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‘We Don’t Shy Away from Challenges’

Meredith-Springfield Pushes the Limits of Technical Blow Molding—Now with EPET

A property of Gardner Business Media MARCH 2019 № 3 VOL 65

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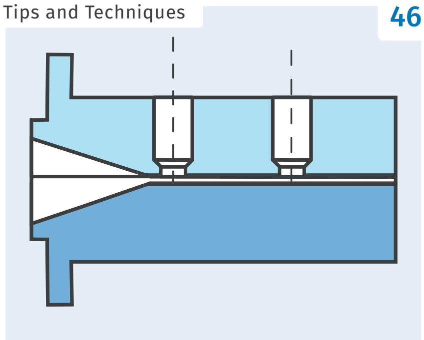
PT Plastics Technology

Tips and Techniques



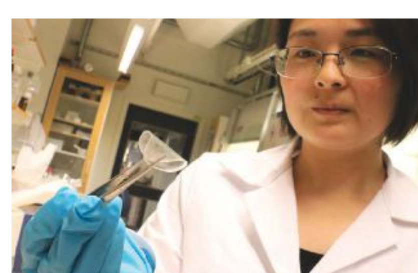
Tips and Techniques

PT Web Exclusives — **There's more on the web at *PTonline.com***

BLOG: Smells Like...Sustainability?

Senior Editor Lilli Sherman checked in on the development of polyether furanoate (PEF) as a biobased replacement for PET in packaging. Work at Sweden's Lund University seeks renewable paths to the furan in PEF, including, as they put it, "poo." Lilli reports, "Chemical engineering doctoral student Ping Wang has produced a plastic based on indole, a heavier hydrocarbon molecule than furan, that is present in human feces and smells accordingly." Thankfully researchers have found less pungent paths to the molecule, with one PEF achieving a Tg of 210 F compared with 158 F for regular PET.

short.ptonline.com/poo



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Get Materials Processing & Property Data On-Line or Via App

Plastics Technology and MobileSpecs team up to give molders more materials data.

A lot has happened since I first wrote in this space about MobileSpecs LLC of Laramie, Wyo. In October 2017, I told you about a new app this company had developed that included processing data (up to 25 molding parameters for each material) on more than 20,000 commercially available materials from more than 100 resin producers and distributors. The purpose of this app was to give you a handy source to establish processing parameters on materials with which you might not be familiar.

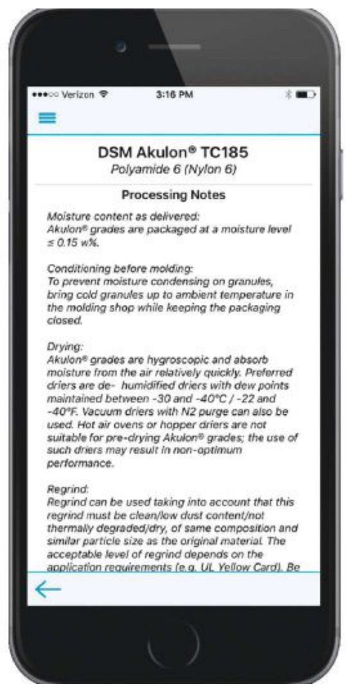
Jim Callari
Editorial Director

With just a few taps on your mobile device, you'll find the material you're looking for and be able to access data for mold shrink, melt flow, recommended processing temperatures, drying parameters, and a bunch more. Detailed text descriptions of each plastic, along with processing notes, provide molders with a great deal of background information about the materials they are processing. What's more, the app offers full supplier processing guides, where available.

"MobileSpecs provides us with the processing data we need to quickly adjust machine settings."

You can download it for free on your Apple or Android phone. It takes seconds to find what you need. You can search for supplier name, generic polymer family, or specific products and grades. The information in the app is continuously updated by MobileSpecs.

MobileSpecs was launched in 2017 by Doug Kenik and Brady Adams. Later, they were joined by Mike Kmetz. Mike was the president and founder of IDES, which developed an online, searchable database called the Prospector that contains property information on tens of thousands of materials from suppliers all over the world. And now MobileSpecs is offering—via both the app and *mobilespecs.com*—complete data sheets on all the 20,000 resins in its database. You can search material by supplier name, product, or grade. Or, you can click or tap on any of the 100 suppliers in the database. From there, you'll be brought to that supplier's full list of materials. You can also get access to complete data sheets on each material by registering—for free—using your email address.



MOBILE SPECS
FOR INJECTION MOLDING

This product is resonating with molders. Says Corie Yodis, a project engineer at Epimed, "We run many materials through our processes, which requires us to adjust machine parameters frequently. The app provides us with the processing data we need to quickly adjust machine settings. The centralized database and easy access to the manufacturers suggested processing data allows us to iterate rapidly, which helps efficiency on the floor. MobileSpecs is also great at responding to customer inquiries and feature requests; recently they added a great feature that allows me to save all of the resins that we commonly use as favorites. The new functionality makes it even quicker and easier to retrieve the processing information I need and tailor the app to my personal uses." Adds John Parker, a senior process engineer at Cosmo Corp., "My first look was a KR01 (Ineos Styrenics' K-Resin SBC), and the MobileSpecs app and desktop version blew me away with not only the parameters but a lengthy breakdown of specifics and cause-and-effect situations."

Have you checked out *mobilespecs.com* or downloaded the app yet? No reason to wait. Give it a whirl. PT

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Hahn Plastics Automation Opens Connecticut HQ, Reveals Plans for Rethink Sawyer Cobots

As reported in our Sept. '18 NPE Close-Up, Hahn Plastics Automation Inc. is a new U.S. branch of the German Hahn Group, supplying robots and plastics automation systems. It recently opened its headquarters in Avon, Conn. The firm represents two German suppliers, Waldorf Technik and Geku, as well as Wemo of Sweden. The new U.S. company will manufacture Geku and Waldorf Technik equipment and will import, stock and integrate Cartesian robots from Wemo. The new firm is headed by Markus Klaus, previously injection molding division manager for Wittmann Battenfeld Inc. Klaus noted that Hahn will continue its relationship with Robotic Automation Systems (RAS) of Waunakee, Wis., which distributes Wemo robots. (See Keeping Up section for new models from Wemo.)

As reported in a December Starting Up, Hahn Group has expanded into the field of collaborative robots (cobots) by acquiring the trademarks, software, patents, drawings and tooling for the Sawyer line of cobots from the former Rethink Robotics, which has ceased operations. In an exclusive interview with *Plastics Technology*, Philipp Unterhalt, recently appointed managing director of Hahn Group and interim CEO for Rethink, spoke about Hahn's plans for its cobot business.

Unterhalt noted that Hahn—a €200-million company with 1200 employees in 12 countries—was already the largest distributor for Rethink Robotics. "We believe in the technology, including Rethink's world-class software and user interface. We think we can improve the reliability and versatility of the hardware," Unterhalt said. Hahn's plans involve three phases. First priority is servicing the 2400 one-armed Sawyer units already in the field. (Hahn has no plans to support or continue Rethink's original two-armed Baxter cobot.)

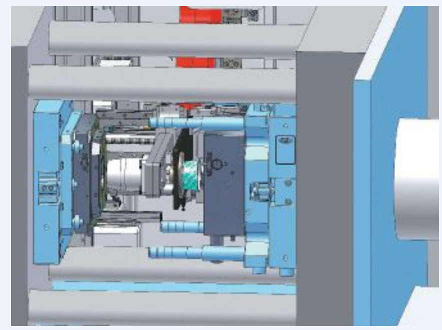
The second phase will be to create a new version, "Sawyer 2.0," that will be faster, quieter and more accurate. And the third phase will be to develop a family of cobots, including larger models with higher payload capacity and reach. Other projects will be to develop new software functionality for cobots and also to create a lower-cost, "lighter" model of cobot, since the current Sawyer has more functionality than some customers need.

Industry 4.0 Advances with New Euromap Interface For Fluid Temperature Controllers

One year after publication of the first draft (a so-called Release Candidate), the finished specification for the OPC UA-based interface for fluid temperature-control devices (Euromap 82.1) has been released by Euromap, the European association of plastics and rubber machinery makers (see Oct. 15, 2018 Blog post). As part of the developing resources for Industry 4.0 "smart factories," the standardized interface is meant to simplify interaction of devices in a production cell, independent of the make or model of the devices. With this interface, temperature-control unit (TCU) settings could be made directly from the injection machine and relevant quality data could be viewed on the press controller.

CBW Automation Gains Swiss IML Technology

Swiss in-mold labeling (IML) automation specialist H. Müller-Fabrique de Moules is transferring its technology and know-how to sister company CBW Automation in the U.S. Both firms are part of Swiss-based Mold & Robotics group, CBW having been purchased



in late 2017. Müller's IML systems will be manufactured in North America for the first time at CBW Automation in Fort Collins, Colo. The first systems ordered from CBW are for large, 2×12 stack molds for injection molded thin-wall PP containers and lids.

Sumitomo Demag Moves & Expands

Injection machine supplier Sumitomo (SHI) Demag Plastics Machinery North America last month announced phase one of its 2019 expansion plan, moving its Norcross, Ga., headquarters facility to a larger office and Tech Center in Suwanee, Ga. At 74,000 ft^2, the new facility is almost triple the size of the former location. The company's Strongsville, Ohio, plant remains in operation.

Completed last month, the move is the first of three expansion phases for Sumitomo Demag in the U.S. this year, further details of which were not released. The new facility will stock and modify SE Series all-electric presses and will house corporate, sales, service and support offices. Machine training classes will begin there in April. The expanded Tech Center will feature SE Series machines from 33 to 562 tons for demos, mold tests, training, and process and applications development.

Davis-Standard Beefs Up Lab Capabilities

Davis-Standard has announced two additions to its Technical Center in Pawcatuck, Conn. By the end of the first quarter, D-S will offer trials for its Helibar groove-feed extruder and the DS Activ-Check control system for continuous extruder monitoring.

The Helibar extruder in the lab will be 2.5 in. (65 mm) with a 36:1 L/D. Helical grooves inside the barrel run along the entire barrel bore, reportedly increasing output rates while improving energy efficiency and reducing barrel and screw wear. Other advantages touted by D-S include lower start-up costs, shorter residence time and the ability to process higher levels of regrind.

The DS Activ-Check system will be mounted on a 4.5-in. (114-mm) extruder. Its continuous monitoring strengthens preventive and predictive maintenance of extruders. Operators can monitor key mechanical and electrical components of the extruder and gearbox and receive early notification of potential component failure to prevent unscheduled downtime. Users can obtain notifications via email and text, and can remotely monitor conditions via smart devices or remote PCs.

U.S. and Swiss Mold Makers Agree to Service Cooperation Partnership

Accede Mold & Tool Co., Rochester, N.Y., and Switzerland's KEBO AG have agreed to provide their respective customers regional service capabilities in North America and Europe. Roger Fox, president, Accede Mold & Tool Co., Inc., told *Plastics Technology*, "This is a service agreement where two strong, family-owned companies share an interest," Fox said. "For Accede it's Europe and for KEBO it's North America."

Andrew Sargisson, sales director for KEBO, says although his company has a "handful" of clients in the U.S. now, "We see North America as a huge potential growth area for us."

Accede specializes in high-end tooling platforms, including cube, two-shot and high-cavitation molds. KEBO is focused predominantly on radial side-gated tools with high cavitation, as well as its own line of specialized hot runners.

Chinaplas Events Cover Recycling, Industry 4.0, Medical Plastics & Much More

Chinaplas 2019 (Guangzhou; May 21-24), which is expected to attract more than 180,000 visitors from 150 countries and regions, will present a series of events to coincide with the show, featuring themes touching on hot topics. The Plastics Recycling & Circular Economy Conference and Showcase, organized in conjunction with *China Plastics and Rubber Journal*, will take place May 20, the day before the show opens. Three themes include Material Science for Sustainability, Recycling Technology and Environmental Packaging.

iPlast 4.0, EUROMAP and VDMA are working again with Chinaplas on the Industry 4.0 Factory of the Future event with two themed areas: the Manufacturing Intelligence Control Room and Smart Factory. The Control Room, located on the viewing deck of Hall 4.2, will display operational data recorded from on-site machines and a remote smart factory. The Smart Factory at Booth 4.2D01 will simulate the production environment of the future.

Visitors can view 15 simulation scenarios, presented by partners including Engel, Ningbo Zhafir Plastics Machinery, Sumitomo (SHI) Demag, Piovan, Matsui, TIG, and Monitor.

Design x Innovation is back with three parts: CMF Inspiration Walls, Design Forum and Chinaplas Designers' Night. Covestro and Springfield are once again sponsoring the event, in addition to first-time participant PolyOne.

For the third year, Chinaplas will feature Tech Talks, May 21-23, covering 11 major themes, including new-energy vehicles, 3D printing, bioplastics, and composites. At Medical Plastics Connect, Chinaplas and partners will promote medical-grade chemical raw materials and equipment, including a Medical Plastics Guided Tour of the show. Finally, there will also be more than 70 technical seminars presented at the show.

'Mini' Low-Pressure Injection Machine Makes Large, Thick Parts at Low Cost

It can mold 70-lb parts 1 in.-thick using 100% regrind, and it can reproduce micro surface detail. Add to that its small size, frugal energy consumption, and zero upfront cost.

By Matthew H. Naitove
Executive Editor

What if you could satisfy short- to medium-run injection molding needs with the capability of a 500-ton press, in a machine that uses one-tenth as much energy and can fit into the space of a large office desk? What if you could do that with no capital investment for the press? And what if that machine would allow you to mold 100% regrind into parts that are stronger than the virgin originals?

If that sounds like an attractive proposition, those are just a few of the benefits cited for a new line of low-pressure injection molding machines being launched by Omachron Technologies in Pontypool, Ont., a new name in plastics extrusion and molding machinery. It's headed by Wayne Conrad, who calls himself "chief scientist and also president." Omachron recently came out with a line of small extruders (see last month's Keeping Up) that also serve as the plasticating section of its molding machines. After seven years in development, the first commercial models of those presses are being built now for a handful of initial customers. The company is expanding capacity to serve a broader molding audience by the end of the year.

Intrusion molding fills at low temperature and pressure, producing low-stress parts.

Omachron Technologies (*omachron-technologies.com*) is the machine-building and moldmaking arm of the Omachron family of companies. Conrad's team has been working together in R&D for the past 40 years and has over 750 patents in fields as diverse as satellite communications, personal watercraft, and appliances (*omachron.com*). Another Omachron company, Omachron Plastics, acts as a test bed for the company's machinery, using it to produce the Plasti-Block line of machineable sheets, rods, tubes, blocks and custom molded parts (*plastiblocks.com*).

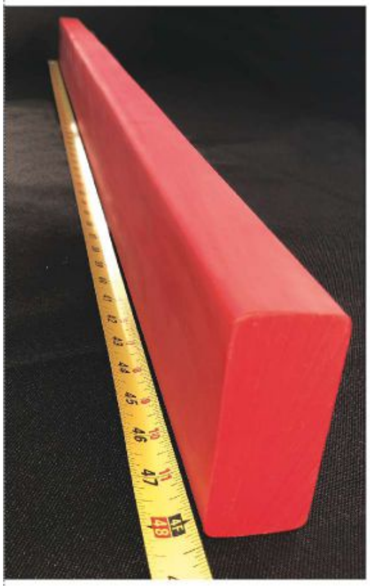
'THE POWER OF SMALL'

Omachron's commercial motto is "The Power of Small," referring to empowering small businesses to tackle big projects with low capital investment, using small-footprint machines with low power consumption. Such machines make possible "distributed manufacturing" close to customers for the machines' output, even in rural areas.

Extruder section of Omachron molding machine, with molded parts, including an 8-in.-diam. HDPE rod (blue).

There's nothing small, however, about the capacity of these molding machines. Conrad says the first model on the market can mold parts weighing up to 70 lb and measuring 24 in. wide × 36 in. tall × 1 in. thick. Conrad likes to "spec" his machines conservatively. This month, he says, Omachron Plastics will mold PE parts up to 140 lb. The firm also has orders for parts measuring 12 × 12 × 6 in. And an accompanying photo shows molded HDPE 2 × 4 in. planks, one made of virgin material 4 ft long and one of 100% regrind 6 ft long.

The secret to all this is a process sometimes called "intrusion molding," whereby the mold is filled by extrusion rather than by



This 2 × 4 in. HDPE plank, 4-ft long, was tooled up and molded only five days after the order was received.

More thick-walled parts molded on Omachron low-pressure injection machine.

injection of a pre-plasticated shot of melt. According to Conrad, this method has the benefit of low pressure, low melt temperature, and very low molded-in stresses. Typical filling pressures are 100 to 300 psi, and final packing pressures run 600 to 900 psi. Conrad cites the example of molding ABS with typical process temperatures 5° to 15° C (9° to 27° F) lower than is recommended by the material supplier—"And we still get perfect parts."

Omachron's machines have molded LLDPE, HDPE, PP, rigid PVC, ABS, nylon, acetal, UHMW-PE, PEEK and PPS. Conrad says it's possible to mold ABS, PVC and HDPE to very nearly the same dimensions in the same tool, regardless of the different materials' shrinkage. That's because his machines fill continuously during packing, through a heated inlet, so as to compensate for shrinkage in the mold.

These compact machines can produce large parts in a facility of only 1000 to 2000 ft².

That also partly accounts for Omachron's success in molding 100% regrind. For example, Conrad says his machines molded reground PVC plumbing fittings into new fittings that were 15% stronger than the originals, due to low molded-in stress. After five regrind cycles, the molded fittings still retained 10% higher strength than the virgin originals, owing to the low thermal stress of intrusion molding—without introducing any additional stabilizer additives.

Besides molding huge parts, this process reportedly also can accurately reproduce surface features down to micro scale—for example, capillary microstructures measuring only 0.001 mil.

SMALL FOOTPRINT

Another benefit of the intrusion molding process is that it greatly reduces the equipment size needed to mold large parts. Three extruders are available for the plasticating section—1 in. diam., 18:1 L/D and 1.25 in., 24:1 or 36:1 L/D. With optimized screw designs and electric motors, they require only 2 to 5 hp to produce from 10-25 lb/hr for the smallest size up to 100-120 lb/hr.

The clamp and mold are typically much larger than the extruder. The machine is all-electric with a proprietary, ballscrew-driven clamp design. The clamp has 144 tons of closing force and 5 tons of opening force. "No individual part of the machine weighs more than 60 to 70 lb," says Conrad. "And it's totally modular, so parts are easy to replace."

Molds are made of aluminum, which reduces weight, cost, and time for machining. (The molds for the 4-ft planks mentioned above were built and initial parts produced only five days after receiving the order.) Some molds are ceramic-based with a flame-sprayed nickel coating for heat transfer and corrosion protection. Molds can be mounted on a pushcart for installation—"One person can do it safely," Conrad asserts.

The machine with mold is about 3 × 7 ft—or about the footprint of a large office desk—and weighs around 2.5 tons without the mold. This is so compact that a molding operation can be established in a facility of 1000 to 2000 ft², according to Conrad.

Low power requirement also characterizes these machines, which can run on single-phase, 220V/80-89A power (or three-phase if desired).

Omachron's machines are available for lease, not sale, so there is no upfront investment (except for molds and perhaps auxiliaries like water cooling). Typical monthly lease costs are \$5000 to \$6000 (USD).

On the other hand, these machines are not for fast-cycle molding. For large, thick parts, molding cycles can range from 10 min to 1 hr.

Conrad says Omachron is building its first 10 commercial machines, which occupies its full production capacity right now. But next year it expects to expand production to 50 to 100 machines.

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

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Several Thermoplastic 'Firsts' Among SPE Automotive Awards

With the addition of an Additive Manufacturing slot, all nine categories exemplify innovation and transferability in the use of plastics.

By Lilli Manolis Sherman
Senior Editor

Spanning nine categories, including one newly added for Additive Manufacturing, the Society of Plastics Engineers Automotive Division's 2018 Blue Ribbon Automotive Innovation Awards (which this editor helped judge) represented a number of "firsts" in either metal replacement or replacement of earlier plastics solutions with better options. In this 48th annual competition, the oldest and largest competition of its kind globally, thermoplastics and/or thermoplastic composites ruled. Here's a look at the winners, starting with the grand winner award—also the winner of the Powertrain category.

POWERTRAIN: VACUUM GENERATION SYSTEM FOR BRAKE ASSIST

The open/close valve-actuation system made its debut in the 2017 Ford F-150 pickup, and was designed and supplied by Tier One supplier Dayco Products and molded by MacLean-Fogg's Engineered Plastics unit. The system utilizes two complimentary resin systems from DuPont Automotive—Delrin 73M30 acetal with PTFE, and Minion 520MP mineral-filled nylon 6—which together prevent "stick-slip" and result in no measurable wear after 2.5 million hot/cold test cycles. A 40% weight savings and a 25% cost savings over current pump systems was achieved.

This application is transferrable to other Ford platforms and is being considered by other car companies.

The 2017 Ford F-150's open/close valve actuation system—made of acetal+PTFE and nylon 6—won the powertrain category and was the grand award winner.

The window-alignment fixture in the 2017 Ford Mustang was produced by Stratasys using its FDM additive manufacturing process and nylon 12 with 35% short carbon fiber.

ADDITIVE MANUFACTURING: WINDOW ALIGNMENT FIXTURE

This fixture appears in the 2017 Ford Mustang convertible and was produced by Stratasys using its Fused Deposition Modeling (FDM) system and nylon 12 with 35% short carbon fiber. The fixture integrates pneumatic control, eyelets for a stowage rack, trigger-switch housing, ergonomic handles, gauge-protector deflector, and pneumatic-tubing retainers and switch mounts. This unit is 30% lighter and cheaper to produce than a traditional welded fixture. It is also much faster to manufacture—taking only 50 hr to build the integrated fixture with handles and mounting brackets. Moreover, ergonomics reportedly were improved significantly. The plastic fixture allows for easier handling and avoided the requirement for a lift assist.

BODY EXTERIOR: THERMOPLASTIC LIFTGATE

This liftgate appears in the 2019 Fiat Chrysler's Jeep Cherokee SUV, and was molded by Magna International's Magna Exteriors business. It's injection molded from Trinseo's DLGF 9411, a 40% long-glass PP with good flow

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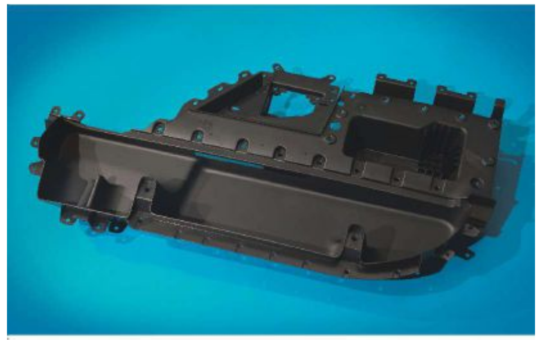
The body exterior winner was the thermoplastic liftgate that replaced a steel design on the 2019 Fiat Chrysler Jeep Cherokee SUV.



The 2018 Ford Lincoln Navigator SUV featured this integrated modular pelvic bolster made of a high-flow, high-impact PP copolymer.

This high-strength, self-tapping composite nut of 55% glass-filled nylon 66 on the 2016 Fiat Chrysler Pacifica minivan won the chassis/hardware category.

properties, and Lyondell Basell's Hifax TYC, a very high-flow TPO containing 30% glass. The integrated tethering attachments are molded in glass-filled nylon. Replacing a steel liftgate with a thermoplastic design enabled a 28% weight reduction and a 50% savings in tooling and capital investment through part integration and manufacturing efficiency.

An industry-first use of conformal infrared welding behind the MIC (molded-in-color) grain class A surface increased structural and dimensional performance and enabled quicker processing. Bonded brackets enabled novel tethering attachments without fasteners, improved metal reinforcement efficiency, and maintained styling surface wrap in D pillars without sacrificing DLO. All this was accomplished within an 18-month window.

BODY INTERIOR: INTEGRATED MODULAR PELVIC BOLSTER

This application appears on the 2018 Ford Lincoln Navigator SUV and is molded by Faurecia Interior Systems from LyondellBasell's Profax SX702, a high-flow, high-impact PP copolymer. The unit

combines two unique side-impact bolster designs. Integrating them into the map packet resulted in tooling cost savings estimated at $100,000. There was an additional $100,000 indirect savings in testing time and $8 per vehicle cost avoidance vs. using add-on bolsters. An approximate 10% weight savings was achieved.

Replacing a steel liftgate with a thermoplastic design enabled a 28% weight reduction.

CHASSIS/HARDWARE: HIGH-STRENGTH, SELF-TAPPING COMPOSITE NUT

This appears on the 2016 Fiat Crysler Pacifica minivan and is molded by ITW Deltar Fasteners from Asahi Kasei Plastics' Leona 90G55, a 55% glass-filled nylon 66. This composite nut has self-healing properties, enabling it to maintain sufficient torque and clamp load even after it has been stripped, unlike the metal nut that it replaces.

Total mass savings is 8 g per location x 121 locations, for a total vehicle mass savings of 2.1 lb for this vehicle. Estimated cost savings per vehicle is $3.25. The composite nut can be translated across all OEMs and many additional applications.

ENVIRONMENTAL: SUSTAINABLE HYBRID COMPOSITES

This center console carrier appears in the 2018 Ford Lincoln Continental luxury sedan and is an industry-first application of composites combining cellulose fiber from trees with long-glass fiber (LGF) in PP to replace 35% short-glass/mineral-filled PP. It used International Paper's Thrive cellulose composite made with Celanese's Celstran PP+HC, containing LGF and continuous glass fiber with PP and recycled PP. Melt compounding was followed by injection molding by Tier One Summit Polymers. A 24% weight savings and 13% cost savings were realized. A total of $2 million cost savings resulted from reducing weight and reducing cycle times by 20% to 40%. This is said to be the largest single automotive part thus far that is made with sustainable plant-based composite materials.

Hybrid thermoplastic composite technology was used for this integrated tire carrier, rear camera & brake light assembly that debuted on the 2018 Fiat Chrysler Jeep Wrangler SUV.

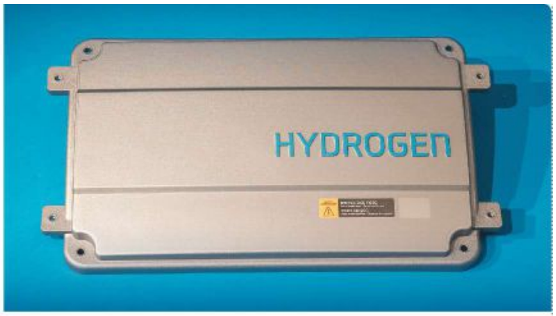
MATERIALS: EMI SHIELDING COMPOUND FOR HIGH-VOLTAGE COVER

This application debuts on the 2019 Hyundai Nexo SUV. It is made of a new conductive plastic compound from Hanwha Compound, developed specifically for EMI shielding of high-voltage junction-box upper covers. Injection molded by Yura Corp., it is made of Hanwha Compound ESM-204B nylon 6/PPO compound with hybrid conductive carbon filler (carbon fiber, nano-carbon fiber/carbon nanotubes, and carbon black). The material, which contains no metal powder or metal-coated fiber, replaces conventional die-cast aluminum covers for reduced weight and manufacturing costs. Weight savings are estimated at 30% (0.3 kg) and cost savings are estimated at 70% ($50 per vehicle.)

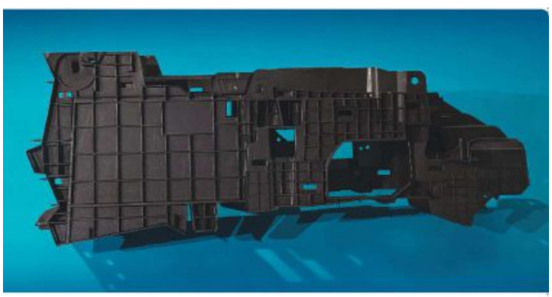
PROCESS/ASSEMBLY/ENABLING TECHNOLOGIES: INTEGRATED TIRE CARRIER, REAR CAMERA & BRAKE LIGHT

This appears on the 2018 Fiat Chrysler Jeep Wrangler SUV. Its hybrid composite technology utilizes Legerra Technologies' injection molded magnesium (thixomolding) and TMD-Grammer AG's overmolding with DuPont's Zytel ST 801 AW, an unreinforced, supertough nylon 66. It is said to offer higher structural strength with reduced weight and improved impact and corrosion resistance.

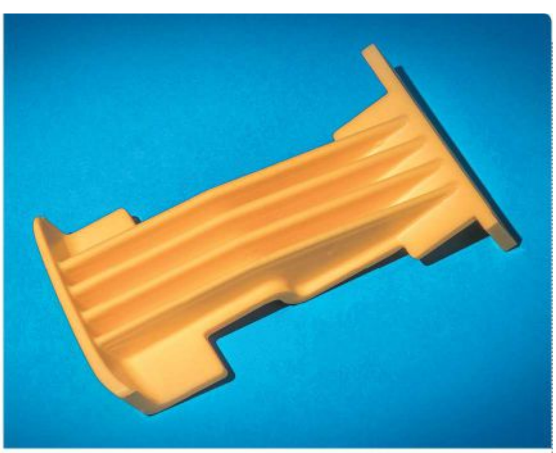
Weight savings are 60% vs. metal stamping and 20% vs. die casting. Cost savings are 20%, with an improved load rating from 85 to 115 lb. The new design also eliminates the need for a steel bracket.



This nylon 6/PPO high-voltage cover on the 2019 Hyundai Nexo SUV won the materials category.



This industry-first center console carrier in the 2018 Ford Lincoln Continental combines cellulose fiber with long-glass fiber in a PP matrix.



This ABS interlocking mechanism improves door-trim performance during side impacts by preventing fracture or separation of components. It made its debut on the 2019 Ford Transit Connect van.

SAFETY: INTERLOCKING MECHANISM DESIGN FOR SIDE IMPACT

This debuts in the 2019 Ford Transit Connect van. It was designed and molded by Faurecia Interior Systems and Thermolympic SL using Trinseo's Magnum 3325MT, a medium-heat ABS with low gloss and high flow. This interlocking mechanism improves door-trim performance during side impacts by preventing fracture or separation of components that could leave sharp edges.

This design provides strong attachments, force absorption, and high impact resistance between two components during side impact. It replaces the need for metal brackets, saving 3.70 kg per vehicle. Cost avoidance of $30.60 per vehicle and tooling-cost savings of $9.88 million were achieved.

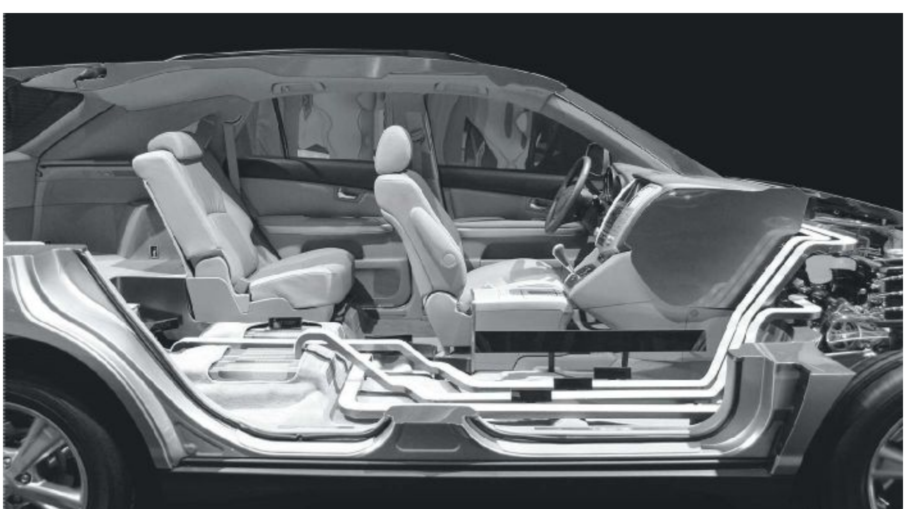
MATERIALS

Heat Deflection Temperature vs. Dynamic Mechanical Analysis

DMA provides a rich and detailed picture of polymer performance, and it can be challenging to understand all the things that we can and should know about our materials. But the fact that it may be hard does not mean that it should not be attempted.

By Mike Sepe

Since we have demonstrated the lack of detail regarding elevated-temperature performance provided by the heat-deflection temperature (HDT) test in the first two parts of this series, one may wonder why it is that we continue to perform it and publish the results. During NPE2018 I gave a short presentation entitled "Never Use HDT Values Again." But perhaps a better objective would be to never perform HDT tests again. We are so accustomed to a particular way of doing things, that as long as someone is generating the test results, people will continue to use them. But to what end?



Metal replacement requires that engineers get realistic data on thermomechanical properties of plastics.

Periodically, the question about the utility of HDT comes up in an online discussion and sometimes specific questions are asked about comparing HDT to dynamic mechanical analysis (DMA). Some of the answers are curious. I saw one response that preferred HDT "because there is a published method for it." In this individual's mind, the fact that a method exists for conducting a test is the foundation for judging the utility of that test. Aside from the fact that there are multiple methods published for DMA, it may be useful to look briefly at the history of HDT methods.

The ASTM method known as D 648 was first published in 1941. Generally, the lower the number associated with the method, the older is its initial date of publication. Most of the commonly used tests for characterizing the mechanical performance of plastics fall into this group, including tensile testing, flexural testing, and the notched Izod impact test. Unlike the HDT test, these other tests had already been well established for metallic materials and were simply adapted for use in plastics.

It is true that methods are periodically reviewed and updated; however, the general framework for performing the HDT test has not changed significantly since its inception almost 80 years ago. ISO 75 is the international analog to D 648. It contains provisions for a greater variety of sample configurations and has instituted a third stress level that is significantly higher than the two that are used in the ASTM version. But the two methods have essentially the same purpose: to identify the temperature at which the modulus of a material declines to a specific value.

Dynamic mechanical analysis first emerged as a relatively user-friendly tool for material characterization in the 1960s, although the idea of using experiments that oscillated a material to learn about its properties goes back to 1909, coincidentally the year

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that Leo Baekeland invented phenolic thermosetting plastic. DMA is a very versatile technique and can be performed on liquids and melts as well as solids. By the 1980s, instruments capable of easily performing tests on solid materials of even very high stiffness were in use and it became feasible to develop the types of curves that we showed for PBT in my February column. The initial ASTM methods for DMA were being developed during this time frame and many variations exist today.

When I first started running DMA tests in the late 1980s, the industry people who seemed most interested were from the thermoset side of the business. Manufacturers of thermosets have long been frustrated by the HDT test because many of their materials, which have evident practical advantages over high-performance thermoplastics at elevated temperatures, often display a lower HDT. The DMA curves painted a more accurate picture. When I began showing DMA curves at conferences, everyone from the industrial disciplines wanted to know where the data came from. It is a question that I still get today, which underscores the lack of awareness in the industry regarding what is available to help us better understand our materials.

It is time that we grew up. From an engineering standpoint, the most practical use of DMA is to provide a complete picture of how modulus changes with temperature.

Of course, the academicians and polymer researchers knew all about DMA. But they were not using it to better communicate engineering performance. They were using it to delve deep into polymer structure and viscoelastic properties. The publications on DMA are full of complex ideas and daunting math that do not typically attract the interest of designers and engineers tasked with developing products, even though the underpinnings of viscoelastic theory govern everything that happens to our plastic products once they are in use. In most scientific disciplines, you have theoreticians who think about foundation problems, experimentalists who verify or overturn the theories, and engineers who figure out the details of turning these discoveries into products.

Unfortunately, in the world of polymers, these groups tend to be very insular and ignore each other. DMA was a casualty of this approach; it remained a research and development tool, and the engineering community that so desperately needed better tools for assessing polymer performance remained oblivious. The versatility of DMA was obscured by its complexity, and without a spokesperson who could articulate its attributes in practical terms it was ignored by the very people who could most benefit from it.

But it is time that we grew up. From an engineering standpoint, the most practical use of DMA is to provide a complete picture of how modulus changes with temperature. If we simply started there, it would be possible to replace HDT data tomorrow with curves of modulus as a function of temperature. From there, it is possible to illustrate the analogy between the effects of temperature and the effects of time under load. DMA provides a very rich and detailed picture of polymer performance, and it can be challenging to develop a complete understanding of all the things that we can and should know about our materials. But the fact that it may be hard does not mean that it should not be attempted. If the plastics industry is going to make a credible case for capabilities such as metal replacement, we cannot continue to provide designers and engineers with HDT values and assume that we have given them enough information to make intelligent decisions about material performance.

I sat in on a webinar a few months ago regarding replacing aluminum with glass-filled nylon in an automotive application. At room temperature the modulus of the two materials was represented to be comparable and the range of temperatures for the application was -40 C to 120 C (-40 F to 248 F). After the webinar, I contacted the presenter to point out that the properties of the glass-filled nylon decline by approximately 50% between room temperature and 120 C, while the properties of aluminum would be essentially unchanged. I wanted to know how that would be communicated to the engineer doing the conversion. When he asked me how I knew this, I told him I had DMA curves. His response: "Well, those are hard to find." And that is exactly the problem.

As it turns out, they are not that hard to find. Many material suppliers, especially those who produce higher performing polymers, have been publishing them in their design manuals for years. They can also be found in some of the better material property databases. But there are problems. Because much of these data were developed by those comfortable with DMA theory, they are not always presented in a form that is user friendly to engineers and part designers. In our next article we will discuss some of these presentation problems and show how to get the most from the available information.

ABOUT THE AUTHOR Mike Sepe is an independent, global materials and processing consultant whose company, Michael P. Sepe, LLC, is based in Sedona, Ariz. He has more than 40 years of experience in the plastics industry and assists clients with material selection, designing for manufacturability, process optimization, troubleshooting, and failure analysis. Contact: *(928) 203-0408 • mike@thematerialanalyst.com*.

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INJECTION MOLDING

Mold-Clamping Details for Profit

Taking time to sweat the details of clamping is not much fun, but they do make a difference in a company's bottom line.

By John Bozzelli

Of the hundreds of variables involved in injection molding, setting up clamp movements often gets less attention than it deserves, both in setup and maintenance. Proper clamp setup and performance requires talent and attention to details. Sequencing core pulls and setting break-away speeds, acceleration, deceleration, clamp tonnage, mold protection, and ejection are some of the requirements for setting up the clamp. All these settings influence part quality (flash, for example), clamp performance, cycle time, and part cost. Clamping is an area where the processor has significant influence over the cost of molding parts. As an example, foul up the mold-protection setting and you can severely damage a tool, shutting down production with no quick fix.

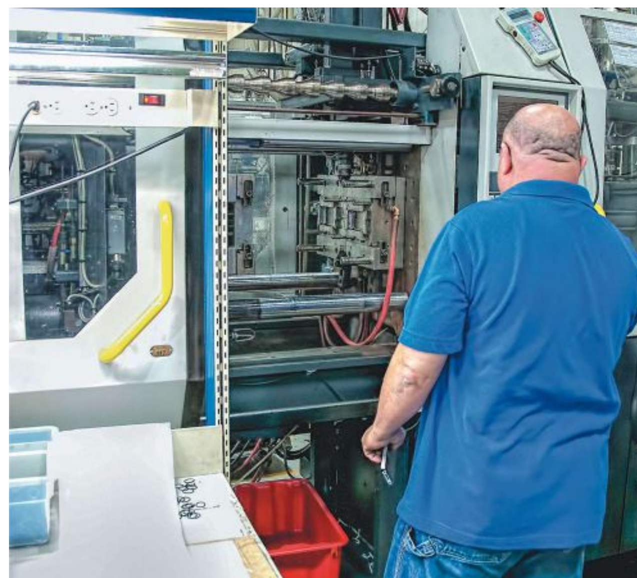
The purpose of the clamp and platen mechanisms are:

- Hold the mold.
- Close the mold with appropriate core-pull sequences and mold protection.
- Open the mold with appropriate core-pull sequences.
- Hold the mold closed with sufficient and uniform force to withstand injection pressures.
- Eject the part(s).

Clamping is an area where the processor has significant influence over the cost of molding parts.

What amazes me is the number of details required for each purpose. About two years ago I collaborated with four colleagues on a column about the proper way to mount a mold. Around that time, my fellow columnist Jim Fattori wrote his own column about locating rings and platen damage. Two articles—just to cover the first of our purposes listed above, and they provided plenty of details, tips, and reasons to respect those that do this job. Let's look at the rest of the list.

Closing the mold again requires attention to details. The first and one of the most daunting challenges is to ensure that core pulls, cam actions, or any other internal or external mold movements are sequenced and working properly. This is no small chore, and with such a variety of cores, horn pins, safeties, etc., I have no simple "To Do" list to follow. All I can offer is that if at all possible, have the moldmaker there for the first mounting and processing setup for his "work of art." Breaking something on the initial trial of a $250,000 mold is humiliating, to say the least.



Proper attention to clamp setup can go far toward minimizing mold damage and wear and optimizing cycle time for maximal part quality and minimal rejects.

Once the mold sequences are lined out, use the mold-movement safety mode to close the mold slowly with low pressure to figure out the position of the mold/clamp where you want mold protection to become functional. Set the mold-protection start position and a slow speed to protect the core, horn pin or other delicate part of the mold. This is not the last fraction of an inch before mold touch. Set a mold-protection speed, force and distance to ensure that the momentum at production speeds does not overcome mold protection. Then check this with a foam cup cut to the proper height. There is often a delicate balance between cycle time and mold protection. Poor mold protection often results in breaking core pins, which require subsequent repairs that result in profit-killing downtime. Conversely, a mold-protection sequence that is set too slow results in excess cycle time, another profit killer.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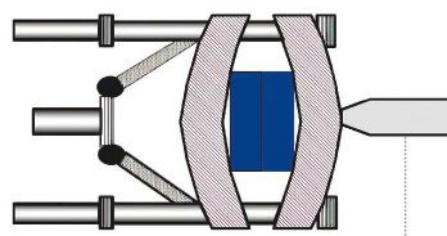
Next on the list is opening the mold. My recommendation is to open slowly for the first few millimeters. Parts do not always release equally from all sides at the same instant. Sometimes the part is held via vacuum or other factor that needs time to release. Jerking the mold open only exacerbates the problem. So open the mold slowly for a short distance, something I rarely see, due to the demand for faster cycles. But making an unusable part chews up cycle time to make another. If release is an issue, search for a mold feature that will alleviate it. It will be a large payback to add something like polish, hone, radius, vacuum break or air poppet to help release the part and keep cycle time down.

Speed is important, but due to the huge mass of these platens and the subsequent momentum, the processor needs to accelerate to the appropriate mold-open speed and distance that allow for mold deceleration to the full-open position. This acceleration and deceleration also apply to mold closing. The mass of the platens is huge and if you do not set these correctly you can have your machine jumping out of its location. Many a Crusty Sr. can tell you stories of machines ripping out electrical and water lines, literally walking across the floor. A significant safety concern! I have seen railroad *rails* bolted to the floor in an effort to keep the machines from hopping around. Granted, some machines are easier than others to set up for this acceleration and deceleration, but it is important to deal with the momentum of massive platens traveling at high speed. The machine should not be jerking around! Open and closing the mold is one issue; keeping it closed during first- and second-stage injection is another.

Toggle Clamp with Platen Wrap Exaggerated



Most of the clamping force, especially in toggle clamps, is on the corners of the mold. Clamping forces can be so high that the platen actually bows in the center, known as platen wrap.

Keeping the mold closed sounds simple, but, again, getting it done right requires attention to the details. First, the mold should take up more than 70% of the platen area. Why? Most of the clamping force, especially in toggle clamps, is on the corners of the mold. Clamping forces can be so high that the mold actually bows in the center. This is called platen wrap (see accompanying illustration). This is why a spotting press does not always tell what is happening in an actual injection molding machine. The spotting press does not provide the high pressures of molding-

machine clamps. Parting lines can be perfect in the spotting press, but not so in the molding machine. Some mold builders actually pre-stress the mold by using slightly longer support pillars in the center of the mold to compensate. Clamp closing forces need to be uniform and just a bit more than is needed. More is not better.

Do not simply max out the clamp pressure for every mold mounted in the machine. Too high a clamp force only wears the mold faster, especially the parting line and vents. Start with the lowest likely clamp pressure and dial up or down as needed. It is also nice if the machine auto-compensates clamp pressure as the mold warms up and expands. Consistent clamping force is best for a consistent process. This is a must-have for molding machines.

Finally, the last step: ejection. Again, there are details to getting it done right. My suggestions are similar to those for mold opening: Slowly eject for the first couple of millimeters, then accelerate to the minimum distance necessary to eject the part(s). Parts rarely eject uniformly off the mold. To become a believer, view a high-speed video of parts being ejected. Expensive yes, but ever so educational. You will often see one side or corner of the part stick or twist. Slow ejection gives it time to break away without twisting or warping the part. Also, parts will not pop off and fly off so fast that they ricochet off the stationary side and get scratched or fly onto the greased tiebars or rails. Lost parts equal lost profits.

> ***It is important to deal with the momentum of massive platens traveling at high speed. The machine should not be jerking around.***

Moreover, it is important to use the minimum pressure possible to eject the part(s). Why? Ejector pins are hardened and can gall after multiple strokes. Galling can get so bad that the pin sticks and actually breaks—with a portion of it still sticking out. The machine will retract the ejector plate; there will be no indication to the machine that anything is wrong. It will then close the mold, forcing the broken piece of ejector pin into the other side of the mold, causing significant and costly damage. If the ejection pressure is set properly—just enough to push the ejector pins out—when galling occurs, there will not be enough force to finish the ejection stroke, and the machine will stop with an alarm for ejection. The machine operator would then check the mold and ejection operation, spot the broken ejector pin, and call maintenance. Yes, you still have downtime, but it will be a heck of lot cheaper than mold damage.

Bottom line: taking time to sweat the details for clamping is not much fun, but they do make a difference in the company's bottom line. Take the time to train processors and setup personnel. Provide them time, tools, and equipment so they can execute the details of molding. Questions welcome.

ABOUT THE AUTHOR: John Bozzelli is the founder of Injection Molding Solutions (Scientific Molding) in Midland, Mich., a provider of training and consulting services to injection molders, including LIMS, and other specialties. Contact *john@scientificmolding.com*; *scientificmolding.com*.

EXTRUSION

Simplified Scale-Up Calculations for Melting

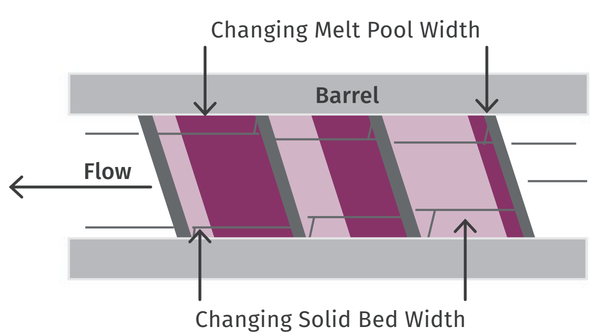
You can avoid complicated computer simulations for many melting scale-ups when designing or evaluating a screw by using a simplified method that can save time and provide good results.

Scale-up (or -down) of single screws for output involves more than just scaling the metering section. Each screw section must be considered individually and then balanced with the other sections. Adding length to one section subtracts from the others, for example. The metering/pumping section can be analyzed pretty well using the drag-flow/pressure-flow equations, as noted in my column in the January issue.

By Jim Frankland

Although some melting occurs in all sections of the screw, the vast majority happens in the compression or tapered-root-diameter section, which is referred to as the melting section. Surprising to many, the effect of conducted heat from the barrel has a relatively small effect on melting, except at very low screw speeds, compared with that caused by viscous dissipation or shearing. Once a melt film forms at the barrel wall, the temperature in the film increases quickly, so there is little temperature difference to transfer heat from the barrel to the polymer. Additionally, the polymer itself is an excellent insulator, resisting heat transfer into the unmelted polymer below the melt formed at the barrel wall. Steel, for example, is 130 times as conductive as LDPE. With the same screw geometry, polymer, and peripheral screw speed, the melting rate is thus largely proportional to the area of unmelted polymer, or solid bed, in contact with the barrel for melting by viscous dissipation or shearing.

Melting Rate Not Influenced by Channel Depth



Notice how the channel depth is gradually reduced in the melting section. This exerts pressure on the melted and unmelted polymer in the channel, so the solid and melt move down the channel at different velocities. Additionally, the relative channel volume is changing due to compression in the channel. Melting rate is largely unaffected by the channel depth, but very closely related to barrel area in contact with the solids.

Determining the melting rate for a conventional flighted screw so that a melting length and taper angle can be determined requires very complex and lengthy analysis. A simpler approach may be used for many scale-up requirements. This approach has been found to give good results when an existing screw with satisfactory performance is being scaled to another size.

In their book, *Engineering Principles of Plasticating Extrusion*, Zhev Tadmor and Imrich Klein showed the average rate of melting in a tapered channel to be:

$$\omega = (\Phi W^{0.5})/(2-(A/\psi))$$

Translating that equation into words: The rate of melting per down-channel distance in a tapered channel is the melting rate multiplied by the square root of the solid-bed width, divided by the quantity two minus the taper rate divided by the unit melting rate per rate of mass flow per unit channel depth. Despite that complexity, all the data to fill in for Φ, A, and ψ in this equation is available or relatively easily calculated, except "W", which is the width of the solids in the channel that are in contact with the barrel. Determining the width of solids in contact with the barrel at any one location is a particularly difficult analysis and is mostly a matter of estimates or analysis of precise pressure data at positions along the melting section.

As shown in the accompanying illustration, the channel depth is gradually reduced in the melting section, exerting pressure on the melted and unmelted polymer in the channel. As a result, the solid and melt generally do not move down the channel at the same velocity. Additionally, the relative channel volume is changing due to the compression in the channel. Melting rate is largely unaffected by the channel depth, but very closely related to barrel area ►

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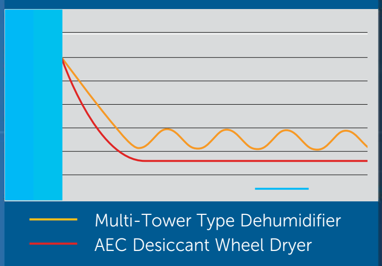

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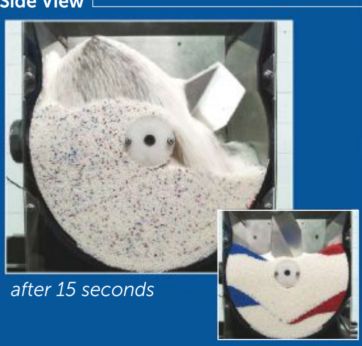
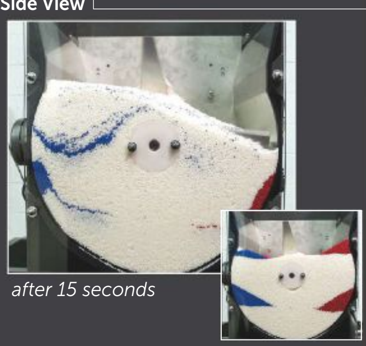


after 15 seconds

before

Industry Standard Paddle

Side View



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in contact with the solids. Consequently, the rate of melting is not directly related to the flow rate or output.

You can use a simplified approach to determine the area of solid contact, which does not actually calculate the melting rate, but only compares the melting performance of one screw to another. Of course, this applies only to processing the same polymer. If the first screw is operating satisfactorily with suitable melt temperature, stability, melt quality and screw life, then a second screw size can be scaled with good results. The same general screw geometry must, of course, be adhered to for this to work satisfactorily. It's also advisable to limit the scale-up to as small a diameter change as possible.

The ratio of the diameters squared with the same channel depths describes the change in output in the metering section $(D2/D1)^2$ for two different screw sizes having the same channel depth and geometry. However, in order to maintain similar melt quality and melt temperature, the channel-depth ratio needs to be scaled up by a second ratio. I have typically used $(D2/D1)^{0.7}$ as a general scale-up factor with good results, as noted in a previous article. Since the channel area is naturally the ratio of the square of the diameters when changing screw size, if the flight pitch and flight width are kept proportional, the increase in melting length required becomes largely proportional to the increase in depth of the metering section or $(D2/D1)^{0.7}$. This means the scale-up in output should be roughly proportional to the scale-up in melting area or $[(D2/D1)^2 \times (D2/D1)^{0.7}]$. That can be measured in helical length or simply times the number of flights at the same helix angle. For example, when scaling from a 4.5-in. to a 6-in. screw, the new melting length can be approximated as:

$(6.0/4.5)^{0.7} = 1.223 \times$ the previous number of flights.

For barrier screws, determining "W" (solid-bed width) is simplified. The main channel is expected to stay essentially full of solids, and the melt is dragged across the barrier into the melt channel as it is formed (assuming the first screw is well designed). This largely eliminates the complex calculation of the varying solid-bed width and an appropriate taper angle or compression rate for the melting section, and allows for more accurate scale-up of barrier screws using the simplified melting calculations.

Although certainly not a rigorous analysis, these approximations have worked well across hundreds of screw scale-ups (and -downs) once a good design is found with good results, thus saving a lot of time. Even if you are not designing a new screw, but just evaluating several different screws, it's a handy reference point.

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

TOOLING

PART 1

Back to Basics on Mold Venting

Here's what you need to know to improve the quality of your parts and to protect your molds.

Compressed gases inside a cavity can cause spontaneous combustion, or "dieseling."

There have been many articles and entire textbook chapters written about venting, but very few explain the complexity of what's actually going on inside the mold and the effect it can have, not only on the molded parts, but on the mold itself. Without this basic understanding, the decision on where to put vents, how many you need, how wide they should be, and how deep they should go is probably an educated guess, or worse—a trial-and-error endeavor.

By Jim Fattori

Let's start off with a couple of basic facts: 1) The mold is not empty before the plastic enters it. It's full of air. That air must escape in order to produce a good part. 2) Vents in an injection mold should let the air out, but not the liquid plastic. If you turn on the spigot to a garden hose, you will hear a hissing sound at the nozzle end for the first few seconds. That's the air escaping out of the nozzle until the hose is full of pressurized water. Mold vents should function the same way.

Flow Rates for Different Barrel Sizes and Injection Velocities

Volumetric Flow Rate, in.^{3}/sec		Injection Velocity, in./sec					
		1	2	3	4	5	6
Barrel Diameter in.	1	1	2	2	3	4	5
	2	3	6	9	13	16	19
	3	7	14	21	28	35	42
	4	13	25	38	50	63	75
	5	20	39	59	79	98	118

The primary considerations that govern how much venting you need in a mold are material flow rate, part volume, material type and grade, shear inducers, and processing conditions.

FLOW RATE

Plastic is injected into a mold at a specific rate of flow—typically in.^{3}/sec. That's an easy calculation to perform. Just multiply the area of the barrel × the injection velocity. The accompanying table lists the flow rates for various barrel diameters at various injection velocities. Obviously, the combination of a large barrel and fast injection yields a large flow rate. Flow rate is the most important factor in deciding how much venting you need.

The mold is not empty before the plastic enters it.

HOW MANY VENTS?

Almost everyone agrees that you can never have enough vents. Several industry experts recommend putting them 1 in. apart, or use any number of vents, as long as at least 30% of the perimeter of the part is vented. These are rules of thumb, which probably work most of the time, but not all of the time.

Let me put some perspective on the complexities of what we're dealing with. Assume you have a 3-in. diam. screw injecting at 4 in./sec. From the table, notice the material flows into the mold at a rate of 28 in.^{3}/sec. That's pretty fast. If I were the mold designer, I might put in say, 10 half-inch-wide vents 0.002 in. deep. That's a total of 0.010 in.^{2} of vent passageway. If I run the numbers, the speed of the air going thought the vents is theoretically: 28 in.^{3}/sec / 0.010 in.^{2} = 2827 in./sec, or 160 mph! You think that's fast? Take into account that once the material flows past a vent that vent becomes useless. Therefore, the speed of the air going through the very last vent at the end of fill in this example is theoretically 1605 mph, or a little over Mach 2. Since I've never heard a sonic boom when molding at high injection speeds, there is obviously more to this than meets the eye.

The general consensus is that the rate at which air escapes the mold should be equal to the rate at which the plastic enters into it. Let's say you're molding a relatively short, thick-walled part at a very slow fill speed in order to prevent getting any voids. One or two vents at the end of fill might be sufficient. But if you were molding a thin-walled part with a long flow length at an extremely fast fill speed in order to fill and pack out the cavity, you are going to need some serious venting. In fact, you probably can't vent it enough, and will need to reduce the injection velocity in order for the air to evacuate in time. If the air cannot escape fast enough, it will cause backpressure within the cavity. That's when part quality issues start to happen.

Flow rate is the most important factor on deciding how much venting you need.

QUALITY ISSUES

What type of quality issues are related to insufficient venting? The more common problems you might encounter are burn marks, short shots, insufficient packing, poor surface definition, internal voids, weak weld lines, dimensional variation, splay, gloss, material degradation, warpage, plate-out, residue build-up in the vents, dead spots, and parts sticking or abrading upon ejection. This formidable list of potential issues should reinforce your understanding of the need for proper venting.

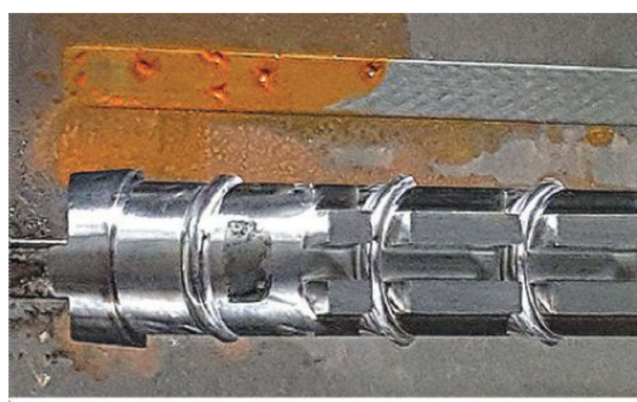
BURNING OR 'DIESELING'

Some people think a small part needs only a little venting, but a large part needs a lot of venting. That's not entirely true. It all depends on the injection flow rate. Remember, the goal is to allow the air to get out of the cavity at the same rate as the plastic coming in. Just because you have a small part with less air doesn't mean it is allowed to escape any slower.

If the air can't get out fast enough, it is going get compressed. That's both good and bad—but mostly bad. It is especially bad if it is a large cavity with a lot of air, because there is more of it to compress. When air compresses, it gets hotter by a process called adiabatic heating—the molecules are closer together and they collide more. To make matters worse, when air gets hot it wants to expand, which further increases the amount of compression and pressure in the cavity. That's why the air in your tires has a higher pressure in the summer, and lower pressure in the winter.

The air inside an injection mold can compress so much that it superheats, which can cause the resin to spontaneously combust, or "diesel," within the cavity and cause the edge of the part to burn and the cavity wall to erode. A diesel engine in a car spontaneously combusts fuel at a compression ratio of about 20:1. As any molder can tell you, there can be a fine line between a good part and a burned part. If you can see or smell burned material, which are actually carbon deposits, correct the problem as soon as possible. It doesn't take long for a cavity to erode, and cause aesthetic and ejection issues. The only good thing about the air compressing inside a cavity is that it becomes denser, and a larger volume of air will ultimately escape. After the compressed air passes though the vent, it is free to expand to its original uncompressed volume in the relief channel on the other side.

When most thermoplastics get hot, they give off gases, referred to as out-gassing of non-aqueous volatiles, or NAVs. The great majority of these gases don't adhere to the sides of the cavity or get absorbed into the plastic. They are continually pushed ahead of the melt front. These gases mix with the oxygen in the open cavity, like the cylinder in a car engine, and become combustible fuel. Some thermoplastics give off more NAVs than others. For example, PS produces very few volatiles, while PC, acetal and PVC give off quite a lot. Various material fillers, additives and colorants can also affect the amount of NAVs a material gives off. Knowing which materials give off high concentrations of gases will affect how many vents you need in order to reduce the risk of burned parts and mold erosion.



Volatiles and colorants can clog a vent.

PROCESSING

If a processor experiences burning that he believes to be due to insufficient venting, he typically reduces the injection velocity, which allows more time for the air to escape. That will usually work, but is it the right thing to do first? In addition to reducing your profits from the increased cycle time, reducing the injection velocity increases the material viscosity, which can cause other problems, such as short shots. It is a good idea to check some of the factors that can cause the material to expel so much out-gas. Maybe the material

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START AHEAD, STAY AHEAD, AND
RUN
RUN
RUN
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melt-flow index is too low and therefore too viscous. Maybe the backpressure or screw rpm is too high. Maybe the barrel temperatures are too high. Maybe the feed throat is too cold. Maybe the barrel size is too big. Maybe the nozzle tip or gate size is too small. Anything that can cause the material to shear or increase in temperature will increase the amount of out-gassing.

CHECK THE VENTS

After checking the various conditions that can create excessive gasses, inspect the vents and vent reliefs. At some point in time they will most likely clog with residue. Using mold cleaner and copper gauze will clean vents quickly and safely. Then check to see if the vents have been crushed or hobbed from going through the break-in period, or from excessive clamp force. Reducing the clamp pressure can often solve a burning issue, and it protects the mold and platens from hobbing. Several newer machines have unique clamping-sequence options, which can regulate the initial closed position or clamp pressure, and then fully close or go into high pressure at a specified point in time. This is referred to as injection-compression or coining, and can help with venting issues, as well as weak weld lines.

Bluing off a mold is a good way to check the condition of the vents.

The most common method used to check vents is with a dial indicator in the tool room. That's fine, but it doesn't take into account everything else that's going on when the mold is in the press and clamped up at high pressure. Some people like to squash a strip of solder or lead to measure the vent depths. The most accurate way to check the vents is to blue off the mold in the press. I recommend doing this in several steps. Start at very low clamp pressure and then repeatedly increase it by 10%, until you reach the pressure you are currently using. That will tell you three things: How much clamp pressure it takes just to get the two halves of the mold to seal off around the perimeter of the cavity; what the minimum clamp pressure is to prevent flashing; and what the condition of the vents are when the clamp is at the selected pressure setting.

Flow analysis can simulate the temperature and pressure of trapped gas.

It is not uncommon for a molder to place a piece of tape or an adhesive-backed label on the parting line where a part is burning to check if there is a venting issue. If the mold has heat- treated cavities and cores and the clamp pressure is reduced, that may be OK for a couple of shots to prove out the root cause, but leaving anything on a parting line for an extended period of time is nothing short of reckless, especially if the cavity or core is relatively soft.

FLOW ANALYSIS

Most of us know that flow analysis is extremely accurate at predicting the flow pattern of the material within the cavity. It shows us the weld-line locations, the dead zones and the last place(s) to fill. What you may not know is that at least one flow-analysis program that I know of can actually simulate the temperature and pressure of trapped gas, or gas that will not escape fast enough through the vents. By changing the process parameters, or adding more vents in the solid model, additional simulations can predict whether the problem will go away—before the steel is even ordered.

For those of you who like to perform a flow analysis after the mold is built, make a series of progressive short shots to determine the last place to fill, as well as any weld lines or dead corners. DuPont recommends the following: "Venting problems may be made more obvious by spraying the mold with a hydrocarbon or kerosene-based spray just before injection. If venting is poor, the hydrocarbon will cause a black spot where the air is trapped. This technique is particularly useful for detecting poor vents in multi-cavity molds. A convenient source of hydrocarbon spray is a rust-preventative spray." Now that's old-school! PT

ABOUT THE AUTHOR: Jim Fattori is a third-generation injection molder with more than 40 years of molding experience. He is the founder of Injection Mold Consulting LLC, and is also a project engineer for a large, multi-plant molder in New Jersey. Contact *jim@injectionmoldconsulting.com*; *injectionmoldconsulting.com*.

Meredith-Springfield Associates, Inc. • Ludlow, Mass.

By Matthew H. Naitove
Executive Editor

'We Don't Shy Away from a Challenge'

Meredith-Springfield thrives on technically difficult blow molding jobs that others avoid. Its latest pioneering effort is pushing the limits in the new field of EPET.

At age 65, Mel O'Leary still works 45 to 55 hours a week at the company he co-founded in 1983. "It has been a wild ride. But I still can't wait to get to my desk in the morning." That is the sound of a man who has built a profitable and expanding business by doing just the kind of work he wants to do—work that the market demands, but has few other takers. O'Leary is president and CEO of Meredith-Springfield Associates (MSA). His firm fills a need for a technical blow molder willing to tackle difficult jobs that require extensive trial-and-error development—and sometimes modifications to screws, heads and other equipment—even for low-volume or one-off jobs.

Meredith-Springfield president and CEO Mel O'Leary holds a large EPET jar molded on the Bekum machine behind him. That machine is dedicated to this new technology and business line that the firm helped pioneer.

"We don't shy away from a challenge," O'Leary states. "We like jobs where we really have to work with a process and tooling to make it do things it wasn't intended for. We learn things that can apply to the rest of the business, even more standard jobs, to make them more reliable, more consistent." For example, "We do long, narrow parts really well. We have developed the shuttle EBM technology to support the melt strength for such parts."

"We avoid the temptation to take on low-margin, commodity blow molding in favor of value-added opportunities."

He adds, "Something we do well that hardly anyone else does is one-shot jobs with tough challenges for customers that can afford it." An example was producing clear PVC globes in flame-like spiral shapes for a three-story chandelier commissioned by a casino in Macao. MSA molded 10,000 each of four different exotic globe shapes.

Another example is special medical parts for lab instruments, where the customer will need only 100 of them, ever. "Nobody else in their right mind would do it. This takes a lot of resources that other molders don't want to sacrifice to oddball jobs. That's why we get a lot of referrals from other molders. We're often the customer's last available option."

O'Leary's first guiding principle is "Take care of the customer." The second is, "Avoid the temptation to take on low-margin, commodity blow molding in favor of value-added opportunities in more technical articles, or applications that offer daunting challenges for others, such as engineering resins, secondary operations like cutting or assembly, or retail-ready packaging."

MSA has fulfilled the latter commitment with unusual shapes in HDPE, PP, PVC, ABS, nylon, TPE, TPU, and fluoropolymers. More recently, it has pushed the envelope in injection stretch-blow molding (ISBM) of PET and the newly burgeoning opportunity in extrusion blow molded (EBM) PET, or EPET.

PULLED IN BY CUSTOMERS

"I started in my basement," recalls O'Leary. He was from Springfield, Mass., and his partner was from Meredith, N.H., which was why they named their new firm Meredith-Springfield. Initially, their three-person firm offered training and consulting. It developed VHS-based blow molding education programs, which O'Leary believes were "the first commercial use of video as a training medium in plastics."

MSA's consulting work expanded to include supporting new product developments. So, in 1988, O'Leary mortgaged his house and bought a blow molding machine and rented 1600 ft² to establish a sampling lab. Demand grew and he added more employees and two more machines for sampling and development work.

Then, in the early 1990s, MSA helped Reebok develop an air-filled inner sole of TPU for athletic shoes. "The special screw and head requirements, as well as drying, made every other molder shun taking on the project," says O'Leary. "Reebok pushed us into limited production to support their launch. We ran 24/7 and shipped four Boeing 747 Freightliners-full of inner soles to China. From that experience, we realized that there was a need for a blow molder that could excel at technical molding and exotic resins."

During the Great Recession years of 2009 to 2012, MSA doubled in sales and size. "Other molders were closing plants, cutting staff, and having trouble servicing clients. We were the last man standing and took on existing work transferred from troubled molders."

He adds, "We were profitable, had no debt and ample cash. A strong balance sheet made us attractive to banks who had few other qualified borrowers and were offering never-lower financing rates." In 2009-2010, MSA bought two Aoki one-step ISBM machines to make its first entry into PET markets. "We knew nothing about it, and we relied on support from resin suppliers like DAK and Indorama. We still run some of the same jobs we started with, and the Cpk on them now is the same as before. That's testimony to the reliability and consistency of Aoki machines." ►

MSA started with one-step ISBM on Aoki machines before expanding into EPET. It may be the only firm doing both in one plant.

In EPET, MSA sticks to its policy of avoiding commodity applications like orange-juice jugs, in favor of more technical applications, like those shown here. Front: a special medical container that's round with one flat side. Rear, left: 1.5 L jar with 4-in. neck opening for storing communion wafers. Rear, right: thick-wall maple-syrup container for hot-filling at 185 F.

These EPET bottles with unusually shaped calibrated necks are other examples of MSA's pushing the envelope in this new field.

MSA's overall sales have grown 7-12% annually ever since the recession, to the current level around \$15 million. "We bought three machines in the last 19 months—one Bekum EBM and two Aoki's—and all are sold out. With 21 new mold programs in the last half of 2018, we're nearly filled to capacity on a five-day week. We're negotiating our next machine purchases and upgrading our central process-water and compressed-air systems and piping to be ready for new machines to be delivered later in the year."

Today, MSA employs around 100 people—about a third of them 10-15 year veterans—at a 90,000 ft² plant in Ludlow, Mass. The facility currently houses six double-sided continuous-extrusion shuttle machines from Bekum (H-155's) and Battenfeld Fischer (lovingly rebuilt FHB 15-2 models). One of those machines is now dedicated to EPET, and more will be in the future. There are also five Aoki ISBM machines (350 and 500 models), and provisions are being made to add three more in the near future.

> *"We went through a lot of pain to get where we are now. But given the opportunities in EPET, I'm still surprised that more mid-sized processors are not trying it."*

One of the largest Aoki machines has double-row tooling and 16 cavities, producing PET spice bottles. The newest machine is an AL-500LL-50S, the first in North America. It's one of a new series, introduced at NPE2018 (see August feature). O'Leary says this machine runs at half the cycle time of earlier ones, so around half as much tooling is required. "This makes it less expensive for the same output in quantities less than 10 million units. It needs half as much tooling for that output, so the ISBM tooling cost can now approach that of EBM. It removes the barrier to the customer getting exactly the neck finish desired." MSA is currently running personal-care bottles on the new machine in three cavities on a 10-sec cycle.

MSA's two largest markets are food packaging and personal care/HIC (household and industrial chemical) containers, each approximately 20% of the firm's business. Medical reagents account for about 10%; and a mix of consumer and industrial products (such as lawn and garden, ice packs, and water-bottle cases) is another 30%.

"When we consider a potential job, I ask, does it fit our equipment? Do we have the expertise for it? I don't care what the market is—except for only two. We avoid cosmetics and automotive work because they require another whole level of management."

CHALLENGING PARTS

Examples of long, thin parts made by MSA include EBM deck balusters of PVC—thick-walled parts imitating highly milled shapes. MSA still runs a lot of PVC, including devotional candle holders produced at a rate of 10 million a year.

MSA explores unusual applications for ISBM PET, too, such as this line of bar ware. These are molded with a dome that is spin trimmed; then the neck is rolled and compressed into a smooth, round profile with a special process and tooling invented in-house.


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One of the firm's most challenging EBM applications is a small lab reagent reservoir of HDPE. "This one really pushed our capabilities," says O'Leary, pointing out its two calibrated neck openings, facing at different angles roughly 180° apart, at opposite ends of the part. What's more, the blow ratio is at 90° to the parting line. "Nine of 10 blow molders would say it can't be done," O'Leary observes. Another unusual HDPE part is a two-chambered part with two necks and a hollow handle. The largest EBM part MSA has molded measured 36 in. tall × 12 in. wide × 8 in. deep.

"We regard EPET as a lower-cost stepping stone to ISBM for bottles with unusual neck finishes or very tough blow ratios."

Although the Reebok mid-sole is no longer in production, MSA blow molds TPU flexible boots and vapor-containment collars for gas-pump dispensing nozzles. Another unusual resin run by MSA is Eastman's Tritan proprietary copolyester, which is used for a gallon handleware jug for photographic chemicals.

MSA thrives on challenges, even in EBM HDPE. This lab reagent container with two calibrated necks at different angles 180° apart, and blow ratio at 90° to the parting line. "That one really pushed our capabilities," says O'Leary. "Nine out of 10 blow molders would say it couldn't be done."

MSA has a few customers for multilayer EBM. One application is a three-layer HDPE container for a surgical adhesive. The inner layer is virgin resin with no additives that could react with the adhesive. The outer layer contains color and UV blocker, while the middle layer is regrind. MSA can also make containers with view stripes.

PET accounts for about half of the firm's business, the majority of that in ISBM. An example of unusual work MSA is doing in this field is a line of bar ware that has a smooth, round lip. These parts are molded with a dome that is subsequently trimmed off. Then, the drink glasses move on a conveyor from the ISBM machine and trimmer to a special lip-former designed by MSA that applies heat and pressure to the rim of each cup, folding it over and welding into a smooth bead.

EPET PIONEER

MSA's experience in the emerging field of EPET (see January Close-Up) goes back at least two decades. O'Leary recalls, "Twenty or 25 years ago, Eastman, DuPont and others promoted a version of EPET, but it was a finicky resin and very expensive, so it faded away.

"Then, 10 years ago, it re-emerged. We did some of the initial sampling for Eastman and DAK. It was a major commitment for us. We accumulated a lot of regrind before we got it figured out. We participated in the development of special screws. We worked with W. Muller on multi-parison head design for EPET." MSA runs up to three parisons and six cavities; O'Leary thinks others run only one or two parisons. It took multiple iterations of both screw and head designs to achieve success.

"The machine also needs tight temperature control and high-temperature barrel heaters. And we had to learn about material handling for EPET—drying, blending and recrystallizing regrind." Drying, in particular, is unfamiliar to many extrusion blow molders. "EPET material has to be bone dry (-45 F dewpoint) or it loses melt strength. And you can't use the regrind if loses IV due to moisture degradation." MSA uses up to 65% regrind in some EPET products.

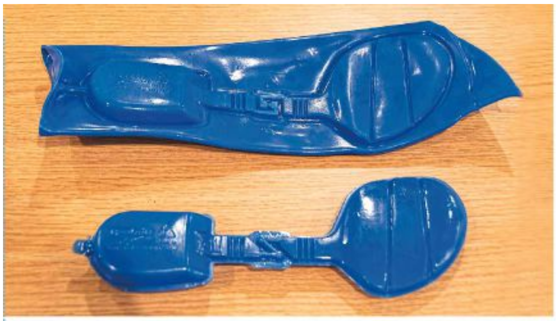
Another EBM challenge in HDPE: This two-chamber part with a blown neck.

"I remember when extrusion blow molding of PVC came in during the 1970s—it was the same sort of learning curve," recalls O'Leary. His conclusion: "We went through a lot of pain to get where we are now with EPET. But the resins are much better now, and the special equipment designs have been worked out. But it's still not for the faint of heart. It's not like molding HDPE, where anything goes. You need strict process control. But given the opportunities in EPET, I'm still surprised that more mid-sized processors are not trying it."

MSA takes on unusual materials, like TPU for this fuel-filler boot.

O'Leary explains, "We regard EPET as a lower-cost stepping stone to ISBM for unique bottles with unusual neck finishes or very tough blow ratios. It's a way for an application to get established at lower tooling cost than for ISBM. It's an option for a brand owner or an independent entrepreneur who doesn't know how big the demand for the product will ultimately be, but he needs a clear bottle and a handle or a large blow ratio or a special neck—all things that don't lend themselves to ISBM."

If the sales volume eventually justifies a step up to ISBM, he notes, the price per container actually goes down. That's because



The TPU Reebok Dynamic Mid-Sole was the job that got MSA into production molding for technically challenging jobs.

MSA tackles one-off jobs that require significant processing development work, even for limited runs. It molded 10,000 each of four different unusually shaped lighting globes in PVC for a three-story chandelier for a casino in Macao.

conventional PET bottle resin (0.8 IV) costs 20-30% less than EPET at 1.3 IV. What's more, ISBM has lower conversion cost, owing to lower labor input and less scrap, according to O'Leary.

EPET is about 12% of MSA's business now, with 15 or 16 steady jobs. Committed to non-commodity work, MSA has not pursued the successful opening for EPET in orange-juice bottles. Rather, MSA has developed unusual and innovative applications in food, personal-care, and medical packaging, such as these examples:

- A 21-in.-long container for a special medical application. It has a 28-mm neck opening and a round profile, except for one flat side, so it won't roll on a counter or bench.
- A 1.5-liter, wide-mouth jar for storing communion wafers. The 4-in. neck opening is achieved by molding a dome and removing it by spin-trimming. (O'Leary is holding the jar with dome attached on the front cover.)
- A maple syrup jar with a heavy wall to mimic glass. What's unusual is that it is filled at 185 F, above the glass-transition temperature (Tg) of the resin—"something that shouldn't be possible," O'Leary notes.
- EPET containers with unusually shaped calibrated necks, such as an oval or a triangular pour spout (photo, p. 42).

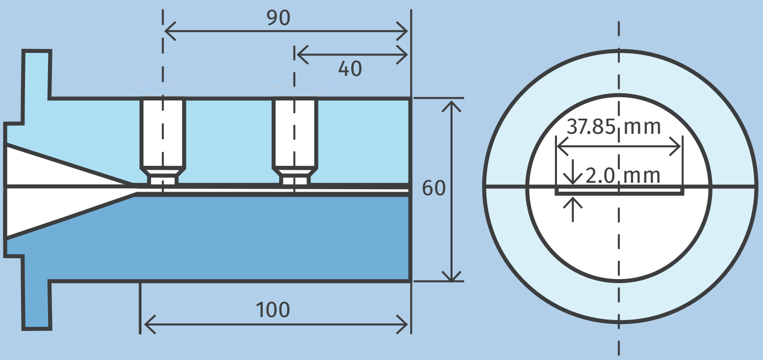
(Read what Mel O'Leary says about automation and information management at MSA at PTOnline.com.) PT

PART 1

How to Determine Viscosity Data Using a Slit-Die Viscometer

Using a slit-die viscometer connected to a lab extruder can generate accurate data on melt viscosity at various shear rates and temperatures, a useful QC tool in processing.

FIG 1 Schematic of Slit Die Used in Study



By Chris Rauwendaal
Rauwendaal Extrusion Engineering

Data on melt viscosity at various shear rates is useful in extrusion operations. Such data provides a valuable quality-control tool. Viscosity data is required in screw and die design and in computer simulation of the extrusion process. Proper selection of an extruder screw or extrusion die requires knowledge of viscosity as a function of shear rate. Further, instabilities such as melt fracture can be quantified and predicted if viscosity data is obtained from a capillary rheometer or slit-die viscometer.

The slit-die viscometer provides an inexpensive method to determine rheological data, especially when compared with a capillary rheometer.

This article describes how a slit-die viscometer connected to a laboratory extruder can be used to obtain accurate data on melt viscosity at various shear rates and temperatures. The slit-die viscometer provides an inexpensive method to determine rheological data, especially when compared with a capillary rheometer.

A slit die has a rectangular channel with a width *W* much greater than the height *H* ($W>>H$). The slit die can be connected directly to a laboratory extruder. Alternatively, a gear pump can be placed between the extruder and the slit die. Figure 1 shows a schematic drawing of the slit die used in this study.

The shear rate at the wall of the slit die is a function of the flow rate. The apparent shear rate can be determined from the following expression:
(apparent wall shear rate) = (flow rate) × (6H²W)

The actual shear rate for a power-law fluid with power-law index *n* is:
(actual wall shear rate) = (apparent wall shear rate) × (0.667+0.333⁄n)

The shear stress at the wall can be determined from the pressure gradient of the measured pressure profile:
(shear stress) = 0.5H × (pressure gradient)

With the shear stress and the shear rate we can determine the shear viscosity:
(shear viscosity) = (shear stress) ÷ (shear rate)

In order to get viscosity data over a range of shear rates, the extruder has to run at various screw speeds. Each screw speed corresponds to a certain flow rate and thus to a certain shear rate. In order to determine the flow rate, the extruder output for each screw speed has to be measured. When a gear pump is used, the speed of the gear pump can be used to determine the flow rate and shear rate.

COLLECTING DATA & CALCULATING VISCOSITY

Data collection is easy when a data-acquisition system (DAS) is available. In this study the data were obtained on a 1-in. single-screw extruder at the Graham Engineering Corp. (GEC) lab in York, Pa. The extrusion runs with the slit die were part of a seminar work-

TABLE 1
Data on Screw Speed, Flow Rate, and Pressures

9-10 Lab 1						
rpm	lb/hr	g/sec	m^3/sec	P_1 psi	P_2 psi	P_3 psi
5.00	0.54	0.06810	8.731E-08	1178	781.6	329.2
10.00	1.02	0.12863	1.649E-07	1549	1067	453.9
20.00	1.95	0.24592	3.153E-07	2040	1435	614.7
40.00	3.84	0.48427	6.209E-07	2675	1914	825.2
60.00	5.52	0.69613	8.925E-07	3016	2205	954.3
78.00	6.84	0.86260	1.106E-06	3205	2385	1036

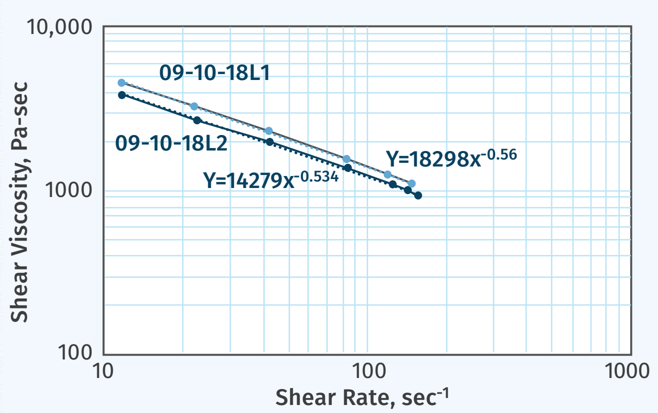
TABLE 2
Data on Pressures, Pressure Gradient, Shear Stress, Shear Rate, Viscosity

9-10 Lab 1					
P_2 Pa	P_3 Pa	P/L Average	Shear Stress, Pa	Shear Rate, sec^{-1}	Viscosity, Pa-sec
5.390E+06	2.270E+06	5.968E+07	52662.16	11.64	4523.842
7.359E+06	3.130E+06	8.153E+07	71937.23	21.99	3271.569
9.897E+06	4.239E+06	1.097E+08	96790.96	42.04	2302.516
1.320E+07	5.691E+06	1.464E+08	129153.48	82.78	1560.19
1.521E+07	6.581E+06	1.687E+08	148826.57	119.00	1250.673
1.645E+07	7.145E+06	1.825E+08	161014.20	147.45	1091.97

shop conducted by Rauwendaal Extrusion Engineering in cooperation with GEC. The data-acquisition software was part of the Navigator XC300 control system used by GEC.

The DAS data was exported to Excel in a CSV (comma-separated values) format. Table 1 shows data on screw speed, flow rate, and pressures for lab 1 with extruder and die temperatures at 400 F. In Excel the data can be processed in a variety of ways. This allows automatic determination of the pressure gradient, shear stress, shear rate, and shear viscosity, as shown in Table 2.

FIG 2 **Melt Viscosity vs. Shear Rate at 400 and 440F**



From the power-law equations shown here you can determine the consistency index and the power-law index at the two temperatures. The power-law parameters are shown in Table 3.

The polymer was a 0.5 MI HDPE 273-83 made by Kazanorgsintez, Kazan, Tatarstan, a republic of the Russian Federation. The extruder was run at six screw speeds: 5, 10, 20, 40, 60, and 78 rpm. The maximum screw speed on this extruder was 80 rpm. These screw speeds correspond to a shear-rate range from about 10 sec^{-1} to 150 sec^{-1}. The extruder was run at two temperatures, 400 F (204.4 C) and 440 F (226.7 C).

In order to get viscosity data over a range of shear rates, the extruder has to run at various screw speeds.

At this point we have enough information to determine the melt viscosity as a function of shear rate. Figure 2 shows the viscosity versus shear rate at two temperatures (indicated as L1 and L2) using a log-log plot. On a log-log plot the data fits well with a straight line. This means that the viscosity can be expressed as a function of shear rate using the power-law equation.

TABLE 3 **Power Law Index and Consistency Index Values**

Power Law Index at 400 F	0.466
Power Law Index at 440 F	0.440
Consistency Index at 400 F	18298 Pa-sec^n
Consistency Index at 440 F	14279 Pa-sec^n

Figure 2 shows the power-curve equations. From these equations we can determine the consistency index and the power-law index at the two temperatures. The power-law parameters are shown in Table 3.

We see a small change (about 5%) in the value of the power-law index from 400 F to 440 F. The consistency index drops significantly (about 30%) from 400 F to 440 F.

We now have data on viscosity vs. shear rate at two temperatures. At this point it is useful to analyze some performance characteristics of the extruder. That will be the focus of Part 2 of this series.

ABOUT THE AUTHOR: Dr. Chris Rauwendaal is a well-known author, lecturer, researcher, entrepreneur, and consultant in the field of extrusion. He holds numerous patents and has written more than 200 articles and seven books related to extrusion, mixing, injection molding, and statistical process control. A Fellow of the Society of Plastics Engineers (SPE), he is the developer of the CRD, VIP, and ASM mixing technologies that utilize strong elongational flow to improve mixing in extrusion and molding. Rauwendaal also developed the HHT (high-heat-transfer) extruder screw designed to improve cooling in foam tandem and other extrusion operations. In 1990 he founded and is still president of Rauwendaal Extrusion Engineering. Contact: *(530) 269-1082; chris@rauwendaal.com; rauwendaal.com.*

Time to Turn Up the Heat on Your Hot-Runner Maintenance Program

Molders are running more hot-runner manifolds than ever, a trend that's expected to continue. But once you have them, you need to keep them in shape. Follow these tips to get going.

By Steve Johnson
MoldTrax Maintenance Solutions

More and more injection molders are specifying hot-runner molds these days. And due to the advantages this technology offers vs. their cold-runner counterparts, suppliers expect hot-manifold systems will be found in 60% to 80% of new tools in upcoming years.

But as great as they are in reducing molding costs and improving design capabilities, hot runners come with a truckload of potential production and maintenance issues. Someone must keep them in good shape, then repair them when they wear out or break, and they will—they *all* will, regardless of the manufacturer or cost of the system. The reason is that *people* have the final say in how they are run, maintained and repaired. Too often it is an element of the molding and shop environment that is the root cause of many of the problems manifolds suffer.

WHAT YOU WILL LEARN

1. **ELECTRICAL POSITIONING/MAPPING:** Map out systems for position verification of TCs, heaters at every PM.
2. **TESTING HEATERS AND TCs:** Right heater size and thermocouple style must be used, installed properly.
3. **IR TESTING:** Use a shot of high voltage to ensure the insulation material is not compromised.
4. **KEEP IT CLEAN AND DRY:** Contamination of insulation is often more of a problem than degradation.

Mold T-Rex New Heater = 200 ohms
10% over new = 220

			Manifold PM Dates				
			2/6/2018	4/6/2018	6/20/2018	8/7/2018	10/23/2018
Zone	Pin #'s	Mold/ Position	Heater Resistance	Heater Resistance	Heater Resistance	Heater Resistance	Heater Resistance
1	1-13	1	221.7	220.6	219.1	219.1	218
2	2-14	2	176.5	176	177.3	176.3	178
3	3-15	3	175.7	174.7	176	174.8	175
4	4-16	4	218.9	221.2	221.9	220.1	218
5	5-17	5	209.8	188	188.3	186.4	187
6	6-18	6	217	217.1	218.7	215.1	213
7	7-19	7	215.1	212.4	210.1	214.4	211
8	8-20	8	170	168.8	170.4	169.8	188
9	9-21	9	220.8	220.8	220.2	220	215
10	10-22	10	168.9	168.4	169.2	168.1	169
11	11-23	11	178.3	177.4	178.4	177.8	178
12	12-24	12	214.4	211.5	210.6	212.6	209
13	1-13	13	170.9	170.7	171.2	170.3	171
14	2-14	14	172.4	171.9	172.3	172.3	173
15	3-15	15	176.3	175.8	176.7	175.7	176
16	4-16	16	170.03	168.2	169.6	168.8	170
17	5-17	Man	17.3	17.2	17.3	17.1	17
18	6-18	Man	17.6	17.5	17.7	17.8	18
19	7-19	Bridge	24.9	24.8	25	24.3	25
20	8-20	Sprue	247	243.9	247.3	246.2	246
21	9-21		0				
22	10-22		0				
23	11-23		0				
24	12-24		0				

A simple Excel spread sheet can be used to track ohm readings at each PM and can be set up to flag the user when a reading crosses a "critical" threshold. This sheet is a proactive tool to better determine heater and thermocouple life.

Not to say that there aren't some systems that are just a pain to work on because "maintenance-friendly features" were not included in the design process. Manifold "performance" always

After the ohm reading is concluded, matching ohms to the pin number on the connector, use a heat gun to verify that the positions match the pin numbers.

An attendee at a Moldtrax training seminar records his readings into the Moldtrax documentation system that has a special section dedicated to hot-manifold components and work instructions.

gets prioritized over "maintenance efficiency," so the repair technicians must learn the nuances of each system based on its own production and maintenance requirements. Things like skinny wire channels with bolted wire clips, wires routed *through* plates instead of *between* them, control boxes with small access holes, thermocouples requiring multiple tight bends to fit properly and/or are jammed under tight-fitting nozzle heaters with built-in elements topped off with potted manifold heaters are just a few bad design ideas that frustrate techs and raise the stress levels along with labor costs—causing some to grab the big hammer just to help "git'r done."

Bench skills, or the physical side of maintenance, is always important to a professional job. But one of the most necessary "soft skills" that repair technicians need to possess is the virtue of patience. The difference between working on a two-cavity manifold system vs. a 48-cavity system is the level of personal organization at the bench, the methodology used, and the patience of Job. Our ability as repair technicians to *not* rush through a preventative maintenance (PM) for the sake of getting a mold back into the press to appease production is paramount to success. Granted, it's a fine line to negotiate, but necessary when you consider the alternative where repairs are short-cut and the mold returns to the shop after a few days worse that when it left.

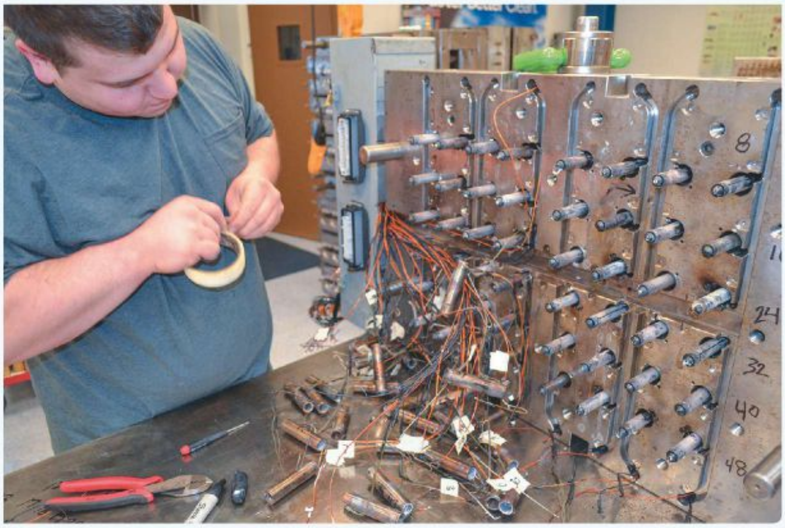
> **One of the most necessary "soft skills" that repair technicians need to possess is the virtue of patience.**

BAD RAP

In mold repair shops around the world, hot-runner systems have the reputation of being "something we don't mess with" when it comes time for in-house repair technicians to disassemble, troubleshoot, clean, inspect and reassemble them. One little mistake like a loose bolt, pinched wire, brass shrapnel (from hammers, punches and other "soft" tools), residual plastic, and other collateral damage inflicted by using the wrong tool the wrong way—and a failure to comprehend how much force should be applied with a tool—can lead to catastrophic results. And that is just on the maintenance side. Failure to use proper startup and shutdown procedures can also have disastrous effects. Such effects are also hard to pinpoint or determine a root cause for, leading processors to exclaim, "It's a tool issue," when in fact it might have something to do with shutting off the water and leaving the heats on over the weekend, or shooting a tool without the proper heat "soak time" to allow for full expansion of critical components. All that is just part of the environment in which manifolds are expected to perform.

The fact is, manifolds and related components are not that difficult to work on when considering the level of maintenance performed by the average repair technicians who work on close-tolerance ejector systems, cores, cavities, spring-loaded slides, cams and other dynamic tooling configurations. Obviously, one can't go brain-dead with *any* type of close-tolerance mold work without creating more issues than get repaired. The difference between a cold runner and a hot runner is making a mistake on a cold runner that causes a water or oil leak is *usually* not as disastrous as encapsulating with plastic a manifold plate full of wires, heaters, nozzles, thermocouples and other delicate components, creating a plastic armadillo. The moral is, the skill required with hot runners isn't necessarily always more demanding, but the consequences of mistakes can be less forgiving.

Whenever hot-runner manifolds are disassembled for PM's or to repair issues that affect production or part quality, a few basic bench principles should be applied. After reading the recommendations below, determine whether these basic rules of hot-runner bench practices are being utilized in your shop. If not, training is in order.



An attendee at a training seminar labels heaters and thermocouples with their home positions, ensuring delicate wires don't need to be re-bent and possibly broken during installation.

SKILL UP ... OR SEND IT OUT?

I took a call today from a large closure company that typically sent out manifold work even for simple issues like seal replacement. They made the decision to PM their systems in-house, and the first manifold they opened up was completely encapsulated with plastic—so now what? Next step for them is to get training on not only how to deal with it, but how to prevent major leaks.

Training to perform in-house manifold PMs and keep hot-runner systems healthy is also gaining steam from custom molders who want to grow their business by taking on more difficult products, and thus molds. Any time a molder skills-up to take on delicate and critical work usually results in faster and more cost-efficient repairs vs. crating it up, shipping it out, and waiting for the work to be completed and returned to the plant. You will be able to react much faster and not have your hands tied in getting your critical production needs to fit a vendor's schedule. We have trained molders who literally saved millions of dollars per year in maintenance costs by keeping hot-runner and other mold work, such as welding and polishing, in-house. Also, your maintenance team will appreciate not having a "ceiling" attached to their skills and development potential, which brings a whole boatload of personnel advantages relating to bench confidence, motivation, professionalism and pay grade.

HOT-RUNNER WEAK LINK

There are many areas in manifold work that deserve more space than this article will allow, so let's focus on the area of greatest need for most shops. Typically, 90% of the attendees at our hot-runner training seminars—experienced or not—are weakest in their electrical skills and understanding how thermocouples and heaters actually work, and what to test for. So here is an overview of some of the work involved when dealing with electrical testing of manifold components in a typical hot-runner system and an explanation of how monitoring this data allows shops to be more proactive.

Electrical/Positional Mapping: Mapping out systems for position verification of thermocouples and heaters is a procedure that should be completed at every PM. It is extremely frustrating for processing techs to attempt to troubleshoot and control a specific cavity position if the heaters or thermocouples are not labeled properly in relation to the connectors and the mold cavity position. This procedure does not take long and does not require a controller, as a standard heat gun and ohmmeter will suffice.

Testing Heaters and Thermocouples: Mold performance and part quality depend on the ability to control precisely the temperature of nozzles, bridges and manifolds. This means the right heater size (diameter and wattage) and appropriate thermocouple style must be used and installed properly. It is critical that this information be documented in a location readily available to technicians.

Typically, 90% of the attendees at our hot-runner training seminars—experienced or not—are weakest in their electrical skills.

Thermocouples read only at the tip, so it is imperative that they be installed at the correct depth and the tip not insulated from the nozzle by an air gap or excess plastic. Thermocouple resistance should read between 2 and 9 ohms using a 3-in. or shorter lead wire. It is not recommended to "splice" thermocouples, as the splice may alter the resistance reading, which makes monitoring and troubleshooting more difficult.

If a thermocouple is "kinked" during replacement or cleaning, it will read at the kinked area—or not at all—so great care needs to be taken when bending and forming a new thermocouple to fit. Many thermocouples in multi-cavity molds are

formed into "left- and right-hand" positions, so it is necessary to re-install them into their home positions, so they do not require "re-bending" that risks breakage.

All heaters (sprue, bridge, manifold, nozzles) should be tested before and after every PM for *connectivity*—i.e., dead shorts or grounding from pinches, cuts or loose connections. A typical ohm-meter may be used, but we really like the Fast Heat MoldXChecker.

We also recommend that a resistance test (measured in ohms) be performed and documented whenever the mold is out of the press, to verify it's in good working order based on historical resistance readings over time. A resistance test verifies the condition of the nichrome element inside the heater

When creating this data sheet, document the resistance of a similar new heater to establish a baseline to compare other heaters with. Over time, as the nichrome heater element degrades, the resistance or ohms reading will slowly rise and can be monitored to get a better idea of when a heater should be replaced. If a heater fails during production, you can go back to the last ohm reading to get an idea of a top "threshold" to use that would signal it's time to replace other heaters approaching this number, helping to fine-tune the threshold and maximize heater life.

It is important to standardize the testing procedure (ohmmeter used and temperature of the heater when tested), as the rise in ohms should be a gradual change but will vary if the heater or room temperature changes. Heaters should only be tested at room temperature—or "cold"—since a warmer heater will have a higher ohm reading than a cold one. As you see in the chart, the ohm readings vary slightly but nothing too alarming.

Training to perform in-house manifold PMs and keep hot-runner systems healthy is also gaining steam from custom molders.

Monitoring resistance is a great proactive tool that becomes more important with long-running molds to ensure cavitation is not lost or production interrupted.

Insulation Resistance Testing (IR): A secondary test we like to perform on heaters is an Insulation Resistance (IR) test that uses a shot of high voltage (typically 500 VDC) to ensure the insulation material (most commonly magnesium oxide, MgO) is not compromised and allowing the electrical current from the element to bleed out to the sheath, which could lead to an early heater failure. MgO has a good combination of dielectric strength and very good thermal conductivity, so it does a great job of insulating the inner heating element electrically, but still allows heat to be conducted out and away to the sheath and into the nozzle or manifold. The temperature limit for MgO is usually around 2000 F, so it can handle internal

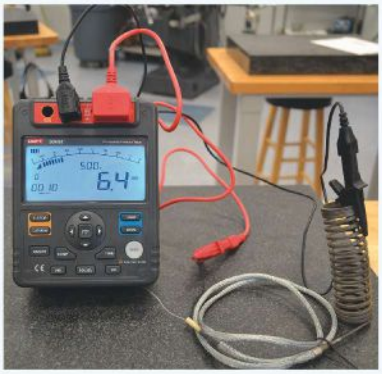
QUESTIONS ABOUT MAINTAINING HOT RUNNERS?
Learn more at PTonline.com
Visit the Hot Runner and Mold Maintenance Zones.

temperatures in the range of 1600 F typically generated by inner nichrome wire elements. Once again, these readings should be taken cold, as the IR (typically measured in mega-ohms) can drop significantly once the heater is warmed up.

General coil-heater specifications from heater manufacturers list IR thresholds in their literature as low as 5 mega-ohms (cold) for unsealed, square-coil or tubular heaters, up to over 100 mega-ohms (cold) in some cases for sealed heaters. Others can have measurements that go into the giga-ohms (1 billion ohms), indicating a very strong dielectric insulation. In theory, a 1 mega-ohm (1 million ohms) IR reading is sufficient for 240V systems, as that would only be about 0.2mA of leakage current. *(V = IR; I = 240V/1,000,000 ohms = 0.0002 amps)*

Regardless, all heaters need to be tested and compared with an "as-new" reading to monitor for degradation. When performing an IR test, remember also that safety is of paramount concern since high voltage is used—so don't touch the metal sheath, bare wires or connectors during the test, or let them contact a steel bench top, which could be enlightening.

Keep it Clean and Dry: Contamination of the MgO is often more of a problem than degradation. MgO is hygroscopic, so it readily attracts moisture—not a good thing. Many high-performance/high-watt-density, hot-runner nozzle heaters are fully sealed to prevent contamination by moisture, oil, etc. but may still be contaminated if the seal is damaged during removal, cleaning or installation. So it is critical to handle these components carefully and never immerse them in any type of solvent or liquid cleaning solution. That said, some tubular elements for manifolds are *not* fully sealed, and are considered less critical because of the larger internal clearances. These can provide many months of service if handled and cleaned properly. If moisture contamination is suspected in the MgO, "baking out" the heaters at a high temp can boil out the contaminants and regenerate the insulation value.



The IR tester shows a heater being tested at 500VDC with an outcome of a perfectly acceptable 6.4 mega-ohms.

Baking out *unsealed* heaters that have absorbed moisture can be done any of several ways:

- Using the "soft-start" function on a controller. Here, the heaters are brought up to temperature very slowly, without using full line voltage. By bringing the temperature up gradually, any trapped moisture or contaminants can be slowly boiled out of the MgO insulation. It's important to understand that even if the thermocouple for the zone might be reading only 150 F, the internal nichrome wire (even with soft-start) may be glowing inside the element at 500-1000 F. So, just like good barbeque, "low and slow" is a good rule to follow here.
- Unsealed heaters can also be placed inside an oven to dry out the internal MgO insulation. An oven temperature in the 250 F range for an overnight cycle can sometimes work a "miracle" and doesn't damage or melt most lead-wire insulation.

Other types of manifold heaters can be left in the manifold and placed in an oven at 850–900 F without damage to the insulation or sheath. This can "refresh" the insulation without damage while the heater remains installed in the hot-runner manifold. However, the lead wires need to be removed beforehand, since they are not rated to 900 F and would just burn away. You can sometimes see a big difference in IR readings before and after "cooking" these manifold heaters in the cleaning furnace as the MgO is renewed.


The Fast Heat MoldXChecker quickly and accurately verifies the health of a mold's electrical system by checking for shorts and ohms.

IS IT REALLY THAT BAD?

Hot-runner work requires a higher level of mechanical and electrical skills to be successful. Mistakes made, and procedures not followed, overlooked or simply ignored can have catastrophic consequences for man and mold. All the economic efficiency that a hot runner brings to the table is lost when it goes down for extended amounts of time while new heaters, thermocouples and other expensive components are ordered and replaced.

ABOUT THE AUTHOR: Steve Johnson is president of MoldTrax Maintenance Solutions, Ashland, Ohio, which provides specialized course work, hands-on bench training, maintenance software, maintenance products, toolroom design and maintenance efficiency auditing. Contact *419-281-0790*; *steve@moldtrax.com*; *moldtrax.com.*

Plastics Technology

WEBINAR *a feature of PTonline.com*

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Predicting Processing Parameters Using Machine Learning

One problem in the injection molding industry is the lack of processing parameters provided to molders and engineers. Materials routinely lack the necessary data to confidently set a first pass of processing parameters. Consequently, these parameters have to be inferred from similar materials or experience. This webinar discusses the development of a new technology to predict missing processing parameters by using Machine Learning. Users will be introduced to Machine Learning, and how it applies to the plastics industry. We will outline approaches using data and computers to reliably predict processing parameters and provide these to the engineer via web and mobile experiences.

PRIMARY TOPICS:

- What is Machine Learning
- How Machine Learning applies to the plastics industry
- Predicting undocumented processing parameters using ML
- Availability of the technology

PRESENTERS

MOBILE SPECS

Jeff Selden,
Director of Machine Learning

Jeff Selden is the Director of Machine Learning at MobileSpecs. Jeff has a PhD in Mathematics from the University of Arizona. Jeff has spent over 20 years as a collegiate instructor and researcher in mathematics.

Doug Kenik, *Managing Director*

Doug Kenik is the Managing Director of MobileSpecs. Doug has a MS in Mechanical Engineering, and has spent 10+ years in the composites and plastics industry as a developer and Product Manager for structural and process simulation software technologies.

Keeping Up With Technology

PRODUCT FOCUS **Extrusion**

EXTRUSION

Non-Motorized Puller Assemblies for Downstream Product Handling

Non-motorized puller assemblies from Versa Machinery are available in pinch-roll and caterpillar designs for a wide variety of downstream handling requirements. They offer speeds up to 900 ft/min and a variety of belt- or pinch-wheel materials.

P series Pinch Wheel feeds are commonly used where materials are insensitive to pinching pressure and in operations requiring minimal pulling force. They are available with roller widths from 2 to 5.5 in., with roll materials offering different traction and wear characteristics. These pinch-roll pullers are suited to manufacturing weed-whacker lines and 3D-printer filaments; moving and punching rigid profiles; and capturing materials trimmed from the edges of various profile and film extrusions.

C Series caterpillar feeds provide uniform pressure over the entire traction length, which enables greater pulling force without product deformation. Belt configurations range from 2 in.-wide × 9 in.-long to 4 × 18 in. These pullers are suitable for pulling materials through braiding machines, feeding disc-brake materials into grinders, and pulling wire and cable, extruded vinyl siding, etc.

Available belt and pinch-wheel materials include sponge, gum rubber, silicone, neoprene, urethane, or nitrile, some of which are FDA approved. Various durometer ratings are available to suit application requirements. Gear-driven units are recommended for applications to 250 fpm. For even higher speeds, belt-driven, low-backlash units are recommended.

Standard non-motorized puller assemblies are equipped with a hand wheel to adjust the belt gap, which opens and closes around a constant centerline. Optional pneumatic operation of the belt booms along a constant centerline allows control of the pressure on the product being pulled and makes repeatable setup almost instantaneous. Additional options include left-to-right configuration, and OSHA guarding package.

EXTRUSION

Gravimetric Blending & Line Control

New from Moretto is the DLK Gravico continuous loss-in-weight blender with extrusion weight control to maintain consistent extrudate weight per linear unit. Suitable for film, pipe, profiles, and sheet, the system meters up to seven components. Its Navigator 9000 touchscreen control manages extruder hauloff and screw-speed control, as well as air-ring and gauge control. It samples 4000 times/sec while handling throughputs up to 4400 lb/hr.

EXTRUSION

Terahertz Sensor For Sheet, Webs

FACTS Inc.'s new TeraGauge sensor for sheet and web offers non-ionizing, non-contact, on-line measurement that is said to be completely safe and capable of operating in harsh environments. This sensor reportedly represents a breakthrough in web-gauging technology with precise, repeatable, high-speed measurement packaged in a compact, single-sided scanner. The FACTS Total Gauge Control System integrates the TeraGauge into a comprehensive, single-window automation solution.

Now, basis weight, density, monolayer and multilayer thickness measurements can be made using the single-sided TeraGauge sensor with accuracy that is equal to or better than conventional technologies. This new measurement architecture can replace multiple scanner and sensor configurations, reducing maintenance while improving accuracy and results. TeraGauge measurements are suitable for clear and opaque film and sheet; foam products; barrier-layer thickness measurement, including individual layer thicknesses; and products with variable mineral filler or pigment content.

FACTS can retrofit conventional sensors on current web-gauging systems with this technology, which reportedly can reduce the measurement payload, rationalize calibration, improve reliability, and lower the cost of web-gauging maintenance and ownership.

COMPOUNDING

Industry 4.0 Solutions for Twin-Screws

In order to meet the ever-increasing demand for data acquisition and analysis, Krauss-Maffei Berstorff has developed two new options for its line of ZE BluePower twin-screw extruders. The first of these developments is hardware and software to synchronously collect, record and analyze all production data from a compounding line. Data analysis provides a basis for process optimization for productivity and quality improvements.

Thanks to its modular design and easy configuration, the system can be adapted to a wide range of applications and scaled in size. All interfaces can be integrated into an overall system that collects and visualizes the desired process data. Pressure, temperature, speed, and volume-flow values of all upstream and downstream components, as well as the extruder parameters, are combined in a single system.

The second development is designed to detect instantly any ingredient metering errors in order to reduce production scrap and enhance line efficiency. This in-line measuring system is based on color measurement: light is projected into the melt, reflected and then detected by a high-resolution glass-fiber sensor. Upon comparison with the previously defined setpoint, any deviation in terms of brightness or color is instantly recognized and indicated. The color-measuring system can be integrated into the overall line control.

INJECTION MOLDING

New App Gives Machine Operating Data Anywhere, Anytime

The German parent of Boy Machines introduced last month its Status App, which provides 24/7 remote production monitoring of Boy injection presses. The app sends data to the Boy server in Germany, from which it is visible on any internet-connected device. Even older Boy machines with analog controls can be connected via the app.

Data visible with the app include the ID of the article being molded, target and actual quantities of parts produced, number of parts remaining in the job, and percent effectiveness.

COMPOUNDING

Multi-Shaft Mixer Can Be Customized

Charles Ross & Son Co., Hauppauge, N.Y., recently designed a custom 150-gal triple-shaft mixer (VersaMix Model VMC-150) with elaborate automation and safety functions. Notable among the special added features are six pneumatic clamps rated at 4000 lb each for remote locking of the mix vessel to the mixer cover, designed for 29.5-in. Hg vacuum and 5-psi internal pressure. The clamps also function as redundant limit switches, allowing operation only when secured. The VMC-150 includes automated valves for powder feed and CIP liquids; RTD multi-point temperature sensor; built-in vacuum-pump assembly; load-cell system; and centralized control interface.

Three independently driven agitators on this type of mixer include a high-speed, saw-tooth dispersing blade for quick product wetout; a three-wing anchor for efficient transport of viscous product throughout the mixing zone; and a third shaft, frequently a high-shear rotor/stator homogenizer for emulsification. The pictured VMC-150 instead features a helical auger screw for submerging floating agglomerates. When reversed, the auger screw surfaces air pockets, resulting in decreased batch cycle time. The sides and bottom of the mixing vessel are jacketed and insulated for operation up to 100 psig at 250 F.

INJECTION MOLDING

Beam-Mounted Articulated Robot for Medium to Large Presses

New from HYRobotics is the H5 series for demolding and handling large parts. It is suited to applications with low headroom and for automating secondary operations. These articulated robots have an unusual design with four servo axes, including two wrist motions, plus a servo traverse axis along a beam. It comes with a new, 7.5-in. touchscreen controller, two vacuum circuits (with sensor), one gripper circuit and one pressure circuit, both with monitoring sensor input. (Watch a video of the robot in action on a 2500-ton press at ***short.ptonline.com/HYRobotics***.)

INJECTION MOLDING

New Picker, Robots & Box Packer

Several new automation products have been introduced by Wemo of Sweden, part of the German Hahn Group and represented here by newly established Hahn Plastics Automation in Avon, Conn. (see Starting Up section). All of these were shown at October's Fakuma 2018 show in Germany.

Wemo's new 3-5 linear sprue picker/robot for small parts (also exhibited at last month's Plastec West show in Anaheim, Calif.) is a modestly priced servo picker/parts remover (shown at left) available with a pneumatic C-axis wrist. It has a Z stroke of 1500 mm, X stroke of 300 mm, and Y stroke of 1000 mm. One vacuum and one gripper circuit (with part-detection sensor) are included. Price is $11,499.

At Fakuma, Wemo's new eLine of economical servo robots was shown for injection machines from 25 to 1000 tons. The model 250 has a 25-kg (55-lb) payload capacity, suited to presses of 500 to 1000 tons. Intended to serve 80-90% of the market, these robots are designed for basic demold-and-drop, pick-and-place applications, but they can also manipulate parts for quality checks, labeling, laser marking, etc.

Also new at Fakuma was the xPacker (photo above left), an enclosed module for palletizing and depalletizing. A conveyor brings full boxes into the module, where a linear servo robot stacks the boxes on pallets. Multifunction tooling senses the size of the box and actuates only the vacuum holes needed for gripping the package. Thus, no setup is required. Plug-and-play design is said to make it easy to install.

MATERIALS

'Anti-Squeak' ABS, PC and Blends

Germany's Albis Plastics (U.S. office in Sugar Land, Texas) is offering its new Alcom MS "Anti Squeak" family of compounds for automotive and consumer electronics. These ABS, PC or PC-blend materials reportedly provide improved stick-slip behavior, which reduces the risk of unwanted noise when coming into contact with other casing materials.

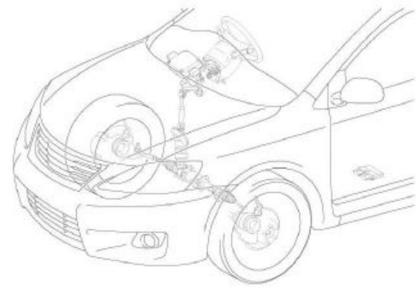
MATERIALS

New PBT with High Alkali Resistance

Japan's Polyplastics Group (U.S. office in Farmington Hills, Mich.) has launched a new PBT that reportedly delivers excellent alkali stress-crack resistance for automotive applications. Duranex 532AR also boasts outstanding hydrolysis and heat-shock resistance and electrical performance for components in the chassis and engine compartment. It is suited to parts that can be splashed by water and mud and chemicals such as snow-melting agents.

Duranex 532AR is said to reduce risk of cracking in molded articles by preventing alkali (often arising from rust formation in metal parts) from penetrating the resin. Recent tests show that when specimens are immersed in alkali, cracking occurs within 2 hr for standard Duranex 3300 PBT and hydrolysis- and heat-shock-resistant Duranex 531HS. In contrast, no stress cracking occurs in Duranex 532AR when immersed for up to 200 hr.

Electrical components and sensors installed near the engine often contain metal inserts and sudden temperature changes can cause heat-shock fractures. This occurs because the metal and resin have thermal-expansion coefficients that differ by roughly a factor of 10.



RECYCLING

Ultra-Fine Melt Filtration for PET

Ettlinger Kunststoffmaschinen GmbH of Germany (U.S. office in Tyrone, Ga.) has unveiled its latest ECO series melt filters with a smaller filtration screen of 60 microns. This reportedly will make it easier to extrude post-consumer recycled PET bottle flake and fines into sheet, packaging tape and fiber, and will help plastics recyclers remove challenging contaminants like paints, silicones, barrier materials, crosslinked fractions and gels from the melt.

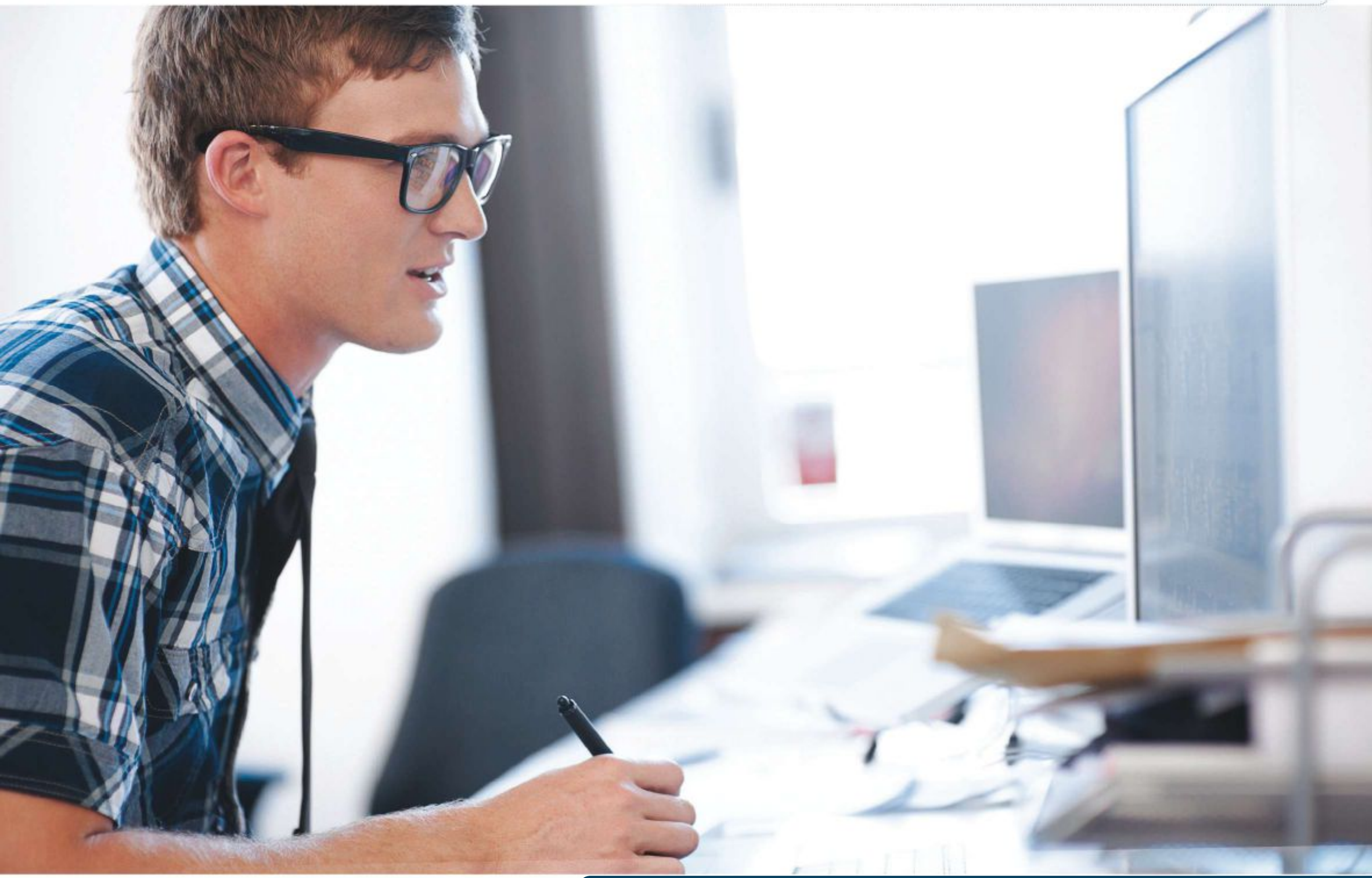
The purity of the recycled material is central to its usability. Ettlinger says that in PET recycling, the efficiency of melt filtration is far more critical than usual. The screen changers and screens normally employed for this purpose have limitations, whereas Ettlinger's self-cleaning ECO filter systems permit compliance with even the toughest specifications.

The core component of the ECO filter is a rotating, cylindrical steel screen with millions of laser-drilled, conical holes. When melt flows through this screen from the outside to the inside, any contaminants are retained on the surface and continuously removed by a scraper. The launch of microperforated filtration fineness of 60 microns is described by the company as a "decisive breakthrough" for PET recycling.

The company says its continuous melt filters open up new possibilities for materials that have traditionally been considered too heavily contaminated or that contain extremely problematic contaminants. Ettlinger's rigid filter screen with laser-drilled microperforation is said to yield much better separation efficiency than standard woven steel-mesh screens. Due to the new 60-micron filtration fineness, the few residual contaminants are no longer visible to the human eye. Significantly reduced occurrence of black specks and other particles helps make the downstream processing more efficient because contaminants result in virtually no torn tapes or fibers.

Plastics Technology

WEBINAR *a feature of PTonline.com*



Wednesday, March 13th
2:00 PM ET

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A Guide to Extruder Upgrades: Building a Business Case for Extruder Upgrades

Have you ever been asked to upgrade an extruder? Are your older systems currently ranked based upon risk? Do you currently have a way to qualify vendors and rate system solutions? Would you like to know the path to obtain more consistent quotations? Would you like a process that allows you to make recommendations to management that ensure the greatest potential for success? If this is part of your job requirements, you will want to attend this session!

PRIMARY TOPICS:

- Identify Your Level of System Risk
- Learn the Key to System Justification
- Qualify Vendor Expertise and Product Capabilities
- Make Logical Recommendations to Management

PRESENTER

Dan Barlow
President

Integrated Control Technologies

Dan Barlow is the President of Integrated Control Technologies, a privately held US-based company that specializes in Extruder Drive and Control Upgrades. With over 30 years of electrical control experience, Dan served as the Vice-President of Operations of one of the largest Allen-Bradley distributors in the South. With his combined technical and procedural expertise, Dan has the ability to provide a logical path for navigating the requirements to a successful extruder upgrade.

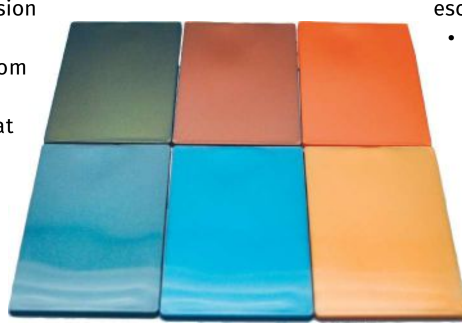
ADDITIVES

Special-Effects Liquid Colors for Packaging & Consumer Products

New special-effects liquid colors, including metallics, pearlescents, super-brights, and transparent tints, plus "natural" grades, are now available from Riverdale Global. The extensive product launch is said to enable makers of packaging and consumer products to enhance shelf appeal and add value while using lower letdowns of colorant than with pellet masterbatch. The increased coloring efficiency of liquid color is attributable to a higher pigment loading per pound of colorant and enhanced dispersion as a result of the liquid carrier.

Like other liquid colors and additives from Riverdale Global, the new special-effect colors are each supplied in a container that stays sealed from the moment it arrives at the processor's loading dock, through storage, handling, and metering into the process, and during return to Riverdale Global for refilling.

The specialty colors include:



- *Deep Pearl*. For these colors, Riverdale Global selected particles that provide a standard pearlescent effect at lower letdowns.
- *Transparent Pearl*. Used at 0.5% loadings in clear resins, these colors exhibit a glitter effect.
- *Blast*. These colors provide super-bright pearlescent effects while minimizing flow lines.
- *Splash*. These colors combine bright specialty pigments and pearlescent particles to yield super-bright effects.
- *Metal*. These colors yield a smooth, flat surface with a metallic sheen.
- *Metal Expression*. Larger particle sizes in these colors yields a glittery metallic effect.
- *Transparent*. These colors can be used at loadings of only 0.1% to tint clear resins.
- *Natural*. Helping to achieve sustainability goals, these are dispersions of FDA-approved colors in natural carriers.

Commodity Resin Prices Bottom Out

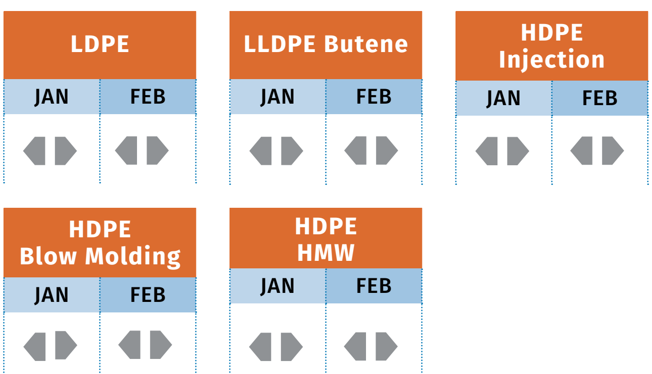
Flat-to-upward pricing trajectory predicted for the five highest-volume commodity resins.

Higher global crude-oil prices, firming prices of key feedstocks, higher export volumes in some cases, and a rebound in demand in some other cases, are key drivers in projections for flat to at least slightly higher prices ahead for PE, PP, PS, PVC, and PET.

By Lilli Manolis Sherman
Senior Editor

These are the views of purchasing consultants from Resin Technology, Inc. (RTi), senior editors from *PetroChemWire* (*PCW*), and CEO Michael Greenberg of The Plastics Exchange.

Polyethylene Price Trends



Market Prices Effective Mid-February 2019

Resin Grade	¢/lb
POLYETHYLENE (railcar)	
LDPE, LINER	95-97
LLDPE BUTENE, FILM	78-80
NYMEX 'FINANCIAL' FUTURES	37
MARCH	37
HDPE, G-P INJECTION	100-102
HDPE, BLOW MOLDING	93-95
NYMEX 'FINANCIAL' FUTURES	40
MARCH	40
HDPE, HMW FILM	107-109
POLYPROPYLENE (railcar)	
G-P HOMOPOLYMER, INJECTION	80-82
NYMEX 'FINANCIAL' FUTURES	51
MARCH	51
IMPACT COPOLYMER	82-84
POLYSTYRENE (railcar)	
G-P CRYSTAL	99-101
HIPS	105-107
PVC RESIN (railcar)	
G-P HOMOPOLYMER	83-85
PIPE GRADE	82-84
PET (truckload)	
U.S. BOTTLE GRADE	61-63

PE PRICES FLAT

Polyethylene prices rolled over in January, with no sign of the announced industrywide 6¢/lb increases. Suppliers delayed the increase, generally splitting it in half—3¢ in February, 3¢ in March. Both Mike Burns, RTi's v.p. of PE markets, and *PCW* senior editor David Barry thought there was a pretty slim chance that suppliers would get even a 3¢/lb hike.

Noted Burns, "This would be a totally supplier-driven increase. They had the highest export volume for December, and the previous five to six months were also record months. Suppliers added 300 million lb to their inventories in December, the highest ever in the last decade." He added that even scheduled plant turnarounds planned for March and April by LyondellBasell (LBI), Nova Chemicals and CP Chem would make no dent in material availability.

The Plastics Exchange's Greenberg reported spot PE volumes to be markedly improved from the last two months of 2018 and plentiful overall. "Export interest remains exceptionally strong and Houston-area warehouses are still full and playing catch-up from the year-end rush. More new resin production is on the way, so it will be worth watching how the growing infrastructure will be able to handle it all."

PCW's Barry reported that in their fourth quarter reviews, PE suppliers conceded that their increased capacity had impacted PE margins. He noted that ExxonMobil Chemical expected downward margin pressure to continue in 2019, whereas LBI sources noted that the slower pace of capacity additions in 2019-20 would provide time for 4-5% global demand growth to absorb the new supply. Barry reported that Sasol had nearly completed commissioning its new 1-billion-lb/yr LLDPE unit at Lake Charles, La.; while ExxonMobil confirmed that its new 1.4-billion-lb LLDPE unit at Beaumont, Tex., was on track for midyear startup; and LBI expects to start up its 1.1-billion-lb HDPE project in Point Comfort, Tex., in the third quarter.

PP PRICES BOTTOM OUT

Polypropylene prices dropped 2¢/lb in January, in step with propylene monomer prices, which settled at 40¢/lb. As we entered February, PP and monomer prices had each dropped by 21¢/lb since November 2018. Not only was there no sign of suppliers' announced profit-margin increases, but there were industry reports of some margin erosion. Still, both *PCW*'s Barry and Scott Newell, RTi's v.p. of PP markets, ventured that PP prices were bottoming out. Newell projected flat February prices and potential for a 4-6¢/lb increase in monomer and PP during March or April. Still, neither source expects PP prices to rise this year to the high levels of 2018.

Said Barry, "Right now, PP prices are pretty much in parity with global prices, which last was the case in the first half of 2018." He noted that PP plants were operating at high utilization rates—mid-90s—due to low monomer costs.

The Plastic Exchange's Greenberg reported that despite growing supplies of propylene monomer upstream, prices had stabilized and were pointing to slowly rising ahead.

Polypropylene Price Trends

Homopolymer	
JAN	FEB
2¢/lb	

Copolymer	
JAN	FEB
2¢/lb	

PS PRICES BOTTOM OUT

Polystyrene prices dropped by 2¢/lb in January, following a 7¢/lb drop in December, and last month appeared to be holding even with January levels, barring an unplanned disruption, according to both *PCW*'s Barry and Robin Chesshier, RTi's v.p. of PE, PS and nylon 6 markets. Both sources thought PS prices had bottomed out, and projected flat-to-upwards movement this month or in April.

PCW's Barry noted that implied styrene production costs based on a 30/70 formula of spot ethylene and benzene feedstocks were 23.6¢/lb, up from around 22¢/lb at the start of the year. He said the monomer pricing trajectory would depend largely on crude-oil and benzene prices and demand for styrene exports. Chesshier noted concern going forward about adequate benzene supplies—both domestic and imports. She expected higher benzene prices, which could result in monomer increases of 3-7¢/lb in March-April, depending on how PS demand shapes up at the start of the second quarter. Upward price movement in spot styrene monomer and butadiene, in addition to benzene, would appear to help support a firming up of PS prices. Chesshier noted higher monomer export demand, coming from new destinations—primarily Africa—to offset export tariffs imposed on China.

Polystyrene Price Trends

GPPS	
JAN	FEB
2¢/lb	

HIPS	
JAN	FEB
2¢/lb	

PVC PRICES MOVING UP

PVC prices held even for the third month in a row in January, but the landscape was likely to change with PVC suppliers seeking a 4¢/lb increase in February, according to both Mark Kallman, RTi's v.p. of PVC and engineering resin markets, and *PCW* senior editor Donna Todd. Kallman ventured that flat pricing or a 1-3¢/lb increase between February and March were equally possible, depending on demand, which appeared to have slowed domestically and globally. The second quarter, when demand typically "heats up," could result in a change in direction for prices, he noted.

Todd noted that one industry pundit was predicting suppliers' increase would be split in half for February and March. "As usual, resin buyers were divided into two camps over the impending 2¢/lb increase for February. Pipe converters were mostly pleased to see a PVC price increase announced, as they figure it will enable them to push up their own pipe prices. Non-pipe PVC converters were not pleased with such an early price hike and "flimsy reasoning"—with "no key drivers to support the increase," Todd reported.

PVC Price Trends

Pipe	
JAN	FEB
	1-3¢/lb

Gen. Purpose	
JAN	FEB
	1-3¢/lb

PET PRICES DOWN, THEN UP

Prices for domestic bottle-grade PET going into February were about 63¢/lb, down 3-5¢ from January. Bloated supply from U.S. producers and imports from around the world are making it a buyers' market, according to *PCW* senior editor Xavier Cronin. Imported PET was in the low-to-mid-60s ¢/lb for delivery to port—higher for East Coast than West Coast destinations. Truckload business was 2-5¢/lb higher, depending on distance.

Cronin reported that market sources saw prices rebounding this month by 1-3¢/lb for prime PET as demand for PET bottles and packaging expands ahead of the warm-weather heavy-consumption period for carbonated soft drinks and other beverages in PET bottles. At the same time, demand for rPET clear FDA pellets remains strong and competes in some instances with prime PET (and offgrade) as consumer brand owners seek more recycled plastic in their packaging. Meanwhile, the removal last fall of U.S. anti-dumping duties from five countries that accounted for about 40% of all imports in 2017 was expected to increase PET imports this year. PT

PET Price Trends

Bottle Grade	
JAN	FEB
	3-5¢/lb

New Year Starts Strong

January Index of 54.6 is fueled by expansion in production.

By Michael Guckes
Chief Economist

The Gardner Business Index (GBI) for plastics processing began 2019 by moving higher, to a level of 54.6 that was led by a strong expansion in production. The sub-indexes for both production and new orders moved higher in January after showing slowing growth during fourth-quarter 2018. (Values over 50 indicate expansion; values under 50 mean contraction; 50 = no change.)

The index is 1% lower than the same month a year ago, just before the Index reached an all-time high. Of the six components used to calculate the Plastics Processing Index, production and supplier deliveries pushed the overall Index up. All other components pulled the Index lower; however, all components posted improved results over the prior month and none showed a contraction. Although production expanded faster than any other component, backlogs also grew for the first time since September.

January's results also marked the first time since July 2018 that every component of the index expanded. During the second half of 2018, exports posted five consecutive months of contraction and backlogs two months of contraction. This lackluster performance occurred simultaneously with new trade tariffs taking affect during the second half of 2018. Despite this multi-month contraction in exports, new orders have expanded in all but one month since the beginning of 2017, suggesting that domestic demand for plastic goods has been able to offset the recent weakness in foreign orders.

For the first time since May 2018, supplier deliveries ceded its position as the leading component of the Index to production (not visible in Fig. 2, which shows three-month moving averages). Still, the latest supplier-deliveries reading remains well within the range of accelerated growth readings experienced at the height of the current business cycle, which began in early 2017.

The Plastics Processing Index is based on monthly surveys of *Plastics Technology*'s subscribers. PT

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

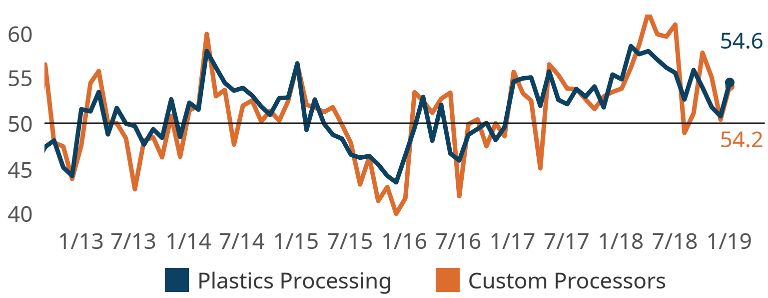


FIG 1

The Plastics Processing Index rebounded at the start of the year after indicating slowing growth during the final months of 2018. All plastics processors, which include captive operations, and custom processors expanded at a similar rate.

Production Overtakes Supplier Deliveries to Raise Index

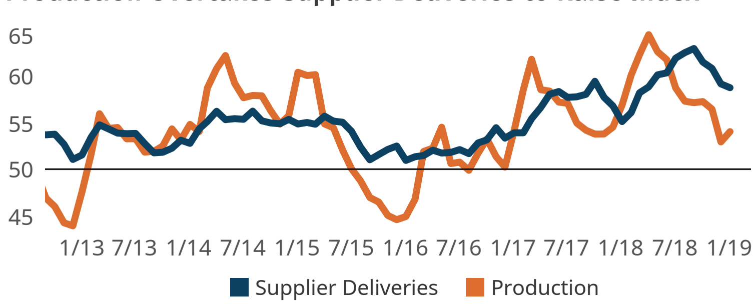


FIG 2

January's production and supplier deliveries readings crossed for the first time since May of 2018. (This is not evident in the graph, which shows three-month moving averages.)

Expectations for Electronics Defy Headlines

The electronics industry seems expected track with the overall economy's growth for 2019, though firms with greater exposure to China may have to be more cauutious during the year.

By Michael Guckes
Chief Economist

The electronics industry entered 2019 overshadowed by concerns over shrinking demand for electronics goods in China, joined with tepid demand in the U.S. This was capped by Apple's January 2 announcement of weaker-than-expected fourth-quarter 2018 sales of its core electronics products. Such headwinds at the start of the year, combined with an extended U.S. government shutdown and prolonged tariff negotiations with China, have generated concerns among many businesses.

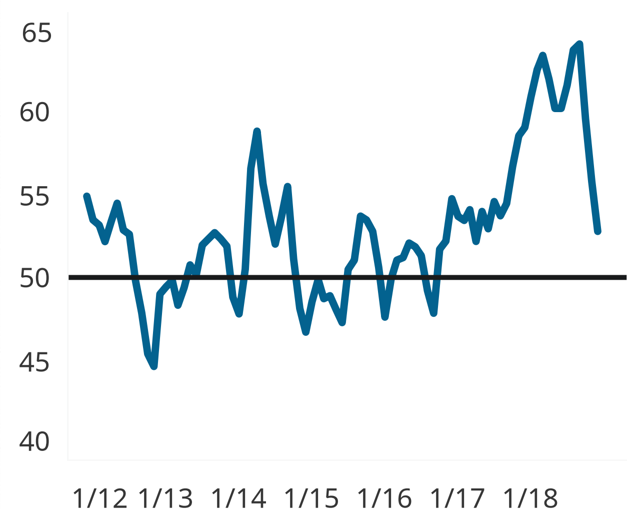
These events have complicated matters for those looking for insights into what 2019 may hold and how to respond in the face of potentially greater near-term volatility. These early announcements sent the Dow Jones Industrial Average into a frenzy during which it fell more than 10% in the course of just a few weeks in December. This was in part because Apple's shares constitute a nearly 5% stake in the Dow Jones Industrials and more than a 10% stake in the Nasdaq 100, according to Factset.

The electronics industry—less Apple's share—is expected to see inflation-adjusted revenue growth of 3.5% in 2019, combined with even stronger earnings growth. This is based on the actual and forecasted financial results of nearly 60 electronics industry firms generating $658 billion in revenues in the 12-month period ending with the third quarter of 2018. Including Apple's third-quarter 2018 projections pushes the industry's overall revenue growth up to 8.5% by year-end 2019. From a domestic perspective, the sector seems expected to follow in line with the overall economy's growth; however, firms with greater exposure to China may have to be more cautious during the year.

The electronics industry—less Apple's share—is expected to see inflation-adjusted revenue growth of 3.5% in 2019.

Gardner's proprietary data from U.S. manufacturers serving the electronics industry largely mirrors Wall Street's tepid 2019 outlook. The latest Gardner employment readings are above long-run averages, which suggests that firms are still optimistic about making investments in people and thus are optimistic for the longer-run. Simultaneously, production, new orders, backlogs and supplier deliveries at year-end 2018 were flat to slightly growing after a two-year period in which many of these measures set record highs. Despite a toughening trade environment in 2018, Gardner's export data did not contract during the second half of 2018, although the data indicated generally slowing export growth through December.

Gardner Business Index (GBI): Electronics



Lastly, Gardner's data indicated that smaller firms (20 employees or fewer) experienced disproportionately more challenging economic conditions during the fourth quarter of 2018 than their larger peers with more than 100 employees. This reinforces the common understanding that smaller firms often have fewer options when maneuvering through more challenging business conditions and thus are more sensitive to economic change.

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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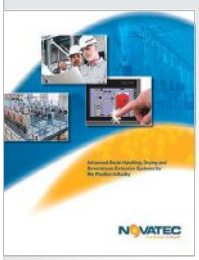

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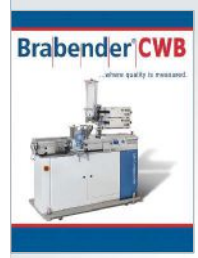

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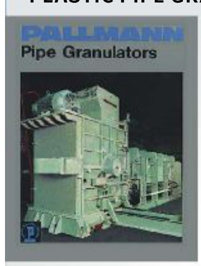

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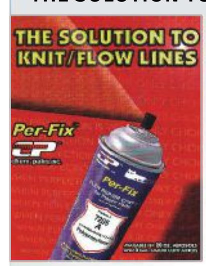

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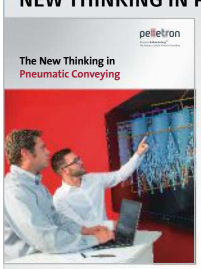

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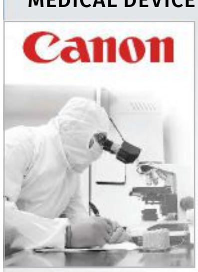

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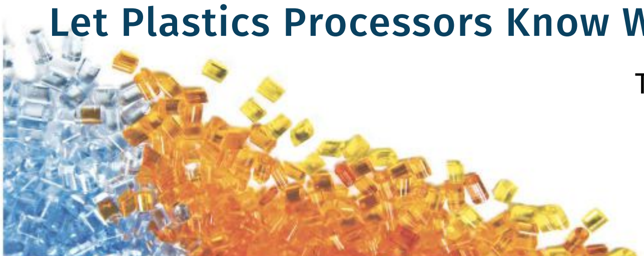

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CORE TECHNOLOGY MOLDING CORP. — GREENSBORO, N.C

Molder Increases Capabilities—But Not Risk—With Flexible Two-Shot Technology

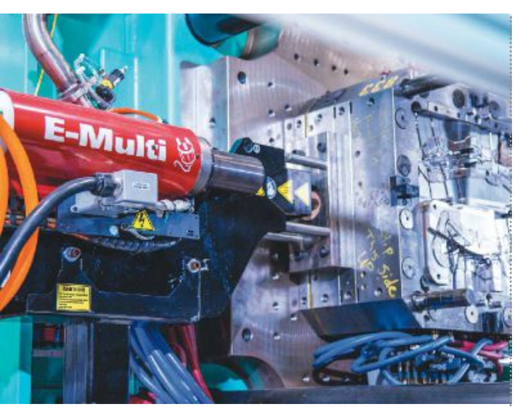
A customer request for multi-material molding presented a market opportunity and potential financial peril: How do you add two-shot without also overextending yourself from an investment perspective?

Core Technology's second two-shot molding cell was built around an E-Multi secondary injection unit and an Arburg injection molding machine.

By Tony Deligio
Senior Editor

Custom injection molder Core Technology Molding Corp., Greensboro, N.C., is a "guinea pig" when it comes to trying out new technologies, according to Brandon Frederick, manufacturing engineer and business development manager. So back in 2016 when a customer approached it about multi-shot molding, Frederick says Core was both curious and cautious.

Since the customer was new to Core and a smaller player in its market space, Core knew that if it added multi-material molding capabilities, how it did so would be critical. "At any given time, this business could potentially go away," Frederick says. "So we thought: What is the most risk-averse approach we could take to do multi-material?"



The second of Core Technology's two E-Multi auxiliary injection units features a 24-g shot size.

Core's answer to that question was the E-Multi secondary injection unit from Milacron's Mold-Masters product brand. This standalone, self-contained system converts existing molding machines to multi-shot and multi-material capability, in some cases eliminating the need to invest in a dedicated two-shot molding machine.

True to its inner guinea pig, Core was willing to experiment with multi-material and opted to do so with an E-Multi. In time, the presence of that unit, as well as the two-shot experience gained, helped deliver a whole new project for the company in 2018. That job included a six-tool multi-material mold package and led to the purchase of a second E-Multi. From zero two-shot molding to seven two-shot tools, Core accelerated into the new capability with relative abandon.

"I don't think we've ever done anything slower than 60 mph," Frederick says. "Whenever we commit to something we always hit the ground running." That second tool package, however, added a another wrinkle to Core's two-shot capability and came with its own learning curve.

In the new six-tool package, the E-Multi was purchased along with a 550-ton Arburg Allrounder injection machine, along with automation and a rotary-table system to spin the tool between shots. "With the second two-shot work cell," Frederick says, "this was really our first rodeo, if you will, with the rotary table."

For those tools, a robot with specialized end-of-arm-tooling removes three bushing inserts from a bowl feeder and places them in the stationary half of the mold. The mold closes and after the bushings are overmolded with glass-filled PP, the mold reopens, rotates 180°, and then the PP part is overmolded with TPE via the E-Multi on the non-operator side of the press in an L configuration. Finished parts are removed by the same robot and set on a conveyor.

"Integrating the E-Multi and the rotary table in the Arburg press was a little challenging," Frederick says, "just because it's a lot of different pieces of equipment that have to talk to each other, and this is not an everyday type of work cell."

With everything running smoothly, Core now has a new competency to show current and potential customers. "The majority of our customers haven't seen anything like this before," Frederick says, recalling a recent visit to a large local player. "They had no idea what I was talking about until I showed them video, and they were like, 'Wow, I've never seen that before.'" PT

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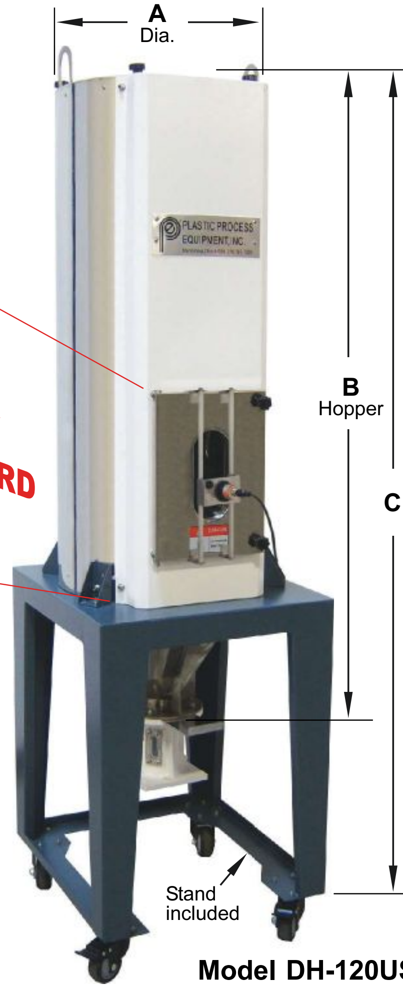

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