Plastics Technology

PTonline.com

OCTOBER 2019 № 10 VOL 65

Plastics Technology TOP SHOPS

Exclusive Benchmarking Survey

For Injection Molders

A property of Gardner Business Media

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VOLUME 65 • NUMBER 10

Plastics Technology

Plastics Technology®

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Do You Have What It Takes to Be a Top Shop?

Check out the results of our exclusive benchmarking study to find out about those who do.

So what's a Top Shop? It's the elite in injection molding, those processors whose technical expertise and operational capabilities put them a cut above the rest.

Jim Callari
Editorial Director

So how do you get to be a Top Shop? To start, check out the cover story on p. xx to learn what these processing operations are doing that you are not.

Top Shops is *Plastics Technology*'s annual benchmarking survey intended to identify best practices in injection molding and those molders that are, well, practicing them. The survey is a retooled iteration of the former World Class Processors study, last conducted in 2016. The main difference between the two is that Top Shops is focused on injection molding.

The survey is conducted by Gardner Intelligence (*gardnerintelligence.com*), a division of Gardner Business Media, the Cincinnati-based publisher and parent company of this magazine and other business-to-business publications that focus on discrete parts manufacturing.

In addition to demographic data, the survey asked for information on some key performance metrics, including areas like sales growth, sales per machine and employee, scrap rate, and setup time, among others. Scoring on 10 of these metrics was used as a means to separate 2019's Top Shops from the rest of the respondents.

Plastics Technology Senior Editor Tony Deligio is the magazine staff member who works with the Gardner Intelligence team to direct this study. While his article in this issue gets into the nitty gritty, let me take a few moments here to offer what I think are some of the more salient finds.

For one thing, if you just shoot-and-ship, your customers may be looking at your competitors that have a wider range of services. This is not a new trend by any means, but the results of our survey reinforce the idea that molding is continuing to evolve into "contract manufacturing." As Tony puts it, "Many molders have long ago added numerous skills and capabilities beyond what happens between the press platens. The Top Shops benchmarking survey focusing on injection molders shows that for the top performers, the evolution beyond a shoot-and-ship plastic part purveyor into a customer's full-spectrum product manufacturing and logistics partner has accelerated."

Broadly speaking, this means that Top Shop molders are bringing more value to the customer to create a true partnership, taking on services such as decorating and machining, offering 3D printing (additive manufacturing) capabilities, providing inventory stocking/logistics services as well as shipping/packaging/labeling.

Not surprisingly, Top Shops also offer a more robust training program for employees than do other molders. Top Shops also offer more in the way of benefits to their employees, according to our survey: By a two-to-one margin or more, Top Shops offered workers 401K plans, bonuses, safety/health programs and education reimbursement, with four times as many providing apprenticeships, leadership development, profit/revenue sharing and certification. Perhaps related, the turnover rate at Top Shops was more than 40% lower than at other respondents.

On the technology side, Top Shops and other molders actually had more similarities than differences. One notable exception: automation. Some 94% of the molders designated Top Shops make use of automation in their plants, in contrast with 74% of other molders. Top Shops also tend to invest more in capital equipment (94% in 2018, compared with 46% for other molders) and people (94% of Top Shops maintained or increased worker rosters in 2019, compared with 13% for the rest of the survey respondents).

And Top Shops engage these people. Says Philip Katen, general manager and president of Plastikos Inc. in Erie, Pa., ""We believe that the open communication aspect of the process is very important to further grow and develop trust, transparency and accountability throughout the company, which in turn should also strengthen the buy-in and commitment among all members of our team."

As our Top Shops benchmarking survey will be an annual endeavor, please be on the lookout for news—in the magazine, its various e-newsletters, and online—on how you can participate next year. Better yet, if you want to be notified directly when the next survey is live, shoot Tony an email at *tdeligio@ptonline.com*.

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Toshiba Expands Assembly Capabilities; Name Change Coming in 2020

At the start of this year, the U.S. Injection Molding Div. of Toshiba Machine completed its move into a 58,000 ft² facility in Elk Grove Village, Ill., replacing a smaller facility in Elgin, Ill. The new plant consolidates the plastics sales, service and assembly functions in one location, just a few blocks away from the Toshiba Machine corporate headquarters and Midwest Technical Center. Expanded basic assembly capabilities allow for faster deliveries of all-electric and servohydraulic presses from 30 to 390 tons. New capabilities include powering up machines for test runs, making software updates, providing special options on custom orders, and providing complete inspection of machines prior to shipping. As a result, new machine installations that used to take three or four days at a customer's plant can now be done in just a few hours. Besides assembly, the new building also houses the parts and service department, and it has over 100 machines in inventory. Some basic assembly also continues at Toshiba's California location for local customers and Northern Mexico. And Toshiba has added more technical people in the field who can help install and troubleshoot machines.

Other big news from Toshiba is that it will change its name—both in Japan and the U.S.—to Shibaura Machine Co. Ltd. on April 1, 2020. This is a return to the original name of the company, founded as Shibaura Machine Tool Co. in 1938. The change also reflects the formal separation of Toshiba Machine from the larger Toshiba Corp. in 2017.

PET Packaging Technologies Debut at K 2019

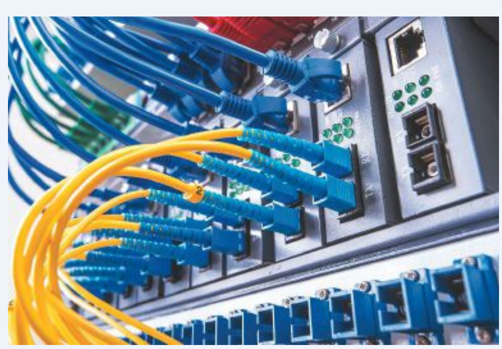
At the K 2019 show in Düsseldorf, Oct. 16-23, SACMI of Italy will present a number of new developments in high-volume compression, injection and blow molding of packaging products, with primary emphasis on PET applications.

- Reflecting the dominant theme of the show—"Circular Economy"—SACMI will present its 220-ton preform injection system (IPS220) running recycled PET in 96 cavities. The company says IPS can run 100% rPET pellets on standard machines, or up to 50% recycled PET flake. IPS is a hybrid toggle-clamp system with an electric-driven screw and two-stage hydraulic injection.
- The company also will present novel online preform quality inspection using polarized light to detect abnormal stress levels. Automated 100% quality inspection with the PVS10L system is said to be made possible with a new control system using artificial intelligence (AI) to "self-learn" all the required checks.
- SACMI will present both HDPE pharma applications for its proprietary compression blow forming (CBF) continuous-extrusion stretch-blow process (photo), as well as newer PET applications.

- Although not displayed at K, SACMI also is offering a new XL series of its SBF rotary reheat stretch-blow molders, capable of handling up to 12 L PET containers, vs. up to 3 L for previous SBF models. The XL line is distinguished by faster, automated mold changing by means of a lifter.
- A non-PET technology to be featured at K is a multilayer version SACMI's continuous compression molding (CCM) system, aimed at producing PP-based single-serve coffee capsules. The new CCMM (multilayer) system allows extrusion of EVOH barrier and tie layers to seal in flavor components of the coffee.

PolyOne to Divest Geon PVC & Maxxam PP

PolyOne Corp. has agreed to sell its Performance Products and Solutions (PP&S) business to SK Capital Partners, a New York private-equity firm that also owns SI Group, manufacturer of performance additives. PP&S is a global provider of formulated PVC and PP materials. Principally, this includes the venerable Geon brand and line of flexible and rigid PVC materials, plastisols and powder coatings used in applications from appliance housings to window profiles and wire jacketing.



Also included is the company's tolling and contract manufacturing services, which serve primarily North American construction and automotive markets and also produce the Maxxam line of specialty PP compounds, including reinforced and flame-retardant formulations for automotive and E/E applications.

The sale is expected to be completed this year, leaving PolyOne to focus on its three remaining segments: Specialty Engineered Materials; Color, Additives, and Inks; and Distribution.

Steve Gerth and Steve Upton

Dri-Air Drying and Conveying System

COMPLETE ROI IN ONLY 14 MONTHS

Schmit Prototypes installed the Dri-Air Industries Hopper Bank Drying System, which has simplified and improved their processing. ***"Being a custom molder we tend to do a lot of changeovers, having resin dry and available to any press is crucial to our success in meeting customers' demands."***

— Steve Upton, President

Schmit did a cost study on the savings the Dri-Air Hopper Bank System has provided, and determined that they made a complete return on investment within 14 months of installing the system.

The Dri-Air system allowed for:

- **Faster changeover as resin is pre-dried and ready to go;**
- **Less energy consumption, both in drying material and cooling our molding department;**
- **More consistent parts with controlled material;**
- **Labor savings with both set up and changeover.**

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SencorpWhite to Sell WM's Thermoformers In U.S., Canada

WM Thermoforming Machines of Switzerland and SencorpWhite have agreed on a deal that will allow the latter to sell WM's thermoforming machines in the U.S. and Canada under a co-branded name. SencorpWhite will be offering WM's FC and new Flex series in-line formers along with the FT tilt-bed series. The WM in-line series consists of full-electric thermoforming machines in a size and throughput range that is said to complement the SencorpWhite 2500 and Ultra series thermoformers. They are aimed at food, industrial, and medical packaging.

WM's tilt-bed FT and Twist series take aim at high-volume dairy products, coffee capsules, and cups. Launched in 2016, the Twist is new version of the company's FT series of continuous formers with in-mold trimming and a tilting lower platen. They'll be offered with with optional extruders and rimming units.

Clariant's Exolit OP Maintains Flame-Retardant Rating After Recycling

Research at Germany's Fraunhofer Institute for Structural Durability and System Reliability LBF reportedly has confirmed that glass-reinforced nylons 6 and 66 containing Exolit OP halogen-free flame retardant from Clariant Corp. maintain their UL 94V-0 rating when recycled back into production streams multiple times. This validation is advantageous for manufacturers who are keen on boosting their use of production waste and post-use recyclate in E/E and automotive applications. Exolit OP is a phosphorus-based additive.

Niigata Restructures North American Sales For Molding Machines

Niigata Machine Techno USA has changed the way its all-electric injection machines are marketed and sold in North America. The company now handles sales, service, support, parts and repair directly from its North American headquarters in Elk Grove Village, Ill. Steve Cunningham, who was recently appointed general manager of the company's Injection Molding Div., will head up this new operation. Cunningham brings more than 33 years' experience, including sales-management positions with Toshiba, Nissei and Maruka.

The move represents a major operational change for Niigata, which previously contracted out U.S. injection machine sales and service to a third-party trading partner. Cunningham will focus on strengthening Niigata's distribution network and market awareness of the firm's MD series of all-electric machines from 55 to 900 tons.

RJG Helps Bring Injection Molding Training To Nebraska College

RJG Inc. and Central Community College (CCC) are working together to bring injection molding training to Nebraska. CCC in Columbus, Neb., will embed RJG education into its curriculum when a new 4000 ft² training lab (photo) is completed at the start of 2020. Kathy Fuchser, campus president and division v.p., and Doug Pauley, assoc. dean for training and development, are driving the training initiative and have brought on board Ben Wilshusen as the trainer for the plastics program.

The effort also involves many local injection molding companies. Machines have been donated by Becton Dickinson, Molex, Arburg and Toyo. Advanced Engineering is donating the complete cooling system, and Major Mold is helping with tooling. Other smaller donations include conveyors and robots.

Amcor Opens Packaging Design and Development Center in Ohio

Global packaging giant Amcor plans greater engagement with home-care and personal-care brands at a new Innovation Center just opened in New Albany, Ohio. The center will assist in design, rapid prototyping, product sampling and testing to help consumer-goods companies stay ahead of their competition. In the personal-care market, for example, speed in prototyping and testing are critical, according to Amcor. The center is staffed by a cross-functional team that can access Amcor's innovations in barrier technology, e-commerce, use of PCR, and other sustainable solutions. Although specializing in home and personal care, the new center is open to packaging customers in all of the segments served by Amcor Rigid Plastics.

Novel Process Aid for rPET Preforms

A newly patented liquid process-aid dispersion for recycled PET (rPET) reportedly allows for greater recycled content in PET bottles by improving the thermal stability of PET throughout the recycling process. Developed by PolyOne Corp., ColorMatrix SmartHeat RHC Reheat additive is said to help minimize yellowing, which can reduce the amount of toner or color required in rPET and PET bottles.

According to the company, as the level of SmartHeat RHC in the recycle stream begins to rise over time, the overall quality of rPET will be improved, contributing towards increased levels of rPET content in PET bottles. PET commonly yellows during the recycle process due to heat exposure and thermal degradation. Adding toners and colorants reportedly can have a detrimental effect on brightness of the product.

Accredited by the Association of Plastic Recyclers (APR), SmartHeat RHC is said to improve preform and bottle color, clarity, mechanical strength, and processability, reducing energy consumption during blow molding. The additive allows for optimization of polymer weight distribution within the PET bottle. This helps in improving the strength and the quality of the bottle, allowing for further lightweighting and improved blowing performance. If color or toning are required, SmartHeat RHC is also available as recycle-friendly tints or toners.

This additive is designed for transparent bottles produced in a two-stage reheat stretch-blow process. It is metered into the PET stream at 0.02% to 0.10%, just above the feed throat of the injection machine, using a PolyOne-supplied ColorMatrix liquid metering system.

High-Performance Thermoplastics Enable Automotive LiDAR Components

At September's Automotive LiDAR 2019 Conference in Dearborn, Mich., SABIC mobility business manager Aurélie Schoemann discussed the emerging role of high-performance thermoplastic optical resins for LiDAR (Light Detecting and Ranging) sensors in cars. Schoemann focused on infrared-transparent resins such as SABIC's Ultem PEI and Lexan CXT PC copolymers, boasting high IR transparency (even in black) and high refractive index.

To prevent obstruction of laser light, LiDAR systems may be embedded in automotive grilles, bumper fascias or headlights, exposing them to harsh weather conditions, road chemicals and debris that can affect their optical transparency and durability. Increasing miniaturization of LiDAR assemblies to make them less noticeable and more cost-effective is yet another challenge. According to Shoemann, SABIC's high-performance thermoplastic resins and compounds can provide greater freedom to design complex, miniaturized and thin-wall geometries compared with glass and epoxy, two materials previously used in LiDAR assemblies.

Enhanced PET Foam Shows Promise As Composite Core Material

Sweden's Nexam Chemical is significantly expanding its collaboration with Swedish composites manufacturer Diab Group (U.S. office in DeSoto, Texas). Diab specializes in core materials for sandwich composite structures such as wind-turbine blades, boats, aircraft, trains, buses and building construction. The two firms started a development project in 2015 for new high-performance PET foams containing Nexam's Nexamite technology as a key property enhancer. The collaboration now generates growing business for Nexam as Diab experiences strong growth in its PET-foam segment.

Launched in 2014, Nexamite PBO (phthalic anhydride and bioxazoline) is a heat-activated chain extender and crosslinker that also works as a compatibilizer and scavenger in production of virgin polymer blends and recycling of mixed plastics.

ExxonMobil to Highlight Sustainable Plastics Applications at K 2019

At K 2019 in Germany this month, ExxonMobil will emphasize sustainability with the introduction of new solutions for a range of applications in packaging, automotive, consumer products, agriculture, building and construction, hygiene and personal care. Some highlights to look for:

- Exceed XP, Exceed and Enable performance PE resins helping to overcome recycling issues associated with conventional laminated structures. New all-PE laminated solutions can easily be recycled where programs and facilities exit to collect and recycle plastic films, while delivering the performance properties needed.
- New technological advances using recycled PE in combination with performance PE polymers to produce a range of sustainable flexible films.
- Vistamaxx metallocene ethylene-propylene polymers, which allow use of low-cost recycled content in high-value applications.
- "Game-changing" film technology that combines Exceed XP with ExxonMobil PP to deliver heavy-duty sack films with extreme performance and high heat resistance.
- New developments in coloring Exxtral specialty TPO compounds for vehicle interiors beyond the dark/black and neutral colors that are currently available. A new PP color spectrum is inspiring original design solutions for car interiors.

Also look for several of ExxonMobil's polymer and application advances in packaging films, auto parts and consumer goods to be demonstrated at exhibits of leading machine manufacturers and presented in a series of TechTalks at the ExxonMobil pavilion.

Molder Adopts 'Semi-Smart' Automation

R&D Plastics finds new and more sophisticated ways to use robots.

By Matthew Naitove
Executive Editor

R&D Plastics, a custom injection molder in Hillsboro, Ore., mirrors in many ways the trends in automation among molders in North America. The firm's plant has evolved from simply demolding parts to pairing up robots of different types for insert feeding, orientation and placement in the mold. The firm builds its own end-of-arm tooling (EOAT) for labor-saving tasks such as flexing living hinges. It is now looking to automate secondary operations with collaborative robots (cobots). The firm is also looking to automate setup of robots and other cell devices along with the injection machine. And it is looking beyond "hard" automation to ways of automating data transfer between machines and central computers.

Frequent mold changes require flexible automation.

Last month's report on the firm's many programs supporting local plastics education and training helps explain why R&D Plastics has been described as a pillar of the Northwest manufacturing community. It is owned and run by CEO Rod Roth (son of Merrill Roth, founder of another storied Northwest molder, Grant & Roth Plastics) and Sal Gonzalez, v.p. of operations. R&D Plastics was started in 1996 (after the sale of Grant & Roth to SPM) and is now approaching record sales of $8 million. It operates from a 28,000 ft² plant with 60 employees and 19 presses from 40 to 720 tons.

"Today, it's less about putting parts in a box, and more about what I call 'semi-smart' automation," says R&D Plastics' general manager, Matthew Barnett.

EVOLVING AUTOMATION

"We are a medium-size molding company with the staff and tools of a much larger company," says Ron Knowlton, v.p. of business development. The firms' capabilities include in-house engineering and elastomeric molding, overmolding, insert molding, structural foam, and more. While the majority of its business is "mold-and-ship" work, there is also a growing volume of value-added secondary operations such as sonic welding, hot stamping, digital printing, assembly, adhesive bonding, and fastener inserting. It has outside sources for plating, painting and hydrographic coatings.

Furthermore, the custom molding business must accommodate a typical eight mold changes in 24 hr, while still operating at 98% good-parts yield and 80% capacity utilization. "Everything we do changes on a weekly basis," comments Don Altorfer, maintenance manager and automation engineer.

These factors help explain the molder's move to increasing automation. Most of its presses have a servo robot—and one cell has two—along with additional automation, including insert feeders and conveyors. Until recently, the plant's robots were all Star and Yushin models, but starting in 2015-2016, R&D Plastics began buying Wittmann Battenfeld robots and now has five, including two W818 and two W843Pro models and a dual-arm W818S,.

Matthew Barnett, general manager of R&D Plastics, expects more purchases of Wittmann robots to follow. "We've been very impressed with their service and support," says Barnett. "They are one of the best service-oriented companies we've worked with." His sentiments are echoed by Altorfer, who visited Wittmann Battenfeld's West Coast Tech Center in Placentia, Calif., for three-day comprehensive robot training. He was able to come back to the molding plant and train his own staff on what he learned there. In addition, Jason Cornell, Wittmann's West Coast Regional Manager for Robots and Automation, comes on-site every couple of months to continue training and demo new features. (Not incidentally, R&D Plastics just bought its first Wittmann Battenfeld injection press, to accompany its existing stable of Toshiba and Sumitomo (SHI) Demag machines.)

R&D Plastics appreciates the flexibility of the Wittmann robots to accommodate the rhythms of a custom molding business. The traverse beam comes pre-drilled and tapped every 5 in. along the underside, allowing for fast adjustments and constant position shifting for constantly changing processes.

As Barnett describes the current phase of automation at R&D Plastics, "Today, it's less about putting parts in a box, and more about what I call 'semi-smart' automation." An example is one insert molding cell in which metal inserts are fed by a vibratory feeder (built in-house) to a conveyor. That leads to a high-speed SCARA robot, which places the inserts in a precise location and orientation for pickup by a Wittmann linear robot that places them in the mold and demolds finished parts.

Another example is some hard/soft overmolding cells in which two presses are placed side by side, one to mold the rigid substrate and one to overmold with TPE or TPU, using a robot to transfer between the two.

Next step may be cobots for automating assembly.

R&D Plastics has a do-it-yourself culture, and it builds a lot its own equipment, including a special CNC sonic welder originally designed by Merrill Roth. The firm also makes some of its own robot EOAT. An example is a tool for flexing living hinges fresh out of the mold, saving the need for a person to perform that task. The EOAT was 3D printed by a new dual-extruder, filament-fed Pro2 printer from Raise3D Technologies, Inc., Irvine, Calif. (*raise3d.com*).

Though it accounts for only 10% of the firm's business today, the growth of value-added secondary operations has R&D Plastics thinking about automation there, as well. "We're starting to look at cobots for jobs like sonic welding," says Barnett.

He adds that automation has benefits for employee morale and hiring. "By implementing the new automation, we are able to reduce some of the more simple mundane tasks and leverage our employees to operate in more of an inspector/packer role and less as a machine operator." And then there is the "cool" factor that appeals to younger workers. "That is very true with our mold setters and junior process technicians. They see an opportunity to learn about automation that they will carry with them throughout their careers, be it here at R&D or wherever they might end up." ►

Dual-arm Wittmann Battenfeld W818S is one of the newer additions at R&D Plastics.

DATA AUTOMATION GROWS, TOO

Savvy molders today agree that automating the flow of real-time manufacturing data is just as important as automating the flow of products and components. That's the case at R&D Plastics, where Ron Knowlton is proud of the firm's ERP system from IQMS, which he says, "provides—among other things—real-time information on exactly what's happening on the molding floor and in value-add, as well as storing information about mold and machine adjustments and preventive maintenance."

Another step forward has come with the purchase of a SmartPower 300 servo-hydraulic Wittmann Battenfeld injection press and associated auxiliaries. This "smart work cell," says Barnett, is equipped to store and retrieve job setups for not just the molding machine, but also the robot, hopper loader, additive feeder, and mold-temperature control unit (TCU). This capability, which the supplier calls Wittmann 4.0, will help make frequent job changes even faster and easier.

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Structural Foam Goes Vertical—Again!

A new generation of vertical presses takes structural foam back to its origins—but with a big shot of new enhancements.

Over 100 years of experience: L. to R.: Wilmington's Ken Bealer, chief mechanical engineer; Russ La Belle, president; and John Allred, v.p. of technology, beside a new vertical press.

By Matthew Naitove
Executive Editor

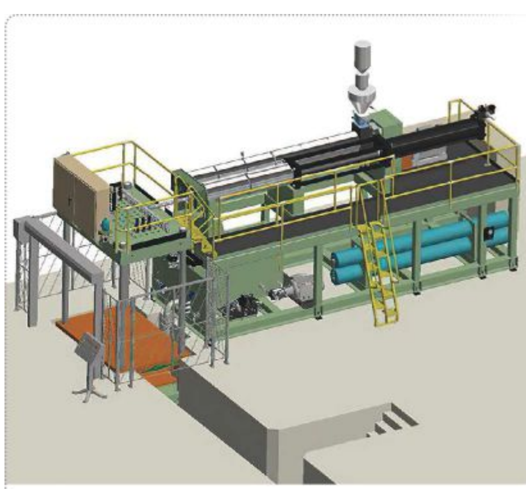
Like the 1980s DeLorean sports car that morphed into a time-traveling aircraft, structural-foam presses have gone "back to the future" and emerged transformed. Wilmington Machinery recently built a pair of vertical-clamp structural-foam (SF) presses for a U.S. customer that wanted the advantages of vertical presses, not least of which is that two of them can fit in the same floorspace as one comparably sized horizontal machine. According to Russ La Belle, Wilmington's founder and president, vertical machines also have the advantage of easier mold installation and removal, and tool costs are reduced by using gravity to reduce the guidance requirements for the ejection system in comparison with a horizontal machine.

So why were these two new presses, in La Belle's estimation, the first vertical SF units built by anyone in the last 20-25 years? He remembers the first SF machines, built to a design from Union Carbide, which owned the original patents to the process. Those were all vertical presses, but they were very slow, by today's standards, as well as inflexible and inefficient.

RENEWING AN OLD CONCEPT

Built to mold enclosures, the two vertical Wilmington presses have 500-ton clamps, platen sizes of 102 × 72 in., tiebar clearance of 90 × 56 in., clamp stroke of 78 in., and max. open daylight of 102 in. More notable is their shot capacity of 125 lb, which La Belle thinks is much larger than for any vertical press ever built before—"That's large for *any* structural-foam press," he says.

Whereas the older vertical SF machines had a single row of nozzles, Wilmington's update of that design has a square array of more than 100 possible locations for up to 20 shutoff nozzles, each one filled independently by Wilmington's Versafil injection system, which sequences the mold fill and provides individual shot control. These more versatile presses each can mount up to six molds with up to 20 cavities—or one large mold with sequential nozzle control.



Layout of new vertical 500-ton SF press with 125-lb capacity. Two-stage screw/plunger injection unit is elevated, with hydraulics and gas accumulators underneath, eliminating the long melt pipe that formerly connected the extruder to the vertical clamp.

The new vertical SF presses have energy-saving servohydraulic drive and Allen-Bradley PLC controls. They also have a more efficient layout that provides a much shorter melt path from the injection barrel to the mold. La Belle explains, "In the old days, the injection unit sat on the floor, with a 12-ft melt pipe to get material to the mold. Our new presses have elevated extruders with the hydraulics underneath." Also mounted beneath the two-stage screw/plunger injection unit are twin gas accumulators.

La Belle adds that the presses were part of a turnkey service that included designing the pits, machine installation, and startup.

MATERIALS

PART 2 The Fundamentals of Polyethylene

PE properties can be adjusted either by changing the molecular weight or by altering the density. While this increases the possible combinations of properties, it also requires that the specification for the material be precise.

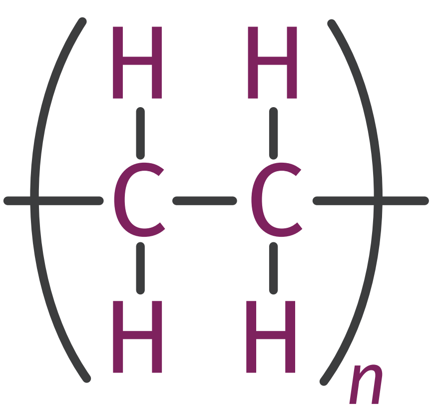
The properties of molecular weight and density provide for a very wide range of performance within the polyethylene family.

By Mike Sepe

Molecular weight is a property that is universally important. In all polymers, the relationship between higher molecular weight and improved performance is well established.

The short-term property that provides the best correlation to molecular weight is ductility, often referred to colloquially as toughness. The higher the average molecular weight of the polymer the more impact resistant it will be. It may be difficult to confirm this relationship by referring only to data-sheet properties, since impact properties are most commonly measured only at room temperature and at a fixed velocity using a notched specimen. Factors such as processing conditions and gate location in the mold used to produce the test specimens can also influence the results of even this narrowly defined set of tests.

Repeating Unit for PE



Shown here is the structure of the repeating unit that makes up the polyethylene chain. These building blocks have a molecular weight of 28 g/mole.

But a broader approach to assessing ductility that includes measurements of elongation at break in a tensile test and determinations of a property known as the ductile-to-brittle transition temperature will demonstrate the relationship between average molecular weight and ductility. A closer examination of the relationship between molecular weight and performance shows that a wider range of properties improve with increasing molecular weight. These include fatigue resistance and environmental stress-crack resistance (ESCR).

Fundamentally, molecular weight is a function of the length of the polymer chains that make up the material. Longer chains contain more of the building blocks that make up the compound. The accompanying figure gives the structure of the repeating unit that makes up the PE chain. These building blocks have a molecular weight of 28 g/mole. In order for a material to exhibit the properties typically associated with polymers, the length of the chain must reach 550-700 repeating units. This is the value of the "*n*" in the figure and provides a molecular weight of 15,000 to 20,000 g/mole.

With increasing molecular weight comes increasing melt viscosity.

But this is the minimum requirement, and if it is necessary to improve performance, longer chains are needed. The upper end of the scale for PE is a class of materials known as ultra-high-molecular-weight polyethylene (UHMWPE). In order for a material to qualify as a UHMWPE, the average molecular weight must reach a minimum value of 3 million g/mole, requiring over 100,000 repeating ethylene units in each chain.

The properties of UHMWPE are beyond those that can be obtained with lower-molecular-weight grades. Unfortunately, with increasing molecular weight comes increasing melt viscosity. The melt viscosity of UHMWPE is so great that processing options are limited to ram extrusion of very thick sections and machining. For injection molding, conventional extrusion, and blow molding, the materials at the high end of the performance spectrum have average molecular weights in the 1-2 million range.

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Material suppliers offer a wide range of grades tailored to different markets. At the lower end of the molecular-weight spectrum are materials designed to fill thin-wall products that must perform for only a short period of time. As we will see later, all commercial polymers are made up of a mixture of chain lengths; therefore, a complete understanding of how a particular grade of material is created involves a measurement of this molecular-weight distribution. However, making these measurements is somewhat time-consuming and expensive and requires very sophisticated instrumentation. So, the industry has come to rely on a property known as melt flow rate or melt index. This is a simple test performed under carefully specified conditions that provides a rate of flow.

This rate of flow is understood to be related to the average molecular weight of the material. A high melt flow rate reflects a low average molecular weight while low melt flow rates are associated with higher average molecular weights. UHMWPE tested under these conditions does not flow at all. But most commercial PEs will have a measurable melt flow rate that will be provided on the data sheet.

Most PEs are tested using a temperature of 190 C (374 F) under a constant load of 2.16 kg (4.76 lb). High-flow materials for thin-walled injection molded products tested at these conditions may have melt flow rates as high as 200 g/10 min. Materials for blow molded bottles that must have optimal impact resistance will have melt-flow values less than 1 g/10 min, often referred to as fractional-melt materials. Materials at the very high end of the molecular-weight spectrum, but not classified as UHMWPE, do not flow appreciably under these conditions and therefore use a second test condition that employs the same temperature but a load that is 10 times greater, 21.6 kg (47.6 lb).

Under this higher load these high-molecular-weight materials will produce a measurable flow rate. This particular version of the test is called the high-load melt index (HLMI) and it is important to take note of how the number on the data sheet is measured. Many years ago, a colleague of mine ran into a significant processing problem when his material supplier shipped him a grade with an HLMI of 18 g/10 min instead of the standard melt index of 18 g/10 min that he had ordered. The specified material was used to produce a relatively large pail. The HLMI material barely flowed through the sprue bushing.

In all other polymers, molecular weight is the property that we manipulate in order to change the balance between performance and processability. Ductility can be improved by incorporating impact modifiers. However, these additives will reduce other performance characteristics such as strength and modulus and related long-term properties such as ►

fatigue resistance. Molecular weight is the one property that improves impact resistance without these sacrifices.

But in PE, there is another tool that allows us to change the balance of properties without altering composition: density. Density is a function of the shape of the polymer chains, not their length. High-density polyethylene is composed of chains that are relatively linear and contain few branches. These chains can pack close together, creating stronger attractive forces between the chains that result in greater strength, stiffness and heat resistance. Lower-density PE grades contain a greater number of branches. These branches may be relatively long or they may be short, depending on how the material is produced. Manufacturers of PEs have gained a very high degree of control over these parameters using the different catalysts that we referred to in last month's article.

But there is a good deal of confusion within the industry regarding the manner in which molecular weight and density are related. Molecular weight refers to the size of the individual polymer chains, density refers to the spacing between those chains. Consequently, these two properties can be varied independently. Some years ago, I attended a conference where a presenter talking about polyethylene materials told those in attendance that high-molecular-weight PEs have high density and low-molecular-weight materials have low densities.

In PE, there is another tool that allows us to change the balance of properties without altering composition: density.

Unfortunately, this is wrong. Two grades of material can have the same average molecular weight but different densities and two grades of material with the same density can have different average molecular weights. This means that the properties of PEs can be adjusted either by changing the molecular weight or by altering the density. This increases the possible combinations of properties, but it also requires that the specification for the material be precise.

In our next column we will focus on the role of density and show some examples of the problems that can arise when we don't get it right.

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4.3"

INJECTION MOLDING

V-to-P Ramp Time and Over-Travel

Many injection machines use ramp time to control the transition from injection pressure to hold pressure and reduce over-travel. Do you know how to set yours?

By Robert Gattshall

If you have read my columns, you know how important I think it is to understand how the injection molding machine you are working with is programmed and how it reacts. Many injection machines have settings that can impact the machine-independence of your process, and you may not even know they are there.

Some of these settings can be manipulated by the molder, but others cannot. One setting that can hinder your ability to produce acceptable product and can also make it nearly impossible to replicate your process in another machine is V-to-P ramp time. Machine manufacturers use ramp time to control the transition from injection pressure to hold pressure.

The manufacturers' goal is to reduce over-travel as much as possible, where over-travel represents quick pressure drops that push the process below the hold-pressure setting. This is due to the time it takes the machine's hardware to communicate and the quality of that hardware. The control CPU and valves communicate in fractions of a seconds, but the milliseconds it takes for the CPU to tell the valve to open or close and then the milliseconds it takes for the valve to mechanically carry out this action can be enough to cause over-travel.

This is why we see the sudden drop in pressure below the hold-pressure setting. And the faster the fill time, the more likely this is to happen. Frankly, we anticipate this over-travel as processors, and compared with the alternative and the impact it can have, many of us prefer it.

When V-to-P ramp time is added, it allows the injection pressure to taper off gradually over a set time after the V-to-P transfer position has been achieved. So a molder might set the V-to-P ramp time for 0.50 sec, which means that for a half a second, the machine tapers off the injection pressure until the desired hold-pressure setting is achieved after transfer. Figure 1 shows an example.

One of the challenges with V-to-P ramp time is if your part is 95% to 99% full and then transfers to pack pressure, instead of the pressure dropping sharply at the set transfer point, it stays high and slowly drops to the hold-pressure setpoint. This could absolutely cause you to flash your mold. When we set up our transfer position, we typically do it with our hold pressure and/or hold time set to zero. So a machine, even with this V-to-P ramp time, will give us the sharp drop-off we are looking for because it is heading to zero pressure either way.

This is a problem, because once I turn my hold pressure and/or time back on, the machine now ramps the V to P gradually; and at 95% to 99% full, the injection pressure remains high, and I flash my mold before I get near my hold-pressure setting. This puts molders in an awkward position. They now have to make adjustments to the transfer position to essentially guess where the 95% to 99% fill position would be with the V-to-P ramp to make sure that the mold is not flashed again. Anytime we use the word "guess" when talking about process development, it is never a good thing.

Anytime we use the word 'guess' when talking about process development, it is never a good thing.

The V-to-P ramp itself is almost acting as a fill/pack stage after the transfer position has been achieved. If you have the ability to set the V-to-P ramp time to zero, I always recommend doing so. If the machine doesn't allow for a zero setpoint, I recommend using its lowest setting. In the future, if the mold must be moved to a different machine, it is critical that one matches the pressure-curve template from the home machine. For the process to be properly moved from one machine to another, the transition from V to P must be equivalent.

KNOW YOUR MACHINE

We have discussed a V-to-P ramp time that the end user could set, but there are some machine manufacturers that have this setting hidden, requiring service-technician-level access to change. Other machines don't even allow it to be modified. I understand the machine manufacturers' rationalization for doing this, but I can't say I agree with it. Ramping like this can extend the life of a valve, especially if the valves are of lower quality.

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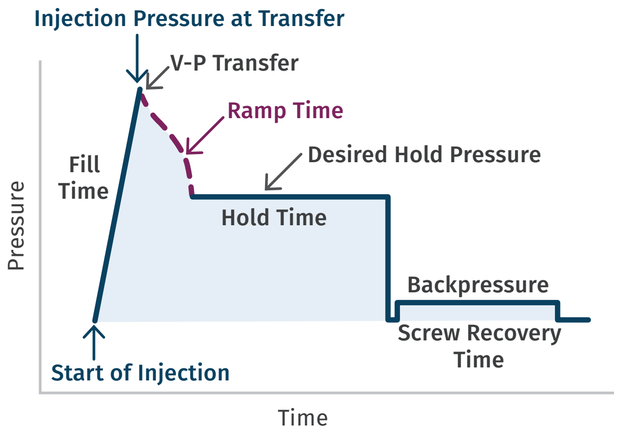
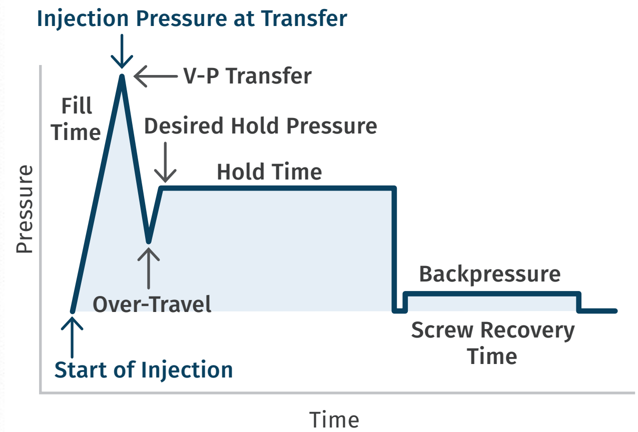
FIG 1 Injection Pressure Graph With Ramp Time



Graph of the injection pressure shows the effects of ramp time after transfer. There is no over-travel, but the pressure remains significantly higher than the desired hold pressure.

FIG 2 Injection Pressure Graph Without Ramp Time



This graph shows the over-travel that will present on most machines after transfer. Even with over-travel, the transfer from filling with velocity to packing with pressure is achieved closer to the desired set point.

Ramp time can also make injection-pressure and hold-pressure outputs appear more repeatable shot to shot. It is much easier to hit your hold-pressure setting if you ease down to it. That said, is it what is best for the process and part quality? Does it make it more difficult to reproduce this process in other machines?

If I develop a process on a mold in a machine that has a preset ramp time for V to P, I must replicate this same pressure curve if I need to move the mold to a different machine. If this alternate machine doesn't have the ability to modify the V-to-P ramp time, it is impossible for the processor to run the same process in the new machine. The machine-independence of our process has been compromised.

Over-travel is a product of how quickly the machine can send and receive signals and the time it takes for the mechanical movements to be executed. The time it takes for this all to happen is insubstantial but it does influence our process. Over-travel is a reality of molding, and as processors we understand why it is there.

I see the pressure curve in Fig. 2 as picture-perfect, and although it has over-travel, it is something we should be able to repeat shot to shot and run to run. It is predictable; there is no need to guess when our parts have achieved their desired fill percentage. It is a curve that will contribute to a machine-independent process, a process that is both robust and repeatable.

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EXTRUSION

Extruder Alignment: Important, but Only Half the Equation

The other half? Aligning and supporting downstream equipment. Here are best practices.

I wrote about the importance of extruder barrel alignment and how it should be done several years ago, but aligning the extruder barrel is not the whole solution. The downstream equipment must also be aligned and supported properly to maintain the properly aligned barrel.

By Jim Frankland

After breaking a screw, a client of mine brought in a competent company to align the barrel. But the new screw lasted all of three weeks. Upon startup one day, the screw broke, and in the process also heavily damaged the barrel, requiring its replacement as well.

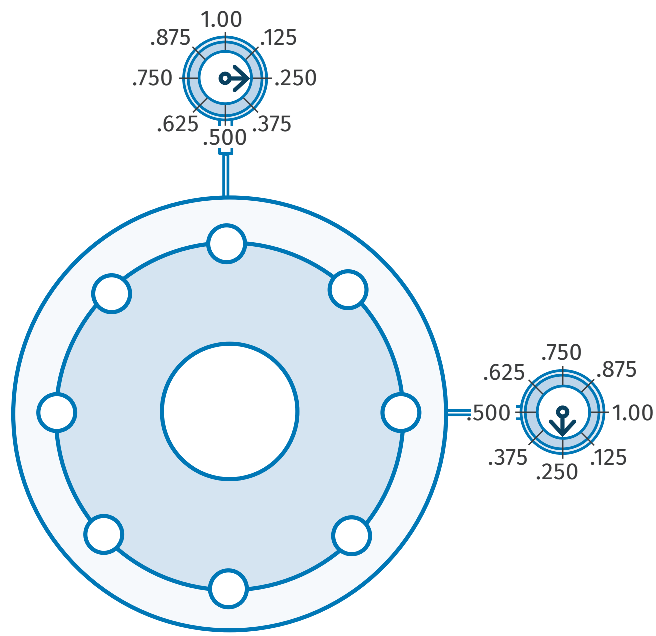
I was asked to be there for the startup with the new barrel and screw. The extruder was started and I immediately heard a grinding sound and noticed a large fluctuation of the drive amps. I had the extruder shut down immediately and asked how they had lined up the downstream components to the extruder.

Barrel alignment is not just a matter of lining up the barrel itself but maintaining that alignment after the whole system is assembled.

The screen changer was a double-piston type and weighed about 4000 lb. Although it was supported in a stand on rubber casters, the floor was very uneven, and the installers had simply pushed the flanges close together and then used the bolts to pull the screen changer into its position on the barrel with no regard for its effect on the barrel alignment.

Next was the melt pump, which weighed about 1750 lb without the drive motor and reducer. Again, the unit was on a stand with rubber casters, but the installers had once more made no effort to align it. Instead, they simply pulled it into place against the screen changer and used the bolts to draw it into position. Finally the die was coupled to the melt pump with the same procedure on a similar stand.

Best Approach to Align Extrusion System



The best approach is to complete the barrel alignment using optical- or laser-alignment equipment. Also put dial indicators, as shown here, anchored to an independent support to maintain that alignment as the downstream equipment is attached and heated up.

I instrumented the extruder barrel flange with two dial indicators mounted at 90° to one another, as shown in the accompanying illustration. As the screen changer was loosened from the barrel, the vertical dial indicator showed a rise in the barrel of 0.255 in. and the horizontal indicator showed a lateral movement of slightly over 0.100 in.

Obviously that totally destroyed the alignment of the barrel to the drive quill, and the resultant bending and repositioning of

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the barrel caused severe contact between the screw and the barrel bore. The point here is that barrel alignment is not just a matter of lining up the barrel itself but maintaining that alignment after the whole system is assembled.

The best approach is to complete the barrel alignment using optical- or laser-alignment equipment, then put dial indicators anchored to an independent support to maintain that alignment as the downstream equipment is attached and heated up. Not only will the mechanical attachment of downstream equipment affect the alignment, but the heating-up phase is also important, as the downstream components and the barrel itself can change position substantially as thermal expansion affects the entire assembly. The only way to determine if the alignment is being altered when completing assembly of the line is to instrument the barrel flange.

The only way to determine if the alignment is being altered when completing assembly of the line is to instrument the barrel flange.

This is a very simple procedure and should be used every time the downstream equipment is reinstalled on the barrel, even if the downstream equipment is mounted on steel rails. The longer the barrel and the heavier the downstream equipment, the more care should be exercised in reassembly of the line. In the case noted, it would have saved two screws and barrels, along with the associated downtime. Estimated total cost was in the hundreds of thousands of dollars. PT

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TOOLING

PART 1

How to Prevent Nozzle Tip Leaks

Instead of learning from your mistakes, stop making them in the first place.

FIG 1

Barrel-alignment mandrel shown here on a nozzle body.

By Jim Fattori

In August I attended a three-day seminar in Ashland, Ohio, on hot-runner systems, given by MoldTrax. It was an excellent program, full of great information. Five leading hot-runner manufacturers spoke about their product offerings and key features of their systems. Steve Johnson, president of MoldTrax, reviewed how to correctly check and repair molds that had been flooded with plastic. Everyone was very impressed at the level of detail and the abundance of tricks Steve uses to bring a mold back to life. The amount of man-hours and replacement part costs required to repair a flooded mold are absolutely staggering.

The seminar reinforced my belief that we desire and *need* all of the latest technology—servomotor drives, sequential valve gates, smart controllers, thermal-imaging devices, etc. At the end of the seminar, Rich Oles, president of Alba Enterprises, showed us slide after slide after slide of flooded manifolds, and explained what happened in each instance. Watching Rich's presentation reinforced my belief that there is a definite lack of understanding of some of the very basics of injection molding. These shortcomings are not limited to some of the personnel out on the production floor. It starts at the very top—with the suppliers of these hot-runner systems and the various mold components.

FIG 2

Barrel-alignment mandrel shown here inside a platen.

Several of the disasters in Rich's slides were a result of material leaking out between the machine's nozzle tip and the nozzle seat on the sprue bushing attached to the hot manifold. It caused a massive blob of plastic to form—often called a hog's head. It had nothing to do with valve-pin wear, controller capability, or even the mold design and construction. This was a direct result of not knowing, not remembering, or not checking some critically important basics to running an injection mold, whether hot- or cold-runner.

> ***Any gap between the locating ring and the sprue bushing needs to be sealed off.***

Material leaking between the machine's nozzle tip and the mold's sprue bushing will immediately make your parts lighter, full of sinks, or even short. This is a big red flag. Monitoring part weight is the best indicator of the stability of your process and the possibility of a leak somewhere in the melt-delivery system. The most common knee-jerk reaction is to increase the shot size or the melt temperatures. Both of these actions only make the situation worse—for both hot- and cold-runner molds.

Depending on the design of your hot-runner system, there may or may not be a gap between the inside diameter of the locating ring and the outside diameter of the sprue bushing. If there is, it's an invitation for material to enter the manifold housing. This open area needs to be sealed off. Some mold makers use a cylindrical piece of pipe, often called a "splash ring." Others use a flat disk mounted underneath the locating ring, with a hole in the center to allow the sprue bushing to slide through. This is similar to those fiberglass "drool disks" one mold-component

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supplier sells to prevent leaking material from working its way back onto the barrel's heater-band wires—only in reverse. Preventing material from entering the hot-runner manifold is critical, but why is there material leaking between the machine nozzle tip and the sprue bushing in the first place?

The most common root cause for material leaking in this area is barrel misalignment. This condition takes only a few seconds to check. Pull the carriage back and then bring it forward again. If you can see it hop up, down, left or right, it's misaligned—by a lot. In addition to potentially causing material to squirt out, misalignment will damage the face of your nozzle tip and the sprue-bushing seat. I've seen barrels so badly misaligned, the nozzle tips didn't even touch the nozzle seat. They slammed into the locating ring.

ALIGNING AN INJECTION CARRIAGE

So how do you align an injection carriage? Most people do it by eye with a mold in the machine. Others use a piece of cardboard or pressure-sensitive film—again with a mold in the machine. They look at the compressed area to see which direction needs to be adjusted. Cardboard and film are actually better methods then sighting it by eye, but all of them are still extremely inaccurate.

A locating ring has a specified diameter of 3.990 in. I could not find a single supplier that specified what the tolerance of that dimension is. The through hole in a machine's fixed platen is typically 4.000 +0.002/-0.000 in. Therefore, a new mold in a new machine can have as much as 0.010 in. of slop between them—in any direction. If your mold-component supplier is not keeping pace with technology, I recommend you make your own locating rings with a larger diameter. A diameter of 3.995 in. cuts the amount of slop in half. If it doesn't fit the through hole in your platen—the protruding dings in the hole need to be stoned off.

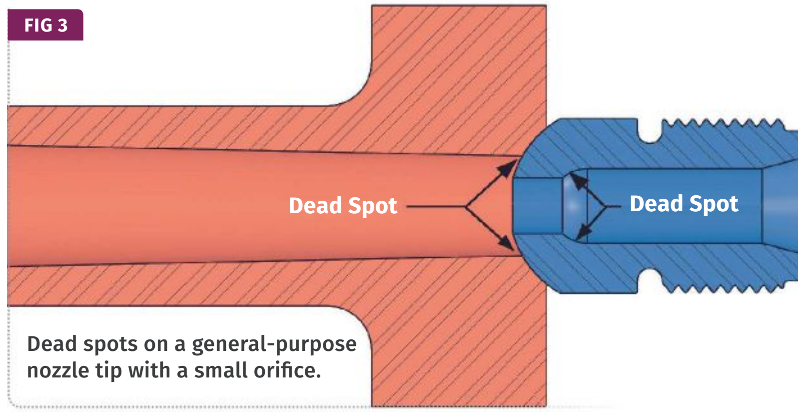
Think about this for a second. You just hung a multi-cavity hot-runner mold in a high-precision all-electric molding machine. You know you have about 0.010 in. of slop between the locating ring and the hole in the platen, and now you are relying on a safety-glass-wearing floor person's eyesight, or the visual inspection of a piece of cardboard to prevent molten material from entering your manifold system.

Fortunately, there is a better way: Make a barrel-alignment mandrel. Turn down a bar of steel to a diameter of 3.999 in. and add a lead-in on one end. Now drill a hole in the center, which will have a slip fit for a custom shoulder bolt with a 7/8-14 thread—or whatever thread size is in your machine's nozzle body. Remove the machine nozzle tip from the nozzle body and screw the mandrel onto the end, as shown in Fig. 1. Remove any mold that may be in the machine. Loosen the carriage leveling bolts and advance the carriage until the mandrel ►

is well inside the platen, as shown in Fig. 2. Now adjust and tighten the carriage leveling bolts. The carriage is now aligned with the center of the fixed platen within 0.0005 in., a minimum of 20 times more accurate than the way you are doing it now.

Just about everyone in our industry talks about how important the melt-delivery system is—from the material hopper to the end of fill. Believe it when I tell you that the most misunderstood, and often the weakest link in this melt-delivery chain is the machine nozzle tip. The rest of this article and all of next month's article will explain why.

FIG 3



Dead spots on a general-purpose nozzle tip with a small orifice.

Many people believe that if the nozzle-tip orifice is too small it can cause the carriage to blow back because there is more steel surface area for the plastic pressure to push against. That's not correct. It doesn't matter if the nozzle-tip orifice is just a pinhole, or if it is the same size as the sprue-bushing orifice. Consider that every piece of steel, from the shutoff nozzle in the barrel all the way to the end of the cavity, is a pressure vessel with various diameters and shapes. The pressure trying to separate the nozzle tip from the sprue bushing is applied to both the steel and the plastic. If you want a close approximation of how much force is trying to push the carriage back, take the peak injection pressure and divide it by the area of the largest orifice.

When the orifice of a machine's nozzle tip is too small, it creates several problems. It will take more pressure to get the material to flow through the smaller diameter than it would a larger diameter. It's better to use that lost pressure to pack out your parts, as opposed to needlessly increasing your electric bill. A small orifice also increases the shear on the material, which raises the temperature of the melt and reduces its viscosity. Would you rather control the temperature of your material with your screw and heater bands, or with a restrictive nozzle tip? (That is a rhetorical question.)

This reminds me of something. One reputable hot-runner manufacturer uses a smaller orifice diameter in its sprue bushings, which then feeds into a larger-diameter flow channel. I always thought that was a bad idea, because of the increased shear on the material. Perhaps this is intentional so that the amount of force trying to blow the carriage back is reduced. That's an interesting tradeoff and something to keep in mind if you ever need a Plan B.

It is critical to properly size the nozzle tip to the sprue bushing.

In addition to increased shear, a small nozzle-tip orifice will have a dead spot for material to stagnate, similar to the dead spot in a general-purpose nozzle tip, shown in Fig. 3. As the injected material rushes past this dead spot, it tries to pull the trapped or stagnant material out. Unfortunately, it also acts as a venturi and tries to pull air into the melt stream, which will look like splay on your parts. All of these reasons dictate why it is critical to properly size the machine nozzle-tip orifice to the sprue-bushing orifice.

Plastic's Technology Magazine's Know-Column columnists (myself among them) are all highly experienced. We got that experience by making mistakes—lots of them. We take the time each month to share these mistakes with you, in the hope that you learn from them and don't make them yourself.

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Top Shops Are More Than Just Molders

The 2019 *Plastics Technology* Top Shops Survey shows that for its highest-rated respondents, injection molding is just one element in a growing suite of services and capabilities offered to customers.

By Tony Deligio
Senior Editor

The concept of a “shoot-and-ship” molder simply passing along parts directly from the tool cavity without any other intervention—be that assisting on the design up front or assembling molded parts into finished products on the back end—has long been quaint. More and more businesses that have “molding” in their name are likely to talk about being a “Contract Manufacturer” in the “About Us” portion of their websites, and for good reason. Many have long ago added numerous skills and capabilities beyond what happens between the press platens. Our new Top Shops benchmarking survey focusing on injection molders shows that for the top performers, the evolution beyond a shoot-and-ship plastic parts purveyor into a customer’s full-spectrum product manufacturing and logistics partner has accelerated.

Axiom Group, one of the Top Shops of 2019, makes extensive use of automation for part handling and secondary operations—key trends among our survey’s top performers.

In addition to demographic data, the survey asked for information on some key performance metrics, including areas like sales growth, sales per machine and employee, scrap rate, and setup time, among others. Scoring on 10 of these metrics was used as a means to separate 2019's Top Shops from the rest of the respondents. Many of the analyses below compare average results for these two groups.

Secondary Processes Offered

	Top Shops	Rest
Assembly	87%	88%
Decorating	58%	42%
Plating	10%	0%
Painting	6%	14%
Welding/Joining	42%	40%
CNC	52%	40%
Annealing	16%	17%
None	6%	5%

Value-Added Services Offered

	Top Shops	Rest
Additive Manufacturing	23%	12%
Contract Manufacturing	68%	51%
Inventory Stocking/ Logistics	65%	51%
Product Design	61%	68%
Product Testing	39%	51%
Product Shipping/ Packaging/Labeling	81%	68%
None Offered	3%	7%

STRIKING SIMILARITIES

When you focus in on the injection molding portion of the survey participants' business, the profile of their machines reveals very similar fleets. Average machine age was 11 years for Top Shops and 12 for all others; machine orientation was 97% and 91% horizontal, respectively; and drive type was 63% and 70% hydraulic. Clamp-force range also saw striking parallels between the two groups of survey participants. The broadest gap—four percentage points—came in presses over 1000 tons (13% for Top Shops and 17% for other participants). In the up-to-100 and 101-500 ton categories, only two percentage points separated Top Shops from other respondents; while in the 501-1000 ton range they both reported an identical 42% owning such machinery.

In traditional secondary processes, both groups of molders largely mirrored the others' offerings as well: assembly (87% for Top Shops and 88% for the rest), welding/joining (42% and 40%, respectively), and annealing (16% and 17%). Only in three categories of secondary operations was there much discrepancy: decorating (58% for Top Shops vs. 42% for others), plating (10% vs. 0%), and machining (52% vs. 40%) .

For the survey participants, the customer profiles were also mostly similar. Automotive (48% for Top Shops and 51% for others) and packaging (19% and 16%), as well as building & construction and military, which were identical at 32% and 23%, respectively, show the survey participants drew business from a fundamentally similar customer pool. There was some divergence among those serving consumer goods (Top Shops 65% vs. 51%), electrical/electronic (45% vs. 35%), industrial (52% vs. 44%) and medical (61% vs. 42%).

Even in the gamut of materials run, there was symmetry. Top Shops processed more PET and TPU and less PVC, but similarities were seen everywhere else. Parity was reported in polyolefins, engineering thermoplastics, TPEs, bioplastics and LSR, as well as recycled plastics, with roughly a third of both groups processing reclaimed resins. Top Shops did process more different types of resins, running an average of 51 different polymers in 2018 compared with 28 for the remaining respondents.

Specialty Injection Molding Technologies

	Top Shops	Rest
Two-Shot	39%	35%
Gas/Water Assist	23%	26%
MuCell Foam	0%	5%
In-Mold Labeling	26%	19%
Insert Molding	84%	82%
None of these	10%	9%

Tool Room Functions

	Top Shops	Rest
Mold Building	55%	46%
Mold Repair	77%	81%

Automation Type

	Top Shops	Rest
Articulated Arm	55%	39%
Cartesian	52%	39%
Sprue Picker	68%	51%

DISTINCT DISCREPANCIES

Divides widened in the value-added portion of the survey, where, for instance, 23% of Top Shops offered additive manufacturing vs. 12% for the rest of the survey participants. Similar gaps appeared in contract manufacturing (68% vs. 51%), inventory stocking/logistics (65% vs. 51%), and product shipping/packaging/labeling (81% compared with 68%).

Variation also appeared in training, where nearly 30% of Top Shops provided a minimum of 21 hr of training for shop-floor employees, compared with 11% of other respondents. The average hourly wage for non-management plant-floor employees was 10% higher at Top Shops, and the differences in benefits was much starker. By a two-to-one

In-House Tool Room

	Top Shops	Rest
Yes	77%	81%
No	23%	19%

Use of Automation

	Top Shops	Rest
Yes	94%	74%
No	6%	26%

Made Capital Investments in 2018

	Top Shops	Rest
Yes	94%	46%
No	6%	13%

margin or more, Top Shops offered workers 401K plans, bonuses, safety/health programs and education reimbursement, with four times as many providing apprenticeships, leadership development, profit/revenue sharing and certification. Perhaps not surprisingly, the turnover rate at Top Shops was more than 40% lower than at other respondents.

Very few questions garnered responses above 90%, so the fact that 94% of Top Shops use automation stood out—especially in contrast to the 74% adoption by the remaining respondents. When it came to addressing the skills shortage, 42% of Top Shops said they responded by adding automation, compared with 21% of the rest of the survey. In terms of staffing, 94% of Top Shops maintained or increased worker rosters in 2019, compared with 13% for the rest of the survey respondents. In addition to investing in people, Top Shops also invested in their facilities, with 94% making capital investments in 2018, compared with 46% of other respondents.

COMMUNICATION FOR THE WIN

With all molders staring down similar market challenges, and armed with a similar technology arsenal at their disposal, differences in performance often come down to business strategies and tactics. The survey revealed stark discrepancies in business practices between the two groups. For instance, 71% of Top Shops undertake a regular review of business compared with just 25% of the rest of respondents. Similar gaps were seen in business-metric goal setting (71% vs. 28%), business-strategy development (74% vs. 23%) and occurrence of regular management and department-head meetings (68% vs. 39%).

Turnover rate at Top Shops was more than 40% lower than at other molders.

Conversations with some of this year's Top Shops revealed that regular meetings, and the communication that happens within them, were a key component of success. Pete Klahorst, managing director of Shape Plastics, Grand Haven, Mich., laid out daily, weekly, monthly and quarterly confabs at his business. In a daily standup meeting, participants talk about one thing they will do that day to improve Shape's KPIs (key performance indicators), while a weekly DMAIC (define, measure, analyze, improve & control) discussion seeks to solve bigger problems with cross-functional teams. "We also have monthly town halls where we will communicate our progress on our KPIs on a plant level," explains Andy Rosenberg, plant manager at Shape. "Then we also have quarterly bonus meetings where all of the plant comes and reports on the metrics and KPIs."

Many businesses use the phrase "open-door policy" to encourage communication, particularly between shop-floor staff and management, but for Chris Moschopedis, v.p. of corpo-

Plantwide Software

	Top Shops	Rest
Process Monitoring	55%	32%
Production Monitoring	64%	49%
ERP	84%	54%
None	10%	19%

Machine Rates

	Top Shops	Rest
Above Average	2%	16%
Average	58%	26%
Below Average	10%	5%
Among the Lowest	3%	3%

Two employees perform a process walk at Axiom. The company conducts layered process audits each shift by production personnel; on a weekly basis by supervisory people; every month by management; and quarterly by members of the executive team.

rate strategy at Axiom Group in Aurora, Ont., a truly open door involves more than a literal door. "We're learning through some recent events that just having your door open isn't the only thing," Moschopedis says. "When you walk by someone and say, 'Hey, how's it going? Great!' and walk away, versus, 'Hey, what are you working on? Any challenges with that? How can I support you? Is there anything that's preventing you from being successful or achieving your objectives?' That's a different set of questions."

Philip Katen, general manager and president of Plastikos Inc. in Erie, Pa., notes that all three of that company's owners and most of its managers are engineers, so they inherently love ►

2019 *Plastics Technology* Top Shops

In addition to demographic data, our Top Shops survey asked for information on some key performance metrics, including areas like sales growth, sales per machine and employee, scrap rate, and setup time, among others. Scoring on 10 of these metrics was used as a means to separate 2019's Top Shops from the rest of the respondents.

- **Applied Molding Technologies,** Frederic, Wis.
- **Axiom Group Inc.,** Aurora, Ont.
- **Certainteed,** McPherson, Kan.
- **Diversified Plastics Inc.,** Brooklyn Park, Minn.
- **Donnelly Custom Manufacturing,** Alexandria, Minn.
- **Engineered Molding Solutions,** McHenry, Ill.
- **Falcon Plastics,** Brookings, S.D.
- **Fedora Manufacturing LLC,** South Acworth, N.H.
- **Injection Molding Enterprises LLC,** Littleton, Mass.
- **Ironwood Plastics Inc.,** Two Rivers, Wis.
- **Logitech,** Suzhou, China
- **Metro Plastics,** Noblesville, Ind.
- **Moldworx,** Gilbert, Ariz.
- **Par 4 Plastics Inc.,** Grand Rivers, Ky.
- **Pioneer Custom Molding,** Pioneer, Ohio
- **Plastic Design International Inc.,** Middletown, Conn.
- **Plasticert Inc.**, Lewiston, Minn.
- **Plastikos Inc.,** Erie, Pa.
- **Polyfab Corp.,** Sheboygan, Wis.
- **Polymer Conversions Inc.,** Orchard Park, N.Y.
- **Pres-Tek Plastics Inc.,** Rancho Cucamonga, Calif.
- **Qualicase Ltd.,** Calgary, Alta.
- **Reed City Group,** Reed City, Mich.
- **SF Mfg.,** Union, Mich.
- **Shape Corp.,** Grand Haven, Mich.
- **Seitz LLC,** Torrington, Conn.
- **Ultradent Products Inc.,** South Jordan, Utah

Shape's newest machine is a 2500 ton Engel combiM press. First shots were expected in early October, with full production in Q1 2020.

Business Best Practices

	Top Shops	Rest
Regular Formal Review of Business	71%	25%
Periodic Formal Review	55%	26%
Business Metric Goal Setting	71%	28%
Business Strategy Development	74%	23%
Regular Management/ Department Head Meetings	68%	39%
Steering Board/Committee Including Outside Membership	35%	11%

Worker Benefits

	Top Shops	Rest
401K	68%	33%
Annual Review	71%	39%
Apprenticeships	48%	16%
Bonus	64%	28%
Education Reimbursement	61%	25%
ESOP	3%	2%
Formal Safety/Health Program	68%	28%
Leader/Supervisor Development	55%	17%
Paid Medical Benefits	81%	30%
Profit or Revenue Sharing	45%	14%
Team Building	52%	12%
Training/Certification	65%	23%
None	3%	2%

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Number of Active Customers

	Top Shops	Rest
High	150	225
Low	2	6
Average	39.1	57.6

Marketing Strategies

	Top Shops	Rest
Online Video	26%	5%
Trade Shows	48%	19%
Print Ads	16%	5%
Online Display Ads	26%	10%
Online Keyword Ads	26%	14%
Print Directory	26%	9%
Online Directory	45%	23%
Open House	19%	3%
No Marketing	19%	11%

Worker Turnover Rate

	Top Shops	Rest
High	46%	52%
Low	1%	1%
Average	12%	17%

numbers and insightful metrics—figures they regularly share with staff. "We believe that the open communication aspect of the process is very important to further grow and develop trust, transparency and accountability throughout the company," Katen says, "which in turn should also strengthen the buy-in and commitment among all members of our team."

At Shape, continuous dialogue also requires consistent respect. "What that means is, we're not always going to agree, but when we have robust dialogue, it's always done from a place of respect," Rosenberg says. "We value peoples' opinions and inputs, so I think that kind of resonates out there in the community."

If these Top Shops have managed to differentiate themselves from their molding peers, what makes them stand out from others is their people; and finding and keeping those people comes down to more than money. "As a company, we can't always buy an employee," Moschopedis says. "We have Magna up the street—there's big OEs and Tier Ones that are multibillion-dollar companies—and sometimes you can't just pay more. We'd rather be the employer of choice, so if you're a twenty-something and you think, 'Well I'm in the manufacturing industry; I'm in plastics; why not choose Axiom? They have a development program; they recognize their people; they share profits—things like that.' For the young kids, that's worth a lot more than another two to three bucks an hour."

> ***The evolution beyond a shoot-and-ship plastic part purveyor into a customers full-spectrum product manufacturing and logistics partner has accelerated.***

When to 'Adapt,' When to Retool?

That is the question pipe and tubing processors typically confront when they specify a line for one product, only to have to add to the product mix when business conditions change. Here are some tips to guide you to the right answer.

Downstream view of a typical medical tubing line for small-diam. tubing. At the end of the line is an automatic coiling system.

By Ernie Preiato and Dave Czarnik
Conair Group

Most extrusion lines for pipe or tubing begin with very basic concerns: How do I process this material into this product with the speed and efficiency needed to make a ROI? Ultimately, these concerns get translated into a series of requirements, then into material specifications and a system of equipment: an extruder, die, sizing method, calibration tooling, cooling system, puller for speed control, and the rest.

Sometimes, processors can develop and purchase an entire line at one time—perfectly matched to material, product, and current production requirements. And, if they are fortunate and successful, they can leverage that line to produce high-quality product for a great customer for a long, long time.

Yet at other times, processors may want to react to business and competitive needs by adapting existing extrusion equipment and tooling. The reasons are many: the need for increased production or profitability, customer gains or losses, changes in product specifications or dimensions, the need to produce different sizes of an existing product, or a change in material suppliers.

But there are risks and difficulties in adapting existing tooling and equipment, and results may produce problems rather than the cost savings that were intended. Below are a number of situations that we have found are common in the experience of pipe and tube extruders, along with discussion of the types of problems and questions that arise from them, and suggestions for resolving them with a minimum of difficulty.

THE IDEAL: EVERYTHING MATCHES UP

To see what can go wrong when changes are made to pipe and tube extrusion equipment, it is important to understand first what needs to be "right" in order for it to work properly. Ideally, any new extrusion line is designed to process a specific material at a specific speed, through a specific die at a specific temperature, and calibrate it to a controlled size through properly designed tooling with an adequate cooling process. Everything is in balance:

- Extruder is appropriate for material mix and production rate;
- Die dimensions are suited to material characteristics and product size;
- Drawdown rate is calculated, so predicted size of extrudate cone matches inlet of sizing tooling;
- Proper sizing method selected, calibration tooling prepared, with cooling adequate to product requirements;
- Production runs smoothly at a selected line speed; line is stable.

If you elect to boost line speed and extruder output, you are raising the risk of process instability.

REALITY: CONSTANT CHANGES, DAILY CHALLENGES

So, what could possibly go wrong with this perfect picture? What are the common situations that processors encounter that can pose extrusion challenges or lead to problems or miscalculations? Can processors respond to those problems by adjusting or adapting capacity? Or, are there times where it's wiser (or necessary) to invest and retool to get the product quality and ROI that are needed?

1. Change Tube or Pipe Dimensions: Frequently, processors of specialty pipe or tube need to make small dimensional changes in a product or produce a slightly different size using the same material. For example, a tubing maker that makes 3/8-in. tubing (0.3750 in. diam), might get an order for ¼-in. tubing (0.25 in. diam). Rather than invest right away in a new die, the processor decides to see if the existing 0.3750-in. die can do the job with the help of new calibration tooling. Experience teaches that, in some cases, it is possible to use a die designed for a larger diameter product to produce a smaller diameter product. But the ability to do so is highly dependent on the material. Materials that exhibit a high degree of drawdown are very forgiving of size reductions. Here are a couple of examples: ►

TABLE 1 Key Material Considerations for Tube and Pipe Extrusion

Material	Drawdown, %	Sizing Type	Wet or Dry	Calibrator Type
ABS	15-25	Contact	Dry	Sleeve
EVA	30	Non-contact	Wet	Pre-skinner
FEP	100	Contact	Dry	Sleeve or wafer stack
Flex PVC	15-30	Non-contact	Wet	Pre-skinner
Nylon	60-70	Contact	Wet	Wafer stack
PC	60-70	Contact	Dry	Sleeve
PE	25-40	Contact	Wet	Sleeve or wafer stack
PEEK		Contact	Dry	Sleeve or wafer stack
PET	60-70	Contact	Dry	Sleeve
PP	40-50	Contact	Wet	Wafer stack
PVDF	100	Contact	Wet	Wafer stack
Rigid PVC	15-20	Contact; non-contact for stiffer grades	Dry	Sleeve
PS	40	Contact or non-contact, depending on application	Dry, Wet	Sleeve Wafer stack Hybrid
TP Urethane	55-65	Non-contact	Wet	Pre-skinner

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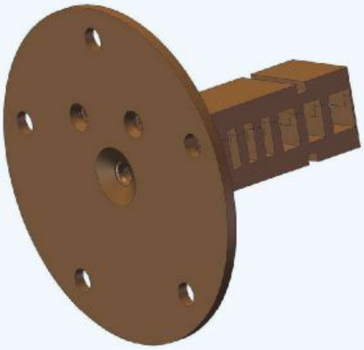
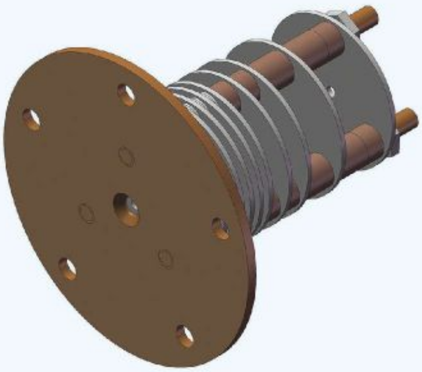
Typical design of a non-contact sizing chamber equipped with an entrance-water well.



The horizontal split in this sleeve calibrator (rectangular section) allows the top to be lifted for proper positioning of the extrudate, then fixed in place when production begins. It also allows water to enter for lubrication, while large slots provide increased contact area for heat transfer within the vacuum-cooling tank.



A wafer-stack calibrator aligns a series of calibration disks, clustering them more closely where the hot extrudate enters to prevent sagging, then spacing them farther apart to reduce friction as the tube cools and firms.

TABLE 2 Sizing Methods for Tube and Pipe

	Contact sizing	Non-contact sizing	Hybrid sizing
Preferred Materials, Characteristics	Stiff materials: PE, PP, ABS, RPVC	Sticky materials: FPVC and softer grades of EVA, TPEs and TP Urethanes.	Sticky, but semi-rigid materials: stiffer grades of RPVC, EVA, and TP Urethanes.
Sizing Components	Product passes through a metal calibration sleeve or "wafer stack," a series of calibration disks at entrance to the vacuum-cooling tank.	Product enters vacuum-cooling tank through a lubricating ring, or "water well" that sets the skin and begins the cooling process.	A water-filled quench chamber is positioned ahead of contact tooling at the entrance to the vacuum-cooling tank.
Sizing Action	Product is dimensioned via contact with beveled sleeve or the edges of successive calibration disks.	Combination of water flow and internal pressure dimensions product as turbulent water flow cools it.	Water flow 'pre-skins' the product so that it can be dimensioned by contact with a sleeve or calibration disks in vacuum-cooling tank.
Dry or Wet	Most materials run dry, except for polyolefins, which need water lubrication for contact sizing.	Wet	Wet

Many medical tube makers are familiar with Pebax (Arkema's polyether block amide), a highly viscous TPE material with a high level of drawdown. A small, thin-wall tube (0.125 in. OD × 0.008 in. wall) will use a drawdown of 50% or more, since the material is more viscous and pulls down quickly as it leaves the hot die. So, it is certainly possible to use a 0.375-in. die to produce a ¼-in. tube using that material.

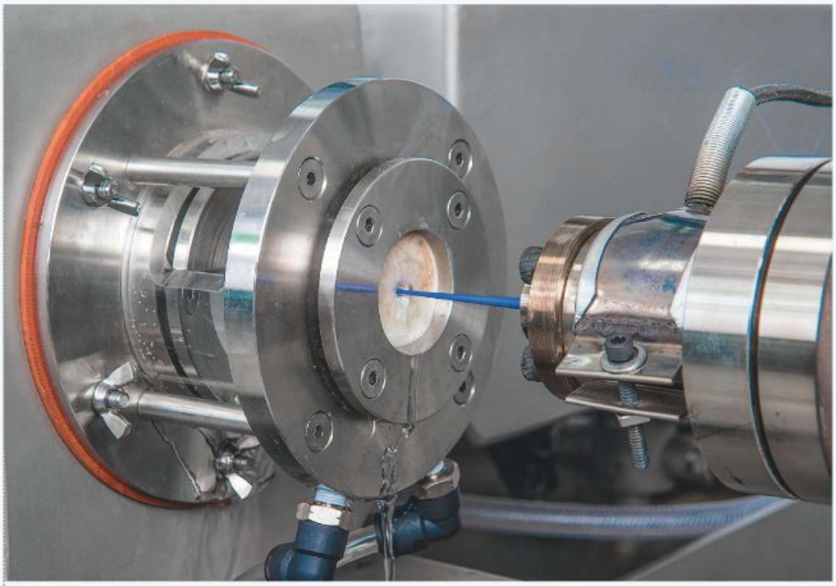
A similar, but more challenging size-reduction task might involve using a 2-in. PE die, plus new sizing tooling, to make a run of 1.5-in. pipe. This is more difficult to manage because the PE has a more moderate degree of drawdown. So, there will be some tradeoffs, like slower line speed or the threat of greater process instability. In this case, going from 2-in. to 1.5-in. pipe might mean that you've got to pull the calibrator away from the die to give the material a chance to draw down so that it will pass into calibration tooling that's appropriate to size a 1.5-in. tube. Otherwise, the cone of the extrudate is going to "overpack" the calibrator opening, so that either it occasionally has to fold up to get through—creating tube irregularities downstream—or it won't get through at all.

So, it is possible to "go smaller" in some cases, based on the material you are extruding. One case where it would not be possible involves a material like rigid PVC. The drawdown rate of that material is so low that you could never achieve a 2-in. to 1.5-in. size reduction. You'd need a new die and new tooling.

2. Increase Production Rate/Speed: When a line is working well, there's always the question: "Can it continue to produce—but at a higher rate? The answer is, once again, that it depends on the mate-

rial you are extruding and the dimensions of the finished product. Experience demonstrates that line-speed increases of up to 20% may be possible if you incrementally increase both puller and extruder speed—and if you're running materials that will tolerate the change—i.e., materials that don't have high drawdown and swell, such as PE, PP or other polyolefins.

Of course, if you elect to boost line speed and extruder output, you are raising the risk of process instability. Higher extruder RPMs will tend to increase material shear in essentially the same way as if you raised the temperature profile of the material. Boosting line speed may also require you to adjust the amount of material going into the extruded pipe or tube, or adapt the "adjusted size" of the contact tooling, since higher line speeds are associated with greater shrinkage of the end product.



Small-diam. tubing enters the die head, then draws down slightly in the short space between the die and a water-filled, non-contact sizing chamber at the entrance to the vacuum-cooling tank.

3. Change Material Supplier: Processors must continually evaluate the quality of the materials they buy, together with the capabilities of the suppliers and manufacturers that provide them. And sometimes processors decide to make changes that can have an effect on the stability and performance of tube and pipe extrusion lines.

With "identical" types and grades of material, small variances in key characteristics can be sufficient to upset pipe and tube extrusion processes and require time-consuming adjustments. For example, a processor who is making nylon tubing for a new customer might select a better grade of material. And, based on their experience with that material, the processor's extrusion team sources tooling and "dials in" the line to perfection.

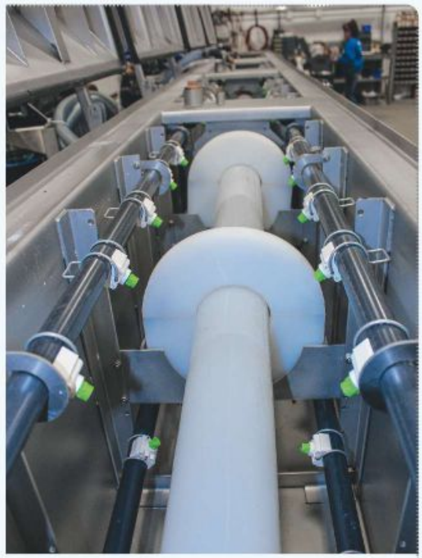
Later on, to take advantage of a great price, the processor sources material from a different supplier. But it may not pay off: Extrusion efficiency suffers because the "identical material" is not quite identical—it has a broader molecular-weight distribution. As a result, it has a greater tendency to swell upon exiting the die, causing periodic overpacking of the calibration tool and tube wall inconsistencies when excess extrudate "folds in" and goes through. Finally, after numerous adjustments and plenty of scrap, the ►

drawdown problem is corrected and the line is stabilized. (If this material switch had happened in reverse—the lack of expected swell would also have caused drawdown problems, with the extrudate being unable to "fill" the calibrator, which was built with the previous material in mind.)

The lesson here is pretty simple: If you want to extrude with consistency, you have to buy materials with consistency. Develop a window of tolerance for the molecular-weight distribution of materials you buy, and stick to it.

4. Get Sizing and Calibration Right: As with the rest of the tube and pipe extrusion process, experience with sizing demonstrates that there are right ways and wrong ways, with many of the rights and wrongs being material dependent.

Sizing a tube or pipe takes place within a calibrator. A calibrator is a heat exchanger that enables the use of contact, non-contact or hybrid sizing methods to control the OD, ID and wall thickness of the product. The sizing method sets the outer skin of the product as initial cooling takes place. Providing the proper amount of total cooling residence time is vital to ensure the final dimensions of the product, since product shrinkage continues until cooling is complete. General cooling guidelines require approximately 30 sec of cooling time for thin to medium wall thicknesses up to 0.060 in. and 1 min or more for up to 0.100 in.



The open lid of a vacuum-sizing tank shows a larger-diam. pipe passing through guides made of UHMW-PE, a material chosen for its lubricity. The guides prevent sagging and aid in size control as the pipe undergoes vacuum sizing and spray cooling.

Previously, we noted the importance of calculating the drawdown of the extrudate cone to match the entrance to the calibrator. Getting that dimension right—and matching the correct sizing approach, tooling, and water/lubrication requirements for your material type—are absolutely critical to smooth downstream extrusion (see Table 1). If you don't get them right, you'll constantly struggle with:

- Slower-than-expected production rates and inability to get line speed "right";
- "Overpacking" the sizing tool;
- Stick/slip inconsistencies in surface finish, including "chatter" marks from lack of lubrication.
- Unacceptable dimensional variability, resulting in the constant need to "tweak" settings.

Of the three approaches shown in Table 2, contact and non-contact sizing methods are by far the more common. Non-contact and hybrid sizing methods are used to size "sticky" materials that require water lubrication to run smoothly into the vacuum-cooling tank. In the case of hybrid sizing, initial contact with water takes place in a water-filled quench chamber positioned just ahead of the vacuum-cooling tank. The chamber "pre-skins" the product before it enters the cooling tank and undergoes conventional contact sizing. ►

Non-contact sizing is the most forgiving with regard to slight changes in product dimensions. Because water, not metal, is making contact with the tube, the tube diameter could increase by perhaps 0.020 to 0.030 in. without the need to change the lubricating ring in the water well. However, contact sizing and tooling are much less forgiving. Making a larger-diameter product that must be contact-sized always requires new tooling, machined to the "adjusted" size of the tube at successive points in the process as the tube shrinks to finished size.

The biggest problems in sizing occur when people mistakenly employ contact sizing tooling when a non-contact approach is needed. Running sticky, flexible materials through a contact die by mistake is a recipe for a messy overpack or "chatter" marks from the constant stick/slip of the product caused by lack of lubricant on the tooling surface.

Non-contact sizing is the most forgiving with regard to slight changes in product dimensions.

Another error involves forgetting or becoming confused about which materials must run "wet"—with a water well for lubrication—and those that don't. For example, it is essential to run polyolefins "wet," using a water well, or they won't tolerate contact sizing. However, if you then switch to a more rigid material, such as PVC, but fail to remove the water well, you will cause dimensional problems because exposing the PVC to water before it is contact-sized in the vacuum chamber is going to start "freezing" its dimensions prematurely.

To many processors, tube or pipe extrusion still looks and feels a lot like an art, since there seem to be so many judgments to be made, so many factors, large and small, to "get right" before a process will work properly. Yet, if you organize and leverage design, materials, and production experience, you may find it possible not only to master this process for tube and pipe products you're currently making, but to cost-effectively stretch the capabilities of your equipment and processes to achieve even greater flexibility, productivity, and output.

Sometimes, you'll need new equipment, new dies or tooling, or improved controls to get the job done. But not always. In our experience, many processors are surprised at what they can learn and accomplish. PT

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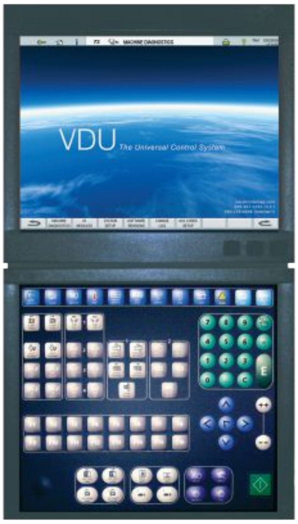

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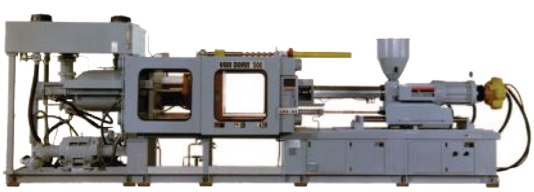

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How Second-Stage Injection Speed Influences Your Process

As an injection molder, you're familiar with first-stage fill-speed profiles and second-stage pressure settings, but have you considered the function of second-stage speed, or "hold flow"? Here's what it does and how it affects your molded part.

By Shane Vandekerkhof
RJG

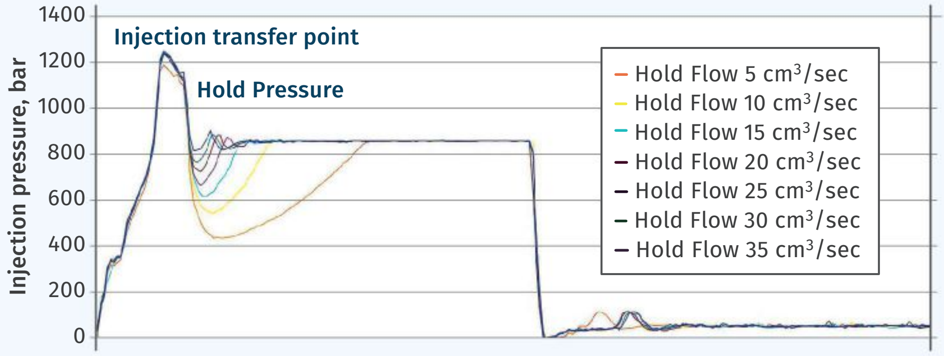
Hold speed or hold velocity? How many machines today have it and what does it do to your process? The machine controller input of hold velocity started to become more and more prevalent with the onset of electrically driven molding machines. The setting tells the machine how fast to move the screw during second stage. But, and this is a big but, second stage is a pressure-limited portion of our process. You can't have velocity control on a pressure-limited portion of a process. So how effective is the speed setting, then?

The molding machine will use the speed that is input into the machine controller only until the set second-stage pressure has been reached. Once your second-stage pressure is reached, you will notice that the screw slows down and may even eventually stop. We look at this velocity input as a matter of response time. The setting is telling the machine controller how fast you want to get to the second-stage pressure setting.

So, the question becomes, "How does this setting impact my process?" The answer to that is simple: Yes.

Here you will find a couple of graphs that represent the injection-pressure profile and the part weight correlated with seven different second-stage velocities, starting at 5 cm³/sec up to 35 cm³/sec moving in 5-cm³/sec increments. Setting speeds in volumetric units rather than linear units of mm/sec or in./sec has been avail-

FIG 1 Hold Flow vs. Hold Time



Hold flow, or second-stage velocity, affects the amount of time it takes to reach holding-pressure setpoint.

able on machines sold in the last 10-15 years, and it has become more popular with molders because it translates speed profiles directly between machines with different screw sizes, etc.

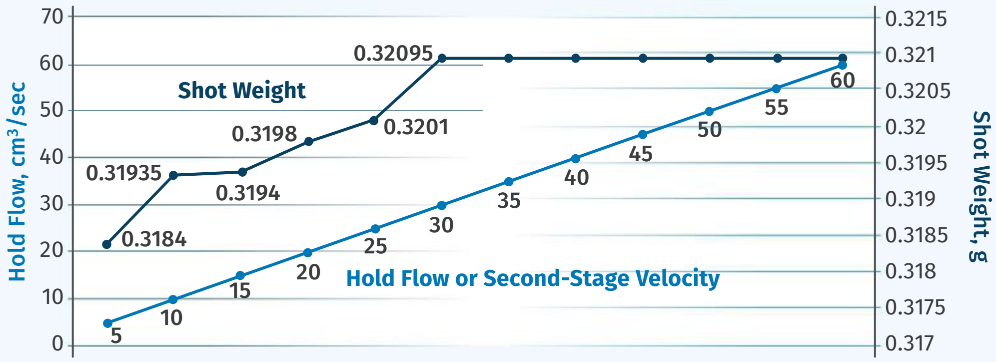
In Fig. 1, you will see that the slowest speed is represented in orange. It shows a large droop in the injection-pressure profile after transfer has been reached. The reason this occurs is that the cavity is short at transfer, and it takes time before the cavity completely fills and starts to pressurize. The resistance in the cavity is now pushing back on the screw, and the second-stage pressure setting is reached and stabilized. As the second-stage velocity, or "hold flow," is increased, you will notice that the droop gets smaller and smaller, and the time it takes to reach the second-stage pressure setpoint gets shorter and shorter.

Speed settings in volumetric rather than linear terms are becoming more popular because they translate directly between different machines.

In Fig. 2, part weight is plotted against the second-stage speed setting. You will notice that the part weight continues to rise until 30 cm³/sec is reached. You will also notice that at this time any additional second-stage speed has no influence on the part weight. This is the sweet spot for where the second-stage speed should be set—at a point where the final part weight is no longer influenced by the second-stage speed.

Remember to think about what is happening to the plastic and to your parts during this time. This is one of the most influential phases of your process for setting the part dimensions. The slower the speed and response are, the slower you are packing out the parts, and therefore allowing the material to cool and solidify.

FIG 2 Shot Weight vs. Hold Flow



The point where part weight levels off is the correct setting for hold flow, or second-stage velocity.

WHAT ABOUT OTHER MACHINES?

If you are like most molders who are scheduling a mold in several different molding machines, it will be important to understand how each of those machines reacts to the second-stage speed setting. Just because 30 cm³/sec works on machine #4 doesn't mean that you will get the same response on machine #12. This could be due to different machine makes and models, ages of the machines, hydraulic vs. electric drive, you name it. There are too many things to list that could contribute to the difference.

You may also have machines that don't have an input for second-stage velocity—many machines out there don't. In this case, the molding machine will typically use the last fill-speed input on the machine controller. If that setting is slow, then the second-stage velocity will also be slow.

OTHER INFLUENCES

Besides the second-stage speed setting, the size of the fill-only part can also contribute to the droop, or slow response. If the fill-only part is 60% full at transfer instead of 98%, then it will take more time for the cavity to fill out and pressurize. When conducting this type of study, we want to make sure that the parts are 98% full at transfer to eliminate that as a potential cause of the response. We want to make sure that we are measuring *only* the influence of the second-stage speed on the process.

Ultimately, we are trying to produce the most repeatable parts in the fastest, most repeatable time, and the second-stage speed setting is an often-overlooked influence on the process. Knowing how your machines respond to this input is one more step toward being better than the next molder. PT

ABOUT THE AUTHOR: Shane Vandekerkhof joined RJG in 2003 as a member of the Customer Support team. He was soon qualified to conduct on-site training for RJG customers in the use of RJG's software and equipment. After two years, Shane took on the role of business development for Europe, where he was responsible for creating new accounts, supporting existing accounts, and working with sales representatives. Shane became one of RJG's trainer/consultants in 2007, teaching RJG Systematic Molding and Master Molder courses. In 2018, Shane became the global education & training integrator, responsible for maintaining and implementing standard training and consulting practices across the globe.

By Heather Caliendo
Senior Editor

3D Printing Enables Customizable Medical Prosthetics

Glaze Prosthetics produces customized prosthetics using HP's Multi Jet Fusion technology.

Glaze switched its production from Selective Laser Sintering (SLS) to HP's Multi Jet Fusion.

One of the most exciting developments in manufacturing is shifting the application of 3D printing from strictly prototyping to actual production manufacturing. In doing so, the process is creating new opportunities that would have been impossible in the past. Among those taking early advantage of this trend are entrepreneurs with start-up companies that are using additive manufacturing (AM) to print parts at prices competitive with traditional manufacturing. Some are using AM technology to create innovations in medical devices that help transform lives. Case in point: creating customizable prosthetics.

Founded in 2017, Glaze Prosthetics in Krakow, Poland, claims to be the only company in the world that allows patients to choose the model, color and finish of their prosthetics and even design and order the products online. The ability to offer such options is partly due to Glaze Prosthetics using HP's Multi Jet Fusion technology, which launched in 2016. The flexibility of this 3D printing technology allows Glaze Prosthetics to continue pushing boundaries in this market by introducing new features to its prosthetic arms, such as a Bluetooth speaker and a power-bank option.

Piotr Sajdak, co-founder of Glaze Prosthetics, says that prosthetics heretofore have been burdened by high cost and typically have been heavy, hard to use and not aesthetically pleasing. Sajdak got involved with the company because he loved the idea that 3D printing can give so many different options to users of prosthetics. And he became the first user of the Glaze system himself.

"We have so many people on the planet—short and tall, small and larger people—so imagine you only offer a couple different sizes," he says. "3D printing gives the opportunity to make customization for any patient."

After the first year of trials, Glaze got in touch with HP last year and the start-up decided to change its production method from Selective Laser Sintering (SLS) to HP's Multi Jet Fusion. This switch lets Glaze produce parts that are lighter and less expensive, but also better. The prosthetics are made primarily from nylon 12 powder.

"Glaze Prosthetics is doing incredible work in the healthcare industry to enable people with missing upper limbs to express their creativity and personality through their prostheses," says Ramon Pastor, v.p. and general manager of HP's 3D Printing Business.

"They are using Multi Jet Fusion technology to create lighter, better fitting, personalized upper limbs that make people's lives easier and more comfortable. I personally love how they embrace uniqueness and personality through their project. It's much more than prostheses; it's about patients with these disabilities regaining confidence and not seeing their disability as a weakness, but as a uniqueness."

THE PROCESS

The first step in the process is taking a patient's measurements, which are then run through the software to prepare all the files to be printed. These files are printed on the HP Multi Jet Fusion 3D printers, which provide dimensional accuracy and repeatability. Glaze uses a third-party fusion software, but it develops its own scripts, which they worked in over the last couple of years. They outsource production through a service bureau.

Glaze Prosthetics is looking to make a difference with its customizable 3D-printed prosthetics for patients around the world.

Multi Jet Fusion "thermal inkjet technology" works by jetting HP functional agents using HP printheads, which selectively fuse the plastic powder with thermal energy. Pastor emphasizes that the part control and accuracy is executed at the voxel level. Voxels are volumetric pixels, the elemental cubic unit that composes a 3D-printed object; and HP's technology has the capacity to specify the properties of each voxel, defining a 3D part point-by-point through a series of fusing and detailing agents.

"Thanks to voxel-level control and the limitless design possibilities of additive manufacturing, we have enabled applications that were previously unthinkable," Pastor says. "We have also improved part performance and reliability by producing engineering-grade parts with optimal mechanical properties, more flexible, versatile and customizable, using less material."

HP Jet Fusion printers recycle almost 100% of the unused material during printing without compromising its quality or properties. This means that the next set of parts printed will always be composed of both new and recycled material. Nothing goes to waste, Pastor says.

Adam Komarowski, R&D manager for Glaze Prosthetics, says Multi Jet Fusion also gives the firm an opportunity to create different sizes such as a new line of prosthetics for children.

Another key factor, Sajdak says, is that the overall process for Multi Jet Fusion costs much less. "We can create really good products that are affordable for everyone," he says. "Price is the most important thing to offer for these people—affordable solutions that will be functional. Glaze itself is a elegant design and stylish, but also provides function."

The World Health Organization (WHO) estimates there are about 30 million amputees around the world — four out of five live in the developing world, and many have no access to prosthetics.

Glaze is now exploring providing 3D-printed prosthetics for patients in those developing areas, such as India or Africa. "Everything we can do is thanks to HP," Sajdak says.

3D PRINTING'S IMPACT

Pastor of HP says that when you consider the journey to the fourth industrial revolution (Industry 4.0), the basic design and manufacturing process hasn't fundamentally changed over the past 100-plus years. In fact, not only have the processes not improved but they've put a substantial ►

strain on our natural resources, pushed production farther from the consumer, and constrained design flexibility and customization.

"We now are seeing innovation take hold and accelerate a massive transformation of traditional manufacturing, including advanced analytics, artificial intelligence and 3D printing," he says. "Digitization, more rapid advancement of product capabilities, and breakthrough economics are critical to this disruption."

Piotr Sajdak is a co-founder of Glaze Prosthetics and the first user of the Glaze system.

Pastor foresees the factory of the future to be built on rapid shifts in technology—including machine learning, industrial IoT, and Big Data—which will require new skill sets and will make manufacturing jobs much different from those of the past. Engineering and design roles will be able to take full advantage of more automated environments, especially with increased utilization of 3D printing, which is expected to escalate the pace of product creation and lifecycles. With a shorter time to market, Pastor says design engineers will need to help push products through to production and "un-learn" constraints of traditional manufacturing that are no longer constraints for 3D printing.

"The democratization of 3D printing design and manufacturing will unleash new possibilities for innovative small- to medium-sized product-development teams and design businesses, entrepreneurs, and universities and research institutions around the world, as well as enable the big factories of the world to become fully digital and rethink how, where and when they manufacture," Pastor says. PT

QUESTIONS ABOUT ADDITIVE MANUFACTURING?

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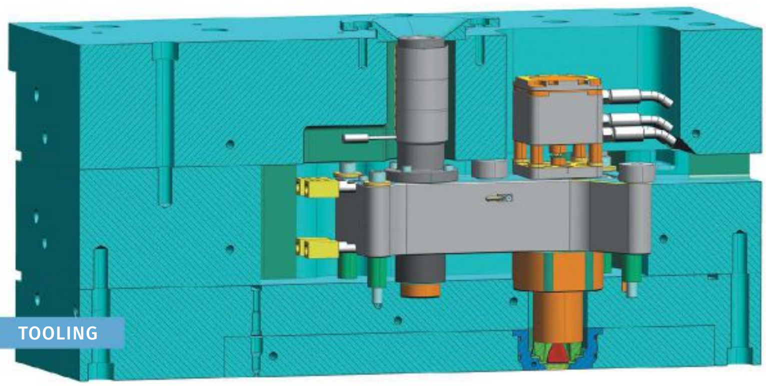
Keeping Up With Technology

PRODUCT FOCUS **Hot Runners & Tooling**



TOOLING

New Flat Die Nozzle & Cloud-Powered Mold Monitoring

Haidlmair Group has created FDU Hotrunner GmbH to distribute and develop the company's FDU (flat die unit), which originally launched at K 2016. At K 2019, FDU Hotrunner will introduce a new valve-gate nozzle, the FDU SLS (Slot Lock System). Building on the company's blade closure shutoff technology, the FDU SLS features a guide system with anti-twist protection for the blade that doesn't divide the melt flow.

Through this, cross sections up to 175 mm² exit area and large shot volumes can be injected without stress or shear at high speed. This also means lower injection pressures can be used than with the conventional FDU, without jetting and consistent fill and hold. The company says the first iteration of the FDU achieved cycle time reductions up to 25%, with even more possible using the SLS version.

At the show, a mold utilizing the new nozzle will be running on a KraussMaffei injection machine making a container. Additional Haidlmair molds will be in action at the booths of Erema, Woojin, Engel and Sumitomo Demag.

The second new Haidlmair company—Digital Moulds GmbH—will market the mold-monitoring system launched at K 2016. This device monitors and records various parameters, including cycle time, temperature, flow rate, cavity pressure and more. New at K 2019 will be a technology that the company says centrally documents and visualizes the entire life cycle of a tool. Mold Lifecycle Management is a cloud-based software that gathers all a mold's relevant information, documents, drawings and parameters in a database. Access can be shared among relevant stakeholders.

TOOLING

Self-Locking Wedge Clamps

Hilma's new self-locking wedge clamps are powered by spring force, making them well suited for clamping dies with a straight clamping edge. The use of springs means no permanent hydraulic supply is necessary and only 160-bar (2320-psi) pressure is needed to release the clamp. The self-locking clamping bolts, which are monitored by inductive switches and visual position, can withstand temperatures up to 160 C (320 F) and come with a rust-protective coating. The wedge clamps offer maximum flexibility when used with hydraulic connections.

TOOLING

Expanded Mold-Base Range, New Hot-Runner Brand

Hasco says its P1 plate range of mold bases has been expanded to include 2000 additional dimensions and new design features, including elements for demolding, heating/cooling, sensors, hydraulics and cylinders. To be presented at K 2019, this includes a modular system for slides, covering a wide range of configuration and installation options and utilizing DLC-coated components. In addition, the company says its app can calculate the surface temperature of a thermal insulation sheet by entering individual parameters like plate type, mold temperature and plate thickness.

Hasco will be presenting products under its "Hasco hot runner" brand for the first time at K 2019. The new Single Shot individual nozzle has been designed as a single nozzle with maximum temperature uniformity and what the company describes as "generous" flow-channel diameters.

The company says when molders use its hot half with a single-needle valve, they benefit from the high efficiency and safety of a complete, ready-to-connect system. The company will also highlight its screw-on Vario Shot nozzle. This product allows for ready-to-mount systems, designed and produced according to individual customer specifications. Easy assembly and dismantling in the mold are guaranteed, as is freedom from leakage and optimum temperature homogeneity.

INJECTION MOLDING

New Hybrid Option For Small Machines

Boy Machines is now for the first time offering a servo-electric injection unit as an option for its servohydraulic machines. The new Servo-Plast eSP unit, with two servomotors for plasticating and injection, is available for Boy 60 E to Boy 125 E presses. Boy says this hybrid option allows operation of the injection unit independently of the hydraulics used for clamping and other functions, which is an advantage for short cycles and large shot sizes relative to the press tonnage.

The new electric injection units have been completely redesigned and incorporate the latest force-measuring technology in a patent-pending arrangement that is said to maintain the highest accuracy for the injection switchover point, which is guaranteed within ± 0.01 mm.

A hybrid Boy 100 E with eSP technology will be running at the K 2019 show in Dusseldorf, Oct. 16-23. It also features a new and more compact design: Compared with its predecessor, the machine length has been reduced by 460 mm.

INJECTION MOLDING

First Look at Vertical Multicomponent Press

As reported in our K 2019 show preview in September, Wittmann Battenfeld will show off the first multicomponent Combimould version of its new vertical-clamp VPower servohydraulic press. More details are now available, including a photo of the new machine.

While a 120-ton version of the VPower Combimould is being displayed at K, the option is offered for the whole line, which ranges from 120 to 300 metric tons. Only the 120- and 160-m.t. sizes were on sale at the start of this year, but the 220- and 300-m.t. models are now also available. Rotary-table diameters run 1300, 1600 and 2000 mm, available with electric servo drive.

In the standard single-injector configuration, the machine's second hydraulic system is used for ejection during the injection molding cycle. But in multicomponent applications, the second hydraulic system powers the second injection unit, so both units can perform injection and plastication simultaneously. Single-component models can be retrofitted with a second injector.

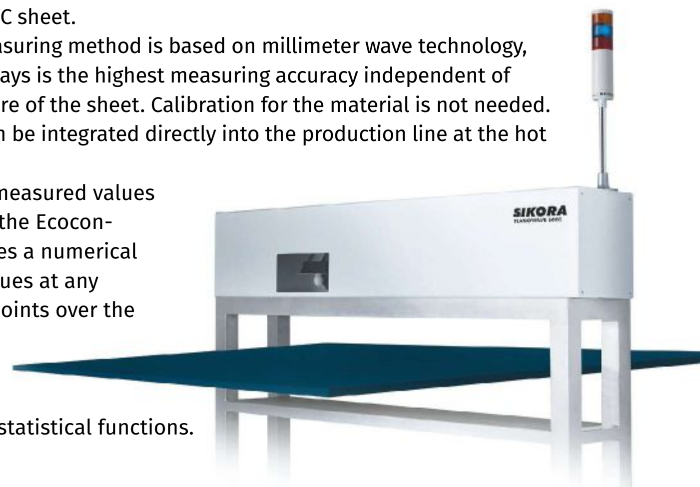
EXTRUSION

Non-Contact Sheet Gauge

To be showcased at K 2019, Sikora's Planowave 6000 is a non-contact, non-destructive measuring system for sheet made from engineering resins like acetal and PEEK. The Planowave 6000 is also suitable for measuring PMMA and foamed PVC sheet.

The measuring method is based on millimeter wave technology, delivering what Sikora says is the highest measuring accuracy independent of material and temperature of the sheet. Calibration for the material is not needed. The Planowave 6000 can be integrated directly into the production line at the hot or cold position.

Visualization of the measured values is done in real time on the Ecocontrol 6000 screen. Besides a numerical display of thickness values at any number of measuring points over the width of the sheet, the operator also receives a graphical display with trend and statistical functions.



EXTRUSION

Rotary-Style Melt Filter

At K 2019, Gneuss Filtration Technology will exhibit several different models—including two new ones—of its patented Rotary Filtration Systems. These continuous filtration systems feature a filter disk on which the screen cavities are located in a ring pattern. Screens on the filter disk that are not active in the melt channel can be changed during production.

A new model, the SF*neos,* was developed to combine the charactertistics of several older models into one simple and cost-efiicient solution, offering the following advantages:

- Constant pressure guaranteed even during screen changes.
- Suitable for most types of polymers and viscosities.
- Compact design thanks to an enlarged active screen area (up to 370 in.^{2}).
- Simple and safe handling and operation with several screens accessible for screen changes.
- Very cost-effective thanks to its improved design.

The SF*neos* is recommended for applications that benefit from continuous, constant-pressure filtration but don't require back-flushing.

Gneuss is also showing a new semi-continuous model, the CSF*primus*. This model is used as a pre-filter, safety filter, or in applications with little contamination. It boasts a very large active screen area for its small footprint.

THERMOFORMING

Sustainability, Digitization on Display

At K 2019, Illig will be presenting a number of new developments in machinery and tooling. Among them is a new, designed-for-recycling plastic/cardboard combination pack. Called IML-T Cardboard, it can be decorated on both sides and features a plastic inlay that easily separates from the outer cardboard layer. This packaging solution can be produced on all Illig IML-T machine lines and offers new possibilities of decorating in thermoforming, the company says.

Illig will also demonstrate cups made of rPET with easily separable paper labels on its new IC-RDKL 80 system. Illig will also showcase the new IC-RDM 76K thermoforming system, which features a completely new drive system and significantly more closing force.

Moreover, Illig will highlight developments in digitization in thermoforming. Illig Connectivity securely connects thermoforming systems into the customer's network, optimizing job and process control, and facilitating data exchange, logging and archiving.

THERMOFORMING

New Form/Cut/Stack Machine

GN Thermoforming Equipment will be launching its new GN580 form/cut/stack thermoformer at K 2019. It's aimed at food, medical, and industrial packaging. This is a smaller version of the company's GN800 launched at K 2016. At K 2019, the GN580 will run 100% post-consumer recycled PET with a common-edge tool, producing meat trays with minimal scrap. Common-edge tooling offers the ability to form a series of square or rectangular trays in a row or multiple rows while eliminating the web between the products.

The high-production GN580 thermoformer has an integrated steel-rule cutting press and stacking station. The most distinctive features are its high degree of automation and ease of tool change, the company says. The GN580 has a forming area of 580 x 465 mm and a cycle time of 45 cycles/min at full stroke. The machine forms 120-mm (4.7-in.) deep parts above and below the sheet line. The control interface has integrated diagnostics and a remote connection. Also included are an energy recovery system in all drives, and maintenance-free precision roller bearings in the toggles. The unit accepts tools from many competitors' machines.

HEATING/COOLING

Pressurized-Water TCU With Cell Connectivity

The new Tempro plus D100 temperature-control unit (TCU) from Wittmann Battenfeld can be fully integrated into the control system of a Wittmann Battenfeld injection molding machine for Industry 4.0 implementation. To be presented at K 2019, the new temperature controller is capable of 9 kW of heat output for temperatures up to 212 F and uses a magnet-coupled, stainless-steel pump. The pump's capacity is 0.5 kW, with a maximum flow rate of 40 L/min (10.5 gpm) and a maximum pressure of 4.5 bar (65 psi). A wear-resistant flow sensor is standard.

FEEDING/BLENDING

4.0 Connectivity and Easy Cleaning

Brabender Technologie is using K 2019 to launch its DSR28 and DDSR20 feeders. The company says it has completely revised the lines, including a new type of gearbox, as well as many new components that allow for easy operation and faster cleaning without tools. The two machines also utiize two possible motor types with an extended adjustment range.

Also new is the FiberXpert fiber feeder for lower feed rates and a FlexWall 40 with an acrylic hopper that can be controlled remotely using a web-enabled mobile device.

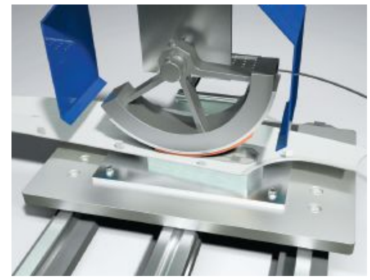
The company calls its new OPC-UA interface a step towards Industry 4.0. Connection to upstream machines, such as vacuum conveyors, is now available in the feeder control and the OP16 control unit. This gives customers control of both machines from a single source, allowing them to optimize refill processes and coordinate machines.

DECORATING

New Way to Apply Touch Sensors to Plastic Parts

New roll-on technology for applying touchscreen sensors to plastic parts will be presented at the K 2019 show. Leonhard Kurz will apply sensors to a washing-machine control panel using the company's patented Functional Foil Bonding (FFB) process. FFB was presented for the first time at the Fakuma 2018 show, but a new semi-rotary variant will be displayed for the first time at K.

In all FFB applications to date, touch sensors have been applied by vertical stamping. But this transfer technique is not suitable, according to Kurz, for larger touchscreen sensors such as the 8-in. version to be demonstrated at K. Kurz therefore developed a new roll-on technology that can transfer large-area sensors without air entrapment. This was achieved by replacing the previous dispensing roller with a half-round silicone segment. This latest development also offers reduced cycle times.



In the demonstration at K, the touch sensors are transported into the FFB machine, detected by a camera inspection system, and positioned precisely on the plastic panel by a robotic handling system. The system uses cleanroom technology and can be adapted to automated inline production.

The touch sensors comprise silver-based metallic grid structures on a PET carrier film. Both conductive and transparent, they are also flexible and can be applied to both flat and slightly 3D parts. The application at K will be backlit.

Kurz notes that touchscreens previously were applied with adhesive lamination in a relatively costly process. Alternating-climate tests reportedly have shown a risk of bubble formation due to outgassing of the plastic. Besides being more cost-effective, the FFB process reportedly does not show such defects in alternating-climate tests.

AUXILIARIES

Conveying, Loading, Blending, Drying & Cooling at K 2019

At the K 2019 show, Moretto will feature an extended range of its X Comb mini dryers, with additions covering higher production needs. Moretto will feature the "On" series, which are suitable for installation directly on the feed throat of the processing machine, as well as the "Side" series, which includes larger models with throughputs up to 53 lb/hr, that run alongside the machine. All Moretto dryers can have the Moisture Meter option, which measures residual moisture in pellets in the hopper in real time.

For PET processors at K 2019, Moretto will showcase an XD 800X series dryer combined with the OTX hopper and Moisture Meter. The turbo-compressor system of the XD 800X paired with the OTX hopper reportedly offers greater energy efficiency. XD 800X dryers do not use cooling water or compressed air, for further energy savings.

Moretto also will highlight a series of products intended for "micro" conveying of small quantities of technical materials. These compact loaders include clean-room-ready models.

For control, Moretto applies the One Wire 3 with FIFO logic. These can be paired with the company's Dolphin manifold for automatic distribution of materials to machines. The company will also highlight its Kruise Kontrol technology, which manages the speed of the material in conveying, reportedly eliminating spikes that can lead to angel hair in the resin and wear on the conveying pipes. Besides air speed, Kruise Kontrol takes material characteristics into account, controlling more than 15 parameters. The company also presented this technology at NPE2018. Another technology on hand in Düsseldorf that was featured in Orlando is the DGM Gravix series dosing units for precision to 0.01%.

New at K, but previously introduced at Fakuma 2018, will be the DPK loss-in-weight system for dosing small amounts of masterbatch or additives with accuracy to ± 0.03%. The hopper is of clear, anti-static acrylic and can be removed without tools for quick material changes. Intelligent storage and masterbatch recognition further speed changes. For micro-dosing, Moretto also offers the DPM model with one to four hoppers.

Moretto will also feature its MOWIS 3 modular supervision software, launched earlier this year. It is remotely controllable and can communicate with ERP, MES and customer data-management systems via the universal OPC UA protocol.

Moretto will also show its X Cooler series of modular chillers. This line can be scaled to meet the processor's needs. The TE-KO series of mold-temperature controllers, meanwhile, is available in water, pressurized, and oil versions for temperatures up to 300 C.

ADDITIVES

Odor Eliminator for Recycled & Filled Compounds

New odor-elimination technology for filled plastic compounds and recycled post-consumer plastics has been introduced by Addisperse, a business of Aromatic Fusion Inc. (AFI), Bensalem, Pa. The new ON concentrates—free-flowing powder ON 106 and pellet ON 108—reportedly work against both common malodors and particularly challenging malodors such as those occurring with natural fillers such as lignin, algae and cellulose. The technology is said to be based on chemicals that interact with malodorous volatiles in the vapor stage. Addisperse can also formulate concentrates tailored to specific customer needs.

MATERIALS

New Self-Bonding LSR for Overmolding onto PC, PBT

At the K 2019 show, Momentive Performance Materials will introduce its new self-bonding Silopren LSR 27x9 family of liquid silicone rubbers for overmolding onto PC, PBT and copolyesters. Available in 30, 40 and 50 Shore A hardnesses, the new family's primer-less adhesion will be demonstrated in over-molding onto high-heat PC for a "butterfly" cell-phone holder that plugs into a car dashboard.

Prices for Nearly All Volume Resins Down

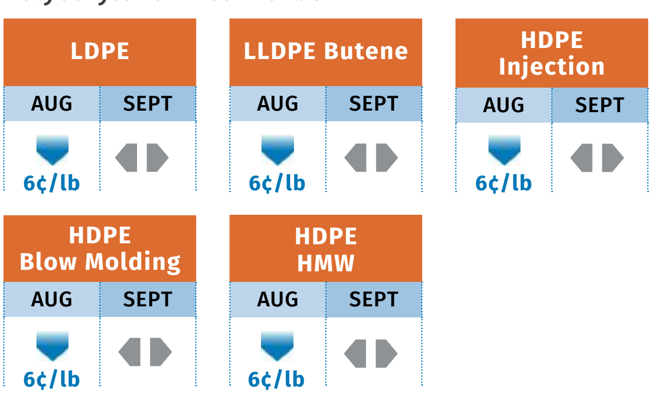
Flat pricing projected in fourth quarter for volume resins.

By Lilli Manolis Sherman
Senior Editor

Volume resin prices, all of which eroded during much of the third quarter, were generally projected to be flat in the fourth quarter, except perhaps for downward pricing of PET and nylons 6 and 66. Major drivers include supply outstripping demand, a slowdown in some key markets such as automotive and construction, lower U.S. GDP, slowed global demand, and tariff-related issues.

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-September 2019

Resin Grade	¢/lb
POLYETHYLENE (railcar)	
LDPE, LINER	92-94
LLDPE BUTENE, FILM	75-77
NYMEX 'FINANCIAL' FUTURES	33
SEPTEMBER	33
HDPE, G-P INJECTION	97-99
HDPE, BLOW MOLDING	90-92
NYMEX 'FINANCIAL' FUTURES	33
SEPTEMBER	33
HDPE, HMW FILM	104-106
POLYPROPYLENE (railcar)	
G-P HOMOPOLYMER, INJECTION	69-71
NYMEX 'FINANCIAL' FUTURES	45
SEPTEMBER	45
IMPACT COPOLYMER	71-73
POLYSTYRENE (railcar)	
G-P CRYSTAL	108-110
HIPS	112-114
PVC RESIN (railcar)	
G-P HOMOPOLYMER	82-84
PIPE GRADE	81-83
PET (truckload)	
U.S. BOTTLE GRADE	50-53

PE PRICES BOTTOM OUT

Polyethylene prices generally dropped a total of 6¢/lb in June and July, though there appeared to be some trail-off into August, according to Mike Burns, RTi's v.p. of PE markets, and *PCW* senior editor David Barry. Suppliers moved back their July 3¢ increase to August and issued a new 4¢ increase for Sept. 1. These sources characterized such moves as primarily a "security" measure against disruptions from a major weather event and an attempt by suppliers to set a pricing floor, but noted that market fundamentals do not indicate a cost push behind the hikes.

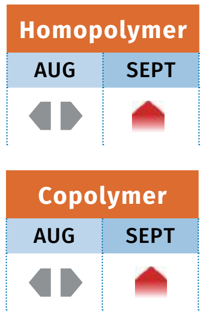
Said Burns, "Supplier inventories remain at record-high levels—all extra resin is moving to exports, which increased 20-35%, nearly on par with new PE capacity brought on stream." All industry sources describe domestic demand as pretty healthy and anticipate that fourth-quarter PE prices may have found a temporary floor. Barry noted that China's new tariffs scheduled for Sept. 1 include an additional 5% tariff on HDPE and LLDPE, while an additional 10% tariff on LDPE imports is scheduled for December.

Reporting on the PE spot market, The Plastic Exchange's Greenberg described August as a very active month. "Processors continued to tap the spot market for favorable deals; the market has been very liquid and the savings substantial compared with general contract levels. All HDPE resins and LLDPE film grades were down a full penny as new reactors pump out these commodity resins, but premium LDPE film was up at least a half cent, with a notable delay in new production. Both LDPE and LLDPE for injection gained a full penny, citing supply tightness in these slightly more specialty grades."

PP PRICES FLAT

Polypropylene prices in August rolled over from July, in step with propylene monomer contracts. However, spot monomer prices were moving up last month, and a modest increase of 1-2¢/lb was noted as possible by PCW's Barry, the Plastics Exchange's Greenberg, and Scott Newell, RTi's v.p. of PP markets. Newell saw this as tied to a couple of supply blips, including a fire at one of ExxonMobil's Baytown crackers, which is expected to be down through September, and Dow's planned maintenance shutdown of its monomer plant for the month of September.

Polypropylene Price Trends



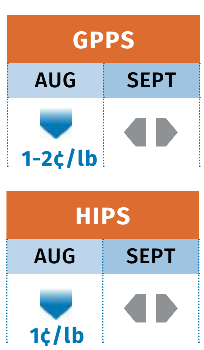
PCW's Barry also thought a modest increase was possible, based on a lot of PP capacity being off-line in Europe, which could strengthen U.S. exports and prices on both continents. Still, Newell noted that both monomer and PP demand has been soft globally: "Almost all major PP markets show negative growth, except for resellers and exports." He characterized the domestic market as very well-supplied with a lot of material being pushed into secondary markets at heavy discounts. He thought processors should have a pretty good chance of getting lower contract prices, as suppliers have been jockeying for position as they head into 2020 contract negotiations.

Noted Greenberg, "As we enter a seasonally strong period of demand, it will be interesting to see if the apparent upstream resin supply tightness begins to impact spot availability, which has otherwise been quite good. "

PS PRICES DOWN

Polystyrene prices dropped 1¢/lb in August in step with benzene contract prices, which fell to $2.54/gal, according to *PCW*'s Barry and Robin Chesshier, RTi's v.p. of PE, PS and nylon 6 markets. Both sources expected PS prices to be flat.

Polystyrene Price Trends

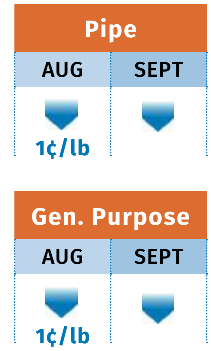


Barry noted that styrene monomer cost, based on a 30/70 formula of spot ethylene/benzene, was 29.4¢/lb, compared with 29.7¢/lb in July, and ventured that PS prices in October could be flat. He characterized supply/demand as balanced due to low plant operating rates. Chesshier saw some potential for higher PS prices in October, noting that benzene prices tend to move up in October as refineries switch from summer to winter fuels. She also noted that historically, September has been a peak season for PS demand in appliances, but that was not evident thus far. "Domestic PS demand was down 5% through July and operating rates that same month were less than 65%, year-to-year."

PVC PRICES DROP

PVC prices in August dropped 1¢/lb and were expected to fall another penny in September, essentially erasing the June 2¢/lb increase, according to both Mark Kallman, RTi's v.p. of PVC and engineering resins, and *PCW* senior editor Donna Todd. Meanwhile, Todd reported that OxyVinyls announced a 3¢/lb hike, for Oct. 1. She noted that an Oxy representative attributed the move to an aim to recoup the August 1¢ decrease and to prevent the September 1¢ decrease.

PVC Price Trends

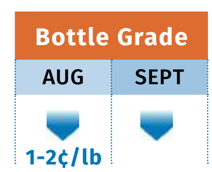


Kallman ventured that prices in October would be flat, noting that there are several downward pressures, including high supplier inventories, high operating rates, and weak demand, which dropped 2% in July. He also noted that exports are strong but trade tariffs are not likely to let suppliers boost export prices, which would pressure domestic tabs.

PET PRICES DROP

PET prices were flat in August and dropped 1-2¢/lb at the start of September, hovering close to the low 50¢/lb range, according to *PCW* senior editor Xavier Cronin. He attributed this to the plentiful supply of domestic and imported resins. He ventured that October PET prices would sink slightly below 50¢/lb for prime PET and to the mid-40s for offgrade resins. Moreover, he ventured that these prices would level off until December when PET's seasonal consumption slowdown kicks in, at which point, prices are likely to drop a few cents lower. This assumes there will be no supply/demand changes due to plant production disruptions, a sharp drop in imports, or unexpected end-use demand changes.

PET Price Trends



According to Cronin, in addition to the bloated supply outpacing demand, another downward pressure factor is falling costs for PET feedstocks, including PTA and MEG, especially for buyers with contract prices tied to raw-material contract prices as published in monthly indexes. He added, "The U.S. remains a coveted market for global PET producers and distributors due to typically good payment terms, the actual price paid for PET compared with other countries, and dependable logistics."

ABS PRICES SOFT OR FLAT

ABS prices eroded through much of the third quarter after remaining flat through most of the first and second quarters, according to RTi's Kallman. Key drivers included a 2% drop in automotive sales for the first half of the year, coupled by continuation of well-priced imports. Based on a very well-supplied market and lower-cost imports, he expected ABS prices through the fourth quarter to remain mostly flat as 2020 contract negotiations take place.

PC PRICES FLAT OR DOWN

Polycarbonate prices eroded in the first part of the third quarter, following flat pricing through much of the second quarter and suppliers' concessions of 8-10¢/lb in first-quarter contract settlements. According to RTi's Kallman, "We've seen a pretty substantial increase in lower-cost imports—up 45% for the first half of 2019, primarily from Southeast Asia, due to tariffs, slowdown in automotive in China, and devaluation of the Yen." He said PC prices could remain relatively flat through the fourth quarter. While feedstock prices went up fractionally through the third quarter, they were stabilizing somewhat .

NYLON 6 AND 66 PRICES LOWER

Nylon 6 prices were softer for the last half of the second quarter and most of the third, after remaining flat in the first quarter, according to RTi's Chesshier. Despite some benzene price fluctuations, there's been no effect on the nylon 6 market because demand has been so weak, domestically and globally. Domestic demand in 2019 is depressed by a slowdown in automotive as well as carpet fibers and textiles." Imports for nylon 6 were down by 8% and exports were down by 9% through July. Typically, the September-October time frame has seen strong demand domestically and in Asia, but the tariffs and devaluation of the Yen were expected to dampen demand. "If demand moves higher and benzene prices move up, suppliers will have a strong opportunity to increase nylon 6 prices," said Chesshier.

Nylon 66 prices have been dropping, generally 5% to 10%, starting in late May, and were expected to move lower in the third quarter and into the fourth, said RTi's Kallman. This was despite modestly higher feedstock costs in the third quarter, but still lower than those in 2018. "Unlike last year, when price hikes were driven by tightness in raw materials, we now have a very well-supplied market. Demand is challenged by a slowdown in automotive demand and lower GDP, which impacts the construction market," Kallman noted. The slowdown in automotive for the first half of 2019 is down 2% in the U.S.; down 3.1% in Europe; and down 12.4% in China. PT

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Contraction Slowed in August

Index registered 48.3 vs. 46.1 for July.

By Michael Guckes
Chief Economist/Director of Analytics

Gardner Business' Plastics Processing Index revealed that contraction had slowed in August, registering 48.3 compared with 46.1 for July. (Index readings above 50 indicate expanding activity while values below 50 indicate contracting activity. The farther away a reading is from 50, the greater the change in activity.)

The fact that the Index moved closer to the 50 mark indicates that while business activity still contracted during August, it did so at a relatively slower rate than in the prior month. An analysis of the underlying components of the Plastics Processing Index reveals that production and supplier delivery activity accelerated, while the remaining components experienced some level of activity contraction. Of those that reported contracting, three reported *slowing* contraction. Only employment contracted at a faster rate in August than in the prior month.

Production activity expanded during the month after posting its first and only 2019 contractionary reading in July. Expanding production activity coupled with a mild contraction in both new orders and export activity resulted in another month of contracting backlogs. August marked the sixth consecutive month of backlog activity contraction; the backlog component is currently the fastest-contracting component of the Plastics Processing Index.

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

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

Gardner Business Index: Plastics Processing

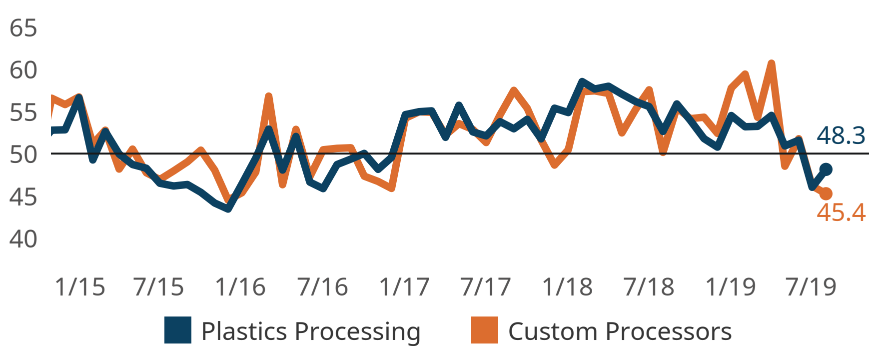

FIG 1

The Plastics Processing Index contracted at a slower rate in August. Supplier deliveries and production reported accelerating business activity while all other components contracted.

Plastics Processing: Production and Backlog

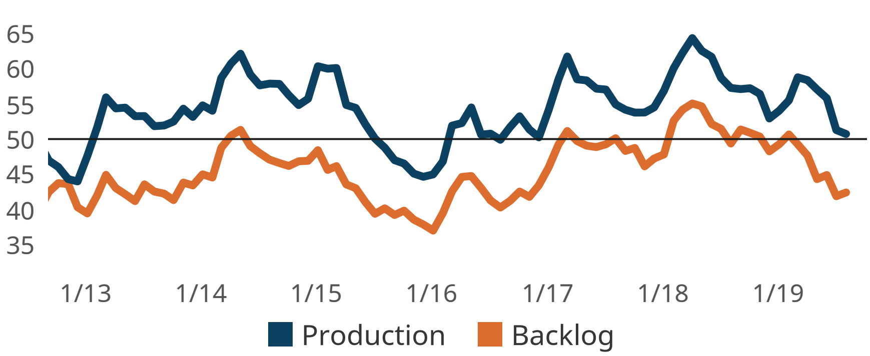

FIG 2

As a result of the recent weakness in new orders and exports, processors have resorted to their backlogs to smooth production volatility.

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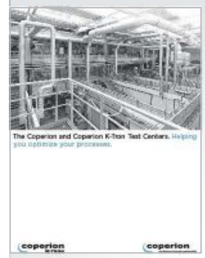

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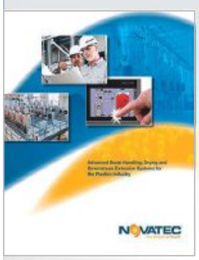

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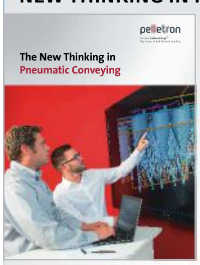

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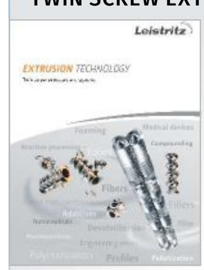

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ITW POWERTRAIN COMPONENTS — CHICAGO

Auto Filters Get Superior Seals With Servo Ultrasonic Welding

Automotive Tier 1 gets stronger welds and shorter cycle times in assembly of small transmission filters—results not possible with vibration welding.

By Lilli Manolis Sherman
Senior Editor

The switch to ultrasonic welding from vibration welding in assembling small (3.5 × 5 in.) transmission filters helped global automotive Tier 1 supplier ITW Powertrain Components solve problems it had experienced with vibration welding—notably weld cycle time, particulates, flash, and the cost of tooling and machines.

The Chicago-based company opted to use the the iQ Servo Ultrasonic Welding System from Dukane. This was the first time a complete transmission filter assembly was ultrasonically welded by ITW Powertrain Components, according to Rich Stuber, project manager. Transmission filters require hermetic seals and are subject to burst tests to ensure leakproof performance.

Dukane says its patented Melt-Match and Round Energy Design is more forgiving of variations in molded parts and allows more plastic to be melted during the process, which results in stronger hermetic welds. In addition, Dukane says servo-controlled ultrasonic welding has been shown to produce consistent parts, reduce particulates and provide tighter process control. Dukane anticipates this capability will be a game changer as processors experience growing demand for electric and hybrid vehicles.

Servo-controlled ultrasonic welding has been shown to produce consistent parts, reduce particulates and provide tighter process control.

Tory Solheim, ITW Powertrain Components design engineer, explains that the Dukane system is used in welding a proprietary transmission filter for a major OEM. It entails first welding in the pleat pack, followed by welding the cover over the pleat pack. These units are molded in a 33% glass-filled nylon 66.

A WELDING FIRST

Stuber of ITW says use of the iQ Servo 15-kHz welding system allowed this filter to be successfully sealed with ultrasonics. "Historically, transmission filters have been assembled with vibration welding, thus creating particulate in the filters and long cycle times (18 sec/weld for vibration vs. 3-4 sec/weld for ultrasonic). Previously we could not achieve the seal requirements (14.5-psi burst test) with pneumatic ultrasonic welders and a standard energy director. Though use of the servo technology and round energy director, we were able to achieve the part criteria with a very reliable and wide process window and a reduced cycle time."

ITW Powertrain says the biggest advantage in using the ultrasonic welders is the ability to perform two different weld processes via a two-stage weld side by side. Photo shows ITW Powertrain's completely assembled auto transmission filter made of glass-filled nylon 66.

Another key feature of the Dukane technology that proved particularly helpful in improving the welding process was Melt Detect. This enabled the company to weld more uniform seals across the part and increase the weld integrity. This feature is especially useful for applications where it is difficult to achieve the required amplitude to melt the parts.

Stuber and Solheim say the biggest advantage with the new technology is the ability to perform—in one unit—two different weld processes via a two-stage weld side by side, instead of having to use two large vibration welders. They see this system as ideal for transmission filters of this size or smaller, and also for other small-scale applications.

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	MENS JUMBO	312-XJ	~~$4.20~~ ***$3.57***	~~$4.05~~ ***$3.38***	~~$3.90~~ ***$3.19***	100 doz. pr.
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	MENS JUMBO	317-XJ	~~$7.40~~ ***$6.07***	~~$7.15~~ ***$5.75***	~~$6.85~~ ***$5.43***	50 doz. pr.
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