), according to *PCW* senior editor Xavier Cronin. The lower end was for higher-volume deliveries, including railcars (190,000 lb) to Midwest locations. This compared with the narrower range of 70-72¢/lb through most of November.

PET Price Trends

Bottle Grade	
NOV	DEC
2-3¢/lb	2-3¢/lb

Cronin reported that PET prices were poised to drop 2-3¢/lb in December as the cold-weather season in most of the U.S. kicked in, and demand for soft drinks and water in PET bottles dropped off. At the same time, there was increased demand for both PET and HDPE for bottle production in California due to the wildfires that devastated the state in November. This was expected to increase prices for PET in West Coast markets by January as inventories at bottle-producing plants are used up.

Meanwhile, PET from Malaysia was at 75¢/lb to U.S. East Coast and West Coast ports. PET was again available from the five countries—Taiwan, South Korea, Indonesia, Pakistan and Brazil—for which anti-dumping duties were lifted. PET from South Korea was available for delivery to the U.S. West Coast by February, although demand from Europe was drawing some Korean PET to that region, given higher prices offered by some E.U. countries and lower shipping costs compared with the U.S.

ABS PRICES DOWN

ABS prices continued flat through November, but a "sea change in all key feedstock costs" was expected by RTi's Kallman to result in lower prices starting in December. He projected a decline of 3-5¢/lb per month over a two-to-three month period.

In addition to a 69¢/gal drop in benzene prices from November to December, butadiene prices came down about 22¢/lb globally since October. Ditto for acrylonitrile, which declined about 10¢/lb. Moreover, prices of Asian ABS imports had dropped substantially, making an adjustment to domestic ABS prices necessary.

PC PRICES FLAT-TO-DOWN

Polycarbonate prices were trending down in the last two months of the year and double-digit decreases were expected this month as new-year contracts were being negotiated, according to RTi's Kallman. This would shave off quite a bit from the 2018 first-quarter price hikes of up to 14¢/lb. "The market has gone from well-balanced to oversupplied due to an influx of lower-priced Asian imports and ample domestic availability," he said.

PRICES OF NYLON 6 LOWER; NYLON 66 STABILIZING

Nylon 6 prices moved up by a couple of cents in the fourth quarter, as suppliers partially implemented their September 5¢/lb increases, according to RTi's Chesshier. "The market dynamics are on the side of processors with prices of key feedstocks dropping, including caprolactam, along with a balanced supply/demand situation." Chesshier anticipated that processors would seek price concessions in December, which would materialize by this month at the latest.

Nylon 66 prices, after spiking by 25-40¢/lb in the first and third quarters of last year, continued to move up in early fourth quarter but stabilized thereafter, according to RTi's Kallman. Prices in the last two months of the year and into this month were likely to remain flat, with the possible exception of some processors hit with delayed price hikes. Relative stability was attributed to a drop in feedstock prices; the start of a general improvement in supply of both intermediates and resins, particularly in North America; a certain degree of conversion from nylon 66 to alternatives; and a global slowdown in automotive. Kallman saw some potential for the market to be more balanced as early as midyear.

Processing Growth Continues as Backlogs Contract

November 2018's Index of 51.9 brings year-to-date average to 55.7, strong growth by historical standards.

By Michael Guckes
Chief Economist

The Gardner Business Index for Plastics Processing dipped to 51.9 in November, though a closer analysis yields a more positive view. The latest reading brings the average year-to-date level to 55.7, a strong expansionary reading by historical standards. (Values over 50 indicate expansion; values below 50 indicate contraction; 50 = no change.) Of the six components that determine the Index, supplier deliveries and production lifted the overall Index higher. Conversely, contractionary readings for exports and backlogs pulled the Index's performance lower. New orders and employment had minimal influence on the Index's performance during the month.

Recent data illustrate the important dynamics between supplier deliveries, production and backlogs. Strong new-orders demand over the last two years resulted in backlog growth at record rates during the first-half of 2018. In response, processors bolstered their supply chains, causing supplier deliveries to become the leading driver of the Plastic Processors Index since May. With the industry now able to handle larger volumes of production, recent months of slower new-orders expansion—which have expanded for a record 23 consecutive months through November—has likely allowed the industry to reduce the backlogs that accumulated quickly during the first half of the year.

As processors work off this backlog it has resulted in contractionary values for the backlog component of the Index, thereby lowering the overall Index. However, this alone should not be considered an indicator or predictor of weakness in the industry.

The index is based on monthly surveys of *Plastics Technology* subscribers.

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: Plastics Processing

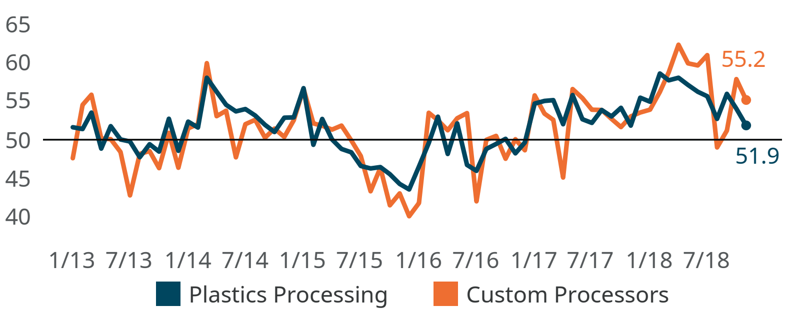


FIG 1

The expansion of the plastics processing supply chain has allowed the industry to respond to new orders as well as begin clearing prior quarters of backlogs.

Processors Catching up with Backlogs

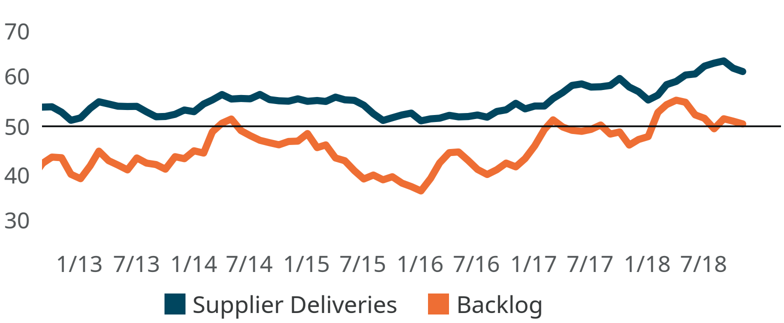


FIG 2

Growth in supply chains and production earlier this year have since allowed the industry to reduce the backlogs accumulated earlier in the year.

Uncertainty in Automotive Market for 2019

It's not clear yet how trade tensions and interest rates will affect stagnant vehicle sales.

By Michael Guckes
Chief Economist

If trade tensions escalate and interest rates increase throughout 2019, the automotive industry may find it harder than expected to expand. During 2018, the auto industry tracked along the same trajectory as the prior year. Unit sales data for 2018 showed growing preference for SUVs and light trucks over cars. This trend is not new: Unit car sales peaked in June 2014 and have seen an average 7.5% annualized contraction in the 17 quarters since then. Truck and SUV sales continue to offset the weakness in car sales, keeping total vehicle sales since mid-2015 at a monthly average of 1.4 million units, or 17.3 million on an annual basis. Looking forward to 2019, several

FIG 1

Value of Shipments – Automobile Manufacturing

Seasonally Adjusted

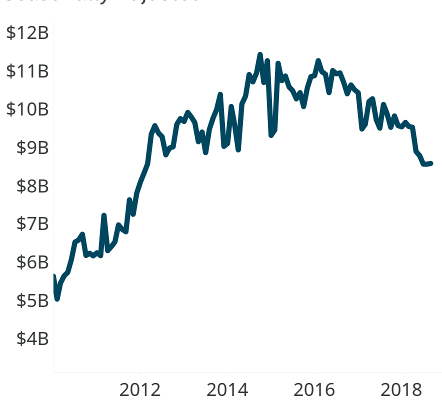
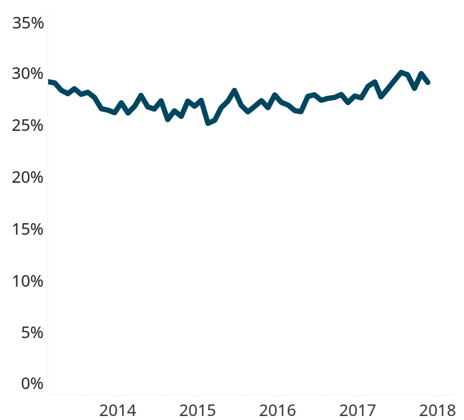


FIG 2

Total Imports as Percentage of Total Domestic Sales



factors, such as interest rates and tariffs, will have significant near-term effects on the automotive market.

This is the third year that interest rates have increased, raising the cost of all loans. The latest data for 2018 indicates that the current vehicle interest rate of 6.16% is 10% higher than a year ago and over 22% higher than two years ago, when the average rate was just over 5%. Initially, these rate increases, which raise monthly finance payments, did not slow the growth in average financing amount, which peaked at over $30,500 during the first quarter of 2018. The latest data available in October showed the average amount financed has now fallen over 2%, or over $600 per vehicle.

Furthermore, recent tariff data indicates that new U.S. trade laws enacted during 2018 have produced asymmetrical effects that have hurt U.S. exports more than they have helped domestic sales. Seasonally adjusted figures from the Bureau of Economic Analysis indicate Canadian and Mexican imports of U.S. automobiles have declined 20% from a year ago. One would have to go back to 2011 to find such low levels of Canadian and Mexican imports of U.S. vehicles. The value of overall U.S. shipments by large automotive manufacturers between April and the latest available data from September indicates a 10% decline.

Truck and SUV sales continue to offset weakness in car sales, keeping total unit sales flat since mid-2015.

Although many of the latest trade regulations have had relatively little time to make their impact felt, the underwhelming change in U.S. import consumption is evident in automotive. The ratio of domestic to imported cars and trucks sold in the U.S. during the second half of 2018 indicated no change through October. The market share of imported vehicles sold in the U.S. during the second half of 2018 has yet to indicate a significant change.

The sheer number of factors impacting the automotive market make it difficult to predict the path of the automotive industry in 2019. If trade tensions escalate and interest rates increase throughout the year, the automotive industry may find it harder than expected to expand. PT

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

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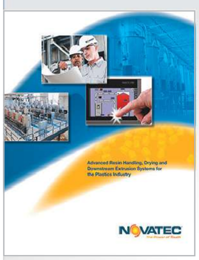

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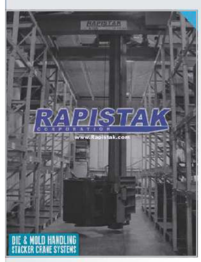

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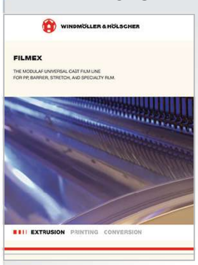

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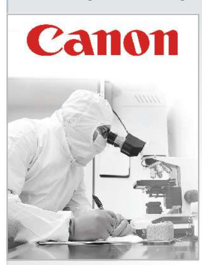

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EVCO Plastics — DeForest, Wis.

Full Plate of New Technologies on the Table at EVCO Plastics

A new low-pressure molding process, 3D printing of production parts and prototype tooling, collaborative robots, and process monitoring with automatic QC are all on the menu.

A "printer farm" with a dozen Markforged 3D printers for prototypes and short runs of up to 600 parts is a new compliment to EVCO's injection molding business.

By Matthew H. Naitove
Executive Editor

Managing nine plants in the U.S., Mexico and China with more than 1400 employees and 183 injection machines from under 100 tons to 3500 tons; and serving business segments as varied as medical cleanroom molding, thin-wall packaging, and large parts for automotive, agricultural equipment and appliances—all that might seem more than enough to keep one company busy. Not at EVCO Plastics. Based in DeForest, Wis., the custom molder and contract manufacturer is pushing ahead to adopt a handful of new or enhanced technologies to expand its services and capabilities.

First on the list is launching the iMFLUX low-pressure molding process from a subsidiary of Procter & Gamble. This novel approach shows promise for reducing cycle times, melt temperatures and clamp-force requirements, while improving part quality and consistency (see March '18 feature). Last month, EVCO began installing iMFLUX controls on five or six machines running some of the most challenging jobs. The first is a 400-ton Toyo press running a Noryl pressure vessel, where EVCO hopes to increase weld-line strength with iMFLUX. Next in line will be Husky packaging machines running 64-cavity stack molds, where "saving an extra second in cycle time would be nice," says EVCO president Dale Evans.

EVCO is applying UR cobots to tasks from insert loading, assembly and packaging to tending its 3D printers, as in this test cell.

Other new initiatives are in 3D printing. One aspect is printing mold inserts for prototyping. Another is branching out into 3D printing as a process to complement injection molding for prototypes and short runs of up to 600 parts. The firm is building a "printer farm" of 3D printers to be served by collaborative robots from Universal Robots (UR) for unloading finished parts. EVCO already has 12 Markforged printers that use fused-filament fabrication (FFF).

EVCO also uses UR collaborative robots, or "cobots" for assembly, insert loading and boxing parts. Interfaced to the injection press, these are flexible and cost-effective automation tools, says EVCO automation engineer Jimmy Lee. Cobots free up labor from simple, repetitive tasks: "We have labor shortages like everyone else. Vision-assisted cobots let us use people for higher-level functions."

Another important new venture for EVCO is launching the firm's first painting line. It will start production soon, pending customer approval of UV-cured sample parts. The first job will be electrical housings, followed by lawn/garden and heavy equipment.

In addition, EVCO is adding more intensive process monitoring of its injection machines, which Bernie Degenhardt, automation manager, describes as one of the company's initial steps into Industry 4.0. He says the goal is to tie together production and process monitoring and automatic quality control into one central system capable of archiving large amounts of historical data. This is starting in the firm's medical molding operation, which requires extensive documentation of product quality.

Evans explains that over the past 20 years, EVCO's eight North American plants have employed a Syscon-PlantStar system for production monitoring. "I can see the cycle time of machines in Georgia or Mexico, and real-time scheduling tells us when jobs will be done and helps us schedule people, materials and equipment."

The firm also uses the PlantStar system for monitoring sensors on plant systems such as central chillers, air compressors and power usage. Now EVCO is pursuing real-time process monitoring on its injection presses. The machine controls monitor sensors for cavity pressure and other parameters on every shot to make accept/reject decisions. The PlantStar system archives 10 process variables from presses of different brands and model years. The system also monitors auxiliary equipment such as dryer temperatures and water flow and pressure from TCUs.

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