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Step Up and Support Manufacturing Day

Host an event and start to change the misconceptions still lingering about manufacturing—and plastics.

Straw bans...bag bans...ocean litter...tariffs. In plastics, there's been a lot to brood about lately. But it's time to aim the discussion at something more positive. Maybe you aren't involved yet in 3D printing. Maybe you don't have the latest collaborative robot. Maybe you are taking a wait-and-see approach with respect to Industry 4.0. Still, you do some cool things in your plant, don't you? Then why not strut your stuff and host an event on Manufacturing Day.

Jim Callari
Editorial Director

Manufacturing Day has been an annual event since 2012. It takes place the first Friday in October, so this year's date is Oct. 5. I've been writing about Manufacturing Day every year in this space because I think it's important. There are a lot of misconceptions about manufacturing, not only among millennials but also their parents. Truth is, you are likely doing things with emerging technologies—things that *you* might take for granted—that are compelling and exciting enough to have someone think twice before they dismiss manufacturing as dirty, noisy, and boring. And just as important, you are most likely looking for young talent.

You do some cool things in your plant, don't you? Then why not strut your stuff on Manufacturing Day?

Manufacturing Day is a national event, executed at the local level, that supports thousands of manufacturers as they host students, teachers, parents, job seekers, and other community members at open houses designed to showcase modern manufacturing technology and careers. The event is co-produced by the Fabricators & Manufacturers Association International, the National Association of Manufacturers, the Manufacturing Institute, and the National Institute of Standards and Technology's Hollings Manufacturing Extension Partnership. Combined, they provide the centralized support necessary to coordinate this nationwide array of simultaneous events.

Manufacturing Day addresses common misperceptions about manufacturing by giving companies an opportunity to open their doors and show, in a coordinated effort, what manufacturing is—and what it isn't. I've attended several events personally and couldn't help but notice wide-eyed students getting the first look at injection molding, mouthing, "Wow" as parts were ejected from the press and subsequently decorated, assembled, and boxed.

In Hartford City, Ind., Petoskey Plastics hosted 100 juniors and seniors from two area high schools on Manufacturing Day 2017.

Manufacturing Day participation has grown quite a bit since it started. There were 830 events that first year. Last year, nearly 3000 events took place across the country, according to the Manufacturing Day website (***mfgday.com***). As the website notes, "Thousands of students, parents, and teachers learned about the rewarding careers that manufacturing offers and experienced first-hand the high-tech innovations in 21st century manufacturing."

The event is growing among plastics processors and their supply base as well. Last year, according to the Plastics Industry Association (PLASTICS), more than 200 plastics industry companies had organized events. Among processors, those hosting events included molder Plastic Molding Technology; film processor/recycler Petoskey Plastics; molder Rodon Group (holding an event for the seventh time); molder Jarden Plastics Solutions; and packaging giant Printpack.

Given the size and scope of our industry, I'd like to see more companies involved in this day. I suggest you go to ***mfgday.com*** and click on Host an Event. It doesn't have to be on Oct. 5; just in October. You can also go to the PLASTICS website (***plasticsindustry.org/event/mfg-day-2018***) for some tools to help you host a successful event. PT

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Amcor & Bemis Combine to Form 'Global Leader' in Flexible Packaging

Two giants in global production of flexible and rigid plastics packaging have agreed to combine to form an even bigger processor. Amcor Ltd. (***amcor.com***) of Melbourne, Australia, and Zurich, Switzerland, will acquire Bemis Co. Inc. of Neenah, Wis. (***bemis.com***), to form a new entity, also to be called Amcor. It will have total sales of around $13 billion, over 250 plants worldwide, and around 50,000 employees. A joint announcement said the new firm will be "the global leader" in both flexible packaging and consumer packaging.

The "new Amcor" will earn 70% of its revenues from flexible packaging. Amcor identified flexible packaging in the Americas as a key growth priority, and this move is a big step in that direction. The merger will add Bemis' leading market positions in North America and Brazil to Amcor's leading positions in Europe, Asia, and Latin America.

Double IMD + IML Injection Molding To Be Demonstrated at Fakuma

At next month's Fakuma 2018 show in Germany, KraussMaffei (U.S. office in Florence, Ky.; ***kraussmaffeigroup.us***) will demonstrate sophisticated applications for two new all-electric presses. Its highly modular PX series is being expanded at both ends of the size range with the new PX 320 (320 metric tons) and PX 25 (25 m.t.). The larger unit is showing off a new capability developed by Leonhard Kurz in Germany (Kurz Transfer Products is in Charlotte, N.C.; ***kurzusa.com***). Earlier this year, Kurz revealed its patent-pending IMD SI Duo technology at the KraussMaffei Competence Forum at KM's headquarters in Munich. This system allows two independent heat-transfer foils to be transported reel-to-reel through a two-cavity mold. The two in-mold decorating (IMD) films transfer the printed decoration to the plastic part under the influence of heat and pressure during molding. According to KraussMaffei, IMD options for multicavity molds before now were limited to continuous designs and flat parts. Single-image designs with precise positions reportedly were not possible.

Kurz has remedied that with a servo-controlled positioning unit for each IMD film, which is integrated into the PX machine. The system uses sensors beside the films to read registration marks on the films for positioning accuracy within 0.01 mm.

At Fakuma, this double-IMD process will be supplemented with in-mold labeling (IML) to produce a 10-in. HMI (human-machine interface) display with integrated electronics, black decorative frame, and scratch-proof coating. A six-axis robot will insert the IML film with printed conductor paths in the stationary mold half. On the moving mold half, two IMD films provide different single-image decorations for two cavities. One of them has a UV-curable top coat for scratch resistance, which is cured outside the mold. This is followed by a laser station that removes flakes and flash and cuts off the sprue. The IMD cell is a mobile unit that can be rapidly docked to different machines.

Meanwhile, KM will also demonstrate at Fakuma its smallest PX model, the new PX 25, in an LSR micromolding application. For this purpose, KM developed a new 12-mm-diam. screw with a spring-loaded check valve.

Resin-Drying Icon Charles Sears Dies at 78

Charles Sears, founder and president of Dri-Air Industries, E. Windsor, Conn., passed away on Aug. 5 after a battle with cancer. He was 78. Sears started Dri-Air in 1985. Before that he worked for Polymer Machinery, Automated Assemblies and Nelmor (AEC). He received his BSME from Northeastern University and MME from RPI. Under his guidance and leadership, Dri-Air quickly became a leading supplier of drying systems.

Dri-Air Industries is a family owned and operated company that employs 27. Sears is survived by his wife Esther, who manages accounting for the company; son Jason, who has been with the company 27 years and runs its operations; his wife and their two sons; and daughter Wendy O'Seep, her husband Greg, and their two children.

General Polymers to Distribute Lotte Chemical PP Compounds In North America

Two-year-old and fast-growing North American resin distributor General Polymers Thermoplastic Materials, Clarkston, Mich. (***gp-materials.com***), has expanded its portfolio with a new distribution agreement with Lotte Chemical Alabama, Auburn, Ala. (***lottechemal.com***). Since the startup of its Auburn compounding facility in 2012, South Korea-based Lotte has become a major provider of prime branded PP compounds. These include short- and long-glass-reinforced PP, mineral-reinforced PP, and TPO compounds. The company's Surpran long-glass PP, manufactured via a pultrusion process, includes glass levels from 20% to 60%.


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New Cellulose-Based Biomaterial For 3D Printing and Molding of Medical Devices

FibreTuff, West Unity, Ohio, recently launched compounding operations to manufacture a cellulose-based biomaterial for 3D printing and molding of Class I and II medical devices for spine, trauma and sports medicine. The company expects to hire about 20 people over the next three years as companies across the U.S. begin to use FibreTuff PAPC filaments and powders for 3D printing.

FibreTuff's PAPC filament can be used in 3D printers without the odors typically associated with the process. In addition, the cost to those printing medical devices, such as cervical spacers and implants, is said to be about 30% less than other products.

According to COO Ted Wolkowski, a key advantage is that it's radio-opaque, which means it can be seen on an x-ray, without need for additives, unlike other products on the market. Other distinguishing characteristics of FibreTuff filament are that it will not dissolve inside the body; it has passed USP Class VI testing for implantation; and its weight and composition are similar to actual bone. Says company founder Robert Joyce, "The 3D bone replacements made with FibreTuff PAPC are so realistic, medical students can use them instead of animal cadavers for practice in sawing, screwing, cutting and laser cutting."

Cellulose-based PAPC will be manufactured in West Unity in the form of filament as well as compounded pellets and bar stock for injection molding, extrusion and machining.

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DSM and APK Cooperate on Recycling Multilayer Barrier Food-Packaging Films

Recovery of multilayer barrier films that consist of a combination of PE and nylon 6—where the former acts as a barrier for moisture and the latter as a barrier for oxygen—is a new mission for recycling technology specialist APK of Germany (***apk-ag.de***) and nylon producer Royal DSM of The Netherlands (***dsm.com***).

APK's Newcycling technology is a solvent-based physical process that reportedly can yield high-quality recycled pellets with properties close to virgin plastics from complex mixtures and multilayer structures. The process is cost-competitive and produces pellets from multilayer PE/nylon 6 packaging waste that can be used again in demanding flexible packaging, according to Florian Riedl, APK's head of business development.

APK is building a plant for recycling multilayer PE/nylon 6 packaging with its Newcycling process that is scheduled for startup in the fourth quarter.

Extrusion Firms Collaborate On Novel Catheter Shafts

Two medical extrusion innovators are combining technologies in a move that will reportedly enable catheters to be produced more efficiently and with greater mechanical integrity. The agreement pairs up Adam Spence, Wall, N.J., a leading manufacturer of reinforced catheter shafts for vascular technologies, with Microspec Corp., Peterborough, N.H., a specialist in complex tubing. As a result, Adam Spence will supply reinforced catheter shafts with Microspec's proprietary multi-durometer extrusions. "This partnership bodes well for customers seeking to enhance performance while lowering costs," says Steve Maxson, v.p. of marketing and sales at Adam Spence (***adamspence.com***).

The most common method of constructing a catheter shaft—for example, one with four different sections of varying durometers—consists of laminating the four tubing sections together over the braided shaft in a reflow process. Microspec's inline multi-durometer extrusion technology, however, "allows two alternating durometer sections to be joined continuously during the extrusion process, ensuring gradual transition from one durometer to another," explains Timothy Steele, founder and CEO of Microspec (***microspeccorporation.com***). "The length of each section can be programed into the extrusion process."

The combined sections are then laminated together, reducing the number of bond joints. "This process will increase productivity, reduce costs, and improve mechanical integrity of the catheter shaft," notes William Li, senior catheter engineer at Adam Spence.

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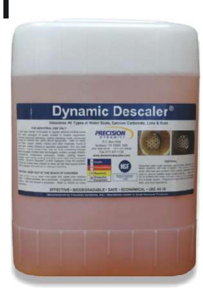

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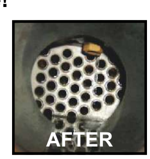

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NPE2018 REPORT

Auxiliaries: A Path to Industry 4.0 Emerges

Industry 4.0 dominated the news in auxiliary equipment at the show, but many questions remain for both suppliers and processors.

By Tony Deligio
Senior Editor

As promised prior to the show, Industry 4.0 featured prominently in the booths of auxiliary equipment suppliers at NPE2018. But just as processors are trying to figure out how it will impact their businesses, machinery suppliers are likewise puzzling out how they will bring the technology to market.

Conversations with those suppliers in Orlando revealed some key questions that remain to be answered, and the responses ultimately will affect the products that processors will be able to buy. Top issues to resolve: Will equipment suppliers build their own 4.0 platform or partner with firms that have already created programs, albeit often for industries outside plastics processing? And if these equipment OEMs want their machines to "talk" to other pieces of machinery in a customer's plant, what language should they teach them to ensure a fully conversant cell?

The outlines of answers came more into focus in Orlando, as some suppliers announced new or augmented 4.0 capabilities that they've developed independently or in partnerships; and movement towards that common language, OPC-UA, also advanced. Development of machine-to-machine communications standards is being spearheaded by the European (EUROMAP) and German (VDMA) associations for plastics and rubber machinery makers in collaboration with other associations, including NPE organizer the Plastics Industry Association (PLASTICS; ***plasticsindustry.org***).

Biplab Pal, CTO and co-founder of MachineSense, walks NPE attendees through his company's suite of Industry 4.0 tools. During the show, MachineSense announced that those tools will become part of Siemens' MindSphere platform.

At the NPE2018 press breakfast immediately prior to the show's opening on May 7, Glenn Anderson, show chairman and senior v.p. of sales, marketing and product management at Milacron (***milacron.com***), noted that suppliers on both sides of the Atlantic continue to collaborate on OPC-UA. "Industry 4.0 is here to stay," Anderson said, "and we're going to have to come up with standards. A very, very important aspect of our business is that we're going to have to have policies."

Progress on the injection molding front was announced at the show during a EUROMAP press tour where several suppliers discussed the newly created EUROMAP 77 standard for data exchange between a press and an MES (manufacturing execution system) central computer. EUROMAP acknowledged in a press release the need to address communications for auxiliary equipment within a cell, citing two standards in development—EUROMAP 82, data exchange between injection molding machines and temperature-control devices; and EUROMAP 79, data exchange between presses and robots.

At the show, Siemens (***siemens.com***) announced that it was adding MachineSense LLC's suite of vertically integrated Industrial Internet of Things (IIoT) programs to its MindSphere platform. As a Siemens Silver partner, MachineSense will gain access to educational materials and, perhaps more importantly, fellow members, to further promote its IIoT to industry. MachineSense (***machinesense.com***) provides power-quality monitoring, energy management, and predictive and preventive maintenance.

Conair, meanwhile, launched its Uptime Guaranteed initiative at NPE2018, which is powered in part by its new Smart Services offering, a Cloud-based database where equipment and process data are transmitted to the Cloud for analysis by proprietary algorithms. Conair (***conairgroup.com***) developed those algorithms, while it partnered with Maven Machines (***mavenmachines.com***) to create the platform. That firm, based in Pittsburgh, was founded on a mobile Cloud-based technology to provide fleet management for the transportation industry, including trucking and rail. "The intention is to pull data from our huge installed base of equipment," explains Sam Rajkovich, Conair's v.p. of sales and marketing. "Our eventual goal is AI (artificial intelligence); getting the machine to understand what is going on and fix itself."

In addition to its own proprietary algorithms, Conair partnered with Maven Machines to create the Industry 4.0 platform that powers its Cloud-based SmartServices offering.

MACHINE LEARNING, MACHINE INTELLIGENCE

The concept of AI or machine intelligence came up more than once at NPE. Machine intelligence can only be achieved if machines can "learn" on their own, and many suppliers see that as the future of machinery in plastics and beyond.

David Preusse, president of Wittmann Battenfeld (***wittmann-group.com***), discussed the burgeoning intelligence of its equipment at the show, specifically citing the company's Smart Removal program for robots, which can teach themselves the fastest path and velocity into the cavity to pull parts. "The machine is getting smarter than man," Preusse states. "It approaches AI."

"The machine is getting smarter than man. It approaches AI."

On the Industry 4.0 front, Preusse noted that Wittmann Battenfeld engineers sit on the committee that's developing standards, and his company was displaying the newest standard—EUROMAP 77—during NPE2018, via a collaboration with ERP and MES software provider IQMS (***iqms.com***), whose software was fully integrated into a Wittmann Battenfeld molding cell, collecting and analyzing production data in real time.

If machines can talk to other machines, there is, of course, the possibility that unwanted devices could surreptitiously join the conversation, breaching a network. Wittmann Battenfeld stressed IT security for its connected offerings of auxiliaries, specifically touting its Wittmann 4.0 router, housed within the molding machine, which automatically assigns IP addresses and security certificates to any equipment added to a cell.

In addition to recognizing what equipment is in the cell and assigning the proper "recipe" to a temperature-control unit, for instance, given the installed tool; or having a robot automatically "home" itself, Preusse said this connectivity alleviates control-screen fatigue. "Today within a cell there are too many displays," he said. "You walk up to cell and see 10 different controllers. With Industry 4.0 you can get all that on a single control."

Preusse acknowledges that Wittmann Battenfeld is in a unique position when it comes to such comprehensive connectivity, as it makes molding machines, auxiliary equipment and robotics. Other suppliers are watching to see how the OPC-UA standards shake out and determining whether the Industry 4.0 tools they deploy will be built in-house, contracted out, or a combination of the two.

Mark Johansen, v.p. marketing & product management at ACS Group (***acscorporate.com***), said his company is determining whether it will be easier to integrate another company's established algorithms, or create its own. In the latter case, companies will have to decide whether to use a subscription model, which could reimagine equipment suppliers as software developers that charge their customers to run the software, the same way Microsoft charges for Windows.

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"Manufacturing can be slow to adopt new technologies," Johansen states. "Part of the issue is putting a value proposition in front of customers. In the short term, equipment costs more; long term, it's harder to know the full benefits. We have to convince plastics-processing plants that Industry 4.0 is worth their time and money."

Dri-Air Industries (*dri-air.com*) launched a full dryer line at NPE2018 that utilizes the OPC-UA protocol, readying its key product for the future. Jason Sears, v.p. of operations, says that Industry 4.0 was a subject of conversation at the show, with some attendees interested and others having "a long way to go." Dri-Air is anxiously waiting to see finalized standards for particular product lines, including dryers, but Sears can see the promise of a new, standardized protocol. With the old SPI protocol—RS485—molding machines could talk to auxiliaries. Going forward, using Ethernet connections and OPC-UA, instead of the press "pinging" the entire dryer, however, it can ask for a specific parameter, which marks progress, in Sears' view.

Italian maker of auxiliary equipment Piovan (*piovan.com*), which operates in the U.S. via its Universal Dynamics subsidiary, touted an upgrade to UnaDyn's long-running FACS platform at NPE2018, as well Piovan's Winfactory OPC-UA supervisory software. Giorgio Santella, Piovan's chief marketing officer, states that OPC-UA architecture builds flexibility into the system, which customers will need.

"By connecting to Winfactory 4.0, the system has open access to any industry 4.0-compliant equipment or machinery," states Santella. "That is what our customers are asking about more and more, because you could buy a piece of equipment today and it might not be industry 4.0 compliant; and then you'll buy equipment tomorrow and it is 4.0 compliant; and the two pieces of equipment can't speak to each other."

"Processors say, 'I need to invest my money and I am so confused about what to buy.'"

Piovan also discussed remote assistance at the show. Allowing service technicians to tie into equipment remotely isn't a new concept; but despite being possible for some time, Santella admits that few processors avail themselves of this amenity out of security concerns. Piovan's solution with Winfactory 4.0 was to create its own Cloud.

Show attendees had the chance to pepper suppliers with questions about security and the broader impact of Industry 4.0, but as with any paradigm shift, questions remain. "Processors say, 'I need to invest my money and I am so confused about what to buy,'" Santella said. "They are not confused about performance, but worried about the future possibility of having their equipment in a network like 4.0. The dilemma is big: 'What should I buy?'"

NPE2018 REPORT

Robots & Automation Tackle Increasing Complexity

Exhibitors highlighted brute strength, complex automation cells, wireless networking, new controls features, and "collaborative" applications. Automated one-minute mold change was another attraction.

By Matt Naitove
Executive Editor

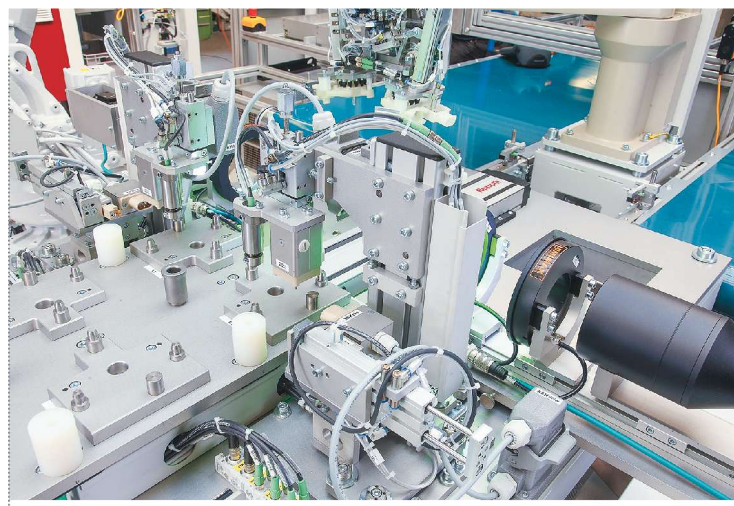
Our April NPE preview, May Show Dailies, and July show highlights reported on new robots and automation systems from Absolute Robot, Arburg, Boy Machines, Beck Automation, Campetella, CBW Automation, Engel, Fanuc America, KraussMaffei, Rethink Robotics, Sepro America, Staubli, Universal Robots, Wittmann Battenfeld and Yushin. But even more news emerged at the show.

NEW AUTOMATION GROUP ASSEMBLED

There's a new group of injection molding robotics companies setting up shop in the U.S.: Hahn Group, an automation-focused holding company based in Germany, is establishing Hahn Plastics Automation (***hahn.group***), consisting of one well-known name and two that are less familiar to U.S. processors. The first is Waldorf Technik of Germany, a specialist in side-entry robots for high-speed medical and packaging applications. Around 20% of its business is already in the U.S. Much newer to this market is Wemo of Sweden, which makes servo pickers and standard top- and side-entry linear robots for a broad range of injection molding applications. Third is GeKu of Germany, a maker of high-end custom automation (primarily top-entry) for automotive, electronics, and white goods. Brand-new to both Hahn Group and to the U.S. market, GeKu has long experience with major automotive tier suppliers for complex jobs like insert loading and vertical press automation. It also builds stand-alone automation for off-line testing of electronics.

New automation group has particular expertise in medical, packaging, automotive, appliances and electronics.

General manager of the new plastics automation group is Markus Klaus (recently of Wittmann Battenfeld). He is looking for a site in New England to locate a manufacturing facility for Waldorf and GeKu products (for now, the group is based at a Hahn Group plant in Hebron, Ky.). Klaus will hire 10 people in the next 18 months to supplement the two engineers from Waldorf and GeKu coming over from Germany to the U.S.



GeKu of Germany, a maker of high-end custom automation for automotive, electronics, and white goods is the newest member of the Hahn Group (which includes Waldorf Technik and Wemo) and is also new to the U.S. market.

LARGEST ROBOT IN NORTH AMERICA

Ranger Automation Systems (***rangerautomation.com***) announced that is it is building "the largest robot in North America" to outfit a 6750-ton injection press being built by Milacron for 20/20 Custom Molded Plastics, Holiday City, Ohio. The molder selected Ranger to build a robot with payload capacity of 400 lb, 18-ft vertical travel, and 12-ft reach on each of two five-axis arms sharing a common beam. This Ranger model RT-6000-S10 will be able to extract parts up to 10-ft wide or tall, independently or in tandem, from either mold half and from stack molds. The giant robot will be an upsized version of the Ranger RT-3000 dual-arm robots running on 20/20's Uniloy Milacron structural-foam machines.

Meanwhile, Star Automation (***starautomation.com***) brought several new developments to NPE. These included a three-axis servo head—wrist, rotate and flip axes—and a new 620 controller for the TW-VII series robots. As reported in July, the head and controller were used in a demonstration of the robot painting Japanese callig-

Ranger Automation is building what it says will be "the largest robot in North America" for a Milacron 6750-ton press at 20/20 Custom Molded Plastics. It will be larger version of this dual-arm, RT-series model already installed at this molder.

raphy. Other new features are quick-change capability for end-of-arm tooling (EOAT) that uses wireless communication between the tooling and the robot. In addition, the vertical axis has received a speed boost, and smaller models now have increased torque for faster acceleration and deceleration.

Also new are ZPX series robots with a high-speed carbon-fiber arm and new 520 control. These robots can extract parts in as little as 0.29 sec, with an overall cycle of 1.97 sec.

Industry 4.0 capabilities have been added to these robots by incorporating the OPC-UA communication protocol in the 520 A and 620 A controller versions. Capabilities include wireless real-time production monitoring, demonstrated at the show by networking all the robots in the booth. Data such as production quantities per shift are available on the web, and email notifications can be sent automatically if a machine or robot goes down.

Other new control capabilities include 3D animation of the robot cycle for use as a final check of a new program or to show a new operator what motions the program calls for. A small USB camera can plug into the control pendant; it can take a picture of a part and save the image. The operator merely touches the image and the control recalls from memory the operating program for that part. Also, a collision-detection feature senses resistance to motion and automatically halts the robot.

"Largest robot in North America" being built for 6750-ton press.

Sepro America (*sepro-america.com*) announced an agreement with Absolute Haitian to offer Sepro three-, five- and six-axis robots with Haitian and Zhafir injection presses in North America. All robots will have a control interface that is fully integrated with, and accessible from, the machine control panel. Absolute Haitian technicians are being trained by Sepro to provide after-sales service. Sepro also has partnered with Machines Pages of France for IML applications.

At the show, Sepro also emphasized its ability to provide complete automated cells with these complex demonstrations:

• *High-speed medical molding with part orientation and cavity separation:* A Sepro S5 linear robot served a machine with a 32-cavity mold. Cavity-separated parts were delivered to a packing station, while a conveyor system fed racks that were each filled with 96 parts. Every 12 cycles, eight 96-part racks were filled and moved by a pick-and-place unit to the exit conveyor and delivered to an operator for packaging.

• *Dual robots serving two 250-ton presses:* One of two S5-25 linear robots mounted on a common beam retrieved inserts from a feeder before it removed molded parts and placed the inserts for the next cycle. Then it transferred the molded parts and placed them in the mold on Press 2 for overmolding. The second S5-25 robot picked the overmolded components, snap-fitted the two halves together, and deposited two finished parts on the exit conveyor.

• *Four-cavity family-mold part removal with press-fit inserts, automatic degating and packing:* While a Sepro Success 22 linear robot removed molded parts from the injection machine and placed them in a trim station for degating, a Sepro 6X-90L articulated-arm robot picked up inserts from a vibratory feeder and positioned them to be pressed into the degated parts and collected in tote bins.

• *Fabric die cutting and overmolding on a vertical press:* A die cutter produced eight circular fabric inserts, which were loaded by a Sepro 6X-90L six-axis robot into an eight-cavity mold on a shuttle table. The table then rotated 180° to position the inserts for overmolding,

Star Automation showed off a new quick-tool-change feature for its TW-VII series robots that uses wireless communication between the robot arm and the tooling.

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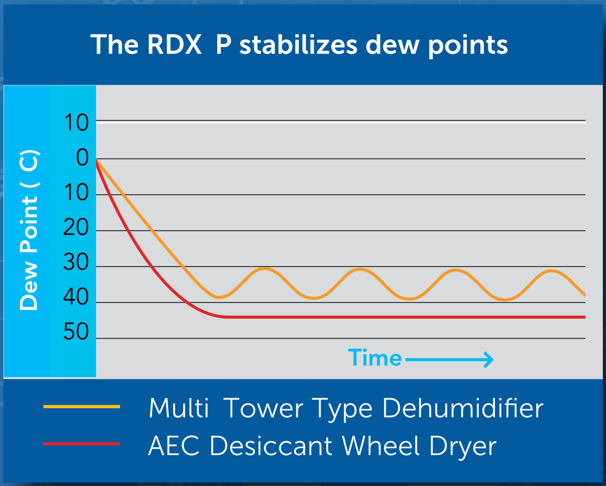

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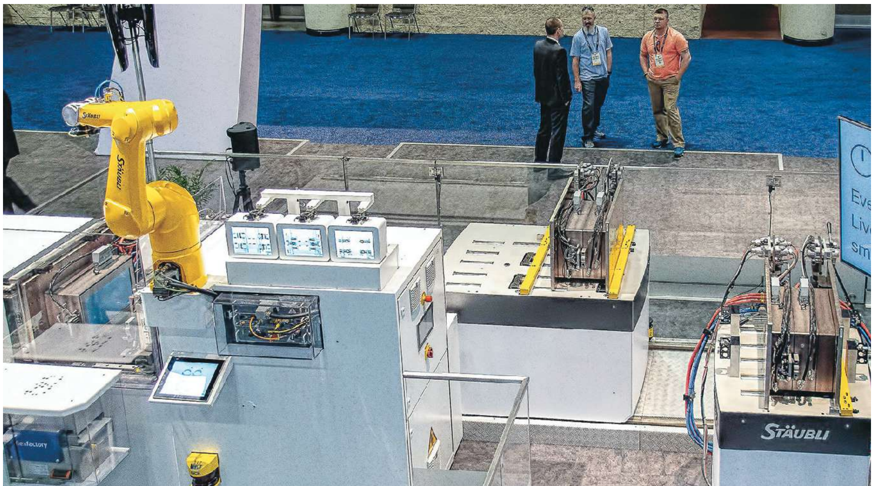

Staubli demonstrated one-minute automated mold change, using a mold preheating station (far right) and rail-guided mold cart (center). Six-axis robot (left) executed automatic change of EOAT coordinated with the new mold.

while delivering eight finished inserts to the robot for removal and placement in eight stacking tubes.

- *Large, complex automotive molding cell with 17 inserts:* A Sepro 6X-90L six-axis robot successively picked and loaded three types of inserts from three vibratory feeders, positioning each into one side of a two-sided stage assembly. An S7-75 linear robot picked the staged inserts, plus a single large insert, and loaded them into one side of the mold and removed a finished part from the other mold half and placed it on an exit conveyor.

As reported in July's NPE Close-Up, Yushin America (***yushinamerica.com***) operated a highly complex cell of its own at NPE, just to show off the multiple capabilities of its robots. The cell involved two injection presses, two linear robots, a seven-axis collaborative robot, IML, pad printing, two threaded parts (unscrewed from the mold and then screwed together by the robots' servo wrists), closing of a hinged closure, and printed cards inserted into the product before assembly.

One-minute automated mold change demonstrated live at NPE.

As reported in April, Yushin debuted its FRA servo linear robot line. Among its new features is arc motion control—multi-axis motions that yield a smooth-arc travel path instead of right-angled corners, which can cut robot cycle times substantially—from 16 sec to 12 sec in the demonstration at the show. Also new is a three-axis servo wrist for the FRA series that is 50% slimmer than previous models. All FRA robots also have built-in cellular communications capability for production data reporting to the Cloud. This Intu Line feature was demonstrated by a display of data from several Yushin robots in different booths at the show, as well as in Japan.

Also reported in April was Yushin's addition of the OB-7 collaborative robot (or "cobot") to its line. Built by Productive Robotics in the U.S., the OB-7 uses a laser scanner to sense obstructions (such as presence of a person), which causes the robot to slow down and eventually stop—and then restart automatically when the person or other obstruction moves away. This feature allows the cobot to run six to eight times faster than other cobots that rely on low speed and torque to prevent accidental injury to a person.

Another new development from Yushin is the CT2 or Clamp Traverse system with two robot arms on a single beam oriented along the axis of the machine instead of transverse. One arm interfaces with the mold and the other with downstream operations. Also running at Yushin's booth was a cell with two robots for demolding, stacking and bagging parts. The controller monitored the two head positions in 3D space to prevent collisions and also counted shots to regulate stacking and bagging.

In the past year, Yushin launched Yushin University: online 24/7 free training with lessons and quizzes and a printable certificate on completion of the course. At least 1800 customers have already signed up, Yushin says.

A new feature being tested by Yushin's beta customers in Japan and not yet released in the U.S. is an EOAT Auto Design Tool. It uses CAD models of the mold or product; or the user can draw the part, as well as provide the layout and spacing. Part geometry can also be simulated by simple shapes. The user chooses from a library of 50 templates of EOAT and designates where to place the suction cups. Then the system designs the full EOAT, including the wrist plate, along with a bill of materials, all dimensions, and the weight. Yushin hopes to offer this on its website in the near future.

Yudo of South Korea (U.S. office in Livonia, Mich.; ***yudo.com***) showed off several new developments, including the Zema 508 ultra-high-speed linear robot with active anti-vibration control, up to 350° rotation, and 5 kg payload capacity (up to 25 kg for other models in the Zema series). It was shown with Yu-Eye vision system for mold and part inspection.

Also new from Yudo is a collaborative robot with six or seven axes, which can stand on a stationary pedestal or ride on a track (Track Motion system). It can be used for machine tending with part removal and QC checks (vision capability optional). It reportedly is being used by Samsung for production of washing-machine components.

Staubli (*staubli.com*) demonstrated automated mold change within 60 sec. A mold in a preheat station outside the machine has a manually actuated Staubli multi-coupling connector that is manually actuated by a single lever. It saves time and prevents any errors in making connections. The preheated mold slides off the table onto a mobile cart on a track; its position is confirmed by proximity sensors. In the injection machine clamp, the two mold halves are locked together, and Staubli automatic multi-coupling devices automatically disconnect all services in 3 sec, without presence of an operator inside the press. The mold slides out of the press onto the cart, and the new mold slides into the press. The ejector is mounted automatically and the mold is clamped magnetically in 3 sec. Proximity sensors ensure proper mold positioning, and intelligent magnetic clamping calculates the required holding force and controls that force throughout the molding process. (It can alarm and stop the press if a fault is detected.) Automatic changing of robot EOAT can be included in the QMC process; an RFID chip on the mold is read by the mold table, which tells the robot what gripper to use.

Staubli says changing a 40-ton mold that today requires 6 hr by conventional means now can be accomplished in less than 5 min. Eliminating an overhead crane both saves time and adds safety, the company claims.

Staubli sources say there are four automated QMC systems of this type in Mexico and five in the U.S. on presses of 2300 to 3000 tons. These sources note that customers may not need all elements of the system—for example, users of high-cavitation molds find that making quick and reliable connections of all mold utilities and services is their highest priority.

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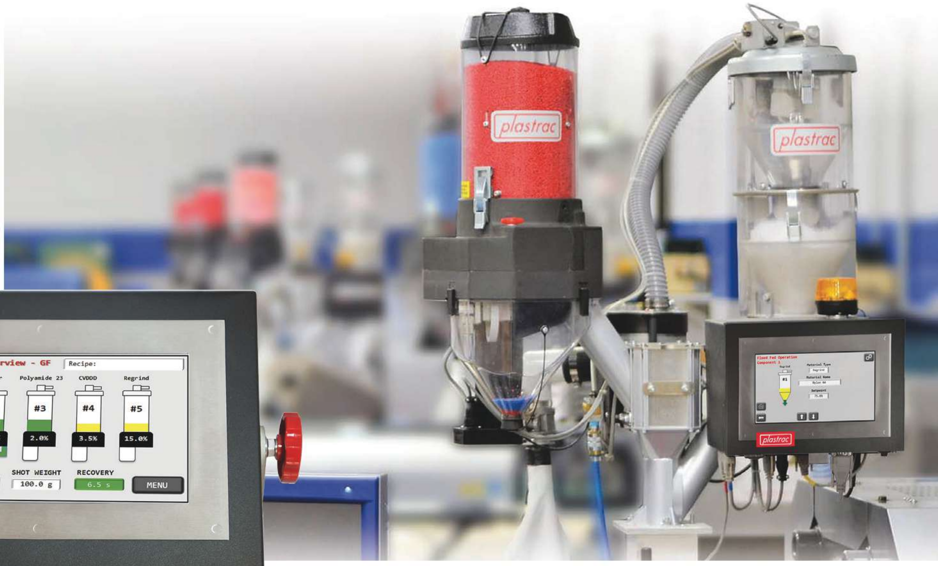

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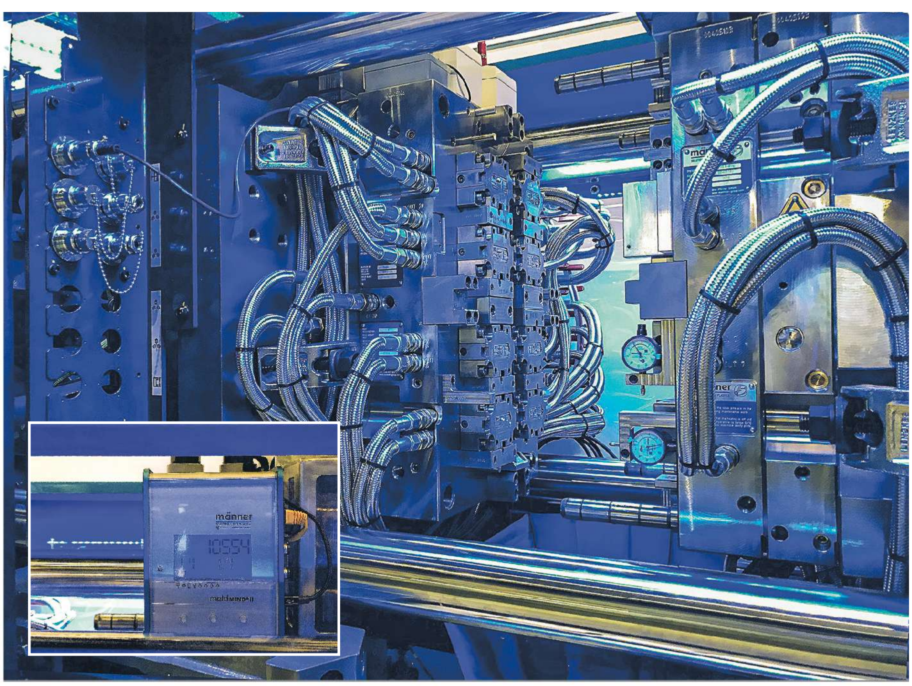
NPE2018 REPORT

Tooling: Molds Join the Industry 4.0 Conversation

At NPE2018, multiple companies displayed mold monitors that would allow the tool in an injection molding cell to "talk" to other equipment and remote computers.

By Tony Deligio
Senior Editor

The ongoing electrification and digitization of tools continued apace at NPE2018 this May in Orlando, as molds shift from one of the few mechanical holdouts in a cell to an active participant in Industry 4.0. In the past, shot counters or in-cavity temperature and pressure transducers conveyed some process and production information from a mold to the operator or perhaps the press itself, but this new class of monitors shares even more real-time production information in even more places, including up to the Cloud for advanced analysis.



Männer's new MoldMIND II module (inset) sits atop the tool communicating locally with the press and sending production data to the Cloud for remote access.

Milacron (*milacron.com*) discussed its SmartMold technology, which it says can serve up information on uptime, cycle count, temperatures, and more—locally or to the cloud, with operators able to dial up a tool on a mobile device. In addition to storing documents, SmartMold can send alerts regarding operational issues or preventive maintenance. At its booth, Milacron displayed SmartMold technology in two cells—with an all-electric Roboshot 500 and new Quantum 260 servo-hydraulic toggle press. The device itself sits on the tool, while a separate screen at Milacron's booth showed all the 10 tools throughout the show utilizing the technology. The units can show OEE (overall equipment effectiveness), calculated in the cloud before being displayed on the web.

SmartMold can also tie into the molding machine, connecting inside the PLC to hook up the whole cell. For this program, Milacron has partnered with Cloud-based service provider ei[3] Corp., which reportedly has 20,000 pieces of equipment in the field utilizing its technology.

Priamus System Technologies (*priamus.com*) upgraded its Quality Monitor, at the heart of which is the new embedded QDaq system. This allows process monitoring without an additional PC. The system, which has an OPC-UA interface, can transfer injection molding process data and parameters, including information culled from cavity-pressure and cavity-temperature sensors, as well as information gained from the process, locally within a plant or globally, to the Cloud or remote locations.

The web-based software portion of the system can be viewed via any browser-supported display, and Priamus offers a specially developed 7-in. display with an LED signal—QScreen—as part of a complete package. At NPE, a Priamus representative pulled up

production data onto an iPad from a Sumitomo Demag press running across the aisle. The data had made a stop-off in the Cloud before it was downloaded to the iPad, which then received an analysis of production, including OEE. For customers with global locations, the system allows real-time insights into production, including the measurement of viscosity, to track batch-to-batch changes in materials. Priamus said those flow calculations factor in pressure and temperature to determine shear stress and, ultimately, viscosity.

MOLD DATA IN THE 'CLOUD'

Männer (*maenner-group.com*) also launched a new monitoring system for injection molds at NPE2018. The company says its moldMIND II can detect errors early on, minimizing downtime. In addition to planning maintenance, Männer says moldMIND II pulls data that can be used to optimize production. Process values such as the actual number of cycles, minimum and maximum cycle times, temperature profiles, operating times, and downtimes of the injection mold are recorded and stored for access anytime. At NPE2018, a company representative pulled up a screen showing operating tools in Germany, the U.S. and China before clicking on the Chinese tool to display its real-time stats.

Molds have shifted from one of the few mechanical holdouts in a cell to an active participant in Industry 4.0.

Männer's second-generation monitor has various interfaces as well as storage and application options. Alarms can be set, and the system can log events, including temperature deviations, sensor breakage, or downtime. If there are critical deviations from a setpoint, an alarm signal can be sent to a smartphone for quick troubleshooting or directly to an MES (manufacturing execution system) central computer. Control signals can also be output via digital I/O—for example, to automatically stop the injection molding machine in the event of a malfunction.

As is increasingly important in markets like medical and automotive, Männer says moldMIND II documents all processes inside the mold throughout its lifecycle. Access to this data can be assigned based on individual authorization levels. Internal memory can also store tool master data or user-manual documentation. Data stored in the moldMIND II Cloud can be remotely accessed from any location via smartphone app, Bluetooth, WLAN, Ethernet, USB or OPC-UA. Mold owners can use a GPS module to obtain an overview of the exact location of their molds.

Milacron's SmartMold technology tracks key process data from the tool, including lifetime cycles, cycles in the last 24 hr, average cycle time, and more.

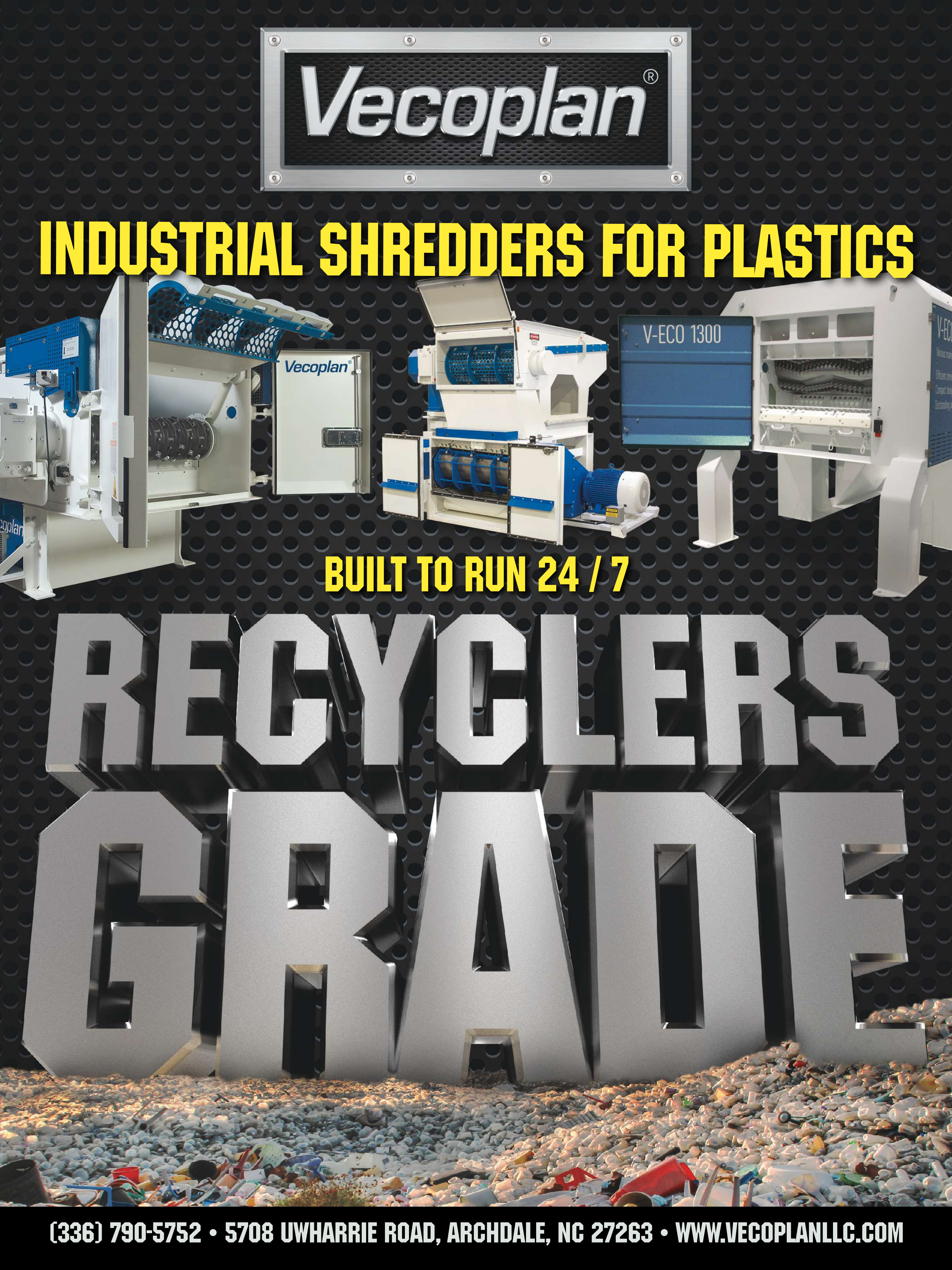
In addition to planning regular maintenance with moldMIND II, including spare-parts management and mold refurbishment, Männer is working towards gathering data for predictive maintenance. "The collection, storage, and analysis of real-time data will enable predictive maintenance," the company states. "This approach will allow early prediction of malfunctions and make it possible for breakdowns to be avoided."

In Orlando, the company also discussed how the system is pushing towards artificial intelligence (AI), wherein data pulled from temperature sensors or vibration sensors in the machine could create a warning that cooling or heating on the press may not be working, stopping the press before bad parts are made. "We aim to make the molding process independent from the operator," a Männer spokesperson explained.

As reported in our April NPE2018 Show Preview, Progressive Components (*procomps.com*) introduced the pairing of its CVe Monitor electronic mold-monitoring device to its CVe Live wireless device, which relays data to the Cloud-based CVe Live website. Glenn Starkey, president of Progressive Components, notes that the company started mold monitoring in 1993 with its first cycle counter, followed shortly thereafter with a software program: ProFile. Among many other benefits, Starkey said the new technology's GPS capability better serves today's molding industry. "In the past, you were dealing with custom molders—small operations, one plant," Starkey notes. "But because of mergers and acquisitions, you get much larger corporations that can lose molds all the time. There are times when companies build new tools because they can't find the old ones."

Hungarian firm Cavity Eye (*cavityeye.com*) displayed a prototype of its new mold and process control and monitoring system, SMC (Smart Molding Control). A company spokesperson says its plan is to bring a finalized product to the Fakuma show this October in Germany. The system consists of a Smart Measuring Plug (SMP), Smart Control Plug (SCP) and a Monitor, Switch and Computer (MSC).

Using a microcomputer and sensor network, the SMP measures and sends pressure curves to the control plug, which then communicates to the press and the robot, helping control the molding process's switchover point from filling to pack-and-hold via 24V digital signals. The SMP can connect to a laptop, and measurement can be run on eight to 32 pressure sensors simultaneously. ►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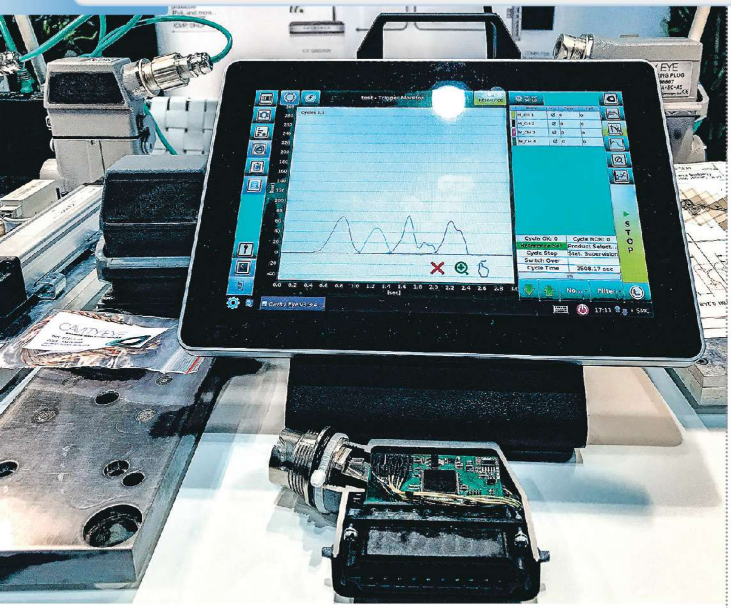

Hungarian production-monitoring equipment supplier Cavity Eye displayed a prototype of its mold and process monitoring system at NPE. It plans to have a commercial version by October.

The company says Cavity Eye provides an economical means to manage mold transfers (determining best process settings), new tool qualification, or failure analysis of existing tooling. Cavity Eye offers four different sensors with pin diameters from 0.8 to 20 mm and maximum load forces from 1000 to 40,000 N (225 to 9000 lbf). The MPM central mold plug collects all the wires of the pressure sensors and can control up to 32 sensors at once. Process parameters including reference curves, tolerances, switchover pressure, and more are uploaded to the built-in memory.

"There are times when companies build new tools because they can't find the old ones."

Austrian moldmaker Haidlmair (***haidlmair.at***) also discussed its tool-tracking software, called Mold Monitoring 4.0 (MM 4.0) at NPE2018. Launched in 2016, the system uses proprietary software and thermocouples wired to the entire tool, as well as a flow sensor to track key mold and machine parameters. Haidlmair says the technology allows active control of the mold during injection, while giving molders a personalized user portal with access to mold documentation as well as injection parameters like cycle times, piece counts, mold pressures, temperatures, and more. Alarms can be set for out-of-spec parameters as well as maintenance. When installed, the system consists of boxes placed on both halves of the tool.

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MATERIALS

PART 8 A Processor's Most Important Job

How processing adjustments can control molded-in stress.

By Mike Sepe

In our review of characteristics that can be controlled to a significant extent through processing, the next item on the list is internal stress in the part, also referred to as molded-in stress. Stress arises from two primary influences: differences in pressure and differences in the rate at which the polymer cools within the part. Flowing molten polymer exhibits a loss in pressure through the system that is related in part to the distance and the cross-sectional area through which the material flows. Therefore, there will be a measurable pressure gradient across any molded part as the material flows from the gate to the last places in the cavity to fill. This variation in pressure will produce variations in the degree to which the material shrinks.

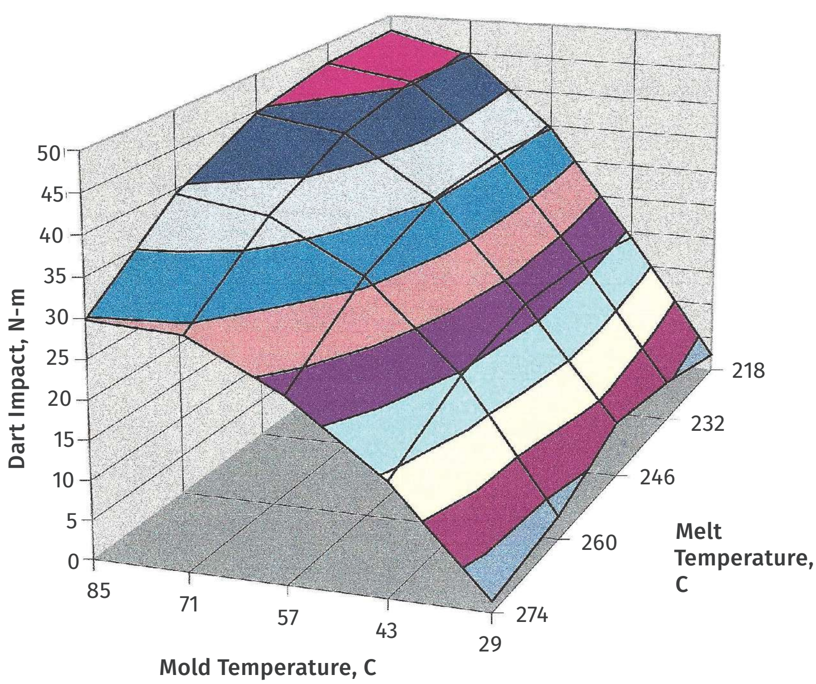
Cooling rate also influences the shrinkage of a material. Even when the cooling-line layout in a mold is done with meticulous attention to detail, which rarely happens, differential rates of cooling are still inevitable due to wall-thickness considerations. Material close to the mold surface will cool faster than material in the part core. The greater the wall thickness of the part, the more problematic this will become.

Orientation is another factor associated with the behavior of the different layers of material flowing through the mold. Polymer chains naturally form an entangled network where the molecules are coiled up. However, when molten polymer flows, differences in the shearing forces between the various layers of flowing material cause the chains to straighten and orient in the direction of flow. This is the mechanism that causes non-Newtonian behavior in polymers.

Shear rates are at their highest just below the part surface, and this is also the layer that cools most rapidly. This rapid cooling limits the time that the polymer chains have to relax from the oriented state to the coiled state. Therefore, the material near the wall will exhibit a relatively high degree of retained orientation in the final part. The level of this orientation will decrease as we move to the center of the part. Not only is the gradient in orientation between the surface and the core a source of stress, but in fiber-reinforced materials, anisotropic shrinkage is caused by the limitations that the oriented fibers place on the dimensional change in the polymer as it cools. This limitation is not observed in the direction transverse to flow, or at least not to the same extent.

Consequently, any fabricated part will contain some level of internal stress that arises naturally from melt processing. In many cases these stresses will appear as warpage. Warpage is the natural result of shrinkage that varies in magnitude within a part, whether it be due to volumetric considerations or driven by orientation. But even if warpage is not evident in the part, stresses are still present. Often, they do not show up

Effect of Melt and Mold Temperature On Impact Performance of ABS



When ABS specimens were prepared in a mold set at a relatively low temperature of 29 C, the energy required to break the test specimens was only 1.5 N-m (1.1 ft-lb), a value associated with a very brittle material. Altering the melt temperature across a fairly wide range did not appreciably change this result. However, when the mold temperature was increased, the impact resistance improved dramatically.

until the part is in the field and experiences an environmental condition such as elevated temperature, contact with a certain chemical, or an impact event. Elevated levels of stress will result in a less-than-optimal response to these application influences.

Warpage is one of the mechanisms by which stress is relieved. When molders fail to deal with root causes and elect to either fixture a part to prevent movement while it cools, or alter the processing conditions to reduce warpage, they are often building in even higher levels of stress. Most processors know that reducing the temperature of the mold is a very effective way of reducing warpage. We have discussed the temporary nature of this improvement when talking about semi-crystalline polymers. But what about materials that do not crystallize? How do amorphous polymers like polycarbonate, ABS, and polysulfone react to the faster cooling rate associated with a lower mold temperature?

When molders fail to deal with root causes and elect to either fixture a part to prevent movement while it cools, or alter the processing conditions to reduce warpage, they are often building in even higher levels of stress.

A study performed on ABS some years ago offers some insights into this question. The accompanying graph shows the results of this study; an evaluation of the effect of mold and melt temperatures on the impact resistance of test specimens molded from a particular grade of the polymer. ABS is generally considered to be a reasonably tough material, and materials in this class will typically produce falling dart energies-to break in the range of 30-40 N-m (22-30 ft-lb) and exhibit a ductile failure mode. However, note that when specimens were prepared in a mold set at a relatively low temperature of 29 C (84 F) the energy required to break the test specimens was only 1.5 N-m (1.1 ft-lb), a value associated with a very brittle material.

Altering the melt temperature across a fairly wide range from 218 C (425 F) to 274 C (525 F) did not appreciably change this result. However, when the mold temperature was increased, the impact resistance improved dramatically. With the mold temperature set at 85 C (185 F), the impact resistance improved to 30 N-m (22 ft-lb) with the melt temperature set at the upper end of the experimental range. This improvement is attributable to the smaller difference in

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cooling rate between the surface material and the core material, coupled with a reduction in the thickness of the oriented layer of material. Both factors reduce the level of molded-in stress in the part, making it more capable of managing an externally applied stress.

The natural response of most processors when presented with these data is to protest that the cycle time will be longer if the mold temperature is increased. However, this objection can be answered by observing what occurs when the melt temperature is reduced. While lowering the melt temperature had little to no effect on part performance when the mold was cold, the same adjustment produced an additional improvement in impact resistance when the mold temperature was increased. The best results, an impact resistance of 48 N-m (35 ft-lbs), were achieved with the lowest melt temperature and the highest mold temperature. By reducing the melt temperature, the increased mold temperature can be managed without changing the cycle time. The best way to remove heat quickly is not to introduce it in the first place. The lower melt temperature also reduces the risk of polymer degradation.

This behavior can be verified by using another measure of molded-in stress, resistance to stress cracking. When molding some clear PC parts using a relatively high melt temperature of 321 C (610 F) and a low mold temperature of 24 C (75 F), it was observed that the parts developed cracks when exposed to olive oil. In fact, parts molded at these conditions spontaneously developed cracks even without exposure to the olive oil if enough time was allowed to pass after the parts were produced. When the mold temperature was raised to 105 C (221 F) and the melt temperature was reduced to 277 C (530 F) the stress cracking was eliminated without lengthening the cycle time. The part surface also had a better appearance because the higher mold temperature delayed the rate at which the surface material solidified.

Any fabricated part will contain some level of internal stress that arises naturally from melt processing.

These are anecdotal results, and in the world of plastics everyone has a good story or two. But this does not pass for science. In our next article we will elaborate on the foundation principles behind these improvements and translate them to the process conditions that ensure optimal performance for the molded part.

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INJECTION MOLDING

Is There a 'Most-Important' Process Parameter?

A case can be made for multiple variables—fill balance, fill time, injection pressure, cavity pressure—as most important. But there is something else altogether that is essential to successful injection molding.

By Robert Gattshall

I was recently asked a question that provoked a serious emotional reaction from me due to its utter disregard for the scientific principles that are the foundation of a molding process. For me, the question—"What is the most important process parameter of a molding process?"—is akin to asking which one of my children I loved more. My first reaction, which I was (fortunately) able to keep from verbalizing: "Are you kidding me?"

A little background: I sat down with a group from a major medical manufacturer to discuss injection molding medical process validations and the principles of Scientific Injection Molding. So, to be asked which parameter is the most important, especially by someone from the medical side of our industry, was surprising, to say the least. Considering that in the medical market, the molding process itself is essentially a customer specification, as critical to shipping product as the part dimensions, I was not expecting this type of question.

If you can't fill the parts the same, you can't pack the parts the same, and thus Cpk values can become extremely low.

Whether it is medical or pharma, the customer typically requires that you show evidence that the product you ran was molded within the process-control limits established during the validation. I would argue that the OQ or Operation Qualification is the stage of the IQ/OQ/PQ protocol where the molder's process is developed, while the PQ (Performance Qualification) sets your upper and lower control limits, but that is a different article.

This conversation was the motivation for this column, where I figured I would argue the points for several process parameters as "most important," and with that maybe help identify whether there is in fact a "most important" process parameter. What better place to start than the answer I reluctantly gave at the time, after making it very clear that all outputs of an injection molding process are important.

- **Fill Balance:** I made it abundantly clear that fill balance on its own is not technically a parameter but actually an output of many parameters. That said, if I had to pick something, fill balance would be one of the starting points of process development. I almost lost my composure when the follow-up question was, "Okay, so what's the most important parameter in controlling fill balance?" My response: "Really?" Literally hundreds of variables can affect fill balance. Whether it is thermodynamics, percentage of regrind, mold dimensions or shear, it is impossible to pick one of these as being more important than the others.

That said, a debate can be had about the importance of having a balanced fill and, more importantly, the effects unbalanced filling will have on part quality and dimensional repeatability, specifically in regard to the medical requirements to hit Cpk and Ppk numbers of 1.33 and 1.67, respectively. The Cpk of a dimensional specification in the medical molding industry is simply the comparison of one cavity to another. So it helps determine the variation from Cavity One to, let's say, Cavity 32 on a 32-cavity mold and so on. Fill balance is absolutely critical from this perspective. If you can't fill the parts the same, you can't pack the parts the same, and thus Cpk values can become extremely low.

Cavities that fill on first stage will be packed out less because the viscosity in these cavities will become extremely high. Don't forget the basic rule of plastic flow: Plastic flows in the direction of least resistance. If we have a two-cavity mold and one cavity is full on first stage and the other is 80% full, the path of least resistance becomes the cavity that isn't completely full.

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A balanced fill ensures that each cavity fills and packs at the same point in time; it ensures that each cavity is experiencing similar process conditions. It is a fundamental on which a process is built, so it's importance is self-evident, but calling it the "most important" parameter is still difficult.

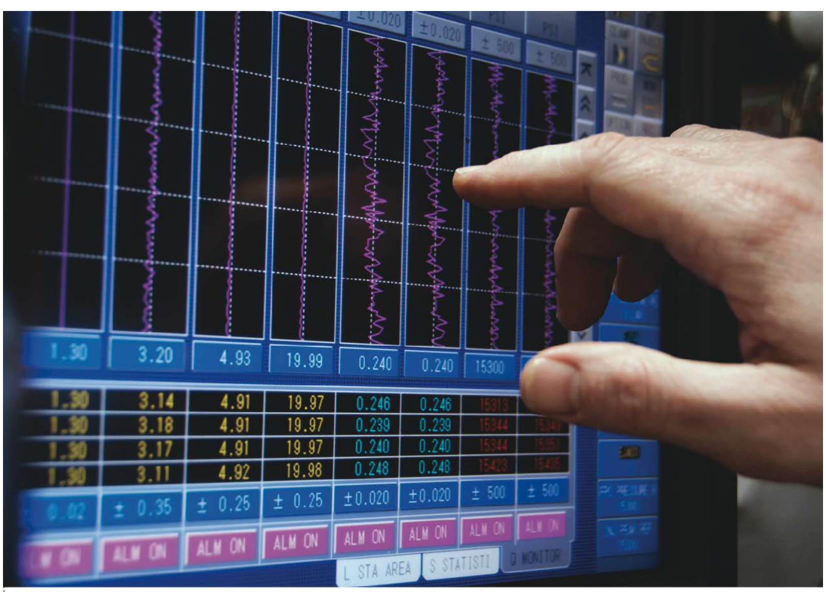
- **Fill Time:** Maybe the most important process parameter is fill time. Let me be clear again—this is an output not a setpoint. The word *parameter* is defined as "a quantity whose value is selected for the particular circumstances." We do select a fill time, but we do so by adjusting machine parameters. The fundamentals of molding that many of us have adopted are focused on outputs of the process.

The entire premise of "what is the most important parameter" is questionable, considering that many parameters contribute to the process outputs. There are many molders that would say fill time is the foundation of your process and there are many experiments used to establish it.

I typically run a study on rheology, viscosity linearity, fill balance, and machine variation before identifying a fill time for a process. Did I say fill balance? I did. Fill balance is greatly affected by the fill rate and will change based on how fast or slow we inject. An injection molding process is a *connected process*, meaning that multiple variables and parameters will have a direct or indirect impact on one another. Very little about an injection molding process is isolated and won't have an impact on something else.

With fill time, some processers may complete fewer experiments and some might even add to the list. Regardless of how fill times are identified, it is critical to ensure that we maintain that same fill time throughout the life of that mold or part. If we maintain a fill time, we ensure molecular-orientation equivalency, which results in filling consistently run to run. If we fill consistently run to run, this will contribute to a consistent shrinkage, shear rate, and fill balance. Again, there are several variables that affect how a part shrinks, and I am only pointing to one. There are many experts in our industry that would say the fill time is the foundation of a robust process, but is it really the most important? Now if we ask, "What do I need to ensure a repeatable fill time?" the answer is the right injection pressure. So. does that mean injection pressure is the most important parameter?

The entire premise of "what is the most important parameter" is questionable, considering that many parameters contribute to the process outputs.



Looking for the "most important" parameter may be futile. But one thing is certain: Your people are your most important resource—more important than the equipment. (Photo: Prism Plastics)

- **Injection Pressure:** Injection pressure is critical to a repeatable process, and although you do expect some variation in this output, if you have insufficient pressure, it can be catastrophic to part quality. Pressure-limited processes lack the ability to adjust themselves based on variation in the material viscosity. If material viscosity increases beyond the available machine pressure, our pressure curve will abruptly flatten out and our fill time will increase. It will take longer for the machine to hit the V-to-P transfer point, if at all. There are several defects this can cause, most notably short shots or underfills.

When we refer to Scientific Molding or Decoupled Molding, we are really referring to a velocity-controlled first stage, but we are completely unable to control that velocity if we have a limit on the amount of pressure we have to achieve it. I know of several processors that kind of ignore injection pressure when it comes to process monitoring, reasoning that "as long as it is not limited, it is not a critical process output," and that we expect to see variation.

I agree that we expect to see variation, but how much is too much and why is that important? I would say that too much variation is anything outside established "normal" variation during validation runs. Depending on the product and customer specifi-

cations, it is important to challenge the process during validation and mimic viscosity changes. For example, if your specification allows for regrind to be added in production, then you need to include a run with regrind during your process validation.

Once you have a baseline and have identified normal variation for your process, when the peak injection-pressure variation exceeds that baseline, it is important to understand why. I am not saying you should immediately reject this product, I am saying that this product needs to be reviewed and more importantly, the molder must identify where the added variation is coming from.

Ensuring that you have a skilled, motivated, and properly trained workforce is ultimately what will determine the quality of the product being sent to your customer.

- **Cavity Pressure:** Given the millions of dollars molders spend every year adding cavity-pressure transducers and equipment to monitor and control their process, cavity pressure must be a critical output. Having the ability to pack out each cavity based on the cavity pressure, or even controlling the V-to-P transfer by cavity pressure, provides dimensional stability from part to part and shot to shot. Although the investment can be substantial, the benefits are proven. That said, my position is not that every product needs this technology.

If you're an automotive molder and you're molding class "A" surface products, even parts that are run within your control limits for cavity pressure may not be acceptable due to visual defects. Cavity-pressure transducers aren't going to let you know whether the parts have a scratch or a spot of rust on your texture. If set up properly, they can monitor for shorts and flash; but cavity-pressure transducers might not catch visual defects that aren't related to material flow.

If the cavity-pressure transducers are installed in the correct locations, peak cavity pressure can provide a high level of control and monitoring. However, I would say the biggest benefit of cavity-pressure transducers isn't even the cavity-pressure output. The cooling-rate output from a cavity-pressure transducer provides the rate at which the plastic shrinks away from the transducer. This can reassure molders that the water is cooling at the same rate on each run. So maybe the argument for cavity pressure is actually an argument for cavity-pressure transducers. That would be a difficult stance to take, however, since there are so many successful molders out there that do not invest in this technology but are still data-driven scientific molders.

- **People as a Parameter:** Trying to identify a "most important parameter" for a connected process like ours is absolutely impossible. There is not a most important parameter nor is there a most important piece of equipment. There is however one critical resource that is "the most important" and that is your team members.

Your people, from technicians to operators to everyone else, are the most important. Whether we are discussing process development, process controls or technologies, the person setting up that job has the most influence on its success. Ensuring that you have a skilled, motivated and properly trained workforce is ultimately what will determine the quality of the product being sent to your customer.

Investing in people as much if not more than you invest in equipment is critical to a safe and successful injection molding process. Think of it this way: If you decide to say that fill time is the most important process parameter and you apply tight control limits, someone still needs to turn those controls on. Someone needs to understand not only how to turn on the controls, but how to troubleshoot them when the equipment doesn't function properly.

Much of our industry's training is focused on engineering and process-development skills, yet we still do not provide training apprenticeships for mold and setup technicians or even operators. We need standards similar to other skilled trades and a clear career path for our technical team members. I have spent many years in injection molding, working with all types of equipment and developing processes and systems to monitor them. I can tell you that these systems can never replace a well-trained technician. Instead, they give them the tools needed to deliver best-in-class efficiencies and part quality to our customers. One is not independent of the other. Like an injection molding process, our resources (equipment and team members) are a connected process and molders cannot be successful isolating them. PT

ABOUT THE AUTHOR: Robert Gattshall has more than 22 years of experience in the injection molding industry and holds multiple certifications in Scientific Injection Molding and the tools of Lean Six Sigma. He has contributed articles for *Plastics Technology* and other magazines on multiple topics, such as scientific process development, process monitoring and the effects of variation. Gattshall has developed several "Best in Class" Poka Yoke systems with third-party production and process monitoring such as Intouch Production Monitoring and RJG. He has held multiple management and engineering positions throughout the industry in automotive, medical, electrical and packaging production. Gattshall is also a member of the Plastics Industry Association's Public Policy Committee. As of January 2018, he joined the IPL Plastics team as process engineering manager. Contact: *(262) 909-5648*; *rgattshall@gmail.com*.

EXTRUSION

How to Estimate and Control Head Pressure

You rightfully worry about melt temperature, but don't overlook head pressure, because the two are closely linked and will influence line performance.

By Jim Frankland

Head pressure never seems to be a big concern of extrusion processors, while melt temperature is something that always worries them. But they are closely connected. The melt temperature at open discharge is a function of the extruder alone; it is controlled by the screw design, screw speed, L/D ratio, polymer properties, condition of screw and barrel, and efficiency of barrel heating/cooling. That becomes a baseline temperature that can be altered only with changes in one or more of those extruder variables.

When head pressure is applied to the end of the extruder, the melt temperature rises non-linearly from the baseline with increasing pressure. That's due to a cascading effect of the pressure flow—output from the screw is reduced as the head pressure increases. As the screw continues to rotate with reduced output, the energy via shear stress going into the polymer is increasing. The increasing energy input results in an increase in the melt temperature and a decrease in the viscosity of the polymer, further increasing the pressure flow and further decreasing the output.

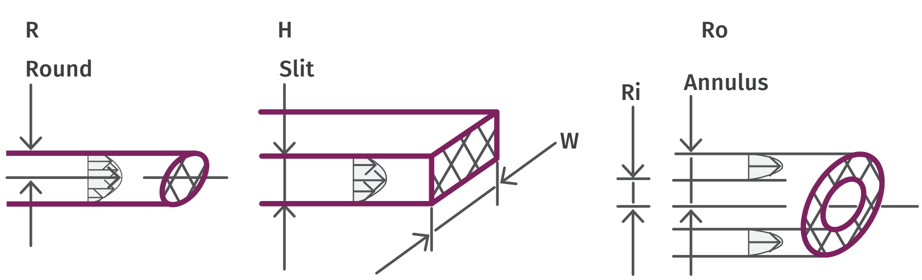


FIG 1 For a round orifice, the pressure is increased by eight times the passage length but decreases by the fourth power of the radius. For a slit orifice and an annular passage, the pressure is increased by 12 times the length and reduced by the first power of the width and the third power of the height or difference in the radii.

So, melt temperature is connected to head pressure and results in reduced output, greater power requirement, more downstream cooling, and maybe even degradation of the polymer properties. This results in greater manufacturing cost and needlessly compromises the performance of whole systems when it is easily diagnosed and corrected.

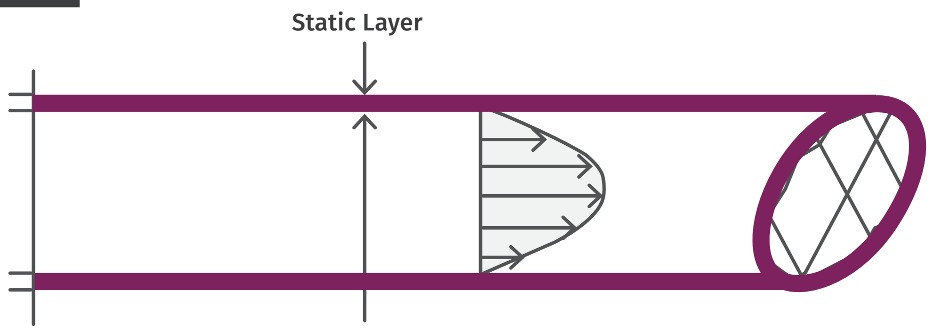
A melt pump can correct much of this effect by allowing a head pressure that is usually much lower than the full head pressure. However, many processes cannot tolerate use of a melt pump due to the incorporation of fillers and the possibilities of polymer degradation and contamination. In those applications, the downstream tooling design is important to the performance and profitability of the line. Unfortunately, there is often no consideration of the effects of head pressure in the selection of the downstream components and its effect on the overall process.

Head pressure further increases the melt temperature from the extruder baseline.

Head pressure can be accurately estimated and controlled by proper design. This involves mostly simple things, such as limiting the length of adapters and flow pipes, proper sizing of the screen changer, die designs specific to the polymer properties, proper sizing of all the flow channels for the expected output, and proper heating of the downstream components.

The simplest forms of flow channels are the circle, slit and annulus. There are simple approximations for calculating each of these basic shapes. By using basic Newtonian formulas for each shape, you can illustrate the principles and get a good estimate of the head pressure (see accompanying table and Fig. 1). Using Newtonian equations requires determinating the viscosity from shear-rate/viscosity curves for that polymer at the appropriate temperature. Newtonian analysis neglects some viscoelastic effects—like viscous heating at the wall and entrance effects as the flow shapes change. The shear rate must be calculated and then applied to the shear-rate/viscosity curves at the processing temperature to obtain the correct

FIG 2



The shear stress at the wall needs to be great enough to provide continuous renewal of the material near the wall to avoid getting a scale or static layer on the walls. Tooling designers have their preferences, but 10 psi is typical.

viscosity. As a result, these are approximate values, adequate for equipment selection, and they show the effect of the important variables to give the processor the knowledge for analysis without benefit of a more rigorous computer analysis.

As you can see from the table, for a round orifice, the pressure is increased by eight times the passage length but decreases by the fourth power of the radius. For a slit orifice and an annular passage, the pressure is increased by 12 times the length and reduced by the first power of the width and the third power of the height or difference in the radii. So, to minimize head pressure, flow passages should be as short as possible and as large as possible. However, "as large as possible" has a definite restriction.

There is often no consideration of the effects of head pressure in the selection of the downstream components and its effect on the overall process.

To clean the walls of the passage (not get scale or a static layer on the walls), the shear stress at the wall needs to be great enough to provide continuous renewal of the material near the wall (see Fig. 2). Different levels of stress are preferred by different tooling designers, but 10 psi is typical. Too low a shear stress at the wall builds temperature differentials into the extrudate from large differences in residence time and will cause unstable flow.

It may even cause degradation of the layer on the wall with thermally sensitive polymers.

Shear stress at the wall is a simple formula but depends on the pressure drop, as calculated top right:

Pressure Drop & Shear Rate for Different Flow-Channel Geometries

Pressure Drop	Shear Rate
Circular flow passage:	
$\Delta P = Q\mu\,(8L)/\pi R^4$	$Y = 4Q/\ \pi R^3$
Slit flow passage:	
$\Delta P = Q\mu\,(12L)/WH^3$	$Y = 6Q/\ WH^3$
Annular passage:	
$\Delta P = Q\mu\,(12L)/\pi(R_0+R_i)(R_0-R_i)^3$	$Y = 6Q/\ \pi(R_0-R_i)^3$

P = Pressure　**Q =** Output　**μ =** Viscosity
L = Length　**R =** Radius　R_0 **=** Outer radius
R_i **=** Inner radius　**W =** Width　**H =** Height
Y = Shear rate

Source: *Processing of Thermoplastic Materials*, Ernest Bernhardt, Reinhold, 1959, p. 249

Shear stress at wall= $\Delta P \bullet R/2L$

L is either the radius of a circular orifice, or the gap between the slit opening (H) or the gap in an annular die (R_0-R_i).

Proper heating of the downstream tooling is an important part of controlling head pressure. The tooling temperatures should be kept as close to the melt temperature as possible. That prevents developing the scale or static layer of colder, more viscous polymer on the inner walls that simply narrows the flow passage and causes increased pressure drop. It's difficult to reduce melt temperature by cooling the tooling because of its effect on raising the head pressure and because of the low thermal conductivity of the polymer.

When assembling an extrusion line for any new shape, the estimation of head pressure from the tooling should be considered in the output and cooling calculations. That's done by minimizing the length of the flow passages and holding the wall shear stress to as close to 10 psi as possible by adjusting the size of the flow passage. PT

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

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Additive Blooming: Origins, Detection, and Control in Polymer Processing

Most polymers contain many non-polymeric components intended to stabilize, toughen, color and lubricate the final product. Certain classes of these additives are capable of migrating to the surface. This additive migration can create a surface that has a composition very different from the bulk of the polymer. If the manufacturing process includes an interface between the polymer and an adhesive or paint, or in the case of a medical device, contact with human tissues, additive migration to the surface (blooming) can have serious consequences. Blooming represents a form of contamination that can result in adhesive or paint failures or worse.

PRIMARY TOPICS:

- The origins of blooming
- Common additives that are subject to blooming
- Strategies for detecting, controlling, and avoiding issues associated with bloomin

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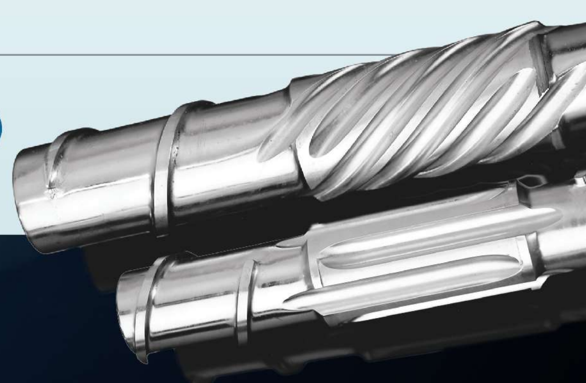

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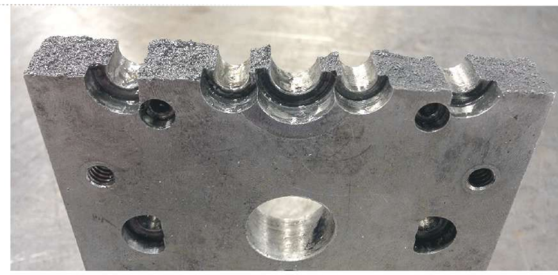
TOOLING

PART 2

Why Ejector Pins Break And How to Prevent It

Here's the when and how to reduce the unsupported length of pins.



An ejector retainer plate can crack when subjected to an uneven load.

By Jim Fattori

Let's start with the basics and build on that. Ejector pins are mounted in the ejector retainer plate by means of a through hole for their body and a counter-bore for their head. The typical head-diameter tolerance of a standard ejector pin is +0.000 to -0.010 in. from nominal. The counter-bore diameter for the head of a pin in the retainer plate is typically ¹⁄₃₂-in. larger than nominal. The typical head-thickness tolerance for a standard ejector pin is +0.000 to -0.002 in. from nominal. The counter-bore depth for the head of a pin in the retainer plate is typically +0.001 to +0.003 in. deeper than nominal. Most pins have a ¹⁄₃₂-in. radius where the shaft of the pin meets the head, so clearance must be provided. Ejector-pin counter-bore sets, available through most molding supply companies, automatically add a chamfer to account for the radius on the pins.

The tolerance for the diameter of an ejector pin varies depending on the size, type and manufacturer. It can be as much as -0.0010 in. below nominal to as little as -0.0000 in. below nominal. Keep in mind, that's a full thousandth. Most mold designers will make the through hole for the pin in the ejector retainer plate ¹⁄₆₄-in. larger than nominal. This allows a standard-size drill to be used and provides roughly no more than 0.008 in. per side of "float" in the event the through hole in the plate does not precisely align with the through hole in the core.

If the slenderness ratio is greater than 100, you can expect the pin will fail due to buckling.

The ejector retainer plate can have holes for the ejector pins, ejector sleeves, core pins, guide bushings, return pins, support pillars, lifters, screws and various other component parts. Basically, these plates look like Swiss cheese. Last month I discussed the problems associated with uneven loads on the ejector system. Cracking a fragile ejector retainer plate in half is one of those problems.

An ejector pin's unsupported length is a critical variable and a common cause of its bending, buckling and breaking. If you have ever watched an Olympic pole-vaulting event, you have seen how much the pole bends after the vaulter plants it in the box and leaps up to clear the bar. These poles can be over 16-ft long. If the vaulter holds the pole in the middle, instead of at the end, how much do you think that pole will bend? Obviously, not nearly as much. The material, hardness, diameter and even the length of the pole did not change. Only its unsupported length changed. The unsupported length is equal to the distance between two fixed or pivoting points of an object. This same premise also applies to ejector pins.

A Swiss mathematician and physicist by the name of Leonard Euler developed two formulas back in the mid-1700s that moldmakers can still use to predict whether an ejector pin will buckle and collapse. One formula is rather simple. It is called the Slenderness Ratio. This ratio is equal to the unsupported length of a slender column, such as an ejector pin, divided by the radius of gyration. Don't get excited. The radius of gyration for an ejector pin is simply its diameter divided by four. So the formula is:

Slenderness Ratio = Unsupported Length ÷ Diameter ÷ 4

TABLE 1

Pin Diam. Vs. Unsupported Length (For a Slenderness Ratio of 100)

Pin Diameter, in.	Max. Unsupported Length, in.
¹⁄₃₂ or 0.0313	0.8
¹⁄₁₆ or 0.0625	1.6
⁵⁄₆₄ or 0.0781	2.0
³⁄₃₂ or 0.0938	2.3
⁷⁄₆₄ or 0.1094	2.7
⅛ or 0.1250	3.1
⁹⁄₆₄ or 0.1406	3.5
⁵⁄₃₂ or 0.1563	3.9
¹¹⁄₆₄ or 0.1719	4.3
³⁄₁₆ or 0.1875	4.7
¹³⁄₆₄ or 0.2031	5.1
⁷⁄₃₂ or 0.2188	5.5
¹⁵⁄₆₄ or 0.2344	5.9
¼ or 0.2500	6.3

Spacer blocks on the back of a mold solve a minimum stack-height problem.

If the value of this ratio is greater than 100, you can expect the pin will fail due to buckling. Working backwards, I used a Slenderness Ratio value of 100 and solved for L, the maximum unsupported length of ejector pins of various diameters. Table 1 details the results for 1/32-in. through ¼-in. ejector pins.

Euler developed another, much more involved formula, and I will spare you from going into too many details about it other than to say the formula allows you to calculate the amount of force a slender column, like an ejector pin, can withstand before it buckles. The formula is very useful in understanding how the unsupported length of a pin is directly related to the amount of force it can apply to eject a part before buckling.

For example, Table 2 shows that a 5/64-in. ejector pin, with an unsupported length of 3 in. can push a plastic part with 99 lb of force before it buckles. A pin with that same diameter and an unsupported length of 1.5 in. can push a part with 394 lb of force before it buckles. While that may be four times the amount of force, you need to be careful here. This quadruple relationship only occurs when you cut the unsupported length in half. If you reduce that same pin's unsupported length by just ½ in., from 3 in. to 2.5 in., the force only increases by 43 lb, which is a factor of just 1.4 times. Regardless, are

TABLE 2 Buckling Force of Ejector Pins

	Minimum Force to Buckle, lb					
Pin Diam., in.	**1/32**	**1/16**	**5/64**	**3/32**	**7/64**	**1/8**
Unsupported Length, in.						
0.50	222	1123	3548	8663	17,964	56,774
1.00	55	281	887	2166	4491	14,194
1.50	25	125	394	963	1996	6308
2.00	14	70	222	541	1123	3548
2.50	9	45	142	347	719	2271
3.00	6	31	99	241	499	1577
3.50	5	23	72	177	367	1159

you beginning to see how important the unsupported length is?

If you think you might have an issue with an excessive amount of unsupported length in a mold, how do you reduce it? The first thing to do is estimate how much ejector stroke is needed to safely eject the part off the core. For a new mold, this can vary depending on the mold design, part geometry, material and other factors. Typically, you add about a half an inch or so to the overall height of the part, but this all depends on ejection speed, undercuts, mold design, robotics and various other factors.

When you order (or design) a mold base, you specify what height you want the ejector-housing rails to be. That dimension is equal to the desired ejector stroke, plus the thickness of the ejector plates and the rest buttons. You shouldn't want to go any longer than your estimation, and you obviously never want to go any shorter. If it turns out that the mold design does not have the minimum stack height required for the intended press, which is common for large flat parts, it is very easy and relatively inexpensive to add spacers to the back side of the ejection clamp plate to make up the difference. Adding a spacer plate to the molding machine's platen, instead of spacers on the mold, is rarely a better alternative.

Let's assume that when the mold goes into production, an ejector-pin buckling problem starts to develop. If the ejector stroke can be shortened, do not add stroke-limiting spacer blocks. They won't help reduce the unsupported length of the ejector pins. You need to reduce the height of the rails and the length of all of the ejector and return pins by an equal amount. Ejector-stroke limiters are beneficial only if you *don't* have a buckling problem, but you want to increase the longevity of the mold by preventing production personnel from over-stroking the ejector plates. If you ever add ejector-stroke limiters, mount them in line with the machine's ejector bars. *I cannot stress this enough.* It is probably the most common cause of bent ejector plates. I like to make the stroke limiters out of a nylon or a hard urethane to help absorb the impact caused by momentum or an improper machine setting.

TABLE 3

Injection Force on Ejector Pins Vs. Buckling Force

Ejector Pin Diam., in.	1/32	1/16	5/64	3/32	7/64	1/8	1
Max. Unsupported Length, in. (Slenderness Ratio = 100)	0.8	1.6	2.0	2.3	2.7	3.1	25.0
Minimum Force to Buckle, lb, at Max. Unsupported Length	91	115	233	394	601	1453	93,019
Force on Ejector Pin, lb, at 40,000 psi Plastic Injection Pressure	31	69	123	192	276	491	31,416

As shown in Tables 1 and 2, the smaller the ejector-pin diameter, the shorter the unsupported length needs to be to prevent it from buckling. Any pin 7/64 in. or smaller should be stepped or shouldered to reduce the pin's unsupported length. The shoulder on stepped pins is 1/8-in. diam., and is available in ½-, 2-, 3- and 4-in. lengths. You want the shoulder of the pin to enter the support plate when the ejector plate is back against the rest buttons. If a 4-in. shoulder is still not long enough to enter into the support plate, you can either have custom pins made or you might be able to use an ejector-pin extension.

Now here's the weird thing: Several mold-component suppliers offer extensions for ejector sleeves, but no one that I know of offers extensions for ejector pins. Maybe someday they will realize this is something molders occasionally need. Until then, we will have to make our own extensions, and there are multiple ways of doing so, as shown in Fig. 1.

In Fig. 2, the ejector pin on the left is mounted in an ejector-pin extension, because the shoulder is too short to enter the back of the support plate. Other pins are depicted with bearing inserts on the bottom of the support plate, on the top of the support plate, and on both top and bottom of the support plate. These bearing inserts are a simple way to reduce an ejector pin's unsupported length. They can be made of various types of metal—from bronze to heat-treated tool steel, whatever is your preference. The ejector pin on the right uses a thin-

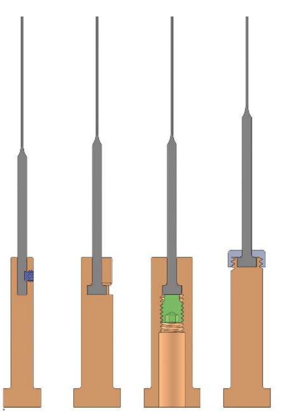
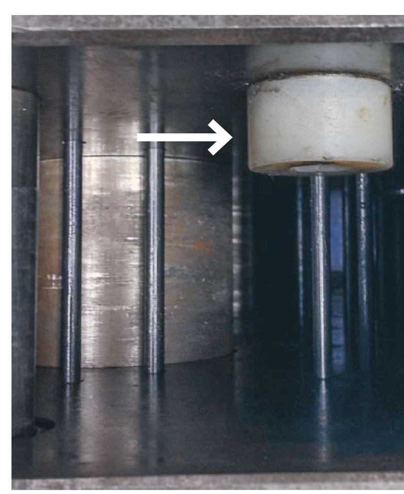


FIG 1 Cross-sections of various ways to make an ejector-pin extension.



If you have to use ejection-stroke limiters, nylon or hard urethane are good material choices

KNOW HOW TOOLING

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Get more insights on tooling from our expert authors: **short.ptonline.com/toolingKH** walled drill bushing, which I have found to be excellent for this application. Here's a test: Which ejector pin or pins in Fig. 1 still has/have a good chance of buckling due to excessive unsupported length?

Let's revisit the practice of providing lateral float around an ejector pin in the ejector return plate. While it sounds like a practical idea to compensate for any misalignment, one study suggests that this added clearance actually promotes wear of the through hole in the core and reduces the force the pin can withstand before it buckles. If the through hole in the ejector retainer plate has significant clearance, the unsupported length increases by an amount equal to the length of the through hole.

It is nearly impossible for an ejector pin to collapse due to high injection pressures.

For example, ejector retainer plates are usually ½ in.- or ⅝ in. thick. Small-diameter ejector pins have a head thickness of ⅛ in. Therefore, the unsupported length of the pin increases by ⅜ to ½ in. That can be a significant amount if the diameter of the ejector pin is 7/64 in. or less, but not much of a concern for pins larger than ⅛-in. diam.

As long as you adhere to the maximum unsupported length calculated using a Slenderness Ratio of 100, it is impossible for an ejector pin to collapse as a result of the material's plastic pressure on the face of the pin. Let me prove it: Table 3 specifies the maximum unsupported length using a Slenderness Ratio of 100 for various size ejector pins—from 1/32 in. up to a full 1.0 in. It then shows how much force it takes for the pin to buckle at that unsupported length. Lastly, it shows how much force is applied to the face of the pins using a ridiculously high plastic pressure value of 40,000 psi. Every pin can withstand two or three times more than this excessive amount of pressure.

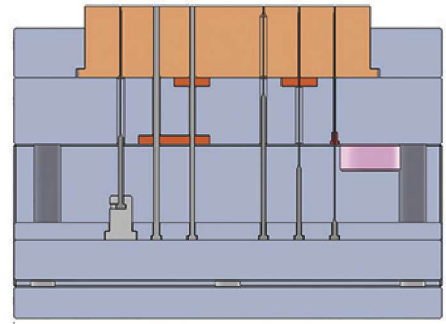

FIG 2 There are several methods you can use to reduce the unsupported length of an ejector pin.

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Accredo Packaging • Sugar Land, Tex.

By Jim Callari
Editorial Director

Accredo's Credo: Designed for Sustainability, Built for Success

In fewer than 10 years, Accredo Packaging has developed innovative packaging solutions—including the first-ever all-PE barrier standup pouch—while maintaining its commitment to being 'green.'

Accredo runs W&H blown film lines to produce films in three-, five- and nine-layer configurations. Photos: Adrian Arroyos

In fewer than 10 years, Accredo Packaging has become a force in sophisticated films for high-end packaging, fueled by a business strategy whose structure from the time it filled its first order in June 2009 has been built on a foundation of innovation, integration, and sustainability. With sales increasing at a clip of a 20% a year, the company (***accredopackaging.com***) has already outgrown its 350,000 ft^2 plant in Sugar Land, Tex., and is building an additional 200,000 ft^2 plant on its 32-acre campus that it expects to occupy next year. When all is said and done, the flexible packaging producer expects to employ more than 500 people in a 24:7 operation that combines high-end film processing—every structure is multi-layer, with capabilities up to 9-layer—with sophisticated printing, laminating, bag- and pouch-making technologies.

The Accredo model is patterned after its sister company, Advanced Polybag Inc. (API), which for more than 30 years has been making grocery sacks in four plants in the U.S. and one in Thailand. Whereas most commodity film processors that venture into high-end packaging take the acquisition route, Accredo was started from the ground up. States Rex Varn, the firm's executive v.p., "The ownership diversified into the high-end packaging business because it saw growth in the grocery-sack market

had leveled out. The idea was to get into producing high-valued products."

The affiliation of API and Accredo gave the latter a degree of buying power that start-ups don't normally enjoy. States Varn, "We don't buy the same materials as API but purchase from the same resin suppliers. That gave us some purchasing power. Instead of being an unknown entity, we came in with purchasing leverage not only for resin but for equipment too."

The company's North American production facility has multiple blown-film extrusion lines from Windmoeller & Hoelscher Corp., Lincoln, R.I. (*whcorp.com*), with technology to produce three-, five-, and nine-layer structures. In short order, Accredo will commission a new W&H blown film line that will be equipped with machine-direction orientation technology. This technology will enable Accredo to produce lightweight, "breathable" films down to 11g/m² for applications that include diapers and feminine-hygiene products, as well as medical drapes and gowns.

Complete integration and sustainability help drive innovations at Accredo, says company chairman/CEO Hank Nguyen (r) and EVP Rex Varn.

In the last year, Accredo North America also added two new 10-color W&H Flexographic printing presses, with another W&H press scheduled to arrive by early first-quarter 2019. In addition, it recently installed a three-layer tandem laminator with registered overvarnish capability.

Working collaboratively with Dow, Accredo produced a "game changing" all-PE, stand-up pouch that has barrier properties and is recyclable.

Much of Accredo's product offerings consist of barrier films for gas-flushing and vacuum-packaging applications that can be utilized on both vertical and horizontal form-fill-seal machines. The firm also produces roll stock and stand-up pouches that can be furnished on a turnkey basis with sliders, zippers, spouts, and a hook & loop reclosure. Accredo's product lines also include towel and tissue overwrap, collation shrink film, wicketed bags, and biobased films. Films are produced in thicknesses from less than 1 mil up to 10 mil. The firm processes PEs of various types, along with renewable PE, PP, nylon, EVOH. "We run Braskem's 'green PE' based on sugarcane feedstock," notes Malcolm Cohn, Accredo's director of sustainability. "We're seeing a lot of growth for these films in sealant webs and for towel and tissue overwrap." At press time, according to Cohn, a national brand was testing film made completely of the renewable PE for towel and tissue film. Accredo believes it's the first film extruder to run this material.

Accredo officials were reluctant to disclose the size of the company—either in terms of sales, volume of resin consumed, or precise number of processing lines. It did acknowledge that the expansion will enable the company to boost annual production of flexible film from 1.5 billion ft to 2 billion ft. "We're not small, and while we may sometimes compete against billion-dollar businesses, we don't consider ourselves large by any stretch of the imagination," Varn says. "However, we have tools at our disposal—including a million-dollar-plus lab—that companies of our size wouldn't normally have. Since we're family owned, we react quickly. We can walk down the hall and talk to the owner and get an answer after a meeting. Decisions are made quickly. Our owners are quick to say yes or no, and if it's yes, we're ordering the equipment tomorrow."

States David Bertelsman, Accredo's director of R&D & Technology, "Being fast and nimble is critical to us. As a custom flexible packaging manufacturer, it's vital that we understand the packaging needs of our customers and respond to those needs quickly. Our mission is to develop films that add value to customers. The tools in our lab allow us to analyze competitive structures so that we understand their characteristics and how they are performing."

He adds, "We can analyze film through microscopy, barrier analysis, and field characterization. We have DSC and FTIR capabilities. The tools support both our own quality control and production as well as R&D. And we have results in hours, as opposed to the weeks it would take if we were to send film samples to outside labs."

A big part of Accredo's business is collation film for shrink bundling water and other products.

Adds Varn, "Sometimes customers come to us for a product having similar characteristics to what they are already using. We can certainly come up with that 'me too' product, but over time ➤

we'll work with them to develop a lower-cost or more sustainable option. Our sustainability story is a very strong point of differentiation between us and our competitors."

THE SUSTAINBILITY STORY

Accredo demonstrates its commitment to green in several ways, says Cohn. "We've integrated sustainability into every aspect of Accredo's business model," he says. "As one of our core values, sustainability is critical in the products we create, their impact upon the environment, our worker-safety initiatives and our environmental policies."

Accredo utilizes 100% wind-generated electrical power and is said to be the first flexible packaging plant in the U.S. to be granted LEED (Leadership in Energy and Environmental Design) Silver certification under the U.S. Green Building Council (USGBC) rating system. LEED promotes sustainable site development and material selection, water conservation, energy efficiency, and indoor environmental quality. The company is also BRC (British Retail Consortium) certified ("AA" Rating), a global standard for food safety established in 1998.

Accredo also offers four sustainable packaging options, Cohn elaborates. Its "conventional" sustainable option product offerings are so named because they provide high-barrier films sourced from conventional hydrocarbon-based raw materials but produced in a more sustainable production process. Cohn states, "We've revolutionized the packaging industry by developing a proprietary printing process that brings new meaning to the term 'expanded color gamut.' Accredo's state-of-the-art printing process can reproduce a world of limitless colors and is so finely tuned that we can guarantee a consistent visual match from job to job, whether hours or months apart. Driven by an innovative ink-delivery system, we eliminate all ink changes (resulting in up to 95% less ink waste and significant reduction in solvent usage) and high-speed setup between jobs."

Included in its sustainable product offerings are compostable films converted into zippered standup pouches like this.

Its recyclable option is perhaps best illustrated by Accredo's 2015 collaboration with the Dow Chemical Company, Midland, Mich. (*dow.com*), and the Sustainable Packaging Coalition (SPC). That effort resulted in the development of all-PE, fully recyclable barrier film for pouches that can potentially replace co-mingled, multi-material structures (e.g. PET/LDPE), which are primarily landfilled. The product is made with Dow's Retain modifiers. Dow says it's the first package of its kind with barrier film that can be recycled in a PE recycling stream. Accredo can supply film—trademarked AccredoFlex RP (recyclable pouch)—in up to 18 layers by laminating two nine-layer structures.

Varn recalls, "We worked with the recycling community to make sure the product met their requirements. This was a long-term project and took a year to qualify. We were the first to develop a film product that is both recyclable and has gas-barrier properties. The moisture barrier is improved as well."

There's a lot of "secret sauce" that went into making this possible. Notes Bertelsman, "Sophisticated raw-materials technology and high-tech machinery combined with processing know-how allowed us to put structures together to create barrier performance and recyclability along with all the other functional performance that these films must have to be successful." The pouch was created for Seventh Generation, Burlington, Vt., making it the first laminated recyclable package for dishwasher pods.

Its renewable option, including Accredo's previously noted work with Braskem, is third-party certified in accordance with ASTM D6866. The material can be run on existing equipment without compromising line speeds.

Accredo is said to be the first company in the world to manufacture a zippered standup pouch made from components certified compostable in accordance with ASTM 6400 standards for compostability in industrial composting facilities. Cohn says new developments in compostable film technology enable Accredo to produce compostable packaging with high moisture and gas barriers.

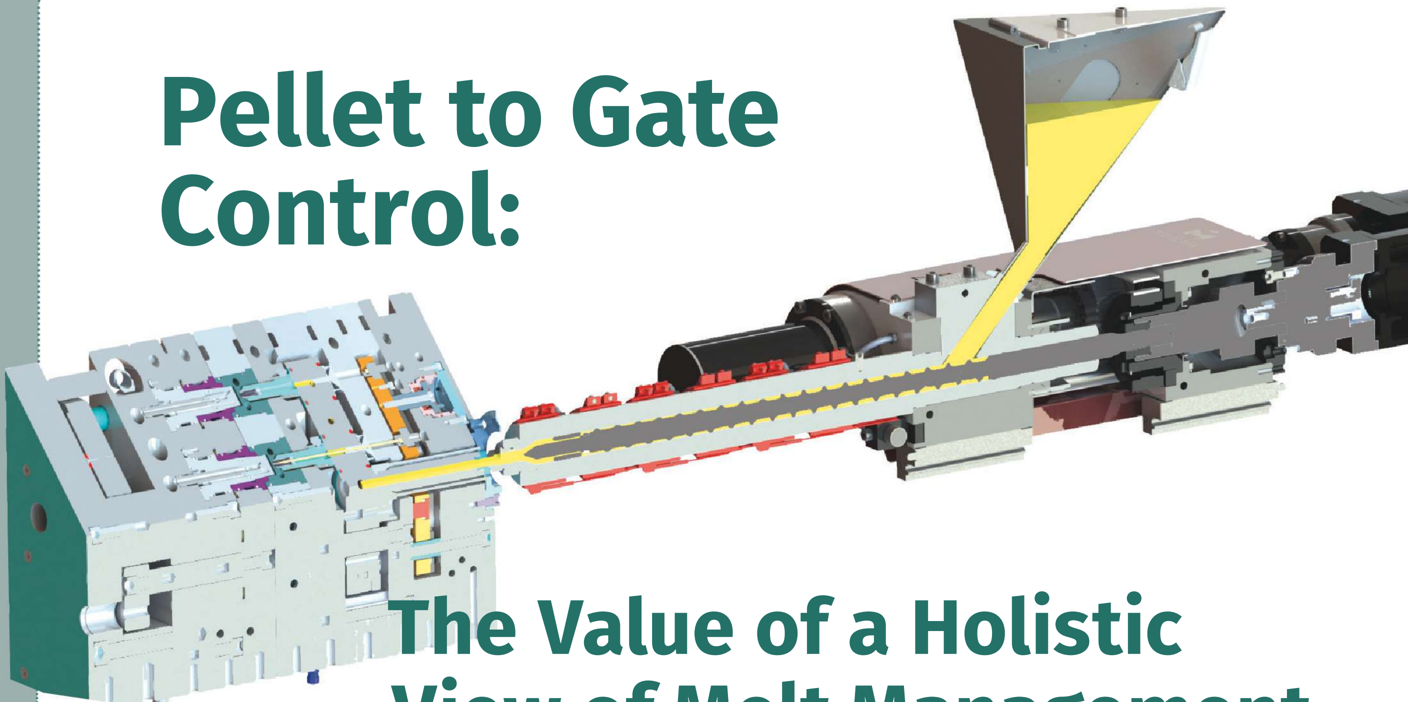
AHEAD OF THE CURVE

At the outset, Accredo will use its new plant for warehousing. But it was built, according to Varn, "in preparation for and anticipation of continued growth." He explains, "Ownership likes to be ahead of requirements, and basically we need more capacity. The building has a raised roof to accommodate installation of additional blown film extrusion lines. Like the original plant, this facility will be equipped with a rail line. Material is fed by railcars to indoor silos, which convey resin to multi-component gravimetric blenders. Depending on the order size, lines can run for a few hours to days on end.

"Accredo has grown significantly since its founding in 2009," says Varn. "We attribute our continuing success to our company owner's investment in leading-edge technologies, including high-tech plant operations, a dedicated workforce, and exceptional customer service," adds Varn.

Concerning future growth, Varn observes: "The further downstream the product goes, the more assets it touches during manufacturing. In the case of pouches, for example, we do it all. And there is lots of ongoing conversion to standup pouches from boxes, cans, jars, etc. We feel we have a leadership position there, as well as in shrink-bundling films and towel/tissue-wrap films." PT

Pellet to Gate Control:



The Value of a Holistic View of Melt Management

Molders tend to think about the elements of a melt-delivery system, from screw to hot-runner gate, in isolation from each other. But taking an integrated view of the whole system can have big consequences for cycle time, part quality, scrap rates, and energy consumption.

By Bruce Catoen
Milacron Inc.

Injection molding: A pellet goes in, and a few moments later a part comes out. Seems simple enough, but what really happens in between these points, and how can optimization of this process create value for you in your operation? What happens in the machine barrel and the hot runner can significantly impact your molding productivity and quality. In this article you will learn how to recognize ways to improve the process of melt creation, delivery and control so that your operation can put more good parts in the box at the end of the day.

Consider the entire melt-delivery system from screw to hot runner as an integral whole if optimization is to be effective.

Operating a profitable molding facility continues to be a greater and greater challenge. Molding complexity continues to increase due to the demand for thinner, lighter and more complex parts. Customers are asking for increased precision, new resins and additives, multi-materials, higher cavitation, frequent color changes, and faster cycles. As a molding cell is pushed ever closer to its edge of acceptance, any weaknesses in the system become more exposed. These weaknesses can create significantly more difficulties in maintaining OEE (overall equipment efficiency). In these cases, the importance of melt quality and balance of fill, for instance, become more and more critical.

TABLE 1 Average to Great: A Few % Matters

OEE Factor	Average Molder	Top 10% Molder
Availability, %	90	94
Performance, %	96	98
Quality, %	96	98
OEE, %	83%	90%

Not many molders consider the entire process from pellet to gate. Frequently, each of the elements in the flow path is optimized independently; and as a result, they could be sub-optimized for the system's performance. The difference between an average and a world-class molder is only a few percentage points (see Table 1). Could an optimized melt-distribution system help an average molder become a world-class molder?

EXPERIMENT IN OPTIMIZED MELT DISTRIBUTION

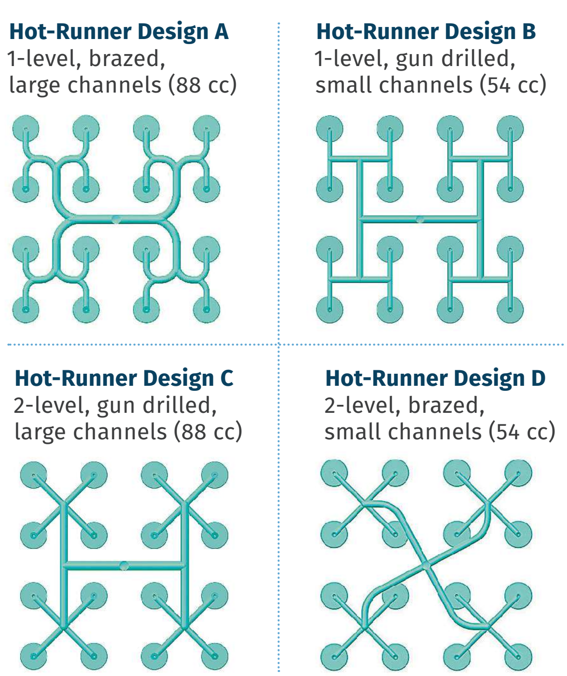
A set of experiments was conducted to determine if an optimized melt-distribution system could create a more homogeneous melt and if that, in turn, would help to improve the overall performance of an injection molding workcell. A 200-ton Milacron-Fanuc Roboshot machine with two different screw designs; a 16-cavity 28-mm cap mold; four different hot-runner configurations (see Fig. 1); and Lexan PC resin were used in different combinations in order to determine the optimized configuration and the difference between the worst and best configurations. Fill balance, pressure drop, part dimensions, color change, energy consumption, and process windows were evaluated to determine the optimal performance. Here's what was found:

Could an optimized melt distribution system help an average molder become a world-class molder?

Injection Pressure vs. Injection Time: Ideally, a part should be injected with as little pressure as possible, as that reduces clamp tonnage, machinery stress, mold wear, energy consumption, molded-in stresses on the part, flash, ejection issues, and other plastic part issues. If the molding workcell has insufficient injection pressure or if the resistance to fill the part is too high to make a good part, a variety of defects such as sinks, warpage, short shots and dimensional variation can occur. Each of these defects could cause significant quality and uptime issues, which would reduce the overall OEE of the workcell.

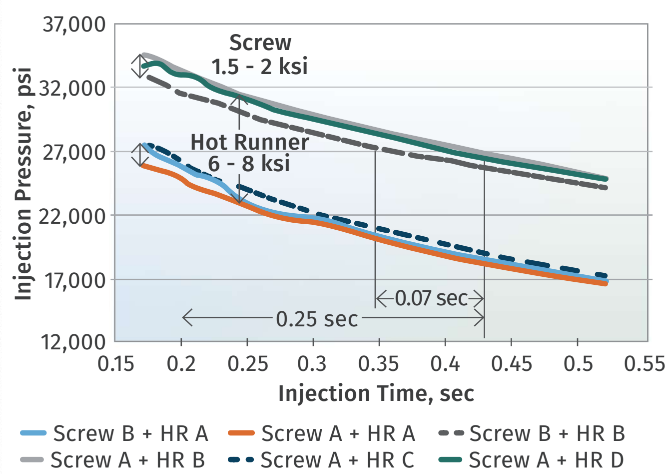
The pellet-to-gate system can have a major impact on the required injection pressure to make a good part (Fig. 2). The hot-runner layout impacted the required fill pressures by up to 6000 psi (41 MPa), or 30% to 40%. Channel sizes were the major factor determining the required injection pressure to produce an acceptable

FIG 1 Four Hot-Runner Designs



An experimental test of the influence of various elements of the melt-distribution system on processing and part uniformity used four different hot-runner designs, including two each with larger and smaller melt channels.

FIG 2 Injection Pressure vs. Injection Time



Hot-runner layout impacted the required fill pressures by up to 6000 psi, or 30-40%. Channel sizes were the major factor. Also, an unbalanced hot-runner system required 10-15% extra pressure to fill out all the parts. Screw design additionally impacted injection pressures by up to 2000 psi or 6-8% of the total fill-pressure requirement.

part. The balance of fill was also found to have a significant effect on the required injection pressure. An unbalanced hot-runner system required 10% to 15% extra pressure to fill out all the parts. Screw design additionally impacted injection pressures by up to 2000 psi (14 MPa) or 6% to 8% of the total fill-pressure requirement.

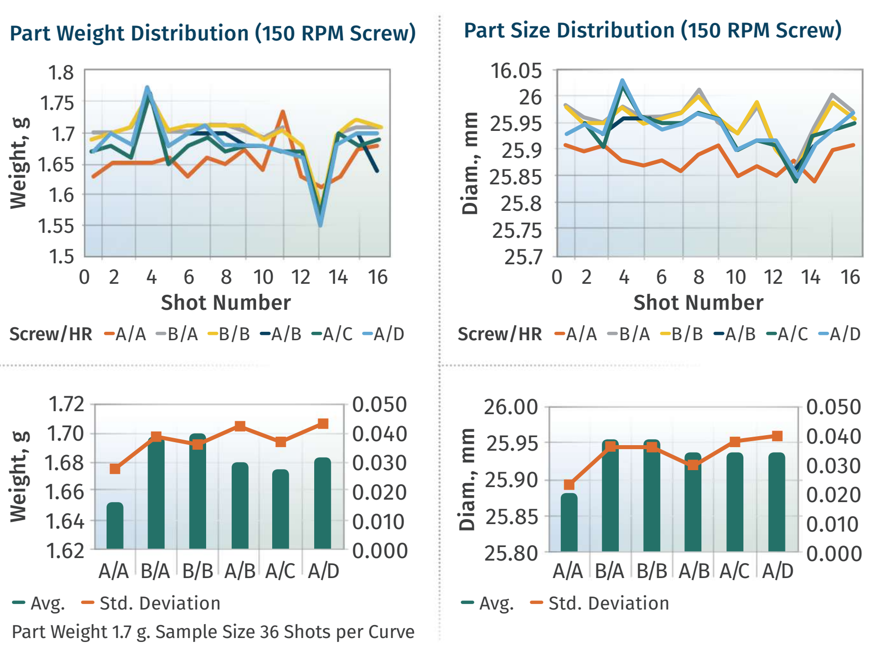
Together, an optimized screw and hot-runner design could reduce required injection pressures by almost 50%. On an overall basis, the most optimized melt-distribution and control system reduced injection time by 0.25 sec. This equates to more than a 3% improvement in OEE and almost 6 million additional parts a year.

Frequently, each of the elements in the flow path is optimized independently; as a result, they could be sub-optimized for the system's performance.

Fill Balance: One of the main objectives of the melt-delivery system is to deliver molten plastic in an identical rheological condition to each cavity in the mold. A well-balanced mold runs a faster cycle, higher uptimes and more uniform parts. The degree of balance is typically determined by molding a statistically significant series of short shots (80% to 90% filled) and measuring the part-weight variation between the molded parts. The smaller the part-weight variation, the better the balance.

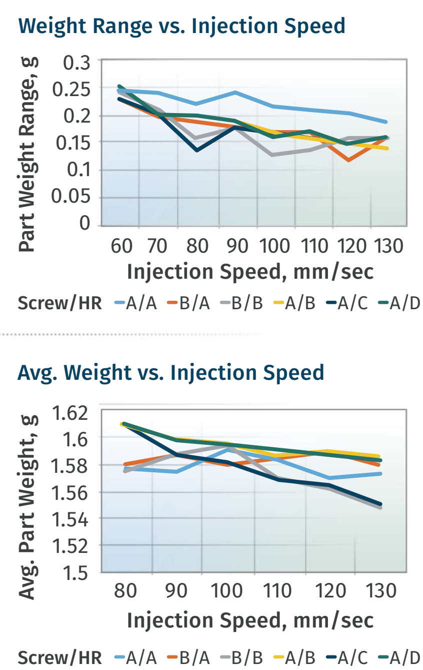
In this experiment, two screw designs and four hot-runner designs were evaluated to find the best hardware configuration for fill balance. The best combination of screw and hot runner could improve fill balance by 17% over the worst combination (Fig. 3). Improved fill balance was also shown to reduce average part weight 0.05 g and reduce part-size variation by 0.1 mm. The barrier-type screw produced parts with higher part-weight variation and higher average part weights. Typically, the hot runner is the singular focus to resolve fill-balance issues, but it can be seen in this test that the screw has a meaningful impact on fill balance, regardless of the hot-runner configuration. In terms of the hot runner, the design with the largest channels and the smoothest rounded corners resulted in the best fill balance. This is because the flow of molten plastic in a runner channel is laminar. The material nearest the walls of the melt channels experiences more shear than the material that flows in the center of the channel. When the plastic rounds a sharp corner, even more shear and momentum loss occurs. A 3% to 5% improvement in OEE could be achieved with the most optimal combination of equipment configuration.

FIG 3 Fill-Balance Impacts of Screw & Hot-Runner Design



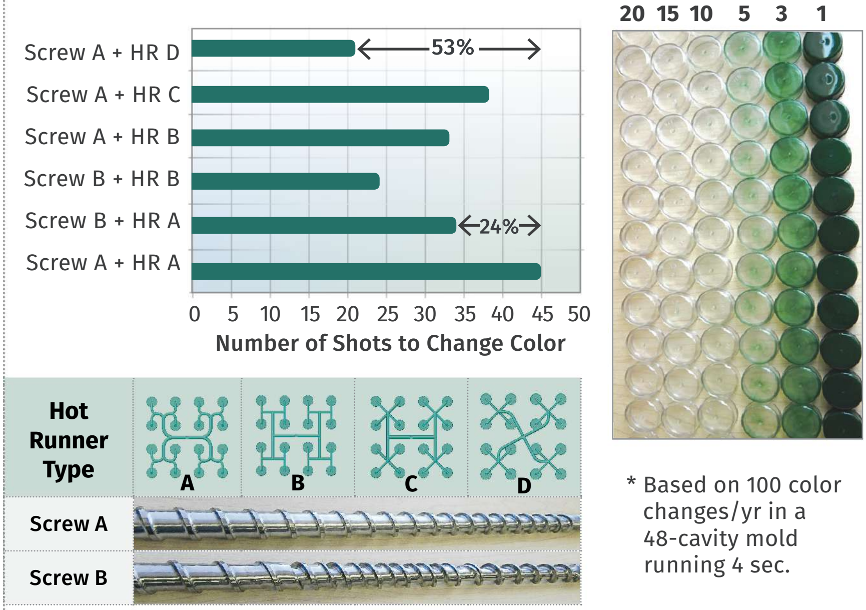
The best combination of screw and hot runner improved fill balance by 17% over the worst combination. Improved fill balance reduced average part weight 0.05 g and reduced part-size variation by 0.1 mm. The hot runner with the largest channels and the smoothest rounded corners resulted in the best fill balance. Also, the barrier screw produced parts with higher part-weight variation and higher average part weights. Typically, the hot runner is the singular focus to resolve fill-balance issues, but this test shows that the screw itself has a meaningful impact on fill balance.

FIG 4 Fill-Balance Impact of Injection Speed



As injection speed increased, part weight decreased and weight range also decreased. A hot-runner design that reduces pressure drop helps take optimum advantage of injection speed.

FIG 5 Dark-to-Natural Color Change

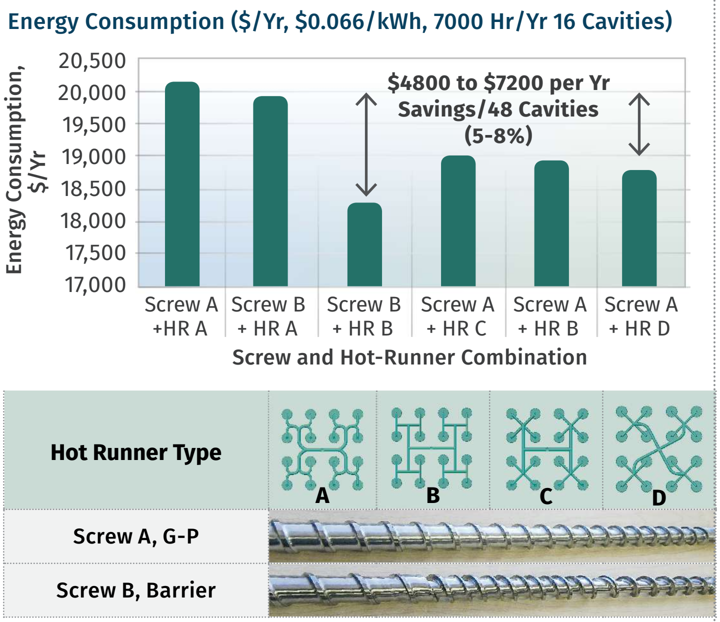


Screw B exhibited a 24% improved color-change time compared with screw A, mostly due to reduced channel depths and higher compression ratio. Hot-runner configuration D performed best, as it has small runner sizes and a contoured channel layout. It is well established that color-change times can be enhanced with higher shear rates (smaller channel and flight depths), as this reduces the residence time of the plastic nearest the barrel and melt-channel walls.

Part Weight vs. Injection Speed: Any reduced variation in part weight improves the performance of a multi-cavity injection molding workcell. It can be seen Fig. 4 that as injection speed increased, part weight decreased and weight range also decreased. In order to take advantage of this phenomenon, the system must have a lower pressure drop and an equal fill balance. So if the fill balance and pressure drop in the hot-runner system is optimized, it provides an opportunity to further improve the part cost via lower part weights and faster cycles.

Color Change: The fastest color change can be achieved with hot-runner configuration D and screw design B, although this combination was not tried together (Fig. 5). Screw B exhibited a 24% improved color-change time compared with screw A, mostly due to reduced channel depths and higher compression ratio. Hot-runner configuration D performed best, as it has ►

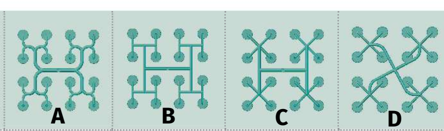
FIG 6 Energy-Consumption Impact of Screw & Hot Runner



A properly designed melt system is also the most efficient from an energy standpoint. Experimental results showed that a molder could save between $4800 to $7200 per year on a 48-cavity mold of this configuration by using screw design B and hot-runner design B. This represents a 5% to 8% improvement in the required energy.

TABLE 2 Overview of Performance (Non-Weighted)

Values Indicate Relative Impact – Higher Values Indicate a More Positive Impact



Hot Runner Type	A	B	C	D
Screw A, G-P				
Energy	1	3	3	3
Color Change	1	3	2	5
Thermal Stability	2	3	3	3
Fill Balance	3	1.5	2.5	3
Pressure Drop	5	3	3	2
Process Window	5	2	3	4
Total	**17**	**15.5**	**16.5**	**20**
Screw B, Barrier				
Energy	1	5	(Amorphous PC: SABIC Lexan LS2)	
Color Change	3	3		
Thermal Stability	1	1		
Fill Balance	2	1		
Pressure Drop	5	4		
Process Window	4	1		
Total	16	15		

small runner sizes and a contoured channel layout.

It is well established that color-change times can be enhanced with higher shear rates (smaller channel and flight depths), as this reduces the residence time of the plastic nearest the barrel and melt-channel walls. The contoured melt-channel path and the lack of a barrier section in the screw are also important for short color-change times, as the smooth paths reduce locations where the old color can hang up. Overall, any geometry that promotes "washing out" the previous color will reduce the time it takes to change colors.

Energy Consumption: A properly designed melt system is also the most efficient from an energy standpoint. The experimental results (Fig. 6) show that a molder could save between $4800 and $7200 per year on a 48-cavity mold of this configuration by using screw design B and hot-runner design B. This represents a 5% to 8% improvement in the required energy.

OVERALL SUMMARY OF PERFORMANCE

Table 2 shows the relative performance of each screw and hot-runner combination. Note that no single combination of screw and hot runner was optimal for each variable tested. For instance, the best performing combination for pressure drop was not the best solution for optimal color change or energy consumption. This is why a molder may settle for a "general" solution that has a balance of good results versus a best result for their particular case. However, the molder should carefully weigh the costs of optimization versus the net benefit it creates. Even a couple of percentage-points improvement in OEE can easily justify the cost of a new hot runner or screw and barrel.

THE KEYS TO EFFECTIVE MELT MANAGEMENT

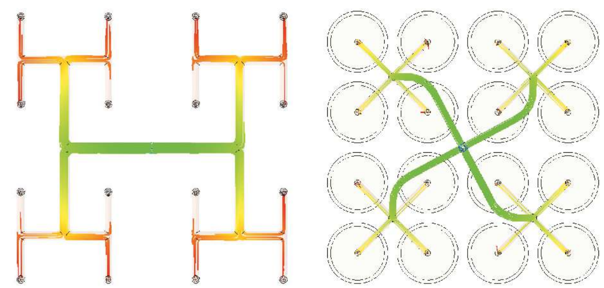
1. Know the pellets. The first and foremost consideration in optimizing a melt-distribution system is to know the resin you are processing. Each type and specific grade of resin has different characteristics and the system design must take these into consideration for optimal performance. Designing the hardware to match the needs of the plastic is the first and foremost requirement in optimization.

2. System thinking versus equipment thinking. The process of melting the plastic and conveying it to the gate of the mold is a complex interaction of the resin, dryers, loaders, color or additive mixing, injection molding machine, and hot runner. All these parts of the process interact and depend on one another for optimization. Typically, each element is optimized in isolation from the others and, as such, a sub-optimized system is created.

3. Plasticating. The process of creating a homogenous melt and injecting it into the hot runner is a key to being a world-class molder. The screw configuration has a major impact on melt homogeneity, which is closely related to repeating weight precision and melt-temperature uniformity. Type B screws exhibited poorer temperature homogeneity and larger temperature fluctuations than the Type A screw when molding this grade of PC resin. The high viscosity of this grade led to a high dependence of homogeneity on screw geometry. The level of homogeneity that is created in the screw is carried into the hot runner and the mold. As the old saying goes, "Garbage in produces garbage out," so creating a good melt is critical.

4. Screw tip to hot-runner inlet. Although it seems like an obvious fact, the interface between the hot runner and the injection unit must match in size and contact radius. Any mismatch in alignment or size can cause flow restrictions, hang-up spots and pressure loss. Any of these, in turn or together, can reduce OEE via slower cycles, increased scrap or greater downtime.

FIG 7 FEA Particle Tracers



Hot Runner B   Hot Runner BD

FEA particle trace shows that two apparently balanced hot runners yield quite different fill balances. The colors represent melt particles having the same residence time in the melt stream. The single level H-style manifold creates non-uniform shearing in the hot runner, resulting in unbalanced fill. The X-style melt-channel path creates a much more even shearing profile and resulting filling pattern.

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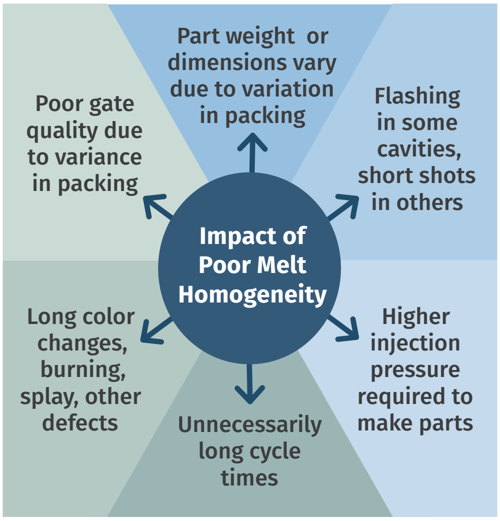
FIG 8 Overall Melt-Homogeneity Impact



Benefits of Pellet-to-Gate Melt-Delivery Optimization:

- Improved Precision
- Reduced Reject Rates
- Uniform Filling of Cavities
- Less Part-Weight Variation and Lower Average Weight
- Shorter Cycle Times
- Improved Part Quality
- Lower Energy Consumption
- **Lower Part Cost**

Summary of impacts of melt homogeneity on productivity, quality and economics.

TABLE 3 Average to Great: A few % Matters (Best Values Boldfaced)

	Baseline	Faster Cycle	Lighter Parts	Greater Uptime	Energy Efficient	All
Cycle, sec	6.5	**6.1**	6.5	6.5	6.5	**6.1**
Weight, g	1.75	1.75	**1.70**	1.75	1.75	**1.70**
Uptime, %	90	90	90	**91**	**90**	**95**
Yield, %	96	96	96	**97**	**96**	**98**
Energy Use, Relative	1.0	1.0	1.0	1.0	0.93	**0.93**
Annual Impact		9 MM Parts	$17,000	6.4 MM Parts	$2600	**6% Higher OEE**

48-Cavity Mold; PP @ 50¢/Lb; 300-Ton Servo-Hydraulic Machine; Conversion Cost: $100/Hr; Run Hrs: 7000/Yr

5. Hot Runner. The task of the hot-runner system is to convey the melt to each of the mold cavities in precisely the same state in which it left the barrel/nozzle. The hot-runner system is not able to adjust any melt inhomogeneity. If a hot-runner system is not correctly designed or manufactured, it may cause disruption to production and flaws in parts. A hot-runner system requires uniform temperature distribution along the flow path, minimum possible pressure drop, no hang-up spots, and moderate shear rates. An unbalanced layout of the hot-runner melt channels can lead to many problems in the parts. As can be seen from the 3D particle-tracer images in Fig. 7, two seemingly balanced hot-runner channels can produce different results. The single level H-style manifold creates preferential shearing in the hot runner, which in turn can create problems in the molded parts. Conversely, the hot runner with an X-style melt-channel path creates a much more even shearing profile and resulting filling pattern.

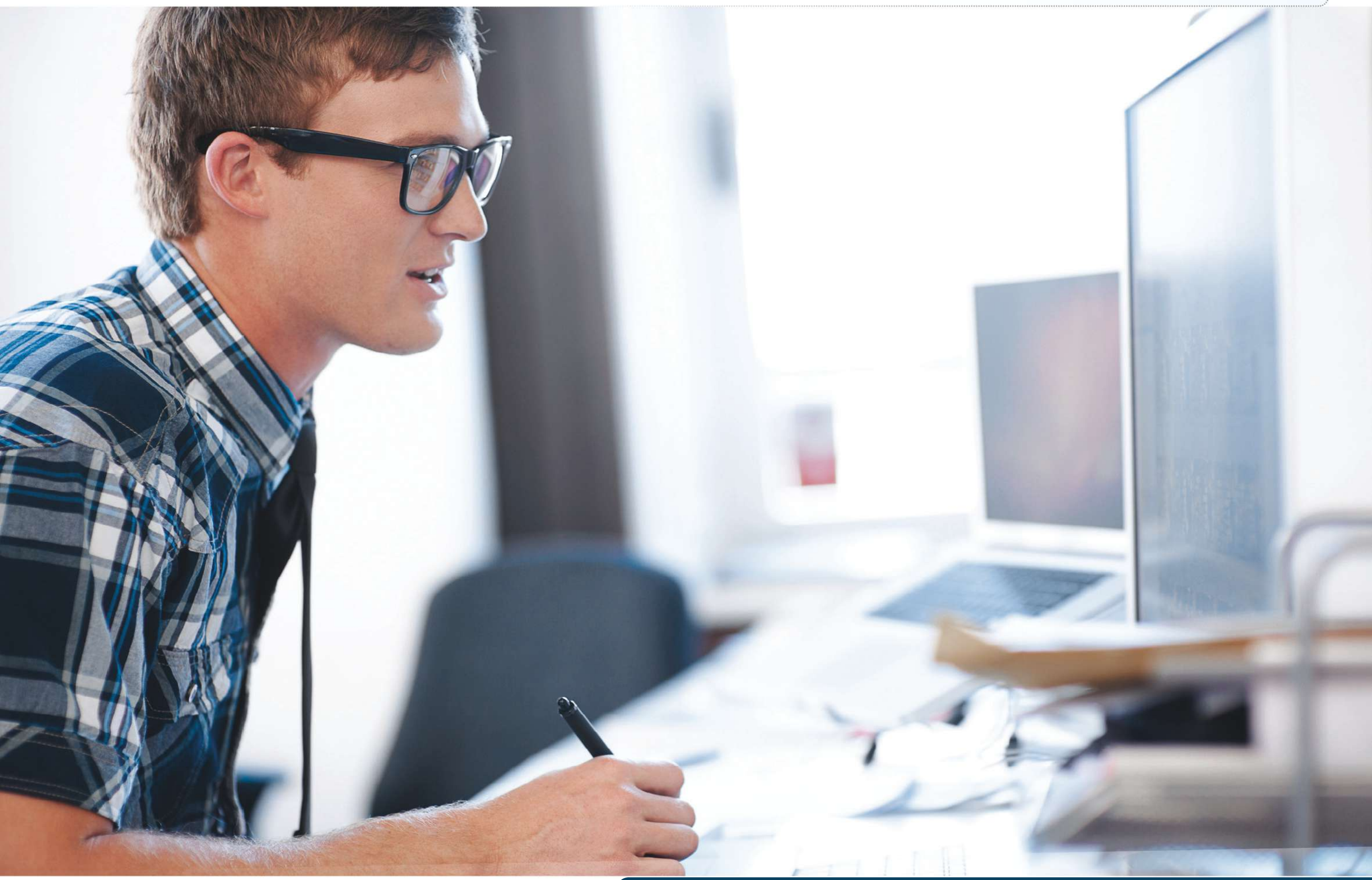
The overall message here is that the screw and hot runner act in conjunction with one another to manage and control melt creation and distribution in the injection molding process. If either the screw or the hot runner is poorly designed, the other element cannot function properly. Failure to optimize the interaction between the screw and hot runner can cause significant problems, resulting in reduced quality, yields and profits.

As in many things, the chain is only as strong as its weakest link. The same can be said of the melt-distribution system. An optimized solution from the pellet to the gate has a material and meaningful benefit to the molder.

The first and foremost consideration in optimizing a melt-distribution system is to know the resin you are processing.

The difference between average and optimal is material to profitability. Variations in dimensions, part weight, balance, gate quality, recovery, and color change can easily make a 1% difference in the system output—scrap, uptime, color change, cycle time (Fig. 8). In this experimental example, a molder could improve its OEE by 6% simply by optimizing the melt-distribution system. With a 48-cavity PP cap mold based on this experimental design (Table 3), running 0.4 sec faster than baseline could mean 9 million more parts/yr. Saving 0.05 g in part weight could save $17,000 in material cost alone. And only 1% greater uptime could yield 6.5 million more parts/yr. Clearly, retrofitting your existing melt-distribution system is worth considering, as the payback for the new components is in many cases only a matter of a few months, and is meaningful and lasting.

ABOUT THE AUTHOR: Bruce Catoen has held the role of Chief Technology Officer for Milacron since 2014 and has worked in a variety of senior leadership roles at Mold-Masters and Husky since 1988. Bruce is the named inventor on 52 patents. He co-authored the book *Selecting Injection Molds* (2007) and has published numerous papers in trade journals and presented at many technical symposiums.



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PRIMARY TOPICS:

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- Material challenges in given applications
- Suggestions to improve conveying for challenging materials

PRESENTER

S. Michael May
Director of Dense Phase Technology

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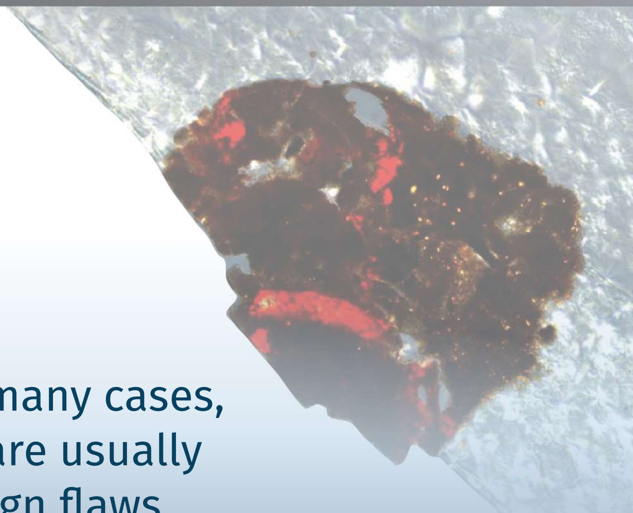
S. Michael May is Director of Dense Phase Technology at Coperion K-Tron, located in Salina, Kansas. He has 20 years of pneumatic conveying and dust collection experience in the mineral, chemical, mining, cement, food and rubber industries, doing everything from selling, sizing, managing, start-ups and service. This experience has given Mike a great deal of knowledge with a large number of materials and processes.

Reducing Low-Level Background Gels in PE Film



While considered acceptable in many cases, they need not be tolerated and are usually attributable to minor screw-design flaws. Here's some advice on what to do about them.

By Mark A. Spalding, Xiaofei Sun, Eddy I. Garcia-Meitin, and Stephen L. Kodjie
The Dow Chemical Company
Gregory A. Campbell,
Clarkson University/ Castle Associates
Timothy W. Womer
TWWomer and Associates LLC

Many polyethylene (PE) film products have a low level of background gels that are considered acceptable for most end users and applications. These gels, however, do not have to be accepted. They exist due to minor design errors in the screw. Screw-design techniques are available that can reduce the occurrence of this type of gel.

The term "gel" refers to any small defect that distorts a film. The low-level background gels at issue here typically do not alarm the quality-control managers in the plant, and as such the film is considered "prime."

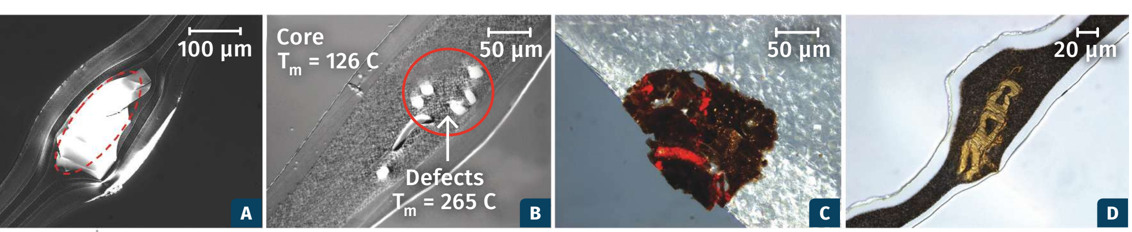


FIG 1 **Photomicrographs of contaminants in film products: a) hard carbon speck from maleic anhydride plate-out; b) polyester contaminant; c) iron oxide particle; and d) a fiber.**

There are many types of gels; these are the most common:

1) Highly oxidized polymeric materials that appear as brittle black specks;
2) Polymers that are crosslinked via an oxidative process;
3) Highly entangled polymeric material that is undispersed but not crosslinked (unmixed);
4) Unmelted resin or solid polymer fragments;
5) Filler agglomerates from masterbatches;
6) A different type of resin or contaminant such as metal, wood, cloth fibers, insects or dirt.

The two types of gels that are the focus of this article are low levels of crosslinked gels and unmixed gels. A crosslinked resin gel is typically formed during an oxidation process, resulting in crosslinking of the resin chains and generation of discolored gels. Highly entangled gels are typically high-molecular-weight polymer chains that are entangled and thus are difficult to disperse during the extrusion process. When analyzed using a hot-stage microscope, the highly entangled gel type will melt as the stage temperature is increased. When the stage temperature is then decreased, the gel will recrystallize, creating the appearance of a gel as a solid polymer fragment. If the gel is exposed to a shear stress right after melting, the stress will often disentangle the chains such that they will not reform when cooled. Since these gels are not oxidized, they are not associated with color. They are commonly referred to as undispersed or unmixed gels.

Troubleshooting PE film extrusion processes where gels are appearing can be difficult due to the number of different types of gels. Because gels can originate from numerous sources, the troubleshooter must be able to identify the characteristics of the gel and recognize the likely source. Process changes must then be performed to mitigate the gel defects.

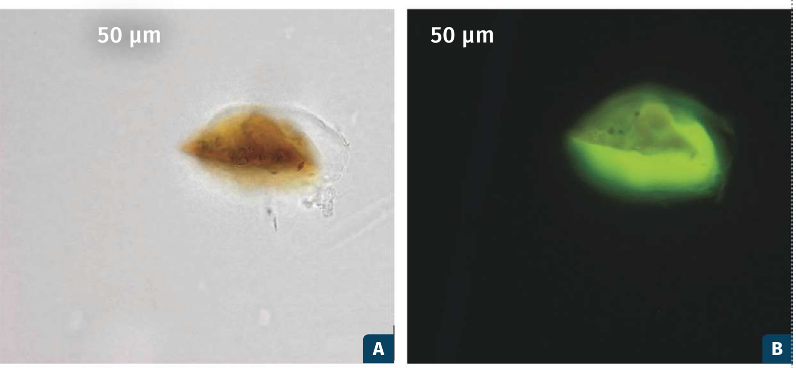


FIG 2 Photomicrographs of gels that originated from stagnant regions of the screw, such as from Moffat eddies: a) a bright-field photograph, and b) the same gel photographed using epi-fluorescence illumination, indicating that the gel is highly oxidized.

GELS THAT OCCUR DUE TO 'MOFFAT EDDIES'

Many PE film processes exhibit a low and continuous level of gels. These are typically oxidized and crosslinked PE material. They occur as black specks and brown soft gels. The gels typically originate from regions of the screw that were stagnant, allowing the resin to have long residence times such that it will degrade. Photomicrographs of these types of gels are shown in Fig. 2. Typical gel sizes range from 50 to 250 microns.

Troubleshooting PE film extrusion processes where gels are appearing can be difficult due to the number of different types of gels.

The most common source of these background gels is stagnant regions at the flight radii. The stagnant regions occur because of the formation of "Moffat eddies" that are due to small flight radii. A photograph of a screw with degraded resin at the flight radii is shown in Fig. 3. This degraded material will slowly separate from the screw and contribute to a constant and low level of gels in the film product. The resin will be in the Moffat eddies for extended periods of time, such that antioxidants cannot prevent the degradation.

Moffat eddies are recirculations or vortices that occur at sharp corners, as shown in Fig. 4. That is, when fluid is put in motion with top-driven cavity flow, flow circulation is generated in the channel as shown in Fig. 4. A secondary circulation also develops in the corners of the channel, creating a low-velocity helical eddy that is outside the high-velocity flows of the main part of the channel.

The Moffat eddies that create the degraded resin occur because the flight radii are too small for the depth of the channel. If the flight radii were larger, the Moffat eddies and consequent resin degradation would not occur. Flight radii sizes are shown in Fig. 5. Flight radii that are 1.5 times larger than the local channel depth are recommended for PE resins.

POORLY DESIGNED MADDOCK MIXERS

Poorly designed Maddock mixers are sources for two types of gels that can appear at a low and continuous level. The gel types include thermally oxidized gels, as shown in Fig. 2, and unmixed gels. As stated previously, unmixed gels are highly entangled species that are molten when they are discharged from the die, but solidify first upon cooling to produce a gel that appears as a solid polymer fragment. Photomicrographs of an unmixed gel going through the heating and stressing process are shown in Fig. 6.

Unmixed gels can be easily removed from an extrusion process by subjecting all molten resin to a one-time high level of stress near the discharge of the extrusion screw. This stress is easily applied using a Maddock-style mixer with a relatively tight clearance on the mixing flight. A schematic of a Maddock-style mixer is shown in Fig. 7. The mixer is designed with pairs of inflow flutes and outflow flutes and a mixing flight with a narrow restriction. The resin flows into the inflow flute. Next, the flow is passed through the narrow restriction created by the mixing flight and the barrel wall. This ►

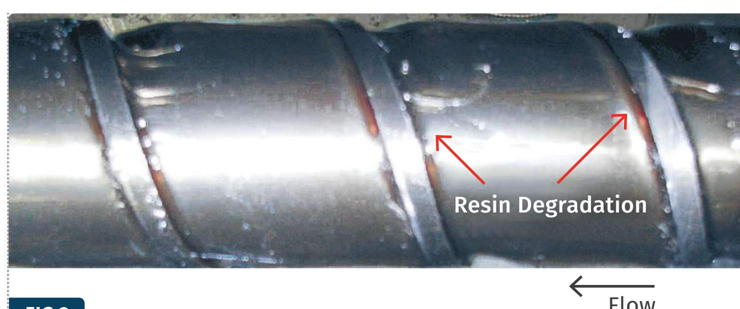


FIG 3 Shown here is degradation at the pushing and trailing flights of a screw running LLDPE.

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narrow restriction will disentangle unmixed gels and trap, melt and disperse solid polymer fragments from the upstream melting section. The flow is then passed to the outflow flute and to the downstream sections of the screw.

The unmixed gels are removed from the extrudate by increasing the stress level in the Maddock mixer. The stress level is increased by decreasing the clearance on the mixing flight. The stress level required to disperse unmixed gels depends on the resin and the level of chain entanglement. In past experience, the stress level required to disperse PE unmixed gels is about 100 to 200 kPa. The shear stress that the material experiences for flow across the mixing flight of the Maddock mixer can be estimated using Equations 1 and 2. The shear stress is responsible for breaking up the entangled species. This calculation is based on screw rotation physics.

Equation 1: $$\dot{\gamma}_M = \frac{\pi(D_b - 2u - 2\lambda)N}{(u+\lambda)}$$

Equation 2: $$\tau_M = \eta\dot{\gamma}_M$$

$\dot{\gamma}_M$ is the average shear rate for flow over the mixing flight in 1/sec.
N is the screw rotation rate in revolutions/sec.
η is the shear viscosity at the temperature and shear rate of the mixing process.
D_b is the barrel diameter.
u is the undercut distance on the mixing flight.
λ is the main flight clearance.
τ_M is the shear stress that the material will experience in flow over the mixing flight.

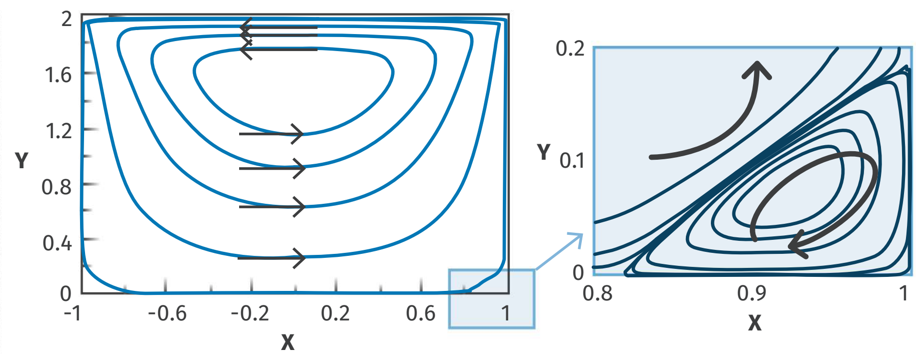


FIG 4 Two-dimensional flows in a screw channel with H/W = 1 (channel depth/channel width). The arrows show the recirculation flows. The shaded area in the lower right corner is expanded to show the Moffat eddy. The main flow is out of the plane towards the reader.

The preferred Maddock mixer design is a typical configuration except for two features. These include setting the mixing flight undercut to about 0.5% of the screw diameter. Most designs set this undercut at 1 to 1.5% of the diameter. The small undercut specified here will disentangle unmixed gels and trap and disperse all solid polymer fragments that happen to flow out of the melting section. A larger undercut of 1 to 1.5% of the diameter can allow unmixed gels and solid polymer fragments to discharge from the extruder.

Poorly designed Maddock mixers are sources for two types of gels that can appear at a low and continuous level.

The second different feature of the Maddock mixer recommended here is that the depth of the inflow and outflow flutes should be half the width of the flute. If the flutes are made deeper, resin degradation can occur, creating gels in the film product. Maddock mixers with extremely deep flutes and large clearances on the mixing flights are common in smooth-bore extruder designs. In poor designs, the flutes are improperly made too deep in order to reduce pressure consumption in the device. These poor designs will cause resin to degrade at the flute edges, resulting in a low level of gels that contaminate the film product.

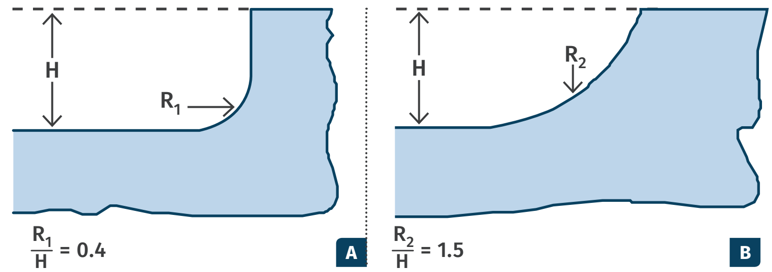


FIG 5 Schematic of small (R_1) and large (R_2) flight radii: a) This small flight radius will likely create a Moffat eddy and lead to degradation of the PE; b) This large radius will likely not create a Moffat eddy.

WHERE DEGRADATION OCCURS ON THE SCREW

If the gel analysis indicates that the defects are due to degraded resin, then the best way to locate the region on the screw where ►

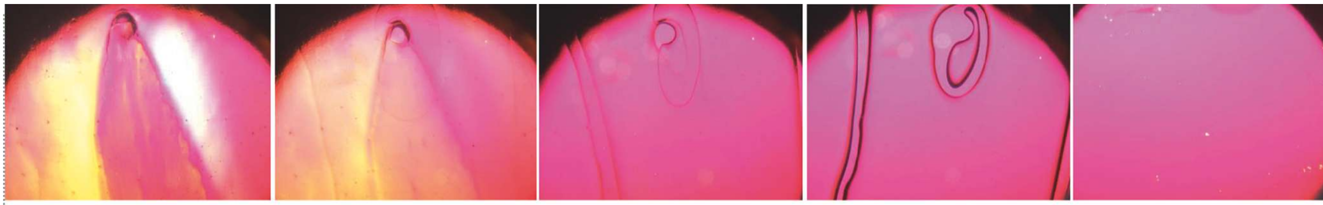
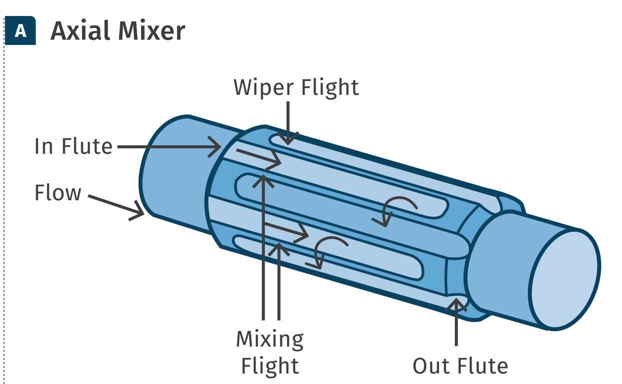


FIG 6 Photographs of an unmixed gel at select temperatures using a hot-stage microscope. The unmixed gel melted at about 135 C. When the gel was smeared by moving the glass cover slip, the stress was enough to disentangle the polymer chains such that the gel would not reappear upon cooling.



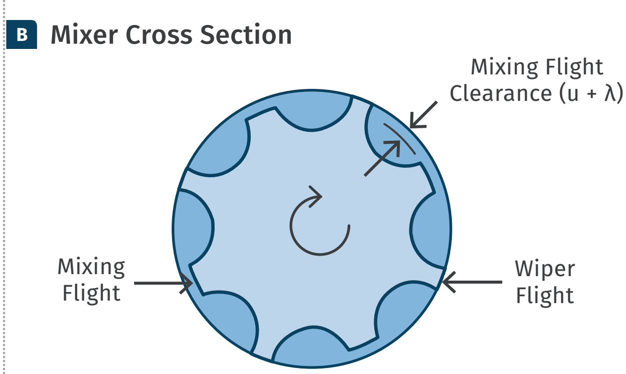


FIG 7 Schematic of a Maddock-style mixer.

the degradation is occurring is to remove the screw from the extruder while hot. For this procedure, pellet flow to the hopper is stopped while screw rotation is continued. The screw is rotated until resin flow out of the die stops. Next, screw rotation is stopped and the transfer line is removed from the discharge end of the extruder. The hot screw should be pushed out about three diameters and then photographed and studied for indications of resin degradation. The metal surfaces should appear clean with only mild discoloration. If a stagnant region exists, then dark colored, degraded material will occupy the space.

> ***The trouble-shooter must be able to identify the character-istics of the gel and recognize the likely source.***

Once the segment is studied and photographed, the hot resin should be removed from the screw using brass tools. Another three diameters are then pushed out and the process is repeated. If the process is running a natural resin and a colored masterbatch, the extruder should be first purged with the natural resin until the extrudate is essentially free of colorant. The screw shown in Fig. 3 was removed from the extruder using this technique.

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Gregory A. Campbell is president and chief technical officer at Castle Associates, Jonesport, Me., where he consults on extrusion and polymer processing issues. He taught chemical engineering for 24 years at Clarkson University in Potsdam, N.Y., where he also served as chair of the Chemical Engineering Dept., Dean of Engineering, and University Chief Information Officer.

Timothy Womer is a recognized authority in plastics processing and machinery with a career spanning more than 40 years. He has designed thousands of screws for all types of single-screw plasticating. He now runs his own consulting company, TWWomer & Associates LLC. Contact: *(724) 355-3311*; *tim@twwomer.com*; *twwomer.com*.

MATERIALS AND ADDITIVES AT NPE2018

News in Materials & Additives

Here's more news in engineering resins, TPEs, bioplastics, polyolefin film grades, PVC, and a range of additives from the Big Show not reported in all our other previous coverage.

SABIC's Thermocomp HMD-D boasts a combination of high modulus and ductility for lighter, thinner and stronger parts.

NPE2018 yielded lots of news in materials and additives. While most of it was reported in our April, May, and June issues, there's still more to report. New developments in engineering resins and customized TPEs reflect trends toward electric and autonomous vehicles. Other new materials include bioplastics, polyolefin film materials for packaging, and novel PVC formulations. There are also new additives ranging from unique functional additives for barrier to a novel conductive additive.

Like others with a focus on mobility trends, Lanxess has new lightweighting materials and technologies that help to extend the range of electric vehicles.

A RANGE OF ENGINEERED PLASTICS

A new series of PC compounds for structural components was unveiled by SABIC (*sabic.com*). Thermocomp HMD-D comprises six grades of glass-reinforced PC said to deliver a unique combination of stiffness and ductility to enable lighter, thinner, stronger parts. Metal-replacement applications range from smartphone cases to medical-device housings and mass-transit interior panels.

Ascend Performance Materials (*ascendmaterials.com*), discussed new nylon 66 copolymers for films in food (e,g., meat and bones) and industrial packaging (e.g., aircraft parts) that are said to combine clarity and better puncture resistance than nylons 6 and 66. They are also being explored as the inside layer of 3-5 layer HDPE resin pellet bags for improved strength that would allow downgauging.

New nylons were also highlighted by Lanxess (*lanxess.com*), adding to several others on which we have previously reported. A key focus was on a new heat-stabilization system, XTS2 (Xtreme Temperature Stabilization) for nylon 66. This system is reportedly able to withstand long-term temperatures of up to 446 F (230 C), providing an alternative to more costly high-heat specialty thermoplastics like fully or semi-aromatic nylons or PPS.

The first grade from the STS2 range is Durethan AKV35XTS2 with 35% glass, which boasts considerably better long-term heat aging than nylon 66 with a standard copper-based stabilizer. The new nylon boasts enhanced flow, which improves surface quality and filling of complex geometries and thin walls. It is designed for auto engine applications that are exposed to unusually high temperatures, such as air-intake manifolds with integrated charge-air coolers or air pipes located near the turbocharger.

Radici Group (*radicigroup.com*) also has developed glass-reinforced nylon 66 grades for automotive that can withstand temperatures up to 410 F (210 C). To support increasing demand for electric vehicles, Radici has developed flame-retardant blends of nylons 6 and 66 for recharge sockets and battery housings and cell covers.

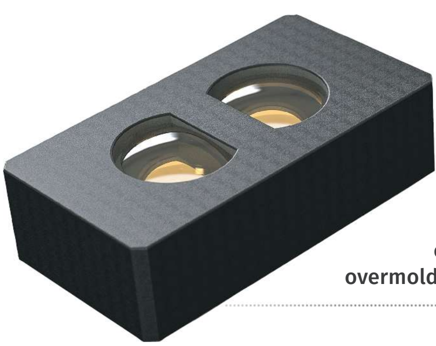
Also aimed at new mobility options are new thermoplastics from SABIC. Among them is a new high-heat, high-energy-density dielectric material, Ultem UTF120 PEI film, in 5-10 micron thicknesses. It is used to produce lightweight auxiliary capacitors that can help offset the weight of battery packs in electric vehicles. Another example is new Noryl NHP5054, an enhanced flame-retardant, glass-filled PPE that achieves a UL 94V-0 rating at 0.75 mm for structural components like battery-pack housing assemblies.

Ascend's new nylon 66 copolymers for food and industrial packaging reportedly have both better clarity and puncture resistance than nylons 6 and 66.

SABIC also showcased what it calls a major breakthrough in production of infrared optical sensor lenses for proximity sensing and gesture recognition in smartphones, video-game controllers, and drones, using its Extem thermoplastic polyimide (TPI). It sports high thermal dimensional stability with a Tg of 512 F (267 C). Other similar resins are either not melt processable or cannot be injection molded. High-volume micromolding of Extem is said to deliver numerous advantages over grinding and polishing of quartz glass and curing of epoxy resin—speed, consistently high quality, and avoidance of costly secondary operations. SABIC showed lenses made of Extem TPI overmolded with nylon 12.

MORE CUSTOMIZED TPES

An extended family of nylon-based TPEs, also known as polyether-block-amides (PEBA), was showcased by Nylon Corp. of America (NYCOA; ***nycoa.net***). With lower specific gravity than TPUs, they are aimed at applications in automotive, sporting goods, personal electronics, composites, and specialty films, the Ny-Flex elastomer range is available in hardnesses from 82 Shore D to 90 A. They are said to exhibit excellent flexibility at low temperature, superior retention of properties at elevated temperature, and exceptional toughness and resilience. High creep resistance, strong resistance to flex fatigue, good abrasion resistance, and superior resistance to grease, oils, and solvents are also claimed.



IR optical sensor lenses for proximity sensing and gesture recognition have been made of Extem TPI and overmolded with nylon 12.

Lubrizol Corp. (*lubrizol.com*) showcased new products such as Estane TPU for 3D printing and Pearlthane Eco TPU, with up to 46% bio-based-content, lower density, and improved low-temperature flexibility for highly flexible films or soft-touch injection molded parts. Also new is Estane VSN self-healing TPU, with unique ability to heal minor scratches in consumer products such as high-end eyewear; and Estane ALR TPU for paint protection and graphics wraps on commercial trucks. Compatible with adhesives and topcoats, it is invisible and boasts self-healing and both impact and weather resistance.

BIOPLASTICS HIGHLIGHTS

Working with Electrolux and another OEM, NatureWorks (*natureoworksllc.com*) showcased newly developed refrigerator liners based on PLA to compete with existing HIPS structures. Now in field testing, one approach involves coextruding sheets with an acrylic core and an outside layer of Ingeo PLA, which are then thermoformed. Both layers are impact modified.

Processability and other key performance properties of the new liners appear to be very similar to HIPS and can also replace ABS liners; and they run on existing equipment with some processing modification. Ingeo's resistance to food oils is equivalent to ABS. Cost is expected to be competitive but with opportunities to downgauge further due to Ingeo's higher stiffness. Another approach being explored entails an all-extruded amorphous Ingeo PLA, which turns semicrystalline when thermoformed. Both approaches are patent pending.


NYCOA has extended its range of Ny-Flex PEBA TPEs.

New entrant Total Corbion PLA (***total-corbion.com***) unveiled a novel technology that can create fully stereocomplex PLA—a material with long, regularly interlocking polymer chains that confer higher heat resistance than typical PLA in a broad range of industrial applications, automotive underhood components, aerospace, marine, and appliances. The proprietary technology reportedly enables PLA applications that withstand temperatures close to 392 F (200 C). The company is offering samples of glass-reinforced stereocomplex PLA for testing.

A. Schulman (***aschulman.com***) launched Eco-Flex RTPV, a recycled TPV compound also containing BASF's Ecoflex biodegradable aliphatic copolyester. Schulman is aiming these compounds to replace vulcanized rubber in lawn & garden tires, mud flaps, brake pads and grips for powertools, where they offer easy processability, lower cost, and recycled content.

OTHER MATERIALS NEWS

Also discussed by Schulman was a developmental combination of polyolefin and barrier resins that is being field tested by film extruders to see if it can help reduce the number of layers or eliminate tie layers. Polybatch BAR is said to offer a balanced moisture and oxygen barrier for applications such as food packaging (e.g., liquid pouches, dry goods, fresh produce, perishable foods); agricultural films that allow processors to "dial in" the degree of permeability; and dry powders, chemicals and fertilizers.


Improved processability combined with extreme film toughness and sealing properties for high-performance coextrusion are claimed for ExxonMobil's new Exceed XP grade.

ExxonMobil Chemical (***exxonmobilchemical.com***) added a grade to its Exceed XP film resins based on advanced catalyst technology and process research. New XP 8784 offers improved processability plus extreme film toughness and sealing properties for high-performance coextrusion films used in laminated sacks, freezer films, barrier packaging and sachets.

PolyOne's Geon PVC business (***polyone.com***) has developed metallic-appearance PVC for appliance consoles and is also focused on new applications including LED lighting in which the body, lens, and other components are 100% PVC and cost half as much as metal. Extrudable and injection moldable compounds for LEDs are targeted for indoor and landscape lighting.

Americhem (***americhem.com***) discussed its new ValuPak EPVC—an enhanced PVC for decking capstocks with durability that exceeds currently used PVC and HDPE. This fully stabilized PVC compound utilizes new weatherable chemistry that boasts outstanding performance in extreme conditions. It also has an excellent price point compared with ASA or ASA blends, Americhem says.

NEWS IN ADDITIVES

A new family of high-performing lubricants and dispersing agents based on non-food crude rice-bran wax was introduced to North America by Clariant Corp. (*clariant.com*). Tested on automotive parts of PC, nylons and TPU, the new additives have been shown to offer improved mechanical properties and enhanced surface finish at efficient dosage levels compared with lubricants based on Montan wax. Another advantage is the absence of yellowing. Applications in E/E and building/construction are envisioned.

SABIC showcased a 'major breakthrough' in production of IR optical sensor lenses for proximity sensing and gesture recognition in smartphones, video-game controllers, and drones.

Baerlocher USA (*baerlocherusa.com*) highlighted its next-generation Baeropol RST proprietary heat-stabilizer technology for use with recycled materials. Based on metallic stearates, Baeropol 6812 boasts improved properties in post-consumer polyolefins, including better melt stability, hydrolytic stability, polymer color, and antioxidant solubility. Moreover, it can be used as a 1:1 direct replacement for most secondary phosphite antioxidants.

A. Schulman (*ashulman.com*) highlighted its new Polybatch EasyPour functional additive masterbatches, available in most polyolefin carriers and PET, which reportedly improve dispensing of liquids from standup pouches and other packaging designs. They are aimed primarily at institutional and industrial food applications.

Huber Engineered Materials (*hubermaterials.com*) discussed its new Martoxid line of conductive additives based on aluminum oxide and targeted for new mobility trends such as electrification, where it reportedly can outperform other aluminum oxides and other conductive fillers. According to Huber experts, the new Martoxid has been enhanced via control of particle-size distribution and morphology to offer improved packing and density, along

Americhem's enhanced PVC for decking capstocks boasts better durability than currently used PVC or HDPE.

with unique surface treatment. It reportedly can be used at filler loadings over 60% without compromising mechanical or rheological properties. It has shown excellent potential for use in PP, TPO, nylons 6 and 66, ABS, PC and LSRs, as well as thermosets.

Heritage Plastics (*heritage-plastics.com*) demonstrated its Minaflex highly-filled calcium carbonate concentrate that has been shown to produce paper-like substrates via blown film.

Addivant (*addivant.com*) showed a new version of Naugard liquid phosphite antioxidant for applications in foamed TPU and TPO.

QUESTIONS ABOUT NPE2018 OR MATERIALS AND ADDITIVES?

Learn more at PTonline.com

Visit the NPE, Materials, and/or Additives Zones.

Keeping Up With Technology

PRODUCT FOCUS Recycling

RECYCLING/SCRAP RECLAIM

Granulators for Thermoform Scrap

At NPE2018, Rapid Granulator, Leetsdale, Pa., introduced a new range of granulators designed specifically to process skeletal waste in-line from thermoforming lines. The ThermoPRO Series handles sheet widths from 600 to 1500 mm and is available in standard and low-built formats. ThermoPRO machines combine features already proven on other Rapid granulators—double-scissors cutting action; "open-hearted" design for fast production changeovers and ease of maintenance; mineral composite base for high stability and low noise—with new elements that were tailor-made to make thermoforming operations easier to run and more cost-effective.

The ThermoPRO (shown here at NPE with Rapid CEO Bengt Rimark) uses a heavy-duty roller feed as standard, enabling problem-free handling of the skeletal waste. This even makes it possible to run several webs into the granulator at the same time. It also facilitates granulation at the start-up of a thermoforming line, when the parts are not stamped out of the sheet, meaning that the entire web, trim and parts together, needs to be fed into the granulator.

724-584-5220 • rapidgranulator.com

RECYCLING/SCRAP RECLAIM

New Shredder with Non-Wrapping Rotor

Republic Machine, Louisville, Ky., showcased at NPE2018 its modular, split-apart shredder design that allows for stand-up cleaning and maintenance. Republic presented its Zoidal non-wrapping cutter design for the shredders, which is used to break down films and fibers and prevent them from wrapping around the rotor. In addition, Republic Machine is now guaranteeing its single-shaft rotor for life. Republic also has upgraded its open-architecture control system, based on Allen-Bradley's Micrologix 1400 control.

877-637-6778 • republicmachine.com

RECYCLING/SCRAP RECLAIM

Low-Speed, Low-Noise Granulator for Sprues

Three new low-speed granulators were introduced at NPE2018 by Wittmann Battenfeld, Torrington, Conn. Replacing the former Junior and Minor models, the new S-Max 2, S-Max 2 Plus and S-Max 3 are designed for inline, closed-loop recycling of sprues and runners of hard and brittle engineering resins with injection machines of up to 300 tons. The screenless granulators generate material throughputs of 27, 44 or 66 lb/hr, respectively.

Wittmann Battenfeld says its new granulators produce less noise, save more energy, have a more compact footprint, need less maintenance, and provide for easy cleaning and maintenance. They are mounted on casters for mobility. A high-level sensor gives a visual and audible alarm to prevent overfilling of the bin. An interface enables full communication with the injection molding machine. An optional shutdown function saves energy by stopping the granulator automatically when the injection molding machine is turned off.

They also have ARS auto-reversing control, which clears jams by automatically stopping and reversing the rotor.

860-496-9603 • wittmann-group.com

RECYCLING/SCRAP RECLAIM

Auto Sort PET Bottles from Trays

At NPE2018, Tomra Sorting Inc., W. Sacramento, Calif., unveiled the new Sharp Eye technology that separates PET bottles from single-layer PET trays. This enhances the previous capability of Tomra's Autosort machine to separate multilayer trays. The company says this breakthrough is commercially significant because small but critical differences in the chemical properties of PET food trays and PET bottles mean that they must be separated for equivalent-product recycling. Additionally, artificial intelligence embedded in Tomra systems also enables seamless analysis of sorted products, making future plants even smarter.

The key to this innovation is an enhancement of Tomra's Flying Beam sensor technology. As the first near-infrared scan system with point-scanning (eliminating the need for external lamps), this focuses only on the area of the conveyor belt being scanned. Allowing a wide range of calibration possibilities, this can distinguish even the finest molecular differences in materials flowing down the recycling line. Combined with Tomra Sharp Eye technology that introduces a larger lens for higher light intensity, it is possible to detect even the most difficult-to-distinguish properties.

916-388-3900 • tomra.com/recycling

RECYCLING/SCRAP RECLAIM

High-Capacity Machine Produces Fine Powders

Pallmann Industries, Clifton, N.J., showcased at NPE2018 its PLMW Turbo-Finer, a high-capacity size-reduction machine for producing extremely fine powders from soft to medium-hard materials. Material is metered into the Turbofiner, pre-dispersed in the high-turbulence air stream, and evenly distributed at the circumference of the pre-size-reduction zone. The material flows though the vertical grinding chamber of the Turbofiner spirally from below to above, passing through several micro-whirl zones with increasing intensity of the air whirls. The material is reduced in size by impact with the grinding path and with other material particles in the micro whirls occurring behind the beater plates of the high-speed turbo rotor.

973-471-1450 • pallmannindustries.com

TESTING

Melt-Flow Indexer Links Lab, Production Machinery

The LMI5500 Series melt flow indexer from Dynisco, Franklin Park, Mass., boasts a more compact footprint, "ground-breaking accuracy" and a unified software platform between all laboratory and online production equipment. The LMI5500 is said to bring a new level of ease of use with its easy-to-clean, removable inspection plate; increased access for sample cutting (with a mirror to help view the die area); and revamped, intuitive touchscreen. This enables processors to obtain detailed analytics of lab and production data globally on a single dashboard.

Features of the LMI5500 Series, which debuted at NPE2018, include:

- New Windows 10 IoT interface;
- Built-in WiFi, Ethernet and Bluetooth, plus multiple USB ports;
- Direct digital scale USB interface for sample weighing;
- Digital encoder for use in B, A/B, and intrinsic viscosity (IV) correlation.
- Gravitational correction feature takes into account the lab's geographical location.

508-541-9400 • dynisco.com

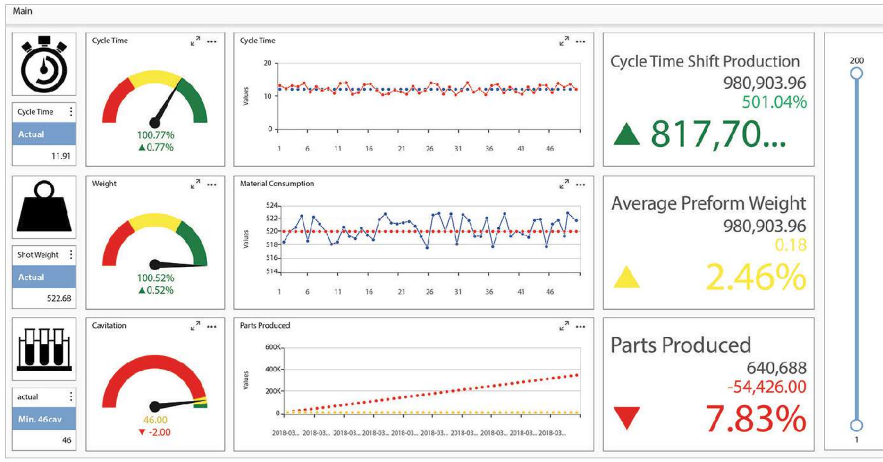
INJECTION MOLDING

Upgraded Process & Production Monitor, New Remote Service App

At NPE2018, Husky Injection Molding Systems, Bolton, Ont., introduced its newly updated Shotscope NX process and production monitor, along with an "augmented reality" app for remote service and trouble-shooting.

The new version of Shotscope NX is a web-based monitoring system that automatically collects information from machines and plants anywhere in the world. It utilizes the OPC-UA communication protocol for interfacing with MES systems. One new feature is a production dashboard that displays cycle time, cavitation, OEE, individual shot-profile graphs, SPC charts, job scheduling, and much more. An unusual element is a real-time calculation of how much resin is being used, based on automated shot-size detection.

Shotscope NX now also allows for remote service access to the system. In a similar vein, Husky showed off a new app for smartphones and tablets that "brings service to the shop floor" without need for a physical visit by a Husky technician. If the customer wears special glasses, the app can utilize augmented-reality technology to allow the remote Husky technician to point to objects of interest or show through gestures how to address a problem. The free app is available on the Apple Store and Google Play.



905-951-5000 • husky.co

MATERIALS HANDLING

Larger Sizes of Economical Loaders

At its 10th anniversary celebration in Austria in June, Wittmann Battenfeld (U.S. office in Torrington, Conn.) presented new, larger models extending its Feedmax basic series of lower-priced central vacuum loaders/receivers. Supplementing the previous models of 3 and 6 liter capacity, the new additions are 15 and 25 L, suitable for higher throughputs of 110 and 220 lb/hr, respectively. These units have a gravity discharge flap with a magnetic contact, whereas the Feedmax plus line has a pneumatic-valve discharge.

These units have a new modular design with quick release. The central part of the chamber is connected to the pedestal by a clamping ring. All parts of the loaders that contact the material are of stainless steel. Flow of pellets into the loader can be optimized by simply twisting the top of the unit. Loading time can be set easily with a potentiometer. Several loaders can be connected and operated jointly by one controller as a small central conveying system.

860-496-9603 • wittmann-group.com

INJECTION MOLDING

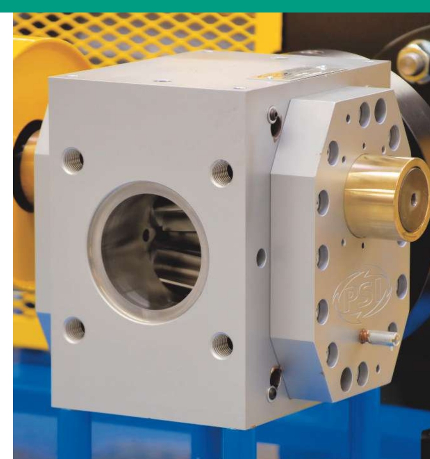
Pre-Assembled Hot Runners, Compact Single Valve Gates

At NPE2018, Mastip Technology, Slinger, Wis., showed two new entries. One is the Nexus pre-assembled and pre-wired systems that are ready to install without need for preheating. The FlowLoc 16, 19 and 27 Series thermal-gate nozzles use a threaded connection to the manifold for a "leak-proof solution." They also feature a copper alloy sleeve with thermocouple embedded near the tip. Those nickel-coated tips can be switched out to run different materials. The nozzles are of 420 stainless steel; titanium nitride coating is available for extra wear resistance. The manifolds, which are all customizable, are available in standard and 420 stainless steel. Lead times range from 15 to 20 days, according to Mastip.

Second, Mastip introduced the pre-assembled VeriShot compact single valve-gate system (pictured), which also acts as a locating ring, ensuring perfect alignment between the mold and machine platens. By housing all the mechanics internally, the new system greatly reduces mold-height requirements, potentially allowing it to run in a smaller press, Mastip says.

VeriShot SVG features Mastip's FlowLoc TX19 and TX27 threaded, leak-proof nozzles and is recommended for applications requiring a highly cosmetic gate finish and fast filling, as well as large parts requiring dimensional accuracy.

262-644-9400 • mastip.com



MATERIALS HANDLING

Small Loaders/Receivers for Medical, Mini Central Vacuum System

Conair Group, Cranberry Twp., Pa., introduced three new products at NPE2018, where "small" is the key descriptive term. First, MedLine ML Series loader and MR Series receivers are small stainless-steel units whose cleanroom-ready design and construction are said to suit them for medical applications on injection machines up to 400 tons. They are designed for bolt-on mounting to Conair MicroWheel dryers or other smaller material hoppers without the need for drilling.

NPE2018 THE PLASTICS SHOW

The ML Series self-contained vacuum loaders have a ⅜-hp vacuum motor and body seals that enable them to convey materials over distances up to 20 ft. The smaller ML-1 loader has throughput of up to 75 lb/hr, while the larger ML-2 loader, with a 5-in.-tall glass extension, handles up to 100 lb/hr. Quick-disconnect lock and hinged motor assembly offer easy access to the loader body and filter assembly during main-

Conair's new MedLine ML Series hopper loader.

tenance or material changes. Optional blowback feature on ML Series motors provides an adjustable cleaning cycle to prolong filter life.

MR Series receivers are designed to operate as part of a central vacuum-conveying system, with material delivered through a top-mounted vacuum-sequencing valve that can swivel in any direction to simplify hose installation. A quick-disconnect clip opens the hinged lid, swinging the vacuum valve out of the way for easy access to the receiver body and filter screen. The MR-1 receiver has a material-holding capacity of 1 lb, while the larger MR-2 receiver has a 5-in.-tall glass extension that increases its capacity to 2 lb. A discharge valve on the bottom of the receiver incorporates a demand switch that automatically replenishes the receiver and hopper.


Conair's MedLine MR Series receiver.

In addition, Conair showed off its new PowerFill 8 mini central vacuum systems, which can deliver material to up to eight destinations. Three models have maximum throughputs from 900 to 3200 lb/hr over maximum tubing lengths from 100 to 225 ft. Mounted on two wheels and featuring an Allen-Bradley PLC and 7-in. touchscreen, these units can link to Conair receivers and valves via plug-and-play electrical and communications cables. Users can select single-material, ratio, volume, and time-fill loading, as well as an idle-mode valve, which allows the vacuum pump to continue running between loading cycles to reduce the number of pump stop-start cycles, which prolongs pump life.


Conair's new Powerfill 8 mini central vacuum system.

724-584-5500 • conairgroup.com

Prices Flat for PE, PVC; Down for PS; Up for PP, PET

Contrary feedstock and demand trends lead to divergent pricing behavior.

By Lilli Manolis Sherman
Senior Editor

A combination of lower feedstock prices, in some cases softer domestic and global demand, and generally improved supply/demand balance have been key drivers in keeping prices steady for PE and PVC and reducing PS prices. Pressure from feedstock prices and resin supply tightness were expected to drive prices of PP and PET upward.

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

Market Prices Effective Mid-August 2018

Resin Grade	¢/lb
POLYETHYLENE (railcar)	
LDPE, LINER	101-103
LLDPE BUTENE, FILM	84-86
NYMEX 'FINANCIAL' FUTURES	48
SEPTEMBER	48
HDPE, G-P INJECTION	103-105
HDPE, BLOW MOLDING	93-95
NYMEX 'FINANCIAL' FUTURES	50
SEPTEMBER	50
HDPE, HMW FILM	110-112
POLYPROPYLENE (railcar)	
G-P HOMOPOLYMER, INJECTION	91-93
NYMEX 'FINANCIAL' FUTURES	57
SEPTEMBER	57
IMPACT COPOLYMER	93-95
POLYSTYRENE (railcar)	
G-P CRYSTAL	106-108
HIPS	112-114
PVC RESIN (railcar)	
G-P HOMOPOLYMER	83-85
PIPE GRADE	82-84
PET (truckload)	
U.S. BOTTLE GRADE	76-78

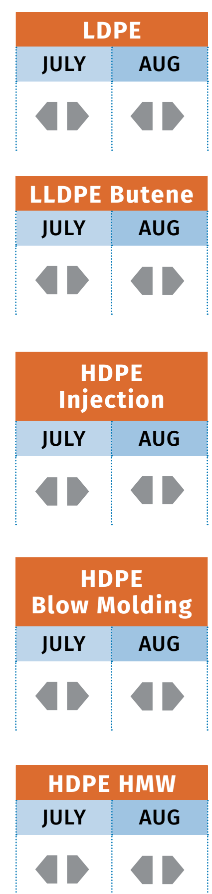
PE PRICES FLAT

Polyethylene prices appeared to have remained steady in July, though suppliers were still trying to implement a delayed 3¢/lb hike. Mike Burns, RTi's v.p. of PE markets, noted that this intent persisted despite contrary market drivers such as lower global PE prices, high domestic inventories, soft global demand, and steady or lower oil prices.

Burns ventured that lower export prices and soft global demand would delay if not negate further price increases in August and September. As for fourth-quarter pricing, he advised keeping an eye on oil price trends: "Lower oil prices and soft global demand may end the past year's continued price increases. Weather will be the last driver heading into this quarter." Meanwhile, spot ethylene monomer prices slipped back below 15¢/lb—below the 2017 low.

PCW reported PE spot prices as flat to lower, noting that availability continued to improve for most grades, except for HDPE blow molding and HMWPE film resins, which were balanced to tight. Greenberg reported very active spot PE trading with steady prices and noted, "Producers have sometimes been vocal in their attempt to finally implement their old 3¢/lb increase, but their plentiful downgraded prime offers suggest otherwise. There is good overall PE availability, and the new capacity has generally exceeded demand."

Polyethylene Price Trends



PP PRICES FLAT TO HIGHER

Polypropylene prices in July held even from June, in step with monomer contracts. Prices in August were likely to be flat to higher, depending on the monomer contract price, according to Scott Newell, RTi's vp of PP markets.

PCW reported spot propylene monomer prices were moving up, as was the case with PP spot prices, driven by both the rising monomer tabs and overall tight supply. Both *PCW* and Newell noted that the gap between wide-spec and prime market prices was wider than normal. Both saw price relief in August as unlikely.

Polypropylene Price Trends

Homopolymer	
JULY	AUG

Copolymer	
JULY	AUG

Newell said a key issue with propylene monomer is that there is no supply cushion to insulate against adverse events. In addition to unplanned outages, two factors are contributing to the tightness: the ethane advantage at refineries, which translates to lower yields of propylene, and the very high volume of monomer exports. "If anything will allow for a decrease in PP prices, it is demand destruction," Newell remarked.

PCW reported that pricing of PP imports in July was attractive on paper, but buying interest was limited, possibly due to long lead times. Newell, however, predicted that lower-cost PP imports were very likely to increase in August and September: "It's difficult at this juncture to project whether that's what it will take to see price relief." He characterized PP demand as "holding up well" but expected some demand destruction. Both Newell and Greenberg noted that suppliers have throttled back production to keep the supply and demand in balance. Both agreed it would make sense for processors to ensure they had adequate inventories as the Gulf hurricane season approached.

PS PRICES DOWN

Polystyrene prices dropped 3¢/lb in July and were likely to remain flat in August and possibly this month, according to Robin Chessier, RTi's v.p. of PE, PS and nylon 6 markets. *PCW* reported PS spot prices as flat to lower amid indications of slower-than-expected downstream demand. Both *PCW* and Chessier characterized PS supply as balanced and styrene monomer availability as adequate. According to *PCW*, implied styrene production costs based on a 30/70 formula of spot ethylene and benzene were up 1¢/lb to 31.7¢.

Polystyrene Price Trends

GPPS	
JULY	AUG
3¢/lb	

HIPS	
JULY	AUG
3¢/lb	

Chessier noted that benzene prices did not react as expected when oil prices rose, hovering instead in the $2.85-2.95/gal. range. As a result, she said it was unusual that a PS price increase wasn't announced for August. She thought that PS prices could remain flat through August and September, partly because this is the start of the seasonal slowdown in demand for the domestic PS market. Things could change if benzene prices go above $3/gal, or if the Trump administration opts not to remove the tariffs on chemicals and plastics.

PVC PRICES FLAT

PVC prices in July held even and were likely to stay that way in both August and September, according to Mark Kallman, RTi's v.p. of PVC and engineering resin markets. He noted that there was no pressure from feedstock prices.

PCW reported that while June ethylene contract prices rose by 1.5¢/lb, ExxonMobil's new 3.3 billion lb/yr ethylene cracker had started up, making it the second olefins unit of that size to come on stream this year.

PVC Price Trends

Pipe	
JULY	AUG

Gen. Purpose	
JULY	AUG

Both RTi's Kallman and *PCW* report that PVC suppliers have been expanding production to take advantage of low ethylene costs. Kallman noted that domestic demand rose, reducing suppliers' inventories and resulting in a well-balanced market. He cautioned that "tariff activity" brought a certain degree of uncertainty in terms of trade flow. *PCW* added, "More and more overseas markets are being closed to U.S. PVC due to anti-dumping duties or tariffs. Buyers abroad are eschewing U.S. resins out of fear that duties could be imposed after they have ordered the resins but before they arrive. In response, U.S. export prices have begun to fall."

PET PRICES FLAT TO HIGHER

Prices for domestic bottle-grade PET in July were steady at 76-78¢/lb delivered Midwest, according to *PCW*. Supply was reportedly bolstered by restarted production at the former M&G Polymers PET plant in Apple Grove, W. Va. With capacity of nearly 805 million lb/yr, the plant was shut down last October, and along with a research facility in Ohio, was acquired by Taiwan's Far Eastern Investment Holdings.

PET Price Trends

Bottle Grade	
JULY	AUG

PET imports from Mexico were down in July due to production issues at plants there. Prices ranged from about 71¢/lb delivered duty-paid West Coast to 78¢/lb delivered to plants in the Northeast.

PCW reported that market sources saw the possibility of domestic and import PET prices increasing 2-3¢/lb in August, driven by strong demand in the thermoforming sector. *PCW* noted that prices this month could continue to rise if production disruptions in Mexico remain unresolved. Another factor is the PET imports from the five countries that were hit with anti-dumping duties in May, forcing buyers to seek alternative supplies.

Processor Business Continues Growth

July's Index is up nearly 7% from last July. Custom processors report second-highest Index since 2013.

By Michael Guckes
Chief Economist

The Gardner Business Index for Plastics Processing indicates that processors' business conditions grew again in July after expanding at their fastest rate in the history of this survey during the first quarter of 2018. (Index values over 50 indicate expansion; values below 50 indicate contraction; an Index of 50 = no change.) The latest reading of 55.9, while below June's 56.3 value, is up 6.8% from July 2017. Business conditions for custom processors increased to 61, up from 59.7 in June, marking the second-highest Index value for these processors since 2013.

The latest overall reading was driven higher by supplier deliveries, new orders, and production. Employment, exports and backlogs all pulled the index lower.

Employment data across most manufacturing industries tracked by Gardner Intelligence posted weaker than expected results in July. Given the currently very low unemployment rate in general—and in manufacturing in particular—Gardner Intelligence believes that low employment readings are not indicative of a decline in the demand for manufacturing labor. Rather, we believe demand is very strong, and low-employment readings represent the difficulty that many manufacturers are experiencing in finding labor for hire at all.

The Plastics Processing Index is calculated by Gardner Intelligence based on monthly survey responses from subscribers of *Plastics Technology* magazine. Gardner Intelligence is a division of Gardner Business Media, publisher of this magazine.

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

Gardner Business Index: Plastics Processing

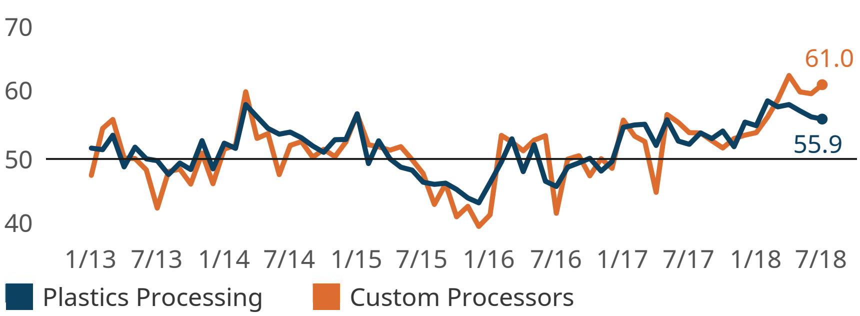


FIG 1

The Plastics Processing Index for July dipped a bit from June, indicating slowing growth. Faster expansion in new orders than production may in part explain this month's expansionary backlog reading. But custom processors recorded the second-best month since the survey was started in 2013.

Supplier Deliveries Support the Index's Recent Expansion

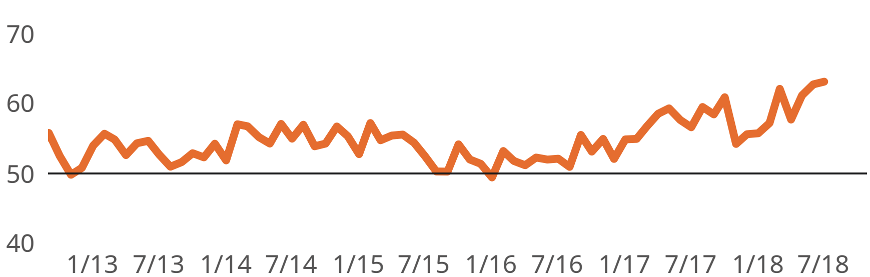


FIG 2

In recent months the Plastics Processing Index has been bolstered by increasing growth in supplier deliveries while most other measures have signaled slowing growth.

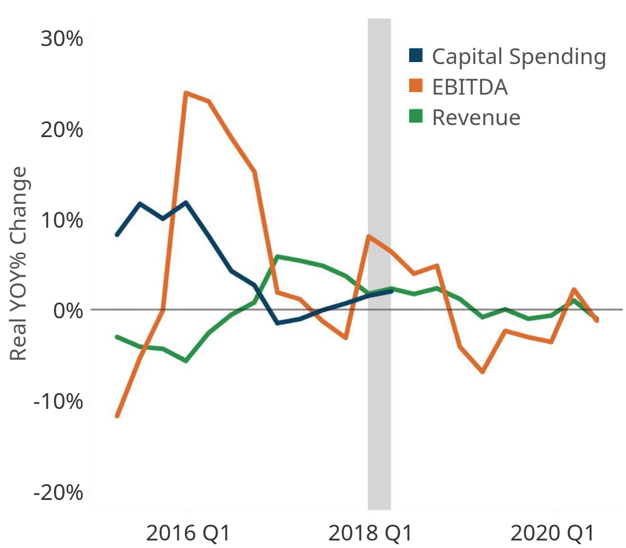
Automotive Industry Beats Expectations

Through the first half of 2018, the auto industry experienced a level of growth that exceeded the expectations of most experts.

By Michael Guckes
Chief Economist

Of the many economic factors that have an impact on the automotive industry, strong employment levels and wage gains are likely the two most significant factors behind that industry's performance in 2018. The industry has exceeded the expectations of many experts from as recently as the end of 2017, despite an eroding financial picture in which banks are less willing to provide credit. Additionally, vehicle-loan default rates are closer to their peak during the Great Recession than to their long-run levels prior to 2008. The recent net effect of these influences has been largely to offset one another, if not slightly benefit the industry. In the first half of 2018, monthly light truck and SUV sales remained near the one-million unit market while car sales during the second quarter were flat, halting an otherwise downward trend.

Automotive Industry and Estimated Results



Band represents last actual quarterly results

A review of Wall Street's financial projections for 23 automotive firms with cumulative first-quarter revenues of $223 billion reveals a somber outlook for the industry between the second quarter of 2018 and mid-2020. Overall earnings and revenues by the end of 2018 are projected to be modestly better than a year ago. However, the cumulative projections for 2019 indicate a flat to slight downward trend in revenues and contracting earnings.

The industry has exceeded the expectations of many experts from as recently as the end of 2017, despite an eroding financial picture in which banks are less willing to provide credit.

Although the Gardner Business Index data are not projected, examining only the automotive data seems to support Wall Street's notions that the industry may need to prepare for a more challenging environment in 2019. In the five quarters ending with the first quarter of 2018, Gardner's data showed new orders and production as the fastest growing industry drivers. However, by the second quarter of 2018, readings for new orders and production had moved lower, giving way to higher readings for supplier deliveries and employment.

Generally, these are considered lagging indicators, as both are slower to respond to economic growth. While this transition of drivers is no guarantee of an immediate economic slowdown, it is consistent with an industry coming off expansionary times.

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

infoNET

This is *Plastics Technology's* online listing for plastic processing equipment builders, material suppliers, auxillary manufacturers and more.

infoFILE
Monthly Resource Guide

You can get copies of literature from suppliers listed on these pages by sending an e-mail to the address provided at the end of each writeup. Or, where provided, contact the company by phone or fax.

PPE GATE CUTTERS - LOWER PRICES

PPE offers the best variety of Gate Cutters at the lowest prices in both our Economy and Premium styles. With 74 different cutters to choose from including heated & pneumatic, you're bound to find what you needed right here at PPE. www.ppe.com

Macedonia, OH • sales@ppe.com

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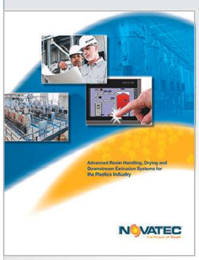
East Windsor, CT • sales@dri-air.com

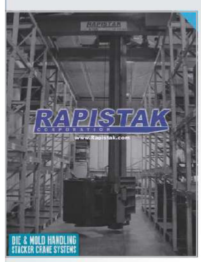
DRY-CONVEY-BLEND-EXTRUSION



Novatec is one of the largest U.S. based manufacturers of resin drying and conveying equipment for the plastics industry. Together, with Maguire Products, we offer the largest line of manufactured resin handling equipment in North America.
Product Overview:
www.novatec.com/about

Baltimore, MD • sales@novatec.com

RAPISTAK-MOLD MANAGEMENT SYSTEMS



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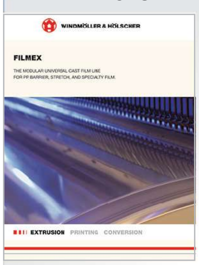

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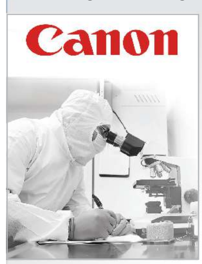

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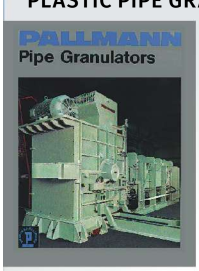

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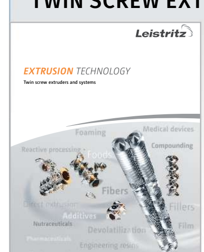

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MAR-BAL INC. — CHAGRIN FALLS, OHIO

Switch to Centralized Vacuum Supply Saves Molder Energy, Boosts Production

Less maintenance means more time for processing, thanks to elimination of vacuum pumps at each press.

Located in a separate room, two R 5 rotary-vane vacuum pumps from Busch currently deliver vacuum to 23 injection machines at Mar-Bal, with capacity to add up to 10 more presses.

By Jim Callari
Editorial Director

Choosing the right vacuum supply can lead to huge productivity gains in plastics processing. Take the case of custom molder Mar-Bal Inc., which two years ago went through a critical review of its existing vacuum supply for injection molding when moving to a new plant. The end result was a collaboration with Busch LLC, Virginia Beach, Va., that has yielded savings in energy and maintenance, as well as increases in production.

Mar-Bal (*mar-bal.com*) was founded in 1970 by Jim Balogh and is now run by Balogh's sons, Scott and Steven. Headquartered in Chagrin Falls, Ohio, the molder sells proprietary products as well as a range of custom molded parts for electrical distribution and control devices, plus a gamut of components for appliances. It runs a 24:5 operation in Ohio, employing more than 130. Mar-Bal also has molding plants in Virginia and Missouri, and just recently opened a facility in Shanghai, China. Mar-Bal's molding is supported by a state-of-the-art laboratory in Ohio where a material engineering team compounds materials to customer specifications.

Mar-Bal molds a range of custom parts for electrical distribution and control devices.

In the early years, Mar-Bal facilities had 30 individual oil-lubricated, rotary-vane vacuum pumps installed directly at the injection molding machines, which delivered the vacuum necessary for evacuating the mold cavity. Each pump required regular service, and Mar-Bal had to shut down presses whenever the pumps needed tending. But when Mar-Bal moved to a new Ohio facility in 2016, it huddled with vacuum specialists from Busch (*buschusa.com*) and developed a new concept to find a more efficient solution to supply vacuum to its presses. The team quickly agreed that a centralized vacuum supply would eliminate the disadvantages of the previous setup.

Replacing the local vacuum pumps at each molding machine with the new central system has reduced energy consumption by a whopping 75%

The new central vacuum system has been in operation since March 2017. Its main components are two Busch R 5 rotary-vane vacuum pumps located in a room outside the production floor. The two pumps deliver vacuum to 23 injection machines, with capacity to serve up to 10 more presses. There are buffer tanks between the central vacuum system and the molding machines to ensure the required vacuum level is constantly available.

Vince Profeta, Mar-Bal's v.p. of product engineering and manufacturing technologies, says the new system is far superior to the previous vacuum supply when it comes to the level of maintenance and susceptibility to failures. What's more, replacing the local vacuum pumps at each molding machine with the new central system has reduced energy consumption by a whopping 75%. According to Profeta, Mar-Bal has also seen an increase in quality since the system was installed.

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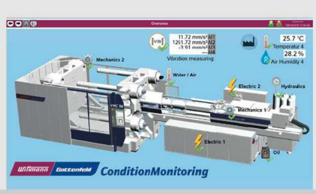

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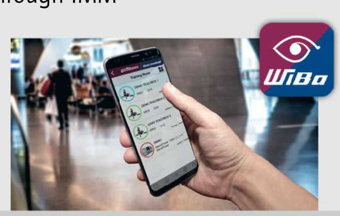

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