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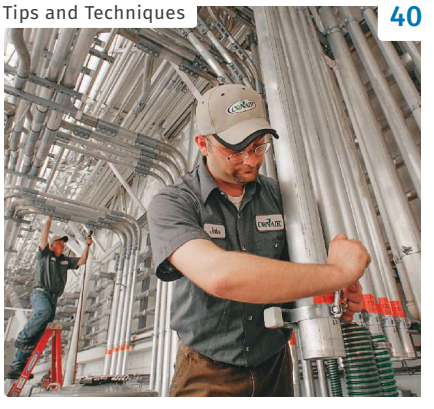

How to Maximize Your Conveying System Performance

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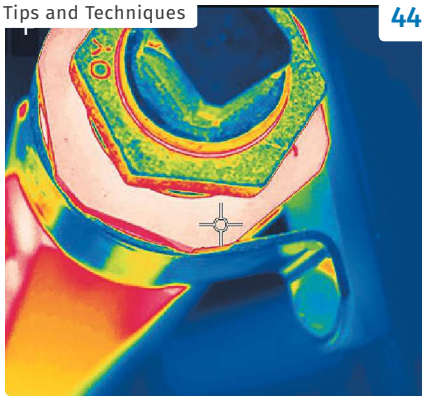

What Thermal Imaging Can Do For Your Molding Process

It can aid in process development, production monitoring, and trouble-shooting. Here's one molder's primer on the subject.

By Michael J. Mortvedt, Juno Pacific

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Time to Step Up

Join the 'conversation' about the value to society of the plastics industry.

Jim Callari
Editorial Director

I was at an association meeting recently when the conversation turned—as it inevitably does at these sorts of get-togethers—toward the numerous environmental challenges our industry faces. You know the list: attacks on bags, foamed PS, bottles, and now straws, etc.; and of course, the "ocean plastics" dilemma. One by one, plastics industry executives at the gathering I attended discussed these issues and talked about what they—as individuals and companies—could do to reverse this growing public anti-plastic sentiment.

As folks were talking, my mind wandered and I heard a mental voice repeating what I have believed for years: "People in our industry do a great job of talking among themselves but struggle to get the word out to the masses." The Plastics Industry Association (PLASTICS) has endeavored to change the conversation about our business with the launch of the website ***thisisplastics.com***, which I wrote about in greater detail in the April 2018 issue. Both PLASTICS and the Plastics Division of the American Chemistry Council have done yeoman's work—with lots more in the pipeline, I am sure—to "change the conversation," but I think we need more input from you processors if we are really going to change how the public perceives plastics.

It's estimated that our industry employs close to 1 million people. I'd guess that with roughly 20,000 plastics processing plants in the U.S., perhaps as many as half of those people are in facilities like yours, turning pellets into parts. So for you, there's a lot at stake. These threats may focus directly on the products you make. If not, maybe yours will be next. Are you engaged at all in the efforts to change the conversation?

If not, I think you can take the first step by talking more to us. Full disclosure: It's in the best interests of *Plastics Technology* Magazine to hear from processors. In each issue, we feature plant-tour type stories that we call On-Site, which focus on processors. Our last editorial page in every issue (Processor's Edge) details specific strategies deployed by processors to solve a problem or gain a competitive edge. Information about processor activities is also peppered throughout this magazine (and on *PTonline.com*), in our Starting Up and Close-Up departments. And just this month, we have a first-hand account from a molder using thermal imaging technology.

All wonderful stuff, and we—not just our magazine, but our industry—need more of it. We need more processors using the resources available in ***thisisplastics.com*** to advocate for our industry. I'd like to see more processors (and OEMs) step up and join PLASTICS. We'd certainly like to see more processors engage with us as we attempt to shine a light on molders, extruders, and thermoformers who make remarkable and ingenious products and engage in best manufacturing processes.

But we sometimes run into stumbling blocks on getting access to processing plants. On many occasions, when I've reached out to a company I know of or heard about, the response has been, "Where is the benefit for us to feature our company in a magazine that my competitors read? I don't want them to know what I'm doing."

The benefits are numerous. Some are warm and fuzzy—you can position yourself as a thought leader among your peers. But others are more tangible. You could reprint the article, for example, and figure out a way—by mail, in person, at an open house—to get it into the hands of local high-school students. Or perhaps you can put a call into the friendly editor of your local newspaper (maybe our youth does not read newspapers much anymore, but their parents do; and besides, all newspapers have websites), tell them about the article, and encourage them to do one of their own.

I think efforts like this—over time—will begin to change the mindset people have about our industry. Who knows, it might even address the skills gap by getting younger people interested in pursuing careers in our business. Are you doing all you can? PT

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Covestro Developing New "Super-Plastic"

Covestro in Germany (U.S. office in Pittsburgh) is working with industry and academic partners to develop a new injection moldable "high-performance thermoplastic," abbreviated HPT and identified only as a "special polyurethane." It is characterized as stable, with high hardness as well as toughness, flexibility, and resistance to heat and many solvents. Anticipated uses include automotive, aviation, and medical. Covestro also emphasizes the environmental and sustainability advantages of the material. It is based on easily accessible basic chemicals used in production of foams, and a novel catalyst system is said to eliminate complex process steps in its production. The result is said to be 30-60% less greenhouse gas emissions and 40-65% lower energy consumption than are required for production of similar thermoplastics. Covestro and its partners are working on a new continuous process for large-scale production that requires fewer solvents than existing processes.

The R&D project is coordinated by Covestro and funded by the German Federal Ministry of Education and Research. Other partners are TWTH Aachen University, the Technical University Berlin, the Leipzig Plastics Center, and aircraft manufacturer Airbus.

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Incoe Moves into New Headquarters

Over the month of August, hot-runner supplier Incoe Corp. moved its three operations in the Detroit area into a new 138,000-ft² global headquarters in Auburn Hills, Mich. It was previously based in Troy, Mich. The $20-million-plus facility features an 85,000-ft² manufacturing area that allows for a more

streamlined flow of operations, and a 2400-ft² molding laboratory. The lab will be adding three KraussMaffei injection molding machines this year. Incoe celebrated its 60th anniversary this year.

248-616-0220 • incoe.com

General Polymers Relocates Headquarters

Fast-growing North American resin distributor General Polymers Thermoplastic Materials, LLC has moved its corporate headquarters from Clarkston, Mich., to Auburn Hills, Mich.

800-920-8033 • gp-materials.com

Winners Announced at SPE Annual Thermoforming Parts Competition

The Society of Plastics Engineers (SPE) Thermoforming Div. announced last month the winners of its annual parts competition, which were presented in late September in Ft. Worth, Texas, at the division's annual conference. This year's winners are:

- **People's Choice:** Profile Plastics, for a medical-cart enclosure (photo).
- **Roll-Fed Consumer–Gold:** Placon, Pokemon tray.
- **Roll-Fed Innovative—Gold:** Placon, nametag organizer.
- **Roll-Fed Innovative—Silver:** CMI Plastics, Knob Creek POP display tray.
- **Roll-Fed Food—Gold:** Global Plastics, egg carton.
- **Heavy-Gauge Vacuum Form—Gold:** Fiber Pad, Bass Boat driver console.
- **Heavy-Gauge Pressure Form—Gold:** Profile Plastics, medical-cart enclosure.
- **Heavy-Gauge Pressure Form—Silver.** Ray Products, medical-device cover.
- **Heavy-Gauge Twin Sheet—Gold:** Therma-Hexx, hydronic heat-transfer panel.
- **Heavy-Gauge Twin Sheet—Silver:** Allied Plastics Inc., bear-resistant lid for roll-out cart.

Photo: Dallager Photography

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Danimer Plans Commercial Production of PHA Bioplastic

Bioplastics manufacturer Danimer Scientific, formerly MHG (Meredian Holdings Group), Bainbridge, Ga., announced plans to purchase and convert an 88,000-ft^2 building in Winchester, Ky., into a fermentation plant to produce its proprietary Nodax PHA biopolymer. Nodax PHA can be used to manufacture biodegradable plastic products, including drinking straws, food packaging, cups, bottles, shopping bags, plates, trash bags, and labels. The material is compostable, 100% biobased, and biodegradable in anaerobic, soil, freshwater, and marine environments. Company leaders aim to start operations in the fourth quarter of 2019.

Nodax PHA begins with fermentation of canola oil by soil bacteria, which convert it into PHA, which is then processed into a powder form. The powder will be transported to the company's Bainbridge facility and combined with other biopolymers to manufacture biodegradable plastic resins. According to Danimer Scientific CEO Stephen Croskrey, this facility will be the world's first PHA commercial production plant.

229-243-7075 • danimerscientific.com

Arkema Launches 3D Printing R&D Center

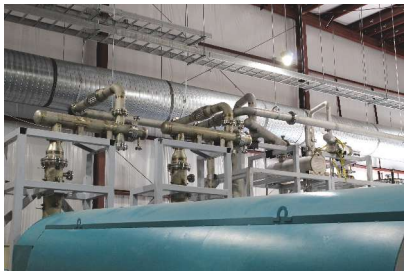
Arkema, King of Prussia, Pa., recently opened its new 3D Printing Center of Excellence at its Sartomer facility in Exton, Pa. Sartomer has designed engineered resins for UV-curable additive manufacturing, marketed under its N3xtDimension brand. These photocurable 3D printing materials yield products with thermoplastic-like mechanical properties for a range of applications.

In the new lab, Sartomer and its partners aim to further develop 3D printing resins. The new center houses UV-based technologies such as stereolithography, digital light processing, and multi jet printing.

800-523-1532 • arkema.com

Renewlogy Converting Landfill-Bound Plastics to Fuel

Renewlogy (formerly PK Clean) converts plastic waste into fuel products. The system can produce fuels such as diesel, as well as materials that serve as the building blocks to make new plastics. CEO Priyanka Bakaya founded the company at MIT in 2011. Renewlogy has made the process more economically viable than others in the plastics-to-oil market, Bakaya says. One way is through its continuous, automated approach versus a batch process. Batch requires cooldown and reheating steps, while the continuous process maintains a consistent temperature. The automated approach also can reduce labor costs.



The company's demonstration facility in Salt Lake City is the first chemical recycling plant in the U.S. designed to operate continuously at commercial scale. Renewlogy reportedly can accept mixed and dirty plastic feedstock and produces low-sulfur fuel with zero toxic emissions. The company plans to build Renewlogy systems at recycling operations across the country. A new facility is under construction in Nova Scotia. And Renewlogy was recently awarded a grant from the Arizona Commerce Authority toward setting up a facility in Phoenix. The company plans to invest the grant in starting operations at a Phoenix facility that already processes waste. Because Renewlogy's facilities are modular and have a small footprint, they can be co-located at plastic waste sites.

"We're working on a number of facilities that will be deployed over the next couple of years," Bakaya says. Renewlogy is also getting involved in helping with the ocean plastics crisis. Its solution is a small, mobile version of its large chemical recycling system that is powered by solar energy. It would target ocean-bound plastics in developing countries and create incentives for local waste pickers to collect scrap plastics that otherwise have low value. Renewlogy has partnered with the nonprofit Plastic Ocean Project, which has been using Renewlogy's conversion unit for converting marine plastic waste into fuel over the past few years.

"Once plastics are collected from the ocean, they are very difficult to recycle," Bakaya says. "We developed our technology to find a solution for hard-to-recycle plastics, and it's incredible to be able to convert these microplastics from the ocean into a clean fuel." The firm is rolling out its Renewlogy Oceans initiative in major rivers across the world, starting with the Ganges River in India next year.

Ultra-Lightweight PET Refill Containers Developed for E-Commerce Channels

Dromo is a new PET bottle system designed specifically for liquid or semi-viscous products sold through e-commerce channels. It is being launched by PTI, Holland, Ohio, for household chemicals, personal-care products, and many others. The bottle refills are designed to be inserted into a rigid, reusable dispenser, of which PTI has engineered several types to address different brand preferences. Dromo bottles can be up to 75% lighter than free-standing PET bottles designed for the retail shelf. The 16-oz PET refill weighs less than 10 g but has passed burst tests of up to 173 psi and drop tests on both base and sides of 6 ft. Opposing flat side panels provide sidewall strength and facilitate stacking prior to shrink wrapping into optional double packs. Bottles can be sealed with a standard threaded closure or a foil seal. They can be made of virgin or up to 100% recycled PET.

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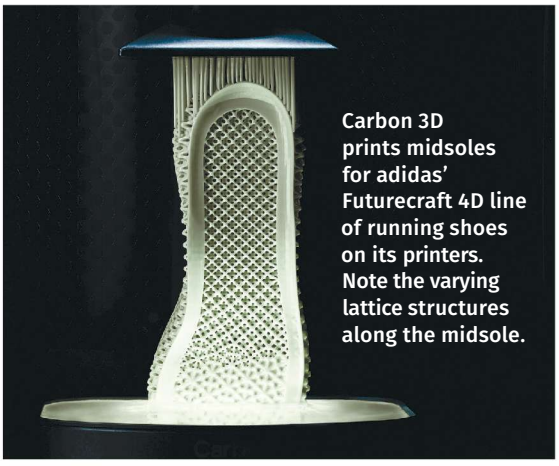
3D Printing, Silicon Valley Style

Carbon's technology seeks to disrupt the 3D-printing industry for good.



Carbon 3D prints midsoles for adidas' Futurecraft 4D line of running shoes on its printers. Note the varying lattice structures along the midsole.

By Heather Caliendo
Senior Editor

It's well-known that Silicon Valley is the home of new technology and advancements. So it makes sense to locate a new, innovative company that could push 3D printing (aka additive manufacturing) beyond prototyping in the same locale as creators of other technologies that are helping to shape the world's future.

Silicon Valley-based Carbon focuses on producing parts in industrial volumes. In fact, one of the company's slogans is, "Stop prototyping, start producing." Founded in 2013, Carbon pioneered a new additive manufacturing (AM) technology that uses light and oxygen to rapidly produce products from a pool of liquid resin.

Carbon CEO and co-founder Joe DeSimone (standing) with other employees in the company open-office design, which is said to promote and facilitate idea sharing.

"We're taking the best of digital from Silicon Valley and bringing innovations, material science and additive manufacturing," says Joe DeSimone, Carbon CEO and co-founder. "Innovation comes in a lot of different ways."

> ***"We explored whether we could make a running shoe out of 3D-printed material that really works. And it does."***

Carbon (***carbon3d.com***) invited *Plastics Technology* to its headquarters in Redwood City, Calif., to learn about the company's technology, business model and applications.

A NEW WAY OF THINKING

Joe DeSimone's entire career has been at the intersection of science, engineering, medicine and polymers. Throughout his time in academia at the University of North Carolina and North Carolina State University, DeSimone published over 300 scientific articles and has more than 150 issued patents in his name—with another 80+ patents pending. DeSimone also previously co-founded several companies, including Micell Technologies, Bioabsorbable Vascular Solutions, and Liquidia Technologies.

While he always found 3D printing technology of interest, DeSimone says he saw limitations with the layer-by-layer approach. He believes the technology as it was didn't have the right properties to produce a real part. In other words, it was a niche technology focused on prototyping.

Carbon co-founder and chief technology officer Alexander Ermoshkin, who also worked at Liquidia Technologies, came to DeSimone with the idea that 3D printing could be done more effectively. Working together, the two eventually got the idea for a new approach. ►

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The company's DLS (Digital Light Synthesis) technology, enabled by its CLIP (Continuous Liquid Interface Production) process, eliminates the shortcomings of conventional 3D printing by harnessing light and oxygen to rapidly produce objects from a pool of resin by literally pulling them upward continuously from the pool in a single pass, like the famous scene in Terminator 2, where the killer robot T-1000 rises from molten metal. The bottom of the growing part is cured continuously by UV light. The printed parts reportedly feature excellent mechanical properties, resolution and surface finish.

Because they are produced in a single layer, parts are said to be more isotropic in properties than 3D-printed parts produced in successive layers. Not only does Carbon's technology produce end-use parts, but it also delivers increased speed, reportedly up to 100 times faster than other AM processes. "It is a big breakthrough in how one can make objects," DeSimone says. After initial formation, parts require post-curing in an oven to develop full properties.

Carbon's 3D printing systems include the M1 printer, which was the first to use Carbon's DLS technology, delivering layerless, high-resolution parts with high-quality surface finish and resolution. The newer M2 printer has twice the build volume, allowing for larger parts, higher throughput and lower part cost, all with the same high-resolution pixels (75 µm) and isotropic prints as Carbon's M1 printer. The Smart Part Washer uses optimized wash protocols so that every part is cleaned consistently with minimal manual labor.

The SpeedCell is a system of connected manufacturing unit operations that enables repeatable production of end-use parts at any scale. The M Series printers and the automated Smart Part Washer are the first in a series of modular offerings that allow a wide range of industries to design, engineer, and build end-use parts with one common manufacturing workflow.

There are other aspects that set Carbon apart too. It offers a unique subscription-based model for its 3D printing systems. The company's approach combines connected, data-centric hardware with regular, over-the-air software updates that take place approximately every six weeks.

DeSimone says the subscription model is one of the most important aspects of the company's business approach. "Customers can get a very high-performing machine at a low price point and not worry about it becoming obsolete," he says. "This is completely new to the 3D-printing industry. But it's also new to a lot of manufacturing equipment. Imagine having your injection molding equipment able to constantly be improved. That's what this model allows us to do."

If the idea of web-enabled software updates reminds you of the electric car company Tesla Motors, it's for good reason. Craig Carlson, who now leads engineering at Carbon, was the former v.p. of software and electrical integration at Tesla. Carbon hired several other former Tesla employees, including Roy Goldman as director of software engineering. He joined Carbon in early 2015, after a little over four years of leading the software team at Tesla that was responsible for the Model S in-car displays, mobile apps and cloud-based systems.

"At Tesla, we were really aggressive about bringing connectivity to machines that people typically don't think of being connected—in that case it was cars," Goldman says. "But we thought there is just as big an opportunity for manufacturing equipment having a lot of benefits with that kind of connectivity. We're helping designers and engineers rethink is possible with our technology."

These are among the M Series 3D printers that Carbon runs in Silicon Valley.

ADIDAS PARTNERSHIP

One of the biggest partnerships to date for Carbon is with adidas, Portland, Ore., which was announced in 2017. The two companies unveiled Futurecraft 4D, the first performance footwear produced with Carbon's DLS technology.

"3D printing is one of those technologies that really can have unlimited possibilities," DeSimone says. "We explored whether we could make a running shoe out of 3D-printed material that really works. And it does."

Carbon's software leverages the company's M Series printers and its wide array of programmable liquid resins to print unique lattices that can replace materials such as in-shoe midsoles. What is especially unique is Carbon's ability to design and make tunable lattices depending on customer application needs. Engineers for the first time can 3D print multiple unique functional zones within the same monolithic part and tune the mechanical properties within each of these functional zones to the application requirements. ►

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adidas partnered with Carbon to develop a midsole that met the performance and comfort required by serious runners. adidas was seeking a platform that would enable it to tune cushioning properties throughout the shoe and ultimately provide bespoke athletic footwear. Carbon's DLS process allows adidas to precisely address the needs of each athlete in regard to movement, cushioning, stability and comfort with one single component. adidas plans for more than 100,000 pairs by end of 2018.

The digitized footwear-component creation process eliminates the need for traditional prototyping or molding. Carbon's technology enabled adidas to execute more than 50 design iterations. Engineers from both companies collaborated closely and tested nearly 150 resin iterations.

The final midsole material is made from a blend of UV-curable resin and polyurethane. It is a stiff elastomer that can be printed in a lattice structure to create a high-performance midsole.

Other potential applications with this technology include bike seats, orthopedic pads and headsets. "That's going to change how we create products and certainly how consumers experience them," DeSimone says. "I would say this is just the very beginning."

Carbon's M Series printers pull a part continuously upward from a pool of liquid resin, while curing the bottom of the growing part with UV light. The M2 printer is Carbon's second-generation 3D printer. It allows for larger parts, higher throughput and lower part cost. It features a build volume measuring 7.4 × 4.6 × 12.8 in.

SPEED OF INNOVATION

Vitamix in Cleveland produces blending equipment for home and commercial use. Vitamix recently partnered with Carbon to redesign a specialized nozzle used in commercial settings. The old nozzle design was intended to be assembled from six injection-molded parts.

Carbon produced an optimized Vitamix nozzle in a single 3D-printed part with no multi-part assembly. Empowered by Carbon's digital manufacturing capabilities that allow for rapid design validation as well as final manufacturability validation, product engineers produced six to seven nozzle design iterations within only four weeks. Using the injection molding approach, a single design iteration and resulting tooling could have taken eight to 10 weeks.

"The constraints of injection molding, I would argue, are the weight on the economy of the world of developing new products—because you can't do things digitally," DeSimone says "You can't move very quickly. There are long lead times. And high tooling costs can put a program at risk."

Carbon exhibited at NPE2018 and Phil DeSimone, the company's co-founder and v.p. of business development (and Joe's son), said that the show allowed Carbon to get in front of molders to position its technology "as another tool in their toolbox" versus a replacement for traditional molding. "We try to connect with them on a product they wouldn't have done otherwise. For us, what we need to do is find that first component," he said.

Carbon has hired several employees who had previously worked in injection molding. Joe DeSimone says the company is eager to take the learnings from injection molding and help educate molders on how to redesign for additive. "It's a complement to what they already do—all those jobs they turned down because the potential customer wants the parts sooner or they only want 100 parts and it's not worth cutting a tool, right? They don't have to say no to those jobs anymore. This gives them the capability to complement their existing infrastructure with a balance between analog and digital in this new frontier."

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New Recycling Technology Debuts At Erema Open House

Several new developments for PET recycling, as well as a new turnkey recycling systems program, made headlines at Erema's recent customer demonstration day.

By Matthew H. Naitove
Executive Editor

Nine speakers, two live demonstrations of PE film and flake recycling, and unveiling of several major new technical and business developments highlighted Discovery Day 2018 at the headquarters and technical center of Erema North America Inc. in Ipswich, Mass. (***erema.com***). The September event was attended by around 130 guests, including recyclers, material suppliers, brand owners, and other users of recycled materials. "Our goal is to take advantage of the growing awareness of the necessity of plastics recycling and drive forward networking within the industry," says Martin Baumann, Erema's v.p. of sales.

The tech center houses four full Erema reclaim systems and a large shredder from Vecoplan LLC, Archdale, N.C. (***vecoplanllc.com***). Live demonstrations included processing HDPE bottle flake to pellets using an Interema RegrindPro size-reduction unit and Intarema TVEplus extruder, ReFresher odor-removal system, and LaserFilter melt filter. The system was switched over to run dirty PE film contaminated with large pieces of aluminum foil, which were removed continuously by the LaserFilter.

Erema North America's Discovery Day in September featured live demonstrations of recycling PE film (foreground) and bottle flake.

TURNKEY SYSTEMS LAUNCH

Perhaps the biggest news at the event was the first announcement in North America of a new global business unit for Erema, focused on supplying entire plastics recycling plants from a single source. Michal Prochazka is head of the new Keycycle venture, which was launched a few months ago in Austria. He said this new systems integration service leverages Erema's plant-engineering expertise to plan all phases of the process from debaling to sorting, washing and pelletizing.

The service starts at the initial project phase with pre-investment support, feasibility studies, and cost analysis. This includes process definition, anticipated throughput volumes, quality targets, final product, and storage.

This is followed by complete engineering and integration services. Keycycle provides overall management responsibility and interfacing between Erema and over a dozen supplier partners for shredding, sorting, washing and compounding.

The next step is plant layout and logistics, followed by detailed engineering, including all utilities like electric power, compressed air, and water treatment. Then Keycycle integrates the actual building of the plant, including the civil engineering side.

NEW TECH FOR PET RECYCLING

Under the heading of "What's new in PET recycling," Christoph Wöss, business development manager for bottle applications of Erema Group GmbH in Austria, reviewed several recent and brand-new developments and previewed one major product announcement that will go public this month.

He noted that the first installation of a system for converting PET bottle flake to new food-grade preforms in a single step took place this past summer in Japan. Suntory, the maker of a well-known whiskey, is the first commercial user of the Xtreme Renew system, which debuted in 2016. It uses Erema's Vacurema system that decontaminates, degasses, dries and crystallizes PET flake before discharging it into a short-barreled extruder. That extruder then feeds the Xtreme preform injection-compression system from Italy's SIPA. According to Wöss, the system at Suntory can produce up to 60,000 preforms/hr while saving more than ►

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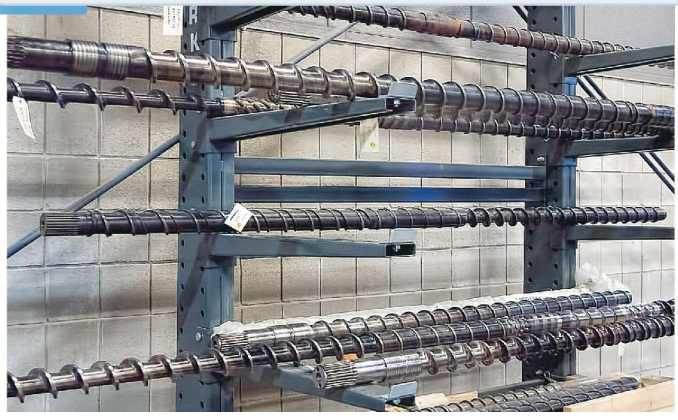

Erema revealed a new extruder screw concept that can provide up to 6° C lower melt temperature and 25% lower AA levels in recycled PET.

30% in energy consumption compared with the normally separate systems for PET recycling and preform molding.

Another first is what Wöss described as "the first PET tray-to-tray recycling plant in the world," which went into production in The Netherlands this past June. The trays Wöss is referring to are thermoformed of 100% RPET by Sneltray BV, a unit of 4PET BV and sister company of 4PET Recycling BV. Wöss says the concept is also applicable to thermoformed PET clamshells widely used for packaging berries and other fresh fruit, as well as salads and sandwiches. The system involves washing the RPET flake, reprocessing through a Vacurema system, crystallizing and rebuilding the material's I.V., and then thermoforming—which is not yet performed directly inline.

Wöss also discussed an Erema system called VOClear, which came out a year ago, for reducing VOCs in PET flake by up to 40%. This add-on to the Vacurema system removes VOCs coming from the PET itself, as well as from contaminants such as PVC or nylon.

In addition, he said Erema has a new extruder screw concept that can provide up to 6° C lower melt temperature and 25% lower acetaldehyde (AA) levels in recycled PET.

Also new is a new concept for inline crystallization of RPET immediately after pelletizing, which uses the latent heat in the pellet to save energy. The system is said to be compact and retrofittable.

Wöss concluded with a sneak preview of what he called a "brand-new, groundbreaking innovation" that will be announced this month at the PETnology 2018 conference in Paris. It combines a modified version of the Vacurema technology with new, patented solid-state polymerization (SSP) technology that restores RPET I.V. while yielding the lowest color generation among existing technologies, and accelerating decontamination and removal of VOCs. Making use of Erema's new inline crystallization technology mentioned above, this new system is said to achieve food-contact approval while achieving higher purity levels "surpassing existing brand-owner standards," Wöss said.

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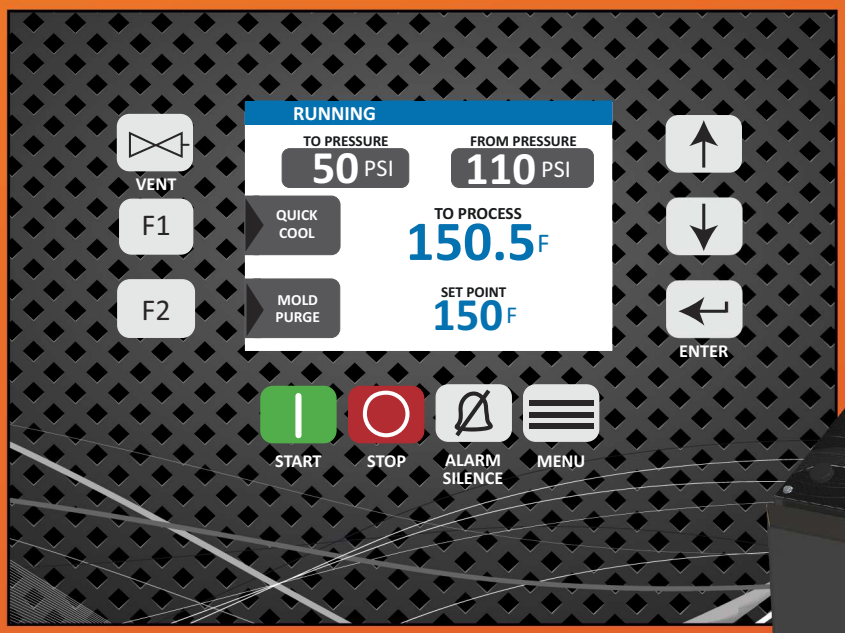

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MATERIALS

PART 10

A Processor's Most Important Job

Glass and carbon fibers are often used to increase material strength and modulus. To maintain these properties, the aspect ratio of these fibers must be maintained.

By Mike Sepe

In previous articles in this series, we have reviewed three aspects of material composition that the processor has a role in preserving or optimizing: molecular weight, crystal structure (if it is expected), and molded-in stress. The fourth aspect of processing that is designed to ensure good retention of mechanical properties is fiber-length retention. Glass and carbon fibers are incorporated into many polymers to increase the strength and modulus of the base material. Other benefits of this modification are an improved level of creep resistance and fatigue resistance.

The reinforcing capability of fibers is related in large part to a property known as the aspect ratio, which is essentially the ratio of the fiber length to the fiber diameter. While the critical aspect ratio is dependent upon a number of factors, it is known that with increasing aspect ratio, properties such as strength and modulus improve. This is the rationale for the development of long-fiber compounds, where the initial length of the fibers is 11-12 mm instead of the 1-2-mm lengths typical of short fibers.

While these may be the fiber lengths incorporated into the compound when it is pelletized and packaged, the final properties of the molded parts produced from the material depend upon the length of the fibers in those parts. Melt processing that employs a screw will generate a significant amount of mechanical work and this has the potential to break the glass fibers. This is why long-glass materials are not compounded using extrusion. Instead the fibers are pulled through a bath of molten resin and then cut to the desired length. But the process conditions that these raw materials experience during molding will have a significant influence on the length of the fibers in the final product. And this is true for both short- and long-glass fiber compounds.

Nylon parts before and after ash tests. Good part on left, bad part on right.

Mechanical work involves shear stress that is generated by the flow of the material during the mold-filling process and by the plasticating of the material during screw rotation. These are necessary aspects of the process, but when it comes to fiber-reinforced materials the process conditions associated with these factors must be selected with an awareness of how they affect fiber length. The accompanying photos show the result of ash tests performed on two parts molded in glass-fiber reinforced nylon. Parts from one lot were reportedly stronger and stiffer than those from the second lot, and the natural conclusion was that the two lots had been made from materials with different levels of reinforcement. However, the ash tests showed that the glass-fiber content had not changed between the two lots of parts. But the ash test did reveal an important difference that accounted for the reported variation in performance.

In the crucible on the left are an as-received part and the resulting residue from the ash test for the good lot. The crucible on the right contains the analogous parts and residue from the defective lot. Note that the ash from the good part still has a

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shape that is close to that of the molded part, while the ash from the bad part is a pile of disconnected fibers. The reason for the difference in appearance is the fiber length in the two parts. Longer fibers stay more entangled and will maintain the overall envelope that defines the part shape; shorter fibers will not.

Fiber-length retention actually starts with mold-design considerations. Flow paths that are too restrictive produce higher shear rates and shear stresses. This is true for the entire melt-delivery system and extends to the cavity itself. Material composition also needs to be considered, specifically any colorant being added to the material. Titanium dioxide, the most common pigment used to produce white and other light colors, is very abrasive and can promote a much greater level of fiber attrition. But in this case the mold had not changed between the two production runs and no color was being added to the raw material. (The slight yellow color of the good part arose from a somewhat longer time in the dryer). This points to the process.

The biggest culprit in decreasing fiber length is the conditions associated with screw rotation: a combination of revolutions per minute, recovery time, and backpressure.

The biggest culprit in decreasing fiber length is the conditions associated with screw rotation; a combination of revolutions per minute, recovery time, and backpressure. Some backpressure is needed to provide a stable volume of material in front of the screw at the start of injection. But if it is excessive it will increase the mechanical work on the material to a point where it does more harm than good. In addition, running too low a temperature in the rear zone of the screw will create additional mechanical work that will cause more fiber breakage and also cause the screw and barrel to wear much faster. I once saw a processor who was running a 65% filled PPS go through three screws in two months because they insisted on running the rear zone at a temperature lower than the melting point of the polymer.

Worn screws and barrels also cause excessive fiber breakage. And if the screw employs a mixing element that is of the high-intensity variety, this will also ensure a high degree of fiber-length reduction. Vented barrels are an example of this, but mixing elements that produce high levels of shear to achieve a homogeneous melt will also negatively impact the integrity of fiber-reinforced materials. ►

Finally, if regrind is being used, the fibers in the reground material are shorter than those in the virgin material, even if the process conditions are optimal. The amount of regrind should be carefully controlled to keep the properties from progressively declining as the material is continually recycled. The higher the regrind percentage, the more second-, third-, and fourth-generation reclaim becomes part of the molded article. I once visited a processor who was producing parts in a 30% glass-fiber reinforced PBT polyester that were consistently brittle. We discovered that 85% of the shot was in the runner, and the runner was being reground and put immediately back into the drying hopper. With very little virgin material being added to the mix, it was not long before at least half the material in the hopper was at least fourth-generation regrind and the glass fibers were little more than powder.

One last example is worth including: There is an increase in the need for polymers that can shield electromagnetic and radio-frequency interference (EMI/RFI). This is achieved by using conductive fillers, and among the choices are long fibers of stainless steel. Levels of this fiber as low as 6-10% can produce the desired results. But effective shielding relies on an overlapping network of fibers through the wall of the molded part. This, in turn, is ensured by keeping the fibers long. It has been shown that excessive length reduction of the stainless-steel fibers degrades the shielding properties.

The amount of regrind should be carefully controlled to keep the properties from progressively declining as the material is continually recycled

So far in this series, we have reviewed four aspects of material composition that the processor has a role in preserving or optimizing: molecular weight, crystal structure (if it is expected), molded-in stress, and fiber length in those materials where fibers are used. We have one more to review, the additive package. We will address this topic in our next column.

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

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INJECTION MOLDING

Identifying and Correcting Splay

Splay adjustments can be a simple fix, or can require several hours of babysitting a press and head scratching. Learn to find the root cause.

One of the most common defects in plastic injection molding is splay. In this column I will help to identify various forms of splay, as well as common (and less common) causes. I will also provide various solutions for removing splay from your process.

By Garrett MacKenzie

The most common reasons for splay are moisture, shear and heat. In nearly every scenario, calculating which of these three is causing splay will help to define the best approach to correct the condition. Each of these categories offers telltale signs that help to identify the type of splay that's present. Through understanding each condition, we as molders can make process changes to remove splay from a process.

Moisture: The most common cause of splay would be moisture. One of the key identifiers of moisture in the process is that visually the splay does not occur in the same place every time, or in some cases the splay is all over the part.

Understanding the effects of moisture, heat and shear in processing conditions is your best form of defense against splay events.

Another visual check for moisture would be the purge puddle itself. If the puddle is foamy and/or riddled with bubbles, moisture could be causing the splay condition.

Holding material in your hand from the dryer can verify that the dryer is working, and material is hot. It does not, however, verify that the material is dry. A moisture analyzer should be used to verify specific moisture content. It is also important to note that some materials can be over-dried. Refer to the material manufacturer's recommendations for ideal moisture level.

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Splay is a defect that can manifest itself in different ways on the surface of a molded part and can be caused by different factors.

Once the cause for the splay has been identified as moisture, the cause for high moisture content must be verified. Here is a list of reasons moisture splay might be present:

- *Improper drying*. Material must be dried for the time and/or temperature provided by the material manufacturer. Allow the material more time to dry at the correct temperature. Drain the first 25 lb from the dryer cone, and retry startup.
- *The dryer is not functioning properly*. Feel the supply and return air lines for the dryer. The supply line should be hot, and the return line warm. In addition, it is good practice to have manual temperature indicators with probes installed in the hoses where the air enters and exits the dryer. If the supply temperature does not match setpoint, or if the return temp is more than 20° F lower than setpoint, there may be a problem with dryer performance.
- *Material throughput is not correct*. An example of this would be using a 100-lb dryer with material use of 60 lb/hr. The material passes through the dryer in 1.5 hr. If the normal dry time is 2 to 4 hr, the material is not receiving an acceptable amount of drying. It is also important to note that with most dryers, the material funnels from the center. Because of this, extra time ►

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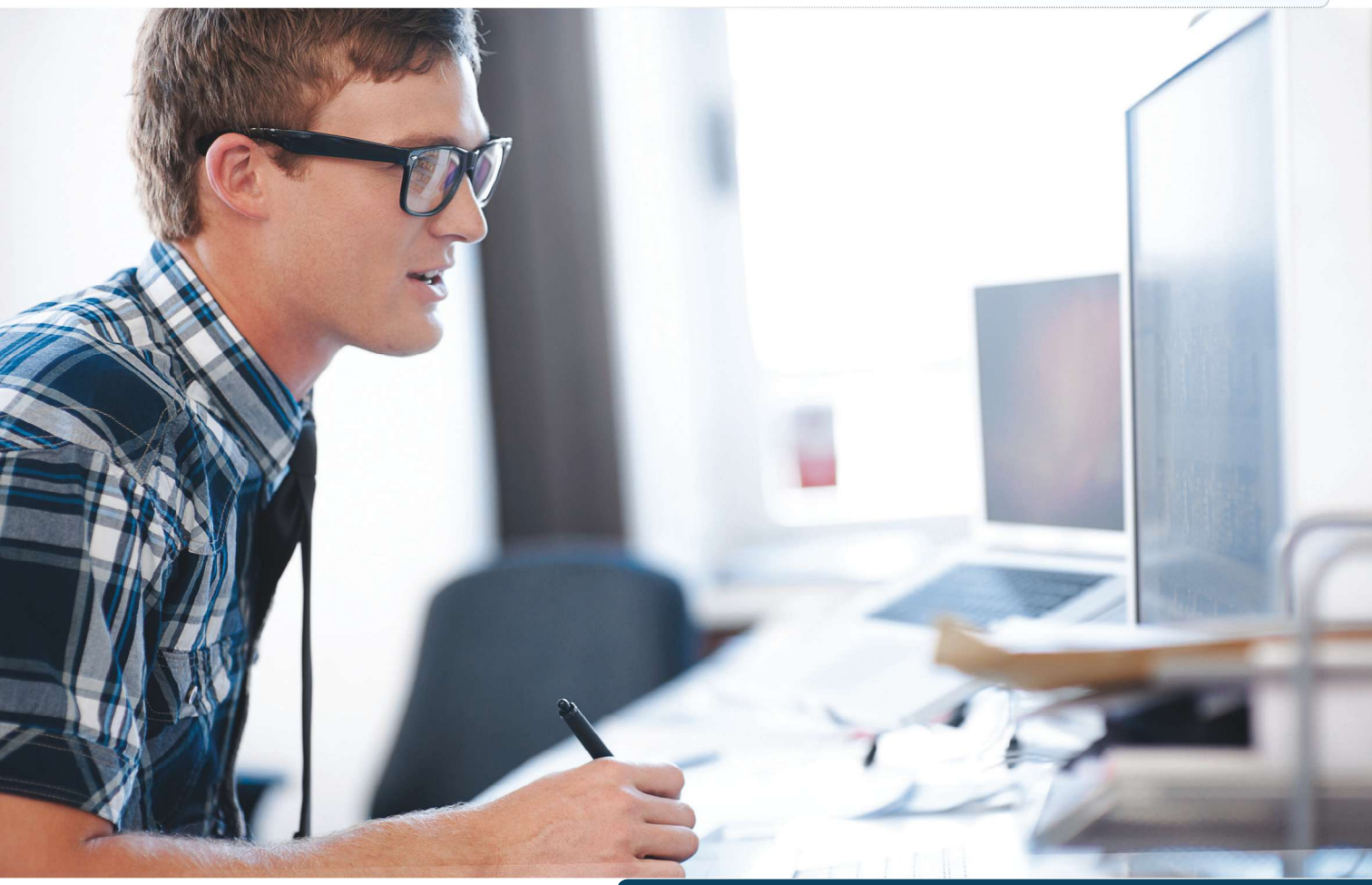

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Christian started his career with Wittmann Battenfeld at the Tech Center in Kottingbrunn, Austria in 1985. After 5 years as a process engineer and 25 years doing customer training for Injection Molding Machines in Austria, he recently relocated to our USA Headquarters, in Torrington, CT, where he manages the Tech Center and molding machine training.

should be added to ensure that material draining from the center has had sufficient time to dry. Based on 4-hr dry time, 5-hr throughput would be sufficient for drying. A dryer size of 300 lb or higher should be used.

• *Material between the feed throat and dryer supply has sat too long*. Material in these areas can take on moisture in as little as an hour. At startup, drain 25 lb of material from the loading system at the feed-throat drain. This will ensure that material loaded has been retrieved in a dry state.

• *Mold leaks*. A water fitting is leaking, or an internal water leak is present within the mold. Investigate the mold for signs that a water leak is present, and correct the condition.

Heat: Too much heat can have an appearance similar to moisture splay. The splay condition can completely cover a part, or it can appear inconsistently in various areas on the part. Look for signs of stickiness or burning. Another sign can be the smell of overheated material. Here are common causes for overheating:

• *Barrel temperatures are too high*. One of the key methods for identifying this condition is melt temperature. Verify that the melt temp. is within the window established by the material manufacturer. If at this stage you are developing a process, melt temperature should first be established at the lower end of the melt window, and then increased gradually until parts are in an acceptable condition.

• *Backpressure is too high*. It is important to note that while backpressure is key to material mixing, overuse can overheat the material. It can also lead to molecular-chain reduction and even material degradation. Backpressure should be set with these variables in mind.

• *Barrel residence time is too long*. The amount of time that material spends in the barrel can lead to material degradation. One countermethod is to lower the barrel temperature in the feed zone to reduce the residence-time effect. Another thing to take into consideration is screw recovery time. The screw should finish recovery 1.5 to 2 sec prior to the end of cooling time. When a process requires a long cooling time, screw-rotate delay can be used to finish recovery at the desired time.

Shear: Generally, shear splay is repeatable, occurring in the same location on a part. The best method for determining root cause is to note where within the flow front the shear is occurring. Beginning-, middle- and end-of-fill splay events tell different stories. Here are common shear-splay causes and methods for correcting the condition.

There are a several reasons a processor might note beginning-of-fill splay. These might include:

• *Decompression after rotate*. The screw is being sucked back too far, leading to air in front of the material. Reduce the suckback position and/or speed to reduce exposure to air. Generally, decompression should be set at 0.1 to 0.4 in., using only the necessary amount of speed it requires to achieve the desired position.

• *Nozzle/mold temperature variance*. A large drop in temperature when material enters the mold from nozzle can lead to beginning-of-fill splay. Increase the mold temperature or decrease the nozzle temperature to offset the condition.

• *Gate size*. Smaller gates might require a slower beginning-of-fill speed.

• *Nozzle-tip/hot-runner drop obstruction*. In situations where the splay condition is new to a validated process, verify that there has not been a change in injection and/or peak pressure. The tip should be inspected for burrs caused by repeated touch-off at the sprue bushing. The runner itself can sometimes offer insight into burring conditions.

Splay conditions that recur during middle of fill are also a clear sign of shearing conditions. Slower injection speeds in the affected fill area will often correct the condition. In addition, areas within the tool that are affected by this should be inspected for burring. Mold details that obstruct the flow of material can also become a shear source.

One of the key identifiers of moisture in the process is that visually the splay does not occur in the same place every time, or in some cases the splay is all over the part.

Splay that occurs repeatedly at the end of fill is another shear-splay identifier. It is a sign of overheating at the gate or drop at the end of fill. End-of-fill shear can frequently be corrected by slowing fill speed at end of fill. It is also important to note that "waxing" of material (becoming more viscous) at the end of fill can create a shear condition. Faster fill at the beginning and middle of the flow front might be required to correct end-of-fill shear.

Understanding the effects of moisture, heat and shear in processing conditions is your best defense against splay. First, investigate what type of splay is occurring. This will help to identify what sources must be evaluated as a root cause. With the root cause identified, it becomes simpler to make the necessary adjustments to correct the condition. PT

ABOUT THE AUTHOR: Garrett MacKenzie is the owner/editor of plastic411.com, as well as a consultant/trainer to the plastic injection industry. He has provided his process engineering expertise to many top companies, including Glock, Honda, Johnson Controls and Rubbermaid, and currently works for a company that provides automotive products to Yenfeng, Faurecia and other top automotive suppliers. He can be contacted at *garrett@plastic411.com*.

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TOOLING

PART 4

Why Ejector Pins Break and How to Prevent It

In this installment the focus is on bearing length, clearances, keying, and machining.

By Jim Fattori

I spent a lot of time researching how much land or bearing length should be used in a core for various sizes of ejector pins. All I was able to find were several ambiguous rules of thumb. Some say the land length should be two times the pin diameter for pins under ¼ in. and one and a half times the pin diameter for pins over ¼ in. Others say the land length should be between ¾ in. and 1.5 in. Several sources say small-diameter pins need a "lot" of land length.

All of these "rules" seem far too general to me. And the rule about needing a long land for a small-diameter pin seems to me to be an incorrect conclusion as a result of an unsupported length issue. So I started to think about the pros and cons of various land lengths, or as my father used to say, "Think in terms of extremes."

If a land length is excessively long, it would cause greater resistance for air and gas to vent out. And because of the increased surface contact area, it would generate a proportionally larger amount of frictional heat and abrasive wear, which could cause a pin to gall. Conversely, if a land length was excessively short, it could prematurely distort the hole in the core because of insufficient bearing surface to resist the forces of pin deflection, misalignment, and the associated side loads. There must be a logical, mathematical solution to this age-old conundrum.

LAND-LENGTH EXPERIMENT

I decided to make a chart starting with a 1-in. diam. pin and assigning it a land length of 1.5 times its diameter. I then incrementally increased the number of diameters by 1% until I reached the smallest standard diameter pin—1/32 in. Interestingly, even though the number of diameters increased, the land length and the amount of surface area decreased, as I suspected would be the case. The accompanying table lists the results of these calculations. I'm not recommending you use these values. They have yet to be validated. But you definitely should consider an ejector pin's land length and the resulting amount of surface area, instead of arbitrarily using some rule of thumb that has little or no empirical validity or is based on incorrect assumptions from previous failures.

FIG 1

Example of a thumbnail ejector pin.

Since there is an exception to every rule, always leave a considerable amount of land length for any pin that ejects the sprue puller, runner, or various types of gates. As mentioned in a previous column, long bosses are often required in order for them to perform their intended function. If there isn't enough land length to extend the length of a boss, that's going to turn an easy fix into an expensive one.

If it ever comes down to having to make a choice between increasing the bearing length or accepting an excessive unsupported length—increase the bearing length. Theoretically, if all of the holes are perfectly aligned and there are proper clearances, you should not get any friction between the pin and the core. But that is in a perfect world—one without temperature variations, material outgassing, injection forces and machining tolerances. As a precaution, molds with very small ejector pins, or a lot of ejector pins, should initially have a short preventive-maintenance interval. Once some history has been established, the interval can be adjusted accordingly.

Empirical Calculation of Land Length vs. Pin Diameters

Pin Size, in.	Number of Pin Diameters	Land Length, in.	Surface Area, in²
1/32	2.80	0.09	0.009
1/16	2.74	0.17	0.034
1/8	2.63	0.33	0.129
3/16	2.53	0.47	0.279
1/4	2.43	0.61	0.477
5/16	2.33	0.73	0.716
3/8	2.24	0.84	0.991
7/16	2.15	0.94	1.295
1/2	2.07	1.03	1.625
9/16	1.99	1.12	1.976
5/8	1.91	1.19	2.343
3/4	1.76	1.32	3.113
7/8	1.63	1.42	3.910
1	1.50	1.50	4.712

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While the table lists the standard ejector pin sizes, ejector pins are readily available in 0.005-in. over-size diameters. If you shop around, you will find pins are also available in diameters as small as 0.010 in. and in increments of 0.0001 in. If you can't find the exact size pin you need for a application, you can also consider using a metric pin. Whenever an odd-sized ejector pin is used, it should be engraved or otherwise marked to avoid mistakes during assembly. One trick is to coat the head of the pin and a portion of the retainer plate with a thin layer of metal stain.

It's good practice to number every ejector pin—even if they are not keyed, or don't vary in size or length. I once had preventive maintenance performed on a mold that ran a low-viscosity material—nylon 66. It just needed a good cleaning and some fresh grease. There was nothing wrong with the mold or the parts it produced. After the PM was performed, we developed flash running down several of the ejector pins and couldn't figure out why. It turned out that the diameters of some of the pins were on the low side of their tolerance, and they were installed in some through holes that were on the high side of their tolerance. The tolerance stack-up was enough to cause a problem for a material that flashes at a clearance of just over 0.0005 in.

For molds running a low-viscosity material, each ejector pin should be measured individually to four decimal places, as well as the holes in the cores they go into. Keep in mind that an ejector pin never stays perfectly in the center of its hole. It will always shift to one side or the other. For this reason, I recommend that the amount of clearance between the hole in the core and the ejector pin should be slightly less than the vent depth recommended by the material manufacturer, but not too much less. A tight fit is one of the biggest reasons why an ejector pin will gall.

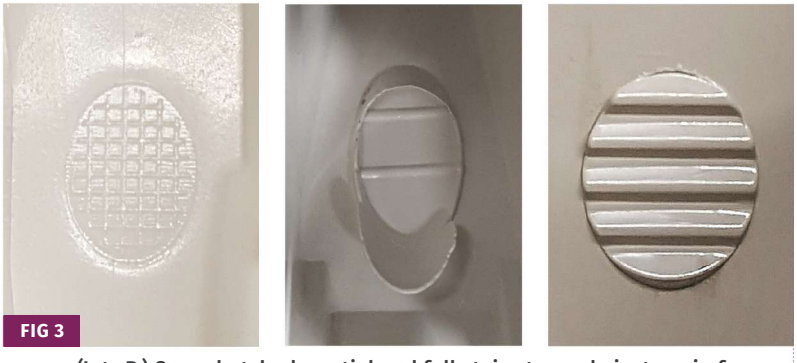

FIG 3

(L. to R.) Cross-hatched, partial and full stair-stepped ejector-pin faces. Notice the down-flash primarily on one side of the partial stepped pin.

In extremely precise molds, the backs of the heads of the ejector pins should be ground so that they are all the exact same thickness, and perfectly perpendicular to the centerline of the pin and the direction of travel. This eliminates the chance of a lateral force being applied to the pin and the through-hole in the core, which can cause several different problems.

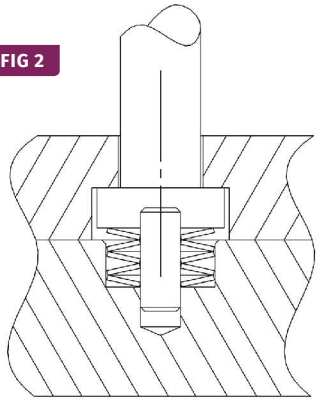

FIG 2

Bellville springs absorb impact and prevent damage in metal-to-metal applications.

SLEEVE EJECTORS

Trying not to stray too far off topic, land-length consideration also applies when you are using a sleeve ejector—both on the outside diameter and the inside diameter. The bearing length on the OD is the same as you would use for an ejector pin of that diameter. The bearing length on the ID is a completely different story. The tip of the core pin inside the sleeve should never disengage from the sleeve's internal land, or bearing length, regardless of how generous the lead-in angle might be—typically 1° per side. Therefore, a sleeve's internal land length should be equal to the ejector stroke plus at least an additional ⅛ in. Otherwise, the tip of the core pin can wear as it rubs against the transition section.

The transition section is the area between the relief diameter and the land diameter. While this may seem like an excessive amount of bearing length, you must consider that the internal bearing length decreases as the sleeve advances to eject the part. Typical internal bearing lengths for standard ejector sleeves are 1.75 in. and 2.25 or 2.5 in. Nine times out of 10, the sleeve needs to be shortened to a required length. This reduces the bearing length. For long-running molds, custom sleeves with an increased bearing length may be warranted. If the ejection system isn't guided and you have an ejector sleeve, add at least two dowel pins in opposing corners connecting the ejector plate and the ejector retainer plate to ensure they are properly aligned. This is also a good idea whenever a component such as a lifter is mounted in the ejector plate.

Some ejector pins must have their position oriented due to a shape or contour machined on their tip. There are several ways to do this. What's important is that when you key an ejector pin, you usually lose lateral float in at least one direction. Therefore, these pins require greater positional accuracy. There is an advantage to keying ejector pins. They remain angularly oriented to any uneven wear on the pin and in the corresponding through-holes

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in the core. This is especially important when a portion of the pin butts up against plastic, and the remaining portion butts up against steel—as is the case with parting-line, "thumbnail," or "toenail" ejector pins. Thumbnail ejector pins (Fig. 1) are a great way to prevent having to use small-diameter pins.

For example, instead of using a 1/64-in. diam. pin in the center of an 0.080-in. outside wall of a part, you can use a 1/8-in. diam. pin and let most of the pin extend beyond the edge of the part and seal off against the cavity. Not only will the larger pin have less chance of buckling, there is an increased amount of surface area pushing against the part. But there is a significant risk to this ejection method—one that I always try to avoid. If the pin is not perfectly flush or slightly below the parting line, the pin will indent the cavity plate or deform a portion of the face of the pin. If that pin isn't keyed and can rotate, it's going to flash parallel with the parting line. If you ever get this condition, don't try to fix it by pre-loading the pin. That will eventually make the situation worse.

Number every ejector pin—even if they are not keyed.

Any ejector pin that shuts off against steel should be through hardened—not nitrided. Nitriding is a surface or "case" hardening process, where the surface is typically between 65 and 74 Rockwell C. This high hardness diminishes gradually to a depth of 0.012 to 0.020 in. Due to the high surface hardness and softer center, nitrided pins can chip when they shut off against steel. Through-hardened pins made from M-2 steel at 60 to 63 Rockwell C are probably the best for steel-on-steel applications.

To avoid chipping or other damage to any type of pin that butts up or seals off against anything other than plastic, I like to add small Bellville washers, also known as a disc springs, under the head of the pin (Fig 2). The spring absorbs the impact and compensates for any change in length, which could otherwise cause flash to develop from a small gap or cause the head of the pin to mushroom from repeated compression. If the ejector plates are not tied into the molding machine and they are not spring loaded, this Bellville washer design works extremely well for preventing damage to return pins, which in this scenario is the only means of positive ejector-plate return.

A pin that is shaped or contoured with a steep angle usually wears out the through-hole in the core on the side opposite the contoured shape, due to the tangential forces applied during both injection and ejection. This is why contoured pins will develop "down-flash" before ►

non-contoured pins will. To help reduce this accelerated wear, the face of the contoured pin should have a stair-stepped relief, often referred to as "teeth." This won't keep the pin from being pushed to the side by plastic pressure, but it greatly reduces the tangential forces during ejection. Instead of stair-stepping, some mold makers use a coarse EDM finish, a cross-hatched pattern, or simply a few notches on the face of the pin to get a better grip on the part. None of these methods are as effective as a full stair-step design (Fig 3).

It is often a good idea to install a shaped pin in a fixed sleeve. If the sleeve wears out, it is easier and cheaper to replace it than having to repair a worn through-hole in the core. Having an ejector pin ride in a fixed sleeve is also ideal if the core is relatively soft, or if the molding material is corrosive. If a shaped ejector pin needs to have its face polished, it should be made of through-hardened steel to prevent "dishing" in the softer center during polishing.

From time to time, a threaded hole has to be added to the face of a large ejector pin or return pin. One common example is when two ejector pins are connected to a bar, and the bar ejects the part. Another example is when an ejector system is spring loaded. Trying to assemble the mold without damaging the ejector pins can be very difficult because of the necessary pre-load. Adding a tapped hole on the end of the return pins and installing a screw and washer keeps the ejector retainer plate in the perfect position for assembly. In order to tap the end of these pins, you either need a nitrided pin, which has a core hardness of 40 to 50 Rockwell C, or an equally soft through-hardened pin.

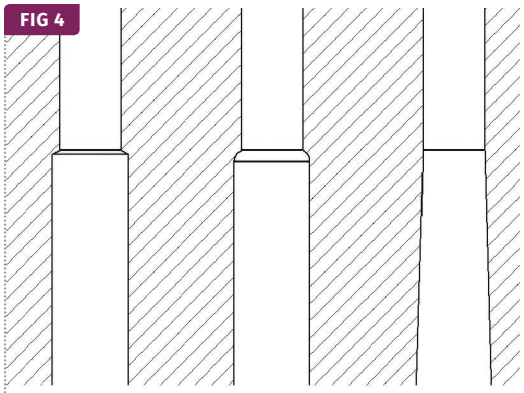
Ejector-pin clearance, or relief holes, are drilled into the back of the support plate and frequently into a portion of the core insert. The clearance depth in the core insert ends at the beginning of the land or bearing diameter. The diameter of these clearance holes is typically 1/32 in. larger than the nominal ejector-pin diameter. That might be fine for larger pins; but for smaller pins, especially any shouldered pins, it is better to reduce this clearance to just 1/64 in.—the same amount that should be used in the ejector retainer plate. The pins will be allowed to bend only about 0.008 in. before the inside diameter of the bore supports the pin and prevents it from bending any further. And yes, when a pin bends and comes in contact with the side wall of a clearance hole, it effectively reduces its unsupported length, which is advantageous for reducing the chances of it buckling and breaking.

For small-diameter pins, reduce the ejector-pin clearance in the support plate to just 1/64 in.

There is a transition section between the clearance hole and the land area in the core. It is formed by the angle on the tip of the drill bit—typically 118° or 135°. While it's not usually necessary, it is good practice to blend the sharp edges at the beginning and end of the transition. Using a ball mill instead of a drill bit helps, but a tapered reamer is considerably better. This prevents the tip of the pin from chipping during assembly—especially if the pin has a texture, engraving, or a contoured shape on the end. Note: When engraving an ejector pin or core pin with a cavity number or other indicia, stay at least 0.020 in. away from the perimeter, especially if the pin is nitrided. If the engraving is too close to the edge of the pin, the pin becomes extremely weak and fragile.

If a mold has interchangeable cores and they are "face" or parting-line mounted, the relief holes for the ejector pins should be reamed with a full taper from the back face of the core to the start of the land diameter. Sometimes it's possible to wire-EDM this taper (Fig. 4). This makes it much easier to align the ejector pins to the land diameter without damaging the pins during the changeover assembly.

FIG 4



Clearance holes installed with (l. to r.) a drill bit, ball end mill and tapered reamer or wire EDM.

Since ejector pins need to be cut to a precise length, care should be taken to remove any small burrs on the tip of the pin. If you are super meticulous and don't like the aesthetics of the heat-induced blue color on the end of a pin, there are various chemicals available to safely remove it. Several toilet-bowl cleaners work just as well at a fraction of the price.

It is not uncommon for the diameter of a boss on a part, or especially on a runner, to be exactly the same as the ejector pin's land diameter. In cases such as this, take a polishing stone and break the edge of the perimeter of the ejector pin—just enough to prevent the sharp edge from digging into the sidewall of the core. A better idea is to make the diameter of the boss at least 0.010 in. larger than the ejector pin. This will also help prevent downflash as the pin begins to wear or corrode.

HOW TO MACHINE EJECTOR-PIN HOLES

There are various methods used to install holes for ejector pins. First, every plate must be ground flat and machined perfectly square before any other machining can be performed. Years ago, plates were stacked together and the larger holes for leader pins, return pins and guide pins were "line bored" to ensure proper hole alignment. With today's precision CNC machines, line boring is no longer necessary. Typical positional accuracy is easily ±0.001 in. but can be much finer if the edges of the mold plates are ground smooth. This gives a more precise indicator reading when setting up the plates in the mill.

Some tool makers like to install all the ejector-pin holes from the front of the core, before the shape of the core is machined. While this will give you excellent positional accuracy, it makes milling precarious because of all the interrupted cuts. That may be acceptable for soft materials, such as aluminum, but you risk breaking cutters on tool steel. You also never want to install ejector pins to size, prior to heat treating. Heat treating can cause the steel to "grow" or warp, which will change the locations of the holes.

Drilling ejector-pin holes from the front leaves a small chamfer, or bell mouth, on the surface. Therefore, never drill from the front unless there is extra stock on the core, which will be removed later. However, if the core is fairly thick or made of pre-hardened steel, and the pin diameter is small, there is the risk that the drill bit will "drift," "walk" or wander out of position as it cuts. In this case, you can drill a smaller-diameter hole from the front, then drill and ream it to the final size from the back. Drilling from the back will leave a slight burr when you break through the front, but it can easily be stoned off. Don't forget to add a countersink to the clearance holes at the back of the core and the back of the support plate to provide a lead-in for the pins.

Molds are expensive, but so is downtime.

It all comes down to this: Molds are expensive, but so is downtime. You have to find a happy balance between how many expensive extra steps to take in the mold design and mold construction, versus the risks and costs associated with mold repairs during its lifespan, as well as not being able to meet your customer's production requirements. PT

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By Heather Caliendo
Senior Editor

Recycling Breathes New Life into Textile Leader

Fiber producer Unifi reinvents itself as a plastics recycler that turns PET bottles into recycled fibers.

PET bottles await a new life as yarn at Unifi's bottle processing center in North Carolina.

Recycling offers a new life to a used product. For Unifi, Greensboro, N.C, it also breathed new life into its business as a textile leader. Unifi (***unifi.com***) is a global textile provider and one of the world's leading innovators in manufacturing synthetic and recycled performance fibers. The company has 3000 employees with manufacturing facilities worldwide.

Through Repreve, one of Unifi's proprietary technologies, Unifi has transformed more than 10 billion plastic bottles into recycled fiber for new apparel, footwear, home goods and other consumer products. Building from that momentum, Unifi is targeting 20 billion bottles recycled by 2020 and 30 billion bottles by 2022.

Repreve is a brand of recycled fiber and pelletized resin, made with up to 100% recycled materials including pre-consumer and post-consumer waste. Unifi works with brands such as Ford, Patagonia, Dockers, Haggar, New Balance and Quiksilver, from surfwear to outdoor gear to car interiors.

Plastics Technology took a closer look at how this textile maker got into the recycling business.

TRUE CALLING

The great-great-grandson of a cotton-mill owner, George Allen Mebane IV founded Unifi in 1971 with a goal to disrupt how textiles are made. The company saw plenty of success for years, but in the 1980s the "polyester fad" declined. Unifi doubled down on more advanced technology as the market discovered new uses for polyester and nylon. For the next 20 years, Unifi enlarged its global footprint and diversified, focusing on high-quality synthetics.

But it wasn't until 2007, with the development of Repreve recycled fiber, that Unifi found its true calling. It started as a way for the company to recycle its own manufacturing waste. But the firm soon realized the enormous potential impact if the company also recycled PET bottles.

"So, instead of us just going through and producing a standard grade of textiles, going into the Repreve brand allowed us to differentiate ourselves from the competition," says Charlie Schwarze, global director of Repreve Recycled Business.

Unifi evolved into a synthetic manufacturer focused on sustainability with the Repreve brand, which has become the fastest growing segment of sales within the company by revenue numbers.

HOW THE PROCESS WORKS

Schwarze says that in the U.S., Unifi works with communities and material recovery facilities (MRFs) to recycle the PET bottles. The company also works with direct sources of bottles such as a bottle distribution facility from a soft-drinks company. Unifi also engages with event venues like stadiums and concert halls to recycle bottles directly.

The bottles are sent to Unifi's Repreve Bottle Processing Center in Reidsville, N.C. The 150,000 ft² center processes more than 2.2 billion PET bottles each year that will eventually become recycled performance fiber. The front-end separation equipment comes from Bulk Handling Systems (BHS), Eugene, Ore., (***bulkhandlingsystems.com***); and nine optical units with in-flight sorting technology are from National Recovery Technologies (***nrtsorters.com***), Nashville, Tenn., a wholly owned subsidiary of BHS. Optical separation units remove non-PET plastics from the raw-material stream and can process 22,000 lb/hr.

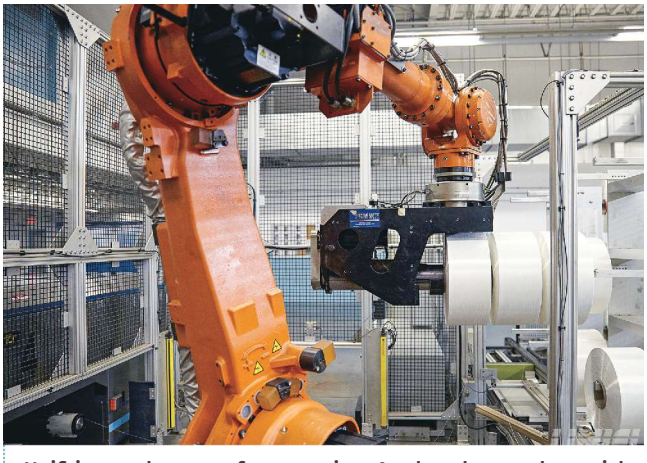
Italy's Amut Spa (North American office in Vaughan, Ont.; ***amutgroup.com***) designed, built and installed the PET washing line. A separate Amut process removes shrink-sleeve labels from the bottles. Autosort Flake equipment from Tomra, Sacramento, Calif. (***tomra.com***), sorts the washed and chopped flake a final time to ensure that impurities have been eliminated and color and flake size are consistent. Unifi employs about 150 in the bottle processing center and leans heavily on its employees to ensure the quality of its recycled PET.

"Technology has gotten us to a certain point, but as PET packaging evolves—lighter weight, more non-clear bottles, more shrink labels, and inclusion of metal in things like spray pumps—our employees that keep the line running and hand-sort bottles are the keys to success in terms of recycled PET quality," Schwarze says.

The production flake is transported to the Repreve Recycling Center in Yadkinville, N.C., where it is extruded and pelletized to make what the company calls "chip." Unifi also sources material directly into the Repreve Recycling Center, including pre-consumer yarn material as well as fabric scraps. These can be combined into what Unifi calls a hybrid blend of pre-consumer and post-consumer waste, which is extruded into chip and then into yarn.

The center occupies more than 105,000 ft² and houses three Starlinger recoSTAR Universal units and one recoSTAR Dynamic unit. (Starlinger's U.S. office is American Starlinger-Sahm, Fountain Inn, S.C., ***starlingersahm.com***.) Of the four Starlinger units, three are hybrid-capable, meaning they can process both post-industrial fiber material and post-consumer bottle material. There's one machine dedicated to just post-consumer bottle flake. The company also utilizes two Starlinger ViscoSTAR solid-state polycondensation units for decontamination and I.V. increase when necessary.

Recycled material is blended, melted and turned into Repreve pelletized resin, which is loaded into silos, each of which holds 1 million lb of chip. Next, the resin heads to Unifi's fiber-spinning plant, where Unifi uses 36 extruders from Oerlikon Textile, Charlotte, N.C., to convert resin into Repreve partially-oriented yarn (POY). Unifi then ships the yarn to its customers.



Unifi is an advocate of automation. As show here, robots pick up spools of thread at the Repreve Recycling Center.

Schwarze says Unifi can solution-dye the material, which allows addition of a pigment or color to the yarn at the POY phase. In Reidsville, Unifi also has a packaged dye facility that can dye the yarn in various colors. The choice of dyeing approach depends on customer needs and the economics that go into selling that yarn.

The yarn then goes to various mills that will knit or weave the fiber into different end products. And then it proceeds to cut and finishing operations, which ultimately ends up on store shelves and branded products. ►

Schwarze says the company also sells some of its flake and chip material into the open market for various polyester end-uses. Unifi sells some material into the strapping market and sells flake PCR for thermoformed sheet as well. "It's a very versatile material that can go into almost any polyester end-market," he says.

RECYCLING DEMAND

The company says its recycled fiber is a high-quality drop-in replacement for virgin fiber that is traceable and certified. Increasing the amount of recycled material in products is becoming more widespread among all different types of brands, which is great news for a company like Unifi. "Generally, what we're seeing is that younger consumers actively seek out and purchase from brands they know to be socially and environmentally responsible. Millennials are drawn to brands that reflect their personal values," Schwarze says.

With less material now being sent over to China, Schwarze says the polyester end-markets for recycled bottles remains strong. While there has been some extra material in the last 18 months since China's National Sword policy went into place, it has been offset by a lot of growth in the recycled PET industry in the U.S.

Some minor challenges remain. For example, when the company recycles bottles at its Reidsville operation, they get non-PET by-products, so the company is becoming creative in finding ways to move those materials.

In the Repreve recycling process, pellets (or "chips") are melted and extruded into a fiber.

With those big goals to recycle 20 billion bottles by 2020 and 30 billion bottles by 2022, one of the challenges is that as of 2016, the U.S. has less than a 29% recycling rate for plastic bottles. As a result, Unifi is looking to get the recycling message out by various partnerships to boost recycling rates at home and through direct recycling of materials from event venues and universities.

For instance, Unifi announced a long-term partnership with the collegiate Pac-12, with Unifi serving as the Founding Sustainability Partner of Pac-12 Team Green and as a sponsor of the Pac-12 Sustainability Conference. Unifi will provide annual grant awards to all 12 of the Conference's member institutions to promote campus zero-waste activities and circular-economy programs. Unifi will

work with the Pac-12 and Pac-12 Networks, creating custom content and media assets to feature sustainability programs and support efforts to recycle billions of plastic bottles into fiber, and will serve as an official sponsor for all Pac-12 championship events.

"At Unifi, sustainability is a core component of the work we do and who we are," says Richard Gerstein, executive v.p. of premium value-added brands and global chief marketing and innovation officer at Unifi. "While we have recycled more than 13 billion plastic bottles into Repreve polyester products, including athletic shoes and apparel, we recognize the need to create a paradigm shift in recycling rates in the U.S. to keep even more bottles out of landfills. Working alongside the Pac-12, our goal is to expand this undertaking to our universities, which are taking a leading role in educating and changing behaviors."

Unifi has also partnered with several NFL teams, the NBA and the PGA by producing apparel and headwear from Repreve recycled fibers and has sponsored co-branded Repreve recycling bins at the events. For instance, at the 79th annual PGA Wyndham Championship in Greensboro, N.C., in August, Unifi partnered with recycler Republic Services to place 300 co-branded Repreve recycling bins throughout Greensboro's Sedgefield Country Club. With the participation of tens of thousands of Wyndham Championship attendees, an estimated 1.8 tons of plastic bottles were collected, recycled and diverted from landfills.

Unifi isn't afraid to invest in new technologies, too. The company offers technologies such as moisture wicking and thermal control that allows them to include performance benefits on top of eco-friendly fibers.

"We will continue to invest heavily in both innovation and technology," Schwarze says. "From a technology standpoint, we are always exploring the next-generation equipment to be able to provide better quality to our customers."

The Repreve Bottle Processing Center has been in operation for only two years. Schwarze says the firm will continue to invest in technology for that facility to develop a higher quality flake that allows it to use more recycled content in its end products. And the Repreve Recycling Center is looking into developing more cost-efficient and better end-product material that can use a higher percentage of post-consumer recycled materials in its yarns.

"As we continue to look at different technologies, we're not afraid to invest," Schwarze says. "And that's what really started the Repreve brand and kept us relevant in the early 2000s when a lot of textile manufacturing in the U.S. went to Asia and Central America. With Repreve being a large part of what Unifi is, it's about investing in sustainability. Innovation and investment in disruptive technology is in our DNA, and we will continue to do that as we evolve as a company. PT

How to Maximize Your Conveying System Performance

If your conveying system isn't up to snuff, and you don't have the budget to overhaul or expand it, don't lose hope. There are many factors that could be limiting your conveying performance, and a number of them cost little or nothing to fix.

By Doug Brewster
Conair Group

Your material handling system is maxed out. Your machines are calling for material and the system can't keep up. You're falling behind on production and you think you need more conveying capacity to catch up.

But before you go looking for a budget to expand your system, maybe there are some simpler, short-term solutions. A number of factors could cause your vacuum-conveying system to come up short in particular situations. These failures often can be traced to maintenance issues, production or material changes, or design flaws built into your system. Let's look at some of these.

WHAT YOU WILL LEARN

1. **VACUUM IS CRITICAL:** It determines how much material can flow through your conveyor system in a given period of time.
2. **DISTANCE CHANGES:** Even small increases in distance can create conveying challenges.
3. **DESIGN LIMITATIONS:** Optimal layouts can be difficult to achieve and maintain in a fast-changing production environment.
4. **UPGRADE:** You can easily "tune up" the your existing conveying system by replacing and upgrading your pump.

VACUUM IS THE KEY

The vacuum level within your system is a key determinant of how much material can flow through your conveyor system in a given period of time. More than the speed of air flow, vacuum level is what determines how much material can be suspended and move in a given column of air. So, if your system isn't keeping pace, look for factors that may be reducing vacuum levels.

> ***Inadequate conveying performance can often be traced to maintenance issues, production or material changes, or design flaws built into your system.***

Are all conveying-system air filters clean and free of dust? After maintenance, have filters and canisters been properly reconnected and sealed? Are all clamps and fasteners secure and leak-free? Any of these things can limit the vacuum your pumps can generate.

Are all flexible hoses free of cracks or holes? Are all of them properly and tightly secured? Flexible hoses are frequently moved, and every move creates potential for wear, improper connection, or leakage. Generally, it is good to minimize use of flexible hoses, since—compared with rigid piping—they also reduce conveying throughput.

PRODUCTION/MATERIAL CHANGES

There are many reasons, including production changes, mold changes, or improvements in molding cycle times, that could mean that you are utilizing material at a higher rate than you used

to, so that you've reached the upper capacity limit of even a well-designed and maintained system.

Has your material mix changed? A new material may have flow characteristics that make it more difficult to convey and that may be putting a subtle drag on throughput rates.

Over time, it's possible that your receiver replenishment cycle times have fallen out of balance. If resin throughput on a given machine has been reduced, but the timing of receiver cycling was not also changed, receiver cycles could be longer than needed. When the receiver becomes overfilled, the pump may continue to try to deliver material or a relief valve may open. In either case, you're not only wasting pump cycles, conveying capacity and time, but also are starving other receivers of needed fill time. You're throwing away capacity instead of putting it where it is needed. So it is important to check all of your receivers periodically; not just the ones that seem to be causing you problems.

DISTANCE CHANGES

Has the position of a material source been changed? It's not uncommon to see a processor that can convey material from one location, but cannot pull the same amount of material from a different location that appears to be about the same overall distance away. Even small increases in distance can create conveying challenges, because vacuum pumps have to sustain sufficient vacuum to keep large amounts of material in suspension and sufficient air velocity (cfm) to keep it moving. There can be a lot of factors that go into calculating the actual distance over which material must be moved in a system.

For example, the effective distance involved in moving material from a point 200 ft across a facility can add up to a lot more than the distance between point A and point B, due to system design factors that, essentially, make the distance longer. Consider this calculation:

- Start with horizontal feet of conveyor line required: In this case, 200 ft.
- If the line is mounted overhead, multiply vertical feet x 2 and add to the previous figure: 20 x 2 = 40 ft.
- If the line contains 90° bends, multiply the number of bends x 20 ft and add to the previous total: 5 bends x 20 = 100 ft.
- Total: 200 + 40 + 100 = 340 ft.

Other factors, including the use of flexible hose, may also add to the overall distance that your pump must pull material.

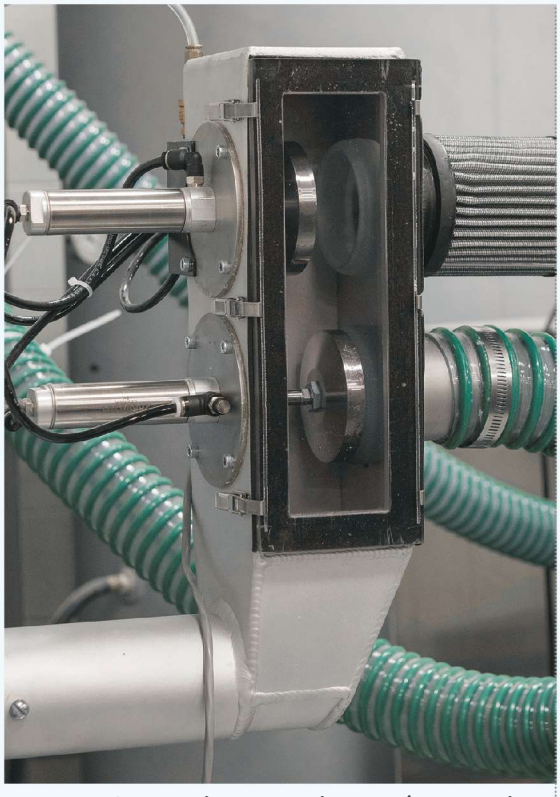
SYSTEM DESIGN LIMITATIONS

Although a good conveying-system design seeks to minimize features that add to the distance or difficulty of moving material, such optimal layouts can be difficult to achieve and maintain in a fast-changing production environment.

When conveying lines run overhead, you not only need to worry about the limits imposed by vertical rises (see above) but you also need to worry about vertical drops—to a resin selection station, for example. Dips or drops like these must be well designed or they will form "traps" in the system, where material plugs can form. If a conveying cycle ends—or a straining pump triggers a vacuum relief valve—while material is still suspended in the vertical tube, the material will fall to the bottom of the "trap," forming a plug.

The remedy is automatic purging, regulated by the conveying control and a valve at the material pickup point. At the appropriate point in a cycle, the valve closes to material and opens to outside air, conveying any material remaining in the line through to the designated receiver before the system begins to supply another destination.

Another design issue that can affect conveying performance is upwardly sloping conveying lines (i.e., lines that incline upward at angles of 45° or so). Unlike 90° bends, where materials flow turbulently through ►



Drops often require automatic purge (such as with this Conair auto-flushing common-line valve) or they can trap materials and form plugs in the system. Use of flexible hoses should also be held to a minimum because they reduce conveying throughput.

Regular filter cleaning, followed by careful reconnection and leak-free sealing, is essential to maintaining proper vacuum levels and airflow in all conveying system components, from vacuum pumps to receivers, and more.

the bend and remain in suspension, the airflow through shallower upward slopes tends to push material to the bottom of the conveying pipe. This forces the system to drag it uphill against not only gravity and but also friction. The relative amount of friction is lower with harder materials (like HDPE or acrylic) that may slide more easily; but friction increases with more rubbery materials, such as TPEs and flexible vinyl. If sloping conveyor pipe runs are sufficiently long—10 ft or more—they can really stress vacuum-pump performance, reducing throughput by up to half, depending on the length and type of material involved. System design flaws like this can have a significant impact on equipment performance.

The effective distance involved in moving material across a facility can add up to a lot more than the distance between point A and point B.

IF ALL ELSE FAILS, UPGRADE

If, after a thorough check, you determine that the existing piping and elements are leak-free and functioning properly, but your existing pump and controls are inadequate for the material volume or lengths required, you can substantially "tune up" the power of your existing conveying system quite easily by replacing and upgrading your pump.

If your first thought is to rebuild an aging pump, or to replace it with a larger model of the same type, consider the merits of upgrading to a long-distance positive-displacement vacuum pump (LDP) of equal or greater horsepower. Typically, these pumps deliver a significant bump in conveying performance with little or no major changes required to existing conveying hardware. Compared with traditional lobe-style positive-displacement vacuum pumps of the same horsepower, new long-distance pumps can provide up to twice the throughput or twice the conveying distance.

How do they do it? More powerful LDP pumps enable processors to increase the level of vacuum within their conveying systems. A higher level of vacuum means that the airstream in the system can suspend and carry more material through the line. Many typical existing conveyor systems run at vacuum levels of 10-11 in. Hg (absolute). However, with an LDP pump of comparable horsepower, it is possible to run at 12-15 in. Hg or perhaps a bit higher. This difference—a greater level of vacuum—enables the same conveying-system plumbing to carry far more material over the same distance or to pull materials over much longer distances.

Upgrading to a long-distance, positive-displacement vacuum pump increases the level of vacuum in a conveying system, enabling its airstream to suspend and carry more material over longer distances.

To manage this additional pump capacity within your existing conveying system, it is a good idea to equip your new vacuum pump with a variable-frequency drive (VFD). Using either the VFD or a conveyor control, you can "tune" the performance of the pump to match system requirements. For example, you can tune the pump speed (rpm) and air volume (cfm) to exactly match the line size and conveying speeds required, while maintaining the operating pressure to match conveying distance and material throughput needs.

For even more precise control and system flexibility, you might also consider upgrading to a conveying control that

If equipped with a variable-speed drive, located between the power drop and the pump, the speed (rpm) and air volume (cfm) of the new pump can be adjusted manually or with control-system "recipes" to match line size, conveying speed, and material throughput requirements.

offers receiver-specific recipes. The latest conveying controls, for example, allow storage of up to 10 recipes for up to 128 receivers. These recipes make it easier to take advantage of all the capabilities of a VFD-equipped LDP pump,

If your vacuum pump is inadequate, consider upgrading to a long-distance positive-displacement vacuum pump (LDP) with a variable-frequency drive (VFD).

allowing conveying parameters to be customized to suit different material types, line sizes or other factors.

Troubleshooting and improving the performance of a resin conveying system that's having problems doesn't always have to be a complex process. In many cases, focusing on the basics, including good maintenance, leak detection and repairs, and occasional checking and updating of key control settings, will go a long way toward preventing problems and maximizing system and pump life. If you're doing these things and are still encountering problems, then it is probably time to call for help from your system supplier. PT

ABOUT THE AUTHOR: Doug Brewster is conveying products manager for Conair Group, based in Franklin, Pa. He is also the primary developer of Conair's Wave Conveying variable-speed conveying system. Brewster joined Conair in 1987 as a systems engineer. Since then he has held a series of progressively more responsible positions, including bulk-system product manager, project manager, national accounts manager, regional manager, national sales manager and customer service manager. In his current position, he has responsibility for continuous improvement in current equipment offerings and new product development. Contact: 814-432-6202; *dbrewster@conairgroup.com*; *conairgroup.com*.

Color variation shows temperature difference based on surface reflectivity. It is a factor to consider when purchasing an IR camera for higher reflectivity surfaces.

What Thermal Imaging Can Do For Your Molding Process

It can aid in process development, production monitoring, and troubleshooting. Here's one molder's primer on the subject.

By Michael J. Mortvedt
Juno Pacific

Thermal imaging is considered both a sophisticated and subjective method to measure temperature because it's taking an "apparent" temperature. However, it can greatly assist in troubleshooting and process development. The purpose of this article is to show how it can supplement—not necessarily replace—other types of heat-sensing equipment and be less subjective.

One of the biggest benefits to using thermal imaging is the speed at which a problem can be noted and quantified. When troubleshooting injection molding equipment, it is a quick way to find discrepancies in barrel heaters, water flows, dryers or mold heaters.

Higher-end thermal imaging cameras (TICs) can be pricey, but there are a lot of low- and mid-grade units that can be just as effective. Over the past few months, we at Juno Pacific, a molder that specializes in medical device manufacturing, have been trying to integrate TICs into our process-development and troubleshooting toolbox. To justify the investment, we took a known, calibrated, handheld pyrometer and compared its accuracy with that of the TIC before we purchased a higher-end camera. The following information is a compilation of the data we collected to justify the purchase and substantiate the idea that the device could be used on for troubleshooting and maintaining process stability.

One of the biggest advantages of using an IR camera for process verification and troubleshooting is the non-contact aspect of getting data.

The first big obstacle that anyone must overcome in making this leap to thermal imaging is to bridge the gap between actual temperature and "apparent" temperature. Since infrared (IR) images are non-contact, they obviously take into account things like ambient temperature and other outside factors. However, as we quickly found, the data proves that there is little discrepancy between the apparent temperatures and contact-temperature measurements in an ambient environment. The speed at which IR images can be viewed and developed is where the real benefit lies.

So, if you're trying to justify spending the money, you might ask questions like these:

- Can you validate this type of method (especially in a regulated industry)?
- Can you prove equivalency to current methods being used?

THE EXPERIMENT

When we were kicking the tires on the idea of using IR images for process development and troubleshooting, we had to answer the same questions. What we decided to do was put some different methods to the test side by side in our normal clean-room environment for comparison. We compared a calibrated, two-zone, handheld pyrometer; a calibrated, fast-response immersion probe; a calibrated, standard 0.125-in. diam. immersion probe; and a TIC. Our methodology was as follows:

1. Take multiple purge samples on one machine.
2. Measure some of the samples with the fast-acting immersion probe (most used melt-temperature measurement method at our shop); not pre-heated.
3. Measure some of the samples with the standard 0.125-in. diam. immersion probe (one of the more readily available probes in our shop); not pre-heated.
4. Measure each sample with the IR camera.
5. Measure some samples using all three methods at the exact same time.
6. Measure and document time to equilibration.

THE RESULTS

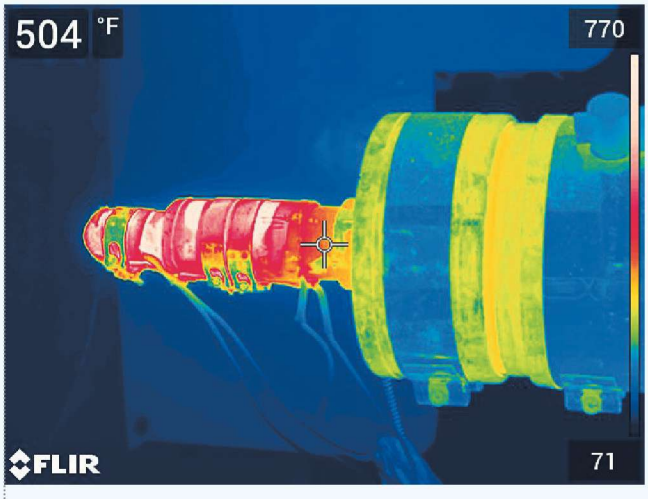
We immediately noticed that the temperature from the IR camera was within 2-4° F of the handheld measurements we were collecting. Furthermore, we noticed that the IR camera was by far the fastest; the fast-response immersion probe was the second fastest; and the thicker 0.125-in. probe was the slowest. What really got us scratching our heads was the amount of time that it took for all three methods to equilibrate.

The more shocking revelation was when we graphed the data for all three measurement methods, which highlighted how the IR camera was producing an accurate "right now" measurement of the melt.

The graph revealed that the IR camera generated an instantaneous measurement of temperature; the fast-responding probe took nearly 30 sec to equilibrate to the IR camera; and the other immersion probe took another 30 sec to equilibrate to the fast-response probe and camera. Using this data, we decided that it was well worth our time and money to purchase a camera to supplement our current methods of melt-temperature measurement and machine-performance analysis.

We identified several machine problems aside from the experiment using the melt probes that normally would go unnoticed. For example, we had a nozzle-body heater that was running too hot, but the machine's controller read that zone as being at the proper temperature because the heater was piggybacked to another zone that was not heating properly and it was compensating for the heat discrepancy.

Water lines that are not flowing can be identified quickly using thermal infrared cameras. The greenish-looking line is blocked or turned off.

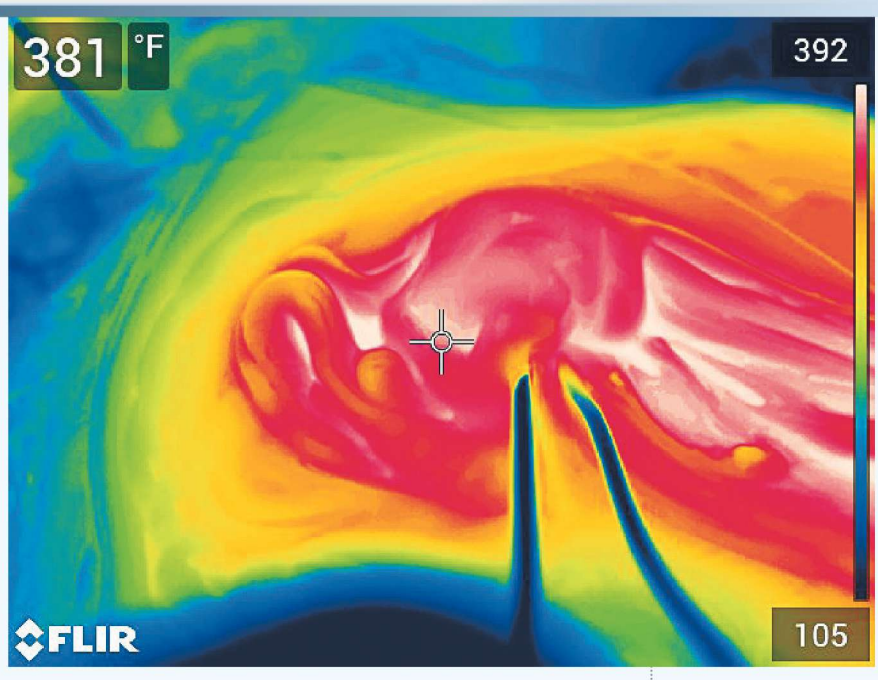


Verification of barrel heats can be performed easily and quickly with TICs. This thermal image shows a failing nozzle-body heater.

LESSONS LEARNED

The camera does a number of tasks for us—from allowing our setup technicians to evaluate water flows, to detecting melt temperatures, to helping our building maintenance crew troubleshoot HVAC problems and diagnose electrical issues.

One of the biggest advantages of using an IR camera for process verification and troubleshooting is the non-contact aspect of getting data. Part ejection temperature, mold-water flow, and dryer operation can all be verified while the machine is running parts. Melt ►



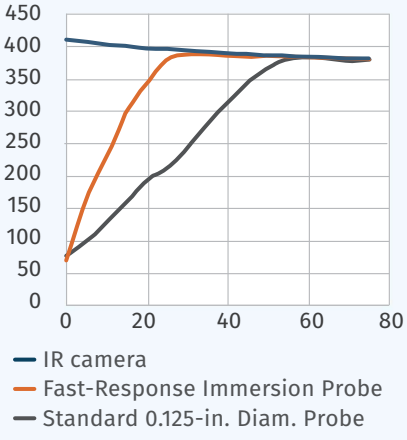
Thermal image of the experiment. On the left is the standard 0.125-in. diam. probe and the fast-response probe on the right.

temperatures can be verified within seconds without the need for preheating probes. (Again, this is not necessarily a replacement, but a quick gut check of what's going on. It's a great supplement.) Even operators running or verifying the machine parameters can be trained easily to use the equipment.

If you have critical processes and want an easy way to troubleshoot, verify and maintain them, it cannot be overlooked how good this equipment has become. It also can't be overlooked that the speed of the results and ease of use makes it easy for anyone to solve problems quickly.

Juno Pacific is a molder and not in the business of selling TICs, so this article is not intended as a sales pitch, but to simply make molders aware of the fact that there are faster, better ways of getting to root causes of problems. If you're thinking about TICs, take the time to validate and verify that they are going to work the way you want them to. Consider multiple brands and models. Test them and then decide what works best for your environment. It doesn't have to be too complicated to produce convincing results that spending the money will be worth it in the long run. PT

Temperature Over Time (Infrared camera vs. Hand-Held)



Results of the three-measurement-method experiment: The IR camera is collecting accurate data right away while the contact measurements are lagging. Measurements are in °F over time in seconds.

ABOUT THE AUTHOR: Michael J. Mortvedt is a process engineer for injection molding at Juno Pacific, Anoka, Minn. He has spent 12 years working for molders in the consumer goods, gears, automotive and medical industries. In his career with molders and others, Mortvedt has been involved in everything from concept through development into production and then on to continuous improvement. He has received Master Molder training from RJG. Contact: *763-703-5009; mjmorvedt@junopacific.com; junopacific.com*.

PRODUCT FOCUS Compounding Equipment

COMPOUNDING

Software for Twin-Screw Element & Barrel Configurations

Burgsmüller in Einbeck, Germany (a KraussMaffei Berstorff company) has developed software for configuring screw elements and barrel housings for twin-screw extruders. Called ScrewCon, the software can be used for configuring the processing sections of a wide range of different twin-screw extruders.

The software provides tailored screw-element and barrel-housing configurations for any application with true-to-scale visualization. In addition to in-depth process-engineering know-how and the specific rating of conveying, kneading, mixing or retaining elements, ScrewCon software offers tips on the optimum material selection for the screw elements and housings to maximize service life and output rates.

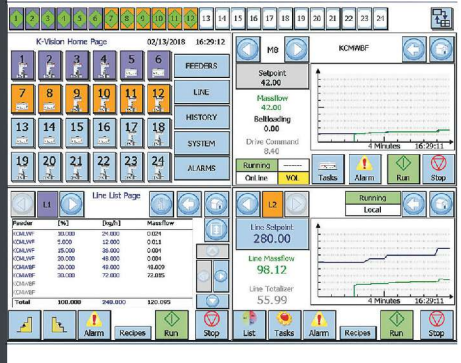
ScrewCon has a library of about 3000 screw elements and barrel housings for different twin-screw extruder brands, types and sizes. If the required elements are not available, Burgsmüller can easily add them using the basic data all machine owners have on hand. Burgsmüller can also provide compounders with the most cost-effective screw configuration by integrating special elements as well, like multi-process elements, shoulder kneading disks or other mixing elements.

+49 05563 705-0 • burgsmueller.de

FEEDING/LOADING

Controller Supports Two Independent Feeder Lines

Coperion K-Tron (U.S. office in Sewell, N.J.) has added new features to its K-Vision software. The K-Vision controller is a graphical operator interface for controlling multiple devices such as feeders or feeder-refill vacuum receivers in a process. With the release of K-Vision Software version 2.0, it can now handle a total of 24 devices (e.g., KCM feeder controls or MPC refill controls) in one or two lines. The previous version managed a maximum of 16 feeder controllers in a single line. K-Vision uses a 12.1-in. color LCD display together with a touchscreen. It offers a quad-screen display mode for viewing multiple pages on one feeder or a single page on multiple feeders.



Designed for simple operation and fast and easy startup, K-Vision offers graphic visualization of process information, utilizing flexible trend graphs. This feeder interface offers event logging and supports all of the different feeding control types for both continuous and batch operation. Easy to maintain, K-Vision software updates can be accomplished with a compact flash card or a USB flash drive.

K-Vision offers a variety of remote-access options. A second K-Vision can be connected via Ethernet as a remote interface for visualization and control of feeder and line parameters. K-Vision also comes with a VNC server, allowing any VNC client—on a PC, tablet or smartphone—connected to the same network to be used as a secondary user interface. In addition to the current connectivity options—including VNC, Ethernet/IP, Profinet, Modbus TCP—K-Vision now also has email capability.

856-589-0500 • coperion.com

COMPOUNDING

High-Speed Mixer Provides Dispersion, Planetary Stirring

PowerMix Model PDM-10 from Charles R. Ross & Son Co., Hauppauge, N.Y., combines high-speed dispersion with planetary stirring action. This is said to impart high shear to hard-to-mix applications with low flowability. Pictured are two PowerMix machines with interchangeable mix vessels. Beyond a traditional kneading action, the mixing mechanism of this proprietary planetary design is suited to heavy pastes and slurry-like applications involving a considerable amount of powders that need to be wetted out and dispersed uniformly.

These 10-gal models feature an additional sawtooth blade on each disperser shaft, doubling the shear-input capacity of the mixer. A rectangular stirrer orbits the vessel, effectively exposing the entire batch contents to the shearing action of the dispersers. For more viscous applications prone to climbing up the stirrer, patented high-viscosity blades are available with a helical curvature that pushes product forward and downward. Fully automated PLC recipe controls and data-acquisition systems are available.

800-243-7677 • mixers.com

ADDITIVES

Anti-Squeak Additive for PC/ABS Auto Interior Parts

A new silicone additive masterbatch from Dow Performance Silicones (previously Dow Corning), Midland, Mich., immediately and permanently reduces COF (coefficient of friction) in PC/ABS automotive interior parts to avoid noise in the vehicle cabin. The first in a new product family, Dow Corning HMB-1903 masterbatch replaces time- and labor-intensive post treatments with felt, lubricants and coatings.

HMB-1903 reportedly delivers high anti-squeak performance that remains stable throughout the life of the part. Tests show this additive achieves an anti-squeak risk priority number (RPN) rating below 3 at a typical loading of 4%. HMB-1903 reportedly also achieves a low score for impulse, which represents the number of stick-slip phenomena occurring during the squeaking test. Caused by friction between two surfaces, these are typically the source of squeaking.

800-248-2481 • consumer.dow.com

MATERIALS

First TPE to Resist Blue-Jean Stains

A new TPE alloy is aimed at phone-case brand owners that have been searching for a blue-jean resistant material. Said to be the first TPE to resist this type of staining on white and light-colored phone cases, CE 3320-70 is the latest addition to the Versaflex line of proprietary TPE alloys from PolyOne Corp., Avon Lake, Ohio.

Versaflex CE TPE also stands up to sunscreen, hand sanitizer, isopropyl alcohol and UV light. This recyclable thermoplastic also processes faster than silicones and adheres well to PC when overmolded.

866-737-2066 • polyone.com

PARTS CONVEYING

New Motors Increase Conveyor Modularity

The new quick-disconnect motor offered on conveyors made by Dynamic Conveyor, North Shores, Mich., reportedly provides benefits that increase conveyor modularity, application options, ease of use and maintenance. The connector enables a quick direct connection between the brushless DC motor and controller with an easy-to-use lock lever that does not require tools or additional hardware. The new connector makes it easier than ever to perform motor replacements or modify control options in the field.

The control package can be mounted anywhere along the conveyor's sidewall, on leg supports, or remote mounted up to 65 ft away from the conveyor. Additionally, the new motor has achieved an IP66 degree of protection for watertight performance, allowing it to be used in high-moisture applications. With the new IP66 rating, DynaCon conveyors can be fully submerged in a water tank when rapid parts cooling is needed.

231-798-1483 • dynamicconveyor.com

RECYCLING

Robust Melt Filter for High-Pressure Applications

The New Model CFO (Continuous Filter Operation) 25 melt filter from ADG Solutions, Tucker, Ga., offers more than 10% larger screen surface area and sizing that is completely imperial—replacing the existing 600-mm model. The cover includes 360° of studs, thereby properly sealing the surface and preventing any leaks. This robust design tolerates much higher pressures of up to 3500 psi.

ADG's CFO line handles a broad range of materials, including PE, PP, PS, PC, and ABS. The filter can handle up to 10% paper and other foreign objects up to 0.75-in. diam. Contaminants such as metal, wood, paper, textile fibers, unmelted plastic granules, and a smaller percentage of aluminum, lead, copper, rocks and other impurities, are readily tolerated.

Recent improvements in the series include a new scraper design that has been refined for smaller purges. This design improves efficiency and covers a broader range of applications. The corresponding computer controls have been updated to allow for a variable number of scrapes between purging cycles so the user can maximize contamination collection. The screen-plate filter has also been redesigned to be thicker and harder and to have more uniform hole quality.

Also available is a new diamond-hard plate surface for aggressive and abrasive processes. This design offers two to three times longer screen life than the existing design.

678-292-6144 • adgs.net

MATERIALS

Self-Bonding LSR Optimizes Overmolding With Specialty Copolyester

A new self-bonding liquid silicone rubber (LSR) from Momentive Performance Materials, Waterford, N.Y., is designed for overmolding onto medical grade Tritan copolyester from Eastman Chemical, Kingsport, Tenn., *without* the need for primers. Silopren LSR 47x9 series cures at relatively low temperatures. Unlike other medical polymers, Tritan complements Silopren LSR's chemical resistance for applications that demand compatibility with powerful disinfectants and solvents. This includes such applications as respiratory devices, sealing elements, gaskets, vibration reduction, and membranes and lenses for electronic device housings.

800-295-2392 • momentive.com;
800-327-8626 • eastman.com

BLOW MOLDING

Larger '1.5-Step' PET Machine

Nissei ASB Machine Co. of Japan (U.S. office in Smyrna, Ga.) is introducing a larger size of its "1.5-step" PF-series injection-stretch-blow machine. These machines incorporate both preform injection and stretch-blowing like a one-step machine, but the two operations are separated for optimum productivity of both operations. Up to now, the largest model in the series was the PF24-8B, with 12 or 24 preform cavities and four or eight blowing cavities—the blowing section that operates three times per injection molding cycle.

The new model PF36/36-600 has 36 preform cavities and a 12-cavity linear stretch-blow system. It can mold bottles up to 600 ml capacity. Its footprint is just 30 cm (11.7 in.) longer than the PF24-8, but increases productivity 50-80% from around 9000 bph to 14,000-17,000 bph.

Other models built on the same platform are the PF36/24-1500 with 24 preform cavities and eight blowing cavities, for bottles up to 1.5 L; PF36/18-2000 (18 preforms, six blowing cavities, for bottles up to 2 L); and PF36/12-5000 (12 preforms, four blowing cavities, for containers up to 5 L). Further models are in development for molding nine preforms and containers up to 10 L and six preform cavities for up to 12 L.

These hybrid machines have hydraulic injection and all downstream functions are fully electric. They utilize a new PC-based control system with larger, 18.5-in. touchscreen that replaces most manual switches.

404-699-7755 • nissei-asbus.com

INJECTION MOLDING

Six-Axis Robots Made Easy to Program

Absolute Robot Inc. (ARI) in Worcester, Mass., has partnered with ABB Inc. Robotics of Auburn Mich. (***abb.com/robotics***), to offer six-axis robots for injection molding. ARI has customized the control interface on ABB robots to make them easy to operate on injection machines of all brands and sizes, as well as with downstream automation equipment.

508-792-4305 • absoluterobot.com/6-axis

INJECTION MOLDING

Digital Manufacturing & Industry 4.0 Highlighted At Fakuma 2018

The "Road to Digitalization" was the theme of Arburg's exhibit at the Fakuma show last month in Germany. The company characterizes this as "the path towards future-proof and efficient plastic parts production." One of the new products and services on display aimed at the coming era of "smart factories" was the Arburg Turnkey Control Module (ACTM), a data collector for complex turnkey systems. This first-time presentation was part of a cell based on a 100-metric-ton all-electric Allrounder 470A press molding two housing parts for a spirit level in 46 sec using a 1 + 1 cavity family mold. The two parts were demolded by an Arburg Multilift V robot and assembled in an automated station together with three bubble levels to produce the finished product. The process included several test steps and labeling of each spirit level with a QR code. The ACTM uses the OPC-UA interface to collect process and inspection information from the injection machine and the camera inspection unit and assigns it to the individual part by means of the QR code. Visitors were able to scan this code with their smartphones to view the corresponding process data on a part-specific website.

"Smart services" also help pave the "Road to Digitalization." Arburg presented the first look at a new customer portal at Fakuma. It provides a variety of cloud-based services and apps. One of these is the "machine overview," which displays important information and documents for each machine. Another is the spare-parts catalog. Arburg also previewed the potential of augmented reality (AR) and predictive maintenance in remote service and troubleshooting.

For Fakuma visitors interested in the latest hardware, Arburg had on display its new-look hybrid Allrounder 820 H (370 m.t.) with the new Gestica control system, which was seen for the first time in a "Packaging" version. This high-performance machine can be provided with injection speeds up to 500 mm/sec. It molded four thin-walled IML containers of 500 ml in around 3.8 sec.

860-667-6500 • arburg.com

INJECTION MOLDING

Bigger 'Boy' Debuts At Fakuma

At last month's Fakuma show in Germany, the parent company of Boy Machines Inc., Exton, Pa., extended the size range of the Boy injection press line to 125 metric tons (137.5 U.S. tons), up from a maximum of 100 m.t. (110 U.S.) previously. The new Boy 125 E servohydraulic machine has tiebar spacing of 18.5 × 16.93 in., up from 16.93 × 14.17 in.; and max. daylight is 32.48 in., vs. 28.54 in. standard before. This provides more room, for example, when using a rotary platen for multicomponent applications, as was demonstrated at the show. The machine will be available next spring.

610-363-9121 • boymachines.com

AUTOMATION

Low-Cost, High-Speed Assembly Robot

A low-cost delta or "spider" robot for high-speed assembly and pick-and-place tasks is newly available from igus Inc., E. Providence, R.I. The low-maintenance, lightweight unit starts at $6200. It can be delivered pre-assembled or can be assembled on-site in about 30 min with easy-to-use instructions, the company says. Stepper motors and encoders ensure accuracy to ± 0.5 mm. Built of aluminum and plastic, the unit weighs 15 kg (33 lb) and occupies an installation space of 420 mm diam. It can carry up to 5 kg (11 lb) at low speeds. Maximum pick rate is 60/min. Max. speed is 3 m/sec.

800-521-2747 • igus.com

MATERIALS HANDLING

Drum Dumper Has Integral Flex-Screw Conveyor

A new Tip-Tite Drum Dumper from Flexicon Corp. Bethlehem, Pa., has an integral flexible-screw conveyor to allow volumetric feeding of bulk material from drums into downstream processes free of dust. A hydraulic cylinder raises and seats the drum rim against a discharge cone, and then a second hydraulic cylinder tips the drum to an angle of 45°, 60° or 90° with a motion-damping feature. At full rotation, a pneumatically actuated slide-gate valve opens and charges the conveyor, which meters the material volumetrically according to infinitely adjustable user controls.

The conveyor transports bulk materials from sub-micron powders to large pellets, while the gentle rolling action of material prevents the separation of blends. The rugged inner screw is the only moving part contacting material, resulting in reduced maintenance and increased reliability. A broad range of screws with specialized geometries is available to handle free-flowing and non-free-flowing materials, including products that pack, cake or smear in other types of conveyors.

The unit accommodates drums from 30 to 55 gal, weighing up to 750 lb. An optional pneumatic vibrator on the discharge cone promotes complete evacuation of non-free-flowing materials. The drum dumper is available in carbon steel, with material contact surfaces of stainless steel, or in all-stainless.

610-814-2400 • flexicon.com

TOOLING

New Mini Mold Components

At last month's Fakuma 2018 show in Germany, Meusburger (U.S. office in Charlotte, N.C.) went "small" with its two newest standard mold components. For example, its E 3310 TT-Slide unit (below) is said to be the "smallest ready-to-use slide unit on the market." It's available with slide surfaces of 12 × 10 mm and 15 × 12 mm. CAD data is available for download. The "TT" designation refers to the T-guides in the slide and cotter. This type of guide is said to guarantee optimal force transmission at high injection pressures through surface contact. The DLC coating on steel of 52 HRC offers both high wear resistance and easy sliding properties. The slide is also said to be suitable for mirror polishing.

The supplied buffer stops the small slide safely and precisely, even at high speed. This function can be implemented directly in the tooling insert or in the cavity plate to save space. The slide and guide can be installed and removed together.

Second, Meusburger introduced the E 7048 "build-in" cylinder with flange (above), said to be suited to the smallest installation spaces. It comes in four sizes with three different strokes each. The smallest flange size is 37 × 25 mm. Surface or flush installation is possible. Double-sealed piston rods with additional rod wipers ensure clean operation, and the Viton FKM seals can withstand temperatures up to 180 C/356 F. The cylinder can be removed quickly and easily by means of a pull-off thread.

704-526-0330 • meusburger.com

HEATING/COOLING

Advanced TCU Controls Both Temperature & Flow Rate

A new mold-temperature-control unit (TCU) designed by a molder for molders, is said to overcome many of the limitations of existing TCUs. Called Nextherm, the system comes from Aquatech, a Piovan Co., and is sold here by Universal Dynamics (Una-Dyn), a sister company. Both are located at the new headquarters of Piovan North America in Fredericksburg, Va.

Nextherm is the invention of Kenneth Johnson, who has more than 49 years of experience in the field, most of that as a mold-design engineer and program engineer in the Plastics Molding Systems Engineering Dept. of The Gillette Co. (now part of Procter & Gamble). When he retired from Gillette, Johnson set out to build a better TCU that would ameliorate mold-cooling problems he had faced throughout his career. The answer was a system called iCool (Intelligent Process Cooling System), described in detail in a May '15 *Plastics Technology* Close-Up article. That system has now been licensed exclusively and on a global basis to Piovan, which has renamed it Nextherm.

Unlike most TCUs, which control only water temperature, Nextherm controls both temperature and flow rate by means of a positive-displacement gear pump with a variable-frequency drive (VFD). The system also uses proprietary software that computes the heat-transfer balance during the molding cycle in order to balance cooling against heat input from the melt, so as to provide a stable mold temperature throughout the cycle.

Nextherm does not require sensors inside the mold. Instead, it uses pressure sensors in coolant flowing to and from the mold and magnetic flow sensors to measure flow coming from the mold. The positive-displacement gear pump provides a reliable measure of flow into the mold. The 15.5-in. touchscreen display shows supply and return water temperatures and pressures, differential temperature and pressure (ΔT and ΔP), and flow rate.

The user can set a maximum pressure differential (up to 150 psi) to protect seals and water lines, and the system will perform a quick test to automatically "learn" the maximum flow rate possible for that mold within that pressure limit. This "LearnMold" mode also automatically ramps the flow rate down from the maximum to generate a pressure/flow curve for the tool, which is checked—and revised, if necessary—on every subsequent startup of the tool to determine whether flow conditions inside the mold have changed.

Using a 5-hp variable-speed pump, Nextherm can match the output of commonly used centrifugal pumps from 0.5 to 10 hp (using no more than 3.2 hp). The gear pump is said to be much more energy efficient than centrifugal pumps; less waste heat from the pump reduces the load on the central chiller or cooling tower, increasing its effective capacity.

Tests at one molder have shown cycle-time reductions of 35-50% with this system. Tighter control of actual mold-temperature control (as opposed to water temperature) claimed for this system offers other potential benefits, such as ability to use a lower melt temperature and/or a higher water temperature.

Una-Dyn/Aquatech currently offers a 30-gpm Nextherm unit, though future plans include models with 60, 90 and 120 gpm.

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Higher Prices for Commodity Resins, Except PP

Higher feedstock prices and strong demand drive price hikes for PE, PS, PVC and PET.

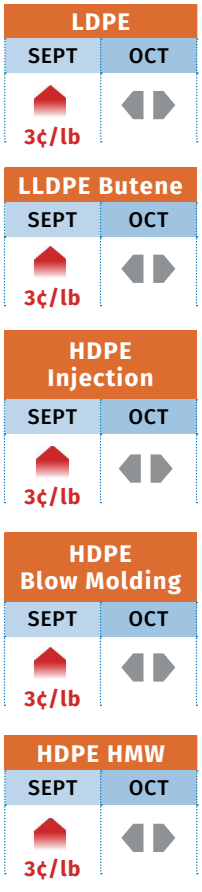
By Lilli Manolis Sherman
Senior Editor

A combination of higher feedstock prices, strong demand and the impact of tariffs drove prices of PE, PS, PVC and PET upward at the end of the third quarter, though PP prices dropped slightly. Overall projections for this month and next were for flat pricing with potential for a slight uptick in the case of PVC, PET, and PP.

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

POLYETHYLENE PRICES UP, THEN FLAT

Polyethylene Price Trends



Polyethylene prices moved up 3¢/lb in September, and suppliers were seeking additional 2-4¢/lb price hikes in October, though the latter may have no legs, according to Mike Burns, RTi's v.p. of PE markets, and *PCW* senior editor David Barry. Said Burns, "The 3¢/lb implemented was a demand-driven increase, with tariffs on China having an impact on any company that ships out anything using stretch-wrap film, garbage and grocery bags, etc." He noted that big-box retail stores cannot call China for film products, as that country cannot compete without cheap U.S. resin. As a result, many domestic processors of PE film—accounting for nearly 65% of the PE market—issued price increases of 4%, citing both strong demand and higher feedstock (ethylene) prices. "I expect this demand to continue through the rest of the year—many large processors are outsourcing," he commented.

Both Burns and Barry ventured that PE prices for the remainder of the year would be flat. Said Barry, "I don't believe PE supplier inventories will be sufficiently reduced, while processors also aim to manage inventories in the last two months of the year. And the market fundamentals are not there to support further increases. The exception might be if Brent crude oil rose up to $90/barrel from $80/bbl." Burns saw potential for processors negotiating lower PE contract prices as they move into 2019.

The Plastics Exchange's Greenberg saw above-average activity and higher prices in the spot PE market last month—HDPE injection grades rose 1.5¢/lb and L/LLDPE film grades moved about 1¢ higher by the first week of October. He noted that the surge of buying had begun several weeks previously due to deeply discounted prices. "Even as the lowest prime offers had been scooped up, buyers were not deterred by fresh offers priced a penny or two higher."

Market Prices Effective Mid-October 2018

Resin Grade	¢/lb
POLYETHYLENE (railcar)	
LDPE, LINER	101-103
LLDPE BUTENE, FILM	84-86
NYMEX 'FINANCIAL' FUTURES	42
NOVEMBER	42
HDPE, G-P INJECTION	106-108
HDPE, BLOW MOLDING	96-98
NYMEX 'FINANCIAL' FUTURES	48
NOVEMBER	48
HDPE, HMW FILM	113-115
POLYPROPYLENE (railcar)	
G-P HOMOPOLYMER, INJECTION	92-94
NYMEX 'FINANCIAL' FUTURES	72.13
NOVEMBER	72
IMPACT COPOLYMER	94-96
POLYSTYRENE (railcar)	
G-P CRYSTAL	108-110
HIPS	114-116
PVC RESIN (railcar)	
G-P HOMOPOLYMER	83-85
PIPE GRADE	82-84
PET (truckload)	
U.S. BOTTLE GRADE	78-82

PP PRICES DOWN, THEN FLAT?

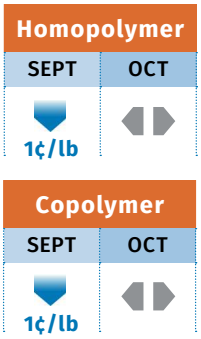
Polypropylene prices dropped 1¢/lb in September, in step with propylene monomer, and expectations for October through ►

December were for fairly flat pricing, according to Scott Newell, RTi's v.p. of PP markets, as well as *PCW*'s Barry and the Plastic Exchange's Greenberg. The latter reported, "We currently expect little change in October PP contracts, perhaps a penny softer. Spot PP prices dropped a penny following lower monomer spot prices, but rapidly returned to flat pricing due to the lack of well-priced spot PP." According to Newell, the PP market is so tightly balanced that prices could move slightly down or even up.

Monomer production issues, particularly related to the new Enterprise and Dow on-purpose propylene plants, have continued due to harsh operating conditions—higher temperatures and catalyst sensitivity that make them harder to operate, according to Barry. He added, "PP suppliers are constrained because of tight propylene. The outlook for pricing is not going to change much, as domestic PP prices are the highest the world. We will keep seeing more imported PP resin and PP finished goods. So far, it hasn't made much difference to PP resin prices due to both planned and unplanned outages."

Both Barry and Newell projected a continued tight PP market into next year due to monomer constraints. Said Newell, "Import volumes have increased, a sign of demand destruction as processors aim to secure additional material from other sources." Greenberg reported that the continued flow of imports, which can be 100 million lb/month or more, has helped to fill the gaps, especially as production disruptions have impacted the already tight supplies.

Polypropylene Price Trends

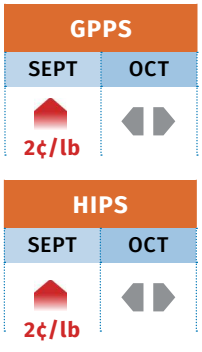


PS PRICES UP, THEN FLAT TO DOWN

Polystyrene prices moved up 2¢/lb in September, driven by rising feedstock costs, but the projected trajectory was for generally flat pricing in October and this month, according to both Robin Chesshier, RTi's v.p. of PE, PS and nylon 6 markets, and *PCW*'s Barry.

Both sources noted that while some September ethylene contract settlements of 33.75¢/lb—up 5¢ from August—were one factor, benzene contract prices went up only 10¢/gal. Benzene accounts for 70% of PS production cost, Barry pointed out. Adds Chesshier, "There ought not to have been any increase based on feedstock costs. Polystyrene suppliers were asking for 4¢/lb when their cost increased only 1¢/lb." She expected that prices this month could be pressured downward if feedstock costs remain flat or drop along with seasonally slowed PS demand. Barry added that while there is some potential for a PS price hike if crude-oil prices spike upward, benzene prices have not been following oil prices lately.

Polystyrene Price Trends

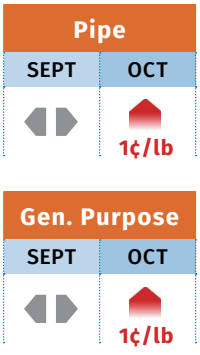


PVC PRICES FLAT TO HIGHER

PVC prices continued flat through September, but suppliers issued a 2¢/lb increase for Oct. 1, a move attributed in part to a September ethylene contract price hike of 5¢/lb. Mark Kallman, RTi's v.p. of PVC and engineering resin markets, thought the increase could be strongly challenged by processors, due to lower export prices, and predicted that October PVC prices would be flat to 1¢ higher. Another price increase for November was emerging, according to *PCW* senior editor Donna Todd.

Todd reported that PVC suppliers had absorbed three other ethylene contract price hikes since May—bringing the total increases to 7.75¢/lb, which would imply an increase in PVC production costs of 3.72¢/lb. "This gives suppliers the incentive to try for another increase of about 2¢/lb, but a price hike in November would face even stiffer headwinds than one in October," she reported. Both Kallman and Todd noted that resin buyers typically expect prices to ease going into the fourth quarter. Kallman said that while there are some PVC plant maintenance shutdowns scheduled for the fourth quarter, improved feedstock costs, domestic seasonal slowdown, and continued softer global demand are likely to keep the market relatively balanced. Todd also noted that with the exception of PVC pipe producers, converters in most market segments would not be able to recoup fourth-quarter price hikes, and lackluster demand and plunging PVC export prices should preclude further attempts to raise prices.

PVC Price Trends

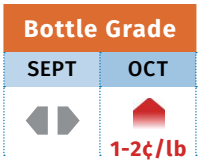


PET PRICES FLAT TO HIGHER

Prices for domestic bottle-grade PET ended September unchanged from August at around 80¢/lb for truckloads and bulk trucks on a delivered basis to customers on the East and West Coasts, and in the mid-80¢/lb range delivered to Midwest locations, according to *PCW* editor Xavier Cronin. Imported PET remained plentiful, with prices largely at parity with domestic PET, though somewhat higher for inland delivery.

Cronin expected that October prices would likely rise a penny or two, driven by strong demand from the bottle and packaging sector. He ventured that November prices would soften by 3-4¢/lb, based on estimates from supplier sources on the seasonal market slowdown.

PET Price Trends



Plastics Processing Bounces Back from Brief Lull

September Index climbs 5.5% from prior month.

By Michael Guckes
Chief Economist

The Gardner Business Index (GBI) for Plastics Processing reversed its direction from the last five months, rebounding to 56 for September (Index values above 50 indicate expansion; values below 50 indicate contraction; an index of 50 reveals no change). The latest reading returns the index to positive territory, gaining 5.5% over the same month a year ago. The index was driven higher by supplier deliveries, followed by new orders and production. New orders, employment, backlog and exports all pulled the average-based index lower.

For a fifth month in a row, supplier deliveries expanded significantly more than all other components of the index. Gardner will be closely watching production figures in the coming months to determine if the above-average expansion of supplier deliveries unlocks additional manufacturing potential that may have been constrained by bottlenecks in the manufacturing supply chain.

Interestingly, any production constraints from the supply chain over the last few months have not seemed to generate increased backlogs. Oscillating between expansion and contraction during the prior three months, backlogs expanded significantly in September, registering their fourth-highest reading since 2013. This increase came despite a simultaneous expansion in production.

GBI is the market-research arm of Gardner Business Media, the publisher of *Plastics Technology*. GBI calculates its monthly index based on replies to surveys sent to subscribers 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

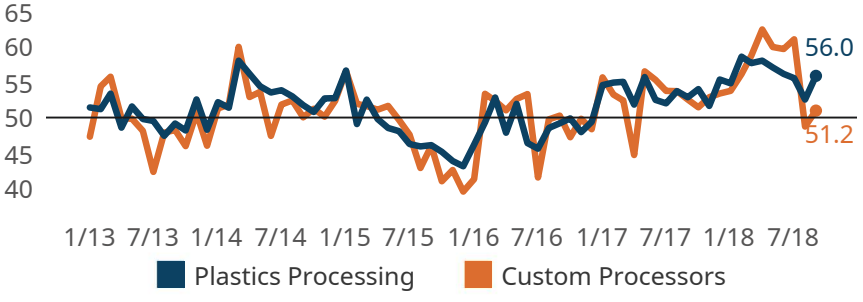


FIG 1

The Plastics Processing Index rebounded from its sharp drop in August. All component readings improved for September. The most significant expansionary changes were in production, new orders and backlogs.

Weakness in Exports Does Not Deter Expansion of New Orders

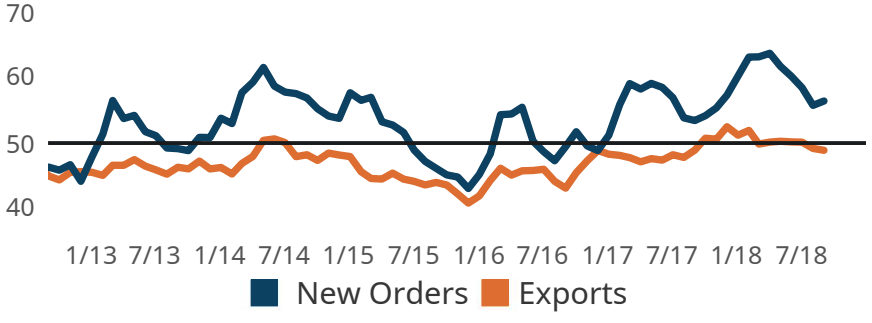


FIG 2

Despite continued contraction in exports, new orders indicated surprising strength for September. Compared with the same month one-year ago, the new orders reading is up nearly 6%. This suggests that domestic demand is more than offsetting any weakness in foreign demand.

Second Quarter Solid in Medical

Data indicates growing capital spending by medical manufacturers through 2018.

By Michael Guckes
Chief Economist

Gardner Intelligence's review of the medical industry using its proprietary data—and the second-quarter 2018 financial filings of nearly 70 publicly traded medical firms—reveals an industry experiencing growth in revenues, earnings, free cash flow and capital expenditures. The latest quarterly results signal a slight increase in the growth rate of capital expenditures. The most significant financial improvement in the industry is in earnings growth, which turned positive during the second quarter after contracting during the preceding two quarters. (All quarterly results are calculated based on the trailing 12 months. Comparisons between two quarters one year apart represents a 12/12 rate of change.)

Growth of capital expenditures, which include spending on manufacturing and equipment, increased from 2.8% at the end of the first quarter of 2018 to 3.7% by the end of the second quarter. This reverses the slowing growth trend in capital expenditures that began after capital-spending growth reached a peak of over 17% in the first half of 2017. An analysis of quarterly data between the fourth quarter of 2014 and second quarter of 2018 indicates a statistically significant relationship between revenue change during a given quarter and a subsequent change in capital expenditure two quarters later. From this simple linear regression analysis, which considers no other factors—and assuming an accurate forecast of revenues based on the consensus Wall Street forecast—this model would predict capital-spending growth of 11.3% during 2018, followed by slowing growth of 6.6% in 2019.

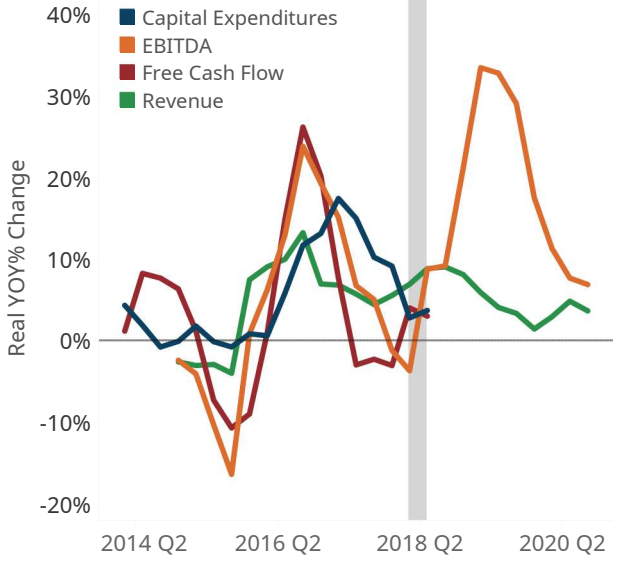
Manufacturers serving the medical industry have experienced strong growth in new orders, production, and supplier deliveries.

Data from the Gardner Business Index from manufacturers supplying the medical industry is consistent with Wall Street's near-term optimism. According to Gardner's survey data in the year-to-date period ending in August, manufacturers serving the medical industry have experienced strong growth in new orders, production and, more recently, supplier deliveries.

Several of the business components that constitute the Index have experienced unusually long periods of continuous expansion, including backlogs and exports. Backlogs have continued to expand every month since July 2017, representing the longest continuous stretch of medical manufacturing backlog expansion in recorded history.

Similarly, one would have to go back to 2012 to find a stretch of time during which medical manufacturing exports expanded for more than eight consecutive months. Ongoing expansion in new orders and production, along with many months of growing backlogs, suggests that manufacturers are highly likely to close out 2018 in very good condition.

Medical Industry Actual and Estimated Results



Data indicates there is a statistically significant relationship between revenue change in a given quarter and capital-expenditure change in the following quarter. Using this simple model, revenue changes in the second quarter of 2018 predict capital-spending growth of 11.3% during calendar year 2018 before growth slows to 6.6% in 2019.

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*

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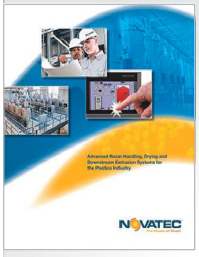

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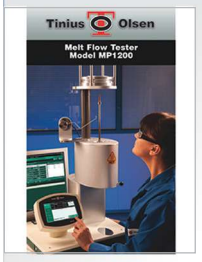

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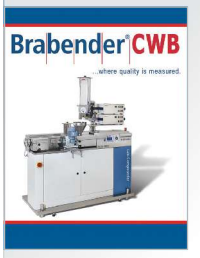

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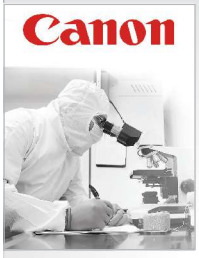

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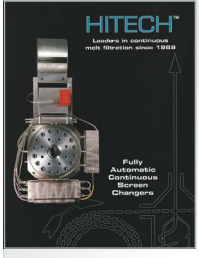

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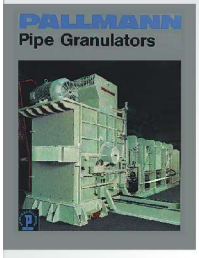

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(Filed October 1, 2018)

Plastics Technology (Publication Number 0032-1257) is published 12 times a year at its general business and publication office: 6915 Valley Ave., Cincinnati, Ohio 45244-3029, Hamilton County. The annual subscription price is $89.

Names of Publisher, Editorial Director, and Executive Editor are, respectively, Ryan Delahanty, James J. Callari, and Matthew H. Naitove. The address for Delahanty is 300 Cardinal Lane, Suite 200, Saint Charles, IL 60175. The address for Callari is 35 Nathan Drive, Old Bridge, NJ 08857. The address for Naitove is 1441 Broadway, Room 3037, New York, NY 10018.

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3. Other Classes Mailed through the USPS	N/A	N/A
4. Free Distribution Outside the Mail (Carriers or other means)	3,885	4,228
E. Total Free Distribution	11,427	11,600
F. Total Distribution (Sum of C and E)	40,040	41,077
G. Copies Not Distributed	700	700
H. Total (Sum of F and G)	40,740	41,777
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PLASTICS TECHNOLOGY (ISSN 0032-1257) is published monthly and copyright © 2018 by Gardner Business Media Inc. 6915 Valley Ave., Cincinnati, OH 45244-3029. Telephone: (513) 527-8800. Printed in U.S.A. Periodicals postage paid at Cincinnati, OH and additional mailing offices.

POSTMASTER: Send address changes to Plastics Technology Magazine, 6915 Valley Ave., Cincinnati, OH 45244-3029. If undeliverable, send Form 3579.

CANADA POST: Canada Returns to be sent to IMEX Global Solutions, P.O. Box 25542, London, ON N6C 6B2. Publications Mail Agreement #40612608.

Printed in the U.S.A.

ITW DELTAR FASTENERS — CHIPPEWA FALLS, WIS.

Conformal Cooling Helps Get Heat Out And Cycle Time Down

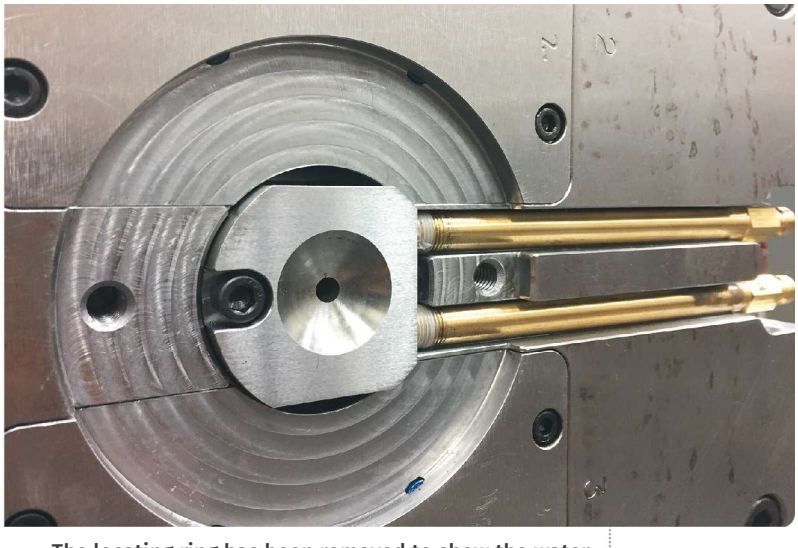
Conformally cooled sprue bushings help automotive molder reduce cycle times and injection pressures for a high-volume component.

New conformally cooled sprue bushing from PCS (patent pending) encircles the melt channel with a 1/8-in. water line.

By Tony Deligio
Senior Editor

Custom molder ITW Deltar Fasteners, Chippewa Falls, Wis., faced a unique challenge with a high-volume acetal fastener. Achieving a quality surface finish required using faster injection speeds, but those speeds also pushed pressures higher in what was already a pressure limited process. "It seemed that anything we tried to do to reduce the pressure—open the sprue, open up the runner, increase the temperature—negatively impacted cycle," explains Brock Cooley, the company's (*itwef.com*) tooling engineer. "So we had to try to find that fine line and balance to achieve the optimum process."

Cooley posed this process challenge to Scott Wahl of mold component supplier PCS Company, Fraser, Mich. (*pcs-company.com*), and Wahl saw an opportunity to pitch a new product borne of a new collaboration. PCS had recently begun working with Jason Murphy, president of Next Chapter Manufacturing (NXCMFG; Grand Rapids, Mich.; *nxcmfg.com*), a toolmaker that applies additive manufacturing technologies. PCS was working with NXCMFG on mold components that utilize 3D printing, and one of the first developments to come from that partnership was a sprue bushing featuring a conformal cooling channel.



The locating ring has been removed to show the water inlet and outlet lines coming in from the side of the mold to the base of the conformally cooled sprue bushing.

That product, which comes in 10 sizes, features a patent pending design that maximizes the surface area of a 1/8-in. water line. Squeezed into a "kidney shape," according to Murphy, the cooling line forms a sort of double helix that wraps all the way around the sprue bushing, crossing at the top before coming back down and exiting at the bottom, with one water inlet and one outlet. The component is formed from H13 steel via direct metal laser sintering.

"Because it is a ⅛-in. water line it enables a higher level of flow," Murphy says, "contrary to smaller, more restrictive lines."

> ***"What the new bushing did was allow us to increase our nozzle size on the press but still have the sprue set up in time."***

Prior to applying the conformally cooled sprue bushing, the eight cavity fastener tool was running a 20.3-sec cycle at 22,500 psi. When the first iteration of the new sprue bushing was installed, those numbers dropped to 17.8 sec and 22,000 psi. When a duplicate mold for the part was made, a new sprue bushing was created and by tweaking the orifice size, the molder dropped the cycle time to 15.7 sec with a pressure of about 18,000 psi. "What the new bushing did was allow us to increase our nozzle size on the press but still have the sprue set up in time," Cooley explains.

PCS and NXCMFG see big opportunities for the new sprue-bushing concept, especially where large sprues meet multiple small cavities. "When you have small parts and multiple cavities," Murphy says, "you have to start out with a very large sprue so that by the time you step down to the smallest cavities, you're feeding them properly. With a larger sprue and small parts, your sprue is going to be the limiting factor in cycle time." PT

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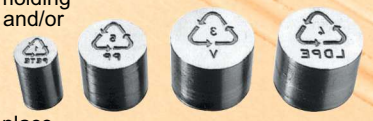

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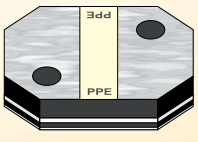

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