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JANUARY 2024 № 1 VOL 70

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On-Site

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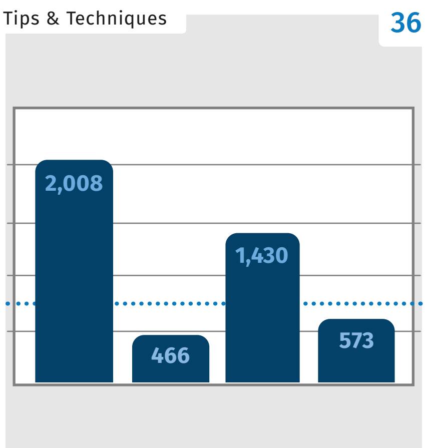

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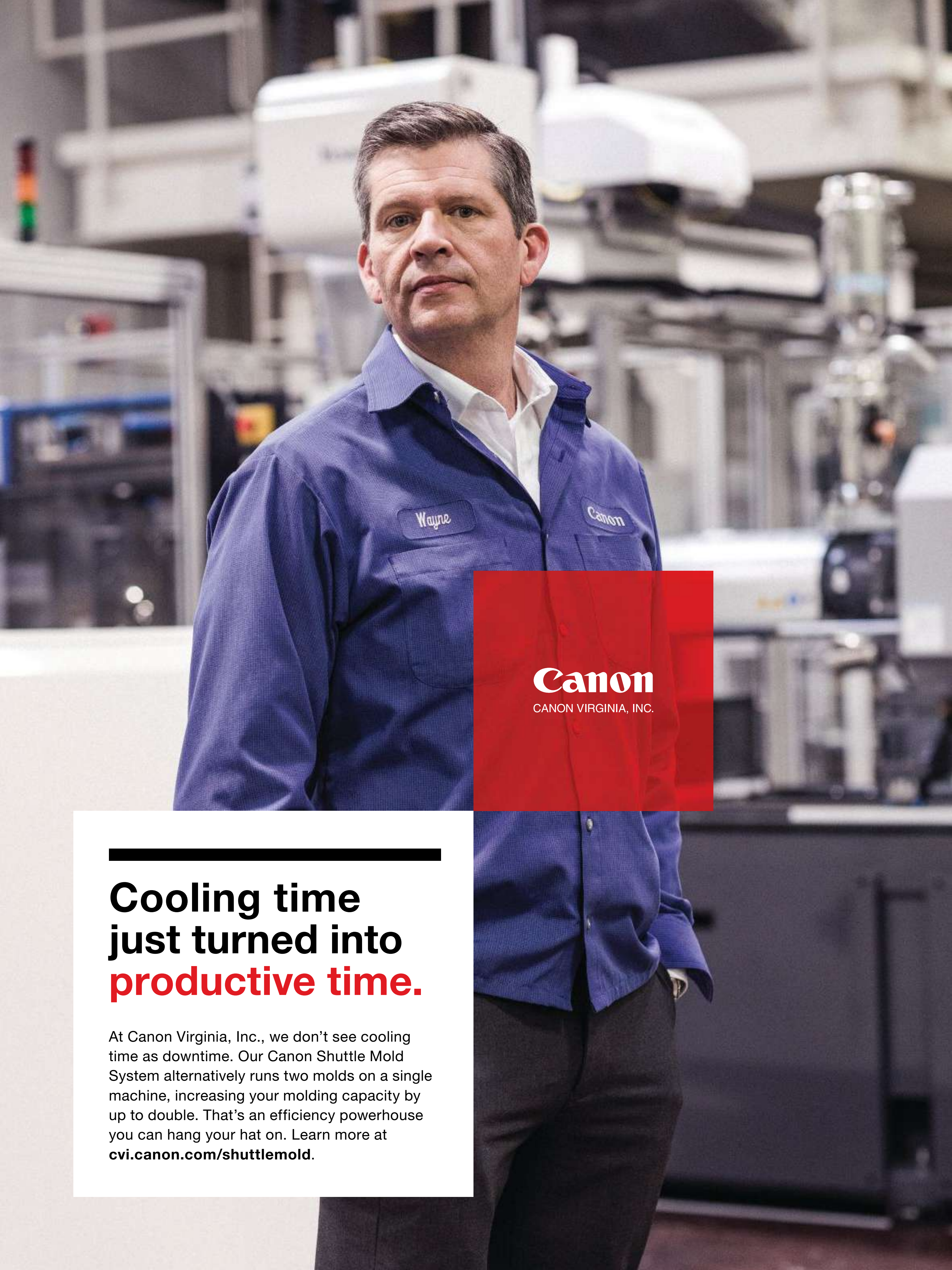
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70 Years ... And Still Going Strong

Plastics Technology is closing in on its 70th anniversary. Here are some of my observations to commemorate the occasion.

If you take a look at the cover of the magazine, at the very top, you will notice that this issue has been marked Volume 70. That means 2024 is the 70th year *Plastics Technology* magazine is published on a continuous basis. This is not quite our 70th anniversary issue — that happens in October — but I think it's a milestone significant enough to warrant a few words.

Jim Callari
Editorial Director

When I got into plastics journalism in 1988, there were maybe a dozen different publications serving various segments of this industry. There were a few devoted to the broad topic of plastics processing, including *Plastics World*, where I started. There were separate, more niche publications focused on compounding, part design and plastics packaging, as well as a new product tabloid devoted to equipment. There was even one ambitious publication that accepted no advertising and, in a fashion similar to *Consumer Reports*, evaluated various types of machinery and equipment.

Over time, some of these publications were sold, shuttered or otherwise faded away — including *Plastics World* — but others popped up. There was one (and briefly, two) devoted to injection molding. There was one (and briefly, two) focused on auxiliary equipment. None of these publications will find their way to your mailbox anymore.

In fact, in print form, there are now only three independently published monthly magazines serving the U.S. plastics market. There are several reasons for this. Mainly, the market has matured over the 36 years I've been a part of it. At one time, it was dominated by huge chemical companies that seemed to develop new polymers every month, and invested big money in marketing and advertising to support these efforts. Over time, many curtailed their R&D, merged or were bought out, or got out of the polymer business altogether. To a less extent, the same kind of thing happened in machinery.

Of course, this is not a trend exclusive to plastics industry media. Overall, there are certainly fewer trade magazines now versus when I got into business-to-business publishing. Nor is it exclusive to business media, as we've all seen firsthand the decline in newspapers, news magazines and the like.

My point: in this media climate, there is something to be said about still being relied on as a credible source of technical information month in and out after 70 years. There is something to be said about stability. In its long history, *Plastics Technology* has been owned by only two companies: first Bill Communications and since August 2000, our current parent company, Gardner Business Media. Since 1981, *Plastics Technology* has had but two chief editors; my colleague Matthew Naitove held the position from 1981 to 2009, and I have had it since.

There is also something to be said about being flexible and adapting to the changing needs of the audience. For many years, *Plastics Technology* was a magazine noted for doing deep dives on new technology. That was a perfectly justifiable position to have at the time, as companies supplying both materials and machinery were churning out new products regularly throughout the 1970s, '80s and even into the 1990s. But, while we certainly devote a lot of editorial effort each and every issue reporting on new products, the pace and magnitude of these introductions has slowed. And, in response, we shifted our focus to helping the reader in the here and now with articles on best practices, troubleshooting and processing tips.

There is also something to be said about not sitting on your laurels, as over the years we have expanded beyond a print magazine to a full-service media enterprise serving up information electronically as well as in-person with conferences and a trade show.

But enough about us. Fact is, we wouldn't still be here if not for the loyalty of our audience. And for that I am humbled, and hope to continue delivering to you the kind of information you rely on for decades to come. Thank you. PT

SPE 2023 Automotive Awards Highlight 'Firsts' and Emerging Technologies

The 52nd annual Society of Plastics Engineers (SPE) Automotive Division Blue Ribbon Automotive Innovation Awards once again celebrated several "firsts" among eight categories, which included innovations in last year's added categories of Electric & Autonomous Vehicle Systems and Aftermarket & Limited Edition/Specialty Vehicles, and an expanded and renamed Sustainability category. As has been the case for the last several years, thermoplastics and thermoplastic composites led by far in all categories, with other hybrid thermoplastic/thermoset processes also included.

The 2023 grand award and category winner, body interior, was the mega bin/frunk which appears in Ford Motor's battery-electric 2024 F-150 Lightning.

This "first" entailed converting from compression-molded painted SMC to mold-in-color injection-molded PP-LFT (40% glass) to produce the industry's largest Class A composite frunk. Produced with Celanese's Celstran PP-GF40 by Cascade Engineering, this conversion resulted in a 48% mass reduction and a 37% cycle time reduction, while eliminating the cost and environmental burden of paint. Also, seal interfaces were improved, secondary routering of holes is no longer needed, and the frunk is fully recyclable at end of life.

Rohm, SABIC Combine on New Film, Sheet Unit

The merger of Röhm's Acrylic Products business unit and SABIC's Functional Forms business has resulted in the formation of Polyvantis. This new company will offer extruded products in the forms of film, sheet, pipe and rod for markets that include building and construction, transportation and aviation, electrical and electronics, automotive, and home and garden.

The deal between the two companies is expected to close by around the second quarter of 2024, subject to regulatory approvals. When it does, Polvantis will have a workforce of about 1,500 employees and 16 production sites across the Americas, Europe, Asia and Africa.

Long-term license agreements have been concluded with both Röhm and SABIC for the respective brands in their segment. The Plexiglas/Acrylite molding compounds business will remain at Röhm as the polycarbonate Lexan resin business will remain with SABIC.

Republic Services Opens Polymer Center, First in a Planned Network

Republic Services Inc. has opened its Polymer Center in Las Vegas, which the company describes as a first-of-its-kind facility in North America. The Polymer Center is expected to produce more than 100 million pounds of recycled plastic each year for use in sustainable packaging and other applications.

The Polymer Center will process plastic bottles, jugs and containers collected from homes and businesses. PET will be diverted to a process that includes optical scanning, shredding and cleaning in caustic wash.

The resulting hot-washed PET flake is suitable for remanufacturing into a new beverage bottle.

HDPE and PP will follow a second path, which includes a series of optical and medium-infrared scanners. The sorted plastics will be organized by color and type. Republic expects that the center will enable increased circularity by returning plastic to packaging applications, rather than downcycling to fiber-based products.

According to the company, plastic bottles will be able to be made into new bottles six to seven times.

The Coca-Cola Company, one of the first customers of the Las Vegas Polymer Center, has committed to use at least 50% recycled material in its packaging by 2030.

The Polymer Center is scheduled to supply rPET to Coca-Cola beginning in January 2024.

Plans for a nationwide network of Polymer Centers are underway, with the second facility expected to open in Indianapolis in late 2024.


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E-Beam Expands Ohio Facility

E-Beam Services Inc. is expanding its facility in Lebanon, Ohio, to the tune of 52,000 square feet.

The company is a leading supplier of contract electron beam processing services for product sterilization and decontamination, and polymer product enhancement, with more than 700 kW of installed accelerator capacity — enough to process a billion pounds of material annually.

The investment and expansion signify E-Beam Services' continued, steady growth, the company says. E-Beam adds that the state-of-the-art space is designed for the housing of another world-class electron beam accelerator and specialized conveyor systems to enable efficient large-volume operations and provide additional capacity to support the customer growth.

Fast Service for Sharpening Pelletizing Rotors

To help plastics processors and compounders keep their pelletizers cutting at peak performance, Bay Plastics Machinery (BPM) has introduced BPM Fast Track, a rotor-sharpening service.

When pelletizer rotors lose their edge, honing them isn't as simple as, say, sharpening a knife. In fact, pelletizing rotors have three distinct angles that all require a specialized process to sharpen properly.

BPM's technicians can sharpen every brand of rotor and even build new ones if required. With BPM Fast Track, after receiving the customers' rotors, technicians analyze and sharpen them, then ship them back to customers.

The entire process takes only two weeks or less. BPM also provides this two-week-or-less repair service for feed rolls.

GEON Performance Solutions Buys PolymaxTPE

GEON Performance Solutions, a global provider in the formulation, development and manufacture of performance polymer solutions, has purchased Polymax^{TPE}, which specializes in the development of premium thermoplastic elastomer (TPE) materials across a diverse range of industries throughout North America, Asia and Europe.

Polymax^{TPE} has two full-service manufacturing sites: Nantong, Jiangsu, China, and Waukegan, Illinois.

Sales and manufacturing operations for both companies will continue as usual through the transition.

MATERIALS

PART 2 The Fantasy and Reality of Raw Material Shelf Life

For the vast majority of thermoplastics, the stability of the materials can be stated in years, not months. But there are exceptions where shelf life can be a serious issue.

By Mike Sepe

The idea of material expiring as it sits on the shelf in the warehouse is often a concept with no scientific basis, as we discussed last month. However, there are materials that do have a shelf life. The majority of these are thermosetting materials, either rigid or elastomeric.

The time-sensitive nature of crosslinked materials is related to the composition of these materials and specifically to the fact these compounds, as provided to the molder, are not completely formed polymers and the catalyst that aids in completing the polymerization and crosslinking process is a constituent in the compound. This catalyst, because it is chemically active, can react prematurely or it can volatilize and be lost to the system.

Most of my time in manufacturing was spent at a company that did both thermoplastic and thermoset molding. We were never concerned with the shelf-life stability of our thermoplastic materials. But some of our thermoset compounds were a different story. We processed a particular grade of melamine-phenolic resin that had to be processed within nine months of being received from the supplier. Failure to do so would result in a material that would not crosslink. This was a demonstrable phenomenon and lab analysis confirmed that the energy associated with crosslinking would not be detected if an old sample of the material was tested.

In plasticized materials and particularly in crosslinked systems prior to processing, shelf life can be a real concern.

Bulk molding compounds (BMC) and sheet molding compounds (SMC) — a type of unsaturated polyester — utilize styrene as a key ingredient. The styrene is used to "dissolve" or soften the low-molecular-weight linear polyester prepolymer and participates in the crosslinking reaction, which is promoted by a free radical initiator. Walking past racks of this material in the plant, the smell of styrene is evident. This confirms that some of the styrene in the compound is volatilizing.

STYRENE AS A PLASTICIZER

Over time, while the material sits in storage, it will become less pliable and somewhat harder because the styrene is essentially acting as a plasticizer. This will influence processing of the material, affecting the time required to achieve minimum viscosity, gel time and degree of crosslinking. If it is stored for long enough, the material may become intractable. We achieved a much longer shelf life for this material in our facility by building a refrigerated storage room where we kept the raw material until a day or two before we were ready to run it. This also made the material more consistent over time.

I encountered an extreme version of this while working on some epoxy parts molded for field effect transformers. Some of the parts were exhibiting defects associated with premature curing that prevented the material from flowing into the mold properly. The problem was traced to the way the material was being handled prior to processing. This particular compound had to be kept at very cold conditions until three days before processing.

It was then brought out of the refrigerated storage room and gradually warmed to room temperature over a two-day period and then had to be processed on the third day. If it sat at room temperature for any longer or if the temperature of the room increased due to seasonal fluctuations, the defects associated with premature crosslinking would appear. These are clear instances of true shelf life concerns. They apply to a wide range of crosslinkable materials (including ►

Scan for more expert advice in materials.

Photo Credit: Getty Images

rubber compounds) where — depending upon the polymer type and the cure system — shelf life of the pre-cured compound can be as little as 2-3 weeks.

Another class of materials where shelf life of the raw material is a consideration are thermoplastic elastomers that rely on the use of plasticizers. Plasticizers are typically fluids that are blended with the polymer to achieve a balance of properties. They are usually of lower molecular weight than the polymer and are therefore prone to migration. The rate of this migration is increased at higher temperatures; and, in molded components, the process can also be accelerated by direct contact with mating parts made from materials that can absorb the plasticizer. In the raw material, this migration will be governed by a variety of considerations which include temperature and humidity.

Therefore, storage conditions are a critical factor in determining shelf life, including whether the material is still in its original packaging and whether that packaging has been compromised. Flexible PVC and plasticized nylons are among the materials that can change over time. The suppliers of the raw materials tend to understate the amount of time the material can be stored without exhibiting a loss in performance, but problems have been shown to occur in materials of this type over a period of a few years, even with good storage practices.

STORAGE CONDITIONS MATTER

This brings us to the topic of storage conditions. Generally, the lower the temperature and humidity at which the material is stored the longer it will maintain its integrity and processability. Exposure to ultraviolet light, ozone, and nitrogen and sulfur oxides produced by combustion will also shorten the shelf life of a material and potentially produce changes in the color of the product as well. Most warehouses where raw material is stored are not climate controlled. Therefore, depending upon the location, temperatures and humidity can become elevated for much of the year.

One February, I worked for a week at a plant in Chennai, India, where the outdoor daytime temperature was already reaching 90°F (32°C) and the temperature in the warehouse was considerably higher. These types of conditions can have a variety of accelerating effects on the stability of a material.

Silo storage introduces another set of variables that can include rapid changes in relative humidity. And, finally, there are the situations where due to a lack of indoor warehouse space, raw material is simply placed outdoors where the elements of sunlight, changes in temperature and humidity, and pollutants in the air can act with greater effect on the material — regardless of whether it is in its original package or has been transferred to a secondary container.

In summary, shelf life is a factor to be considered when managing material storage. For the vast majority of thermoplastics, the stability of the materials can be stated in years, not months, and the notion that a polymer expires like a food or a pharmaceutical is a fanciful notion that may be used by material suppliers to absolve them of responsibility for an out-of-specification condition. However, in plasticized materials and particularly in crosslinked systems prior to processing, shelf life can be a real concern and extra measures such as refrigeration can and should be used to extend the useful life of a product.

When in doubt, testing will determine whether storage conditions influence the integrity of the material. Specimens molded from a new lot of raw material and the older lot can be tested for mechanical performance. In the case of crosslinkable rubber compounds, torque rheometry can be performed to characterize the time required to achieve minimum viscosity and cure. These objective measurements replace the vague statements about shelf life that often serve as a belief system devoid of science.

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 45 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

The Experience Curve and Well-Trained Process Technicians

Pairing external big picture training with internal job-specific instruction can help your process technicians meet quality expectations as well as production targets.

By Robert Gattshall

Over the years in the injection molding industry, I've had the opportunity to work with hundreds of different molders. Regardless of where I was, the need for better internal training programs and strong technical resources are always topics of discussion. Training is key to developing those technical resources, but the term "training" is misused more often than it should be.

To start, most of the time when people are complaining about a lack of training, they are really referring to experience or the lack thereof. There are many different options for training a process technician these days, but the least we can hope for is that whatever training is applied, it decreases the experience curve.

The experience curve is a bell curve with "years in the industry" along the X-axis and "unique issues never experienced before per year" on the Y-axis. That Y-axis, by the way, never hits zero again, regardless of how long you're in injection molding. While the right training, with a major focus on troubleshooting techniques, can greatly reduce a process technician's reaction time and his or her ability to solve these issues on their own, there is nothing that can completely take the place of experience.

Process technicians are often faced with a selection of inherent challenges, from old or malfunctioning equipment; worn-out or even damaged molds; and material issues, including running regrind with no generation tracking as well as process windows that are so narrow that normal variation causes part defects. Now we'd all like to be able to say, "This doesn't happen at my plant; our process development is robust."

We all know that in the real world that isn't always the case. Whether there isn't financial justification to address the issue, or customer demands force us to keep running, most of us have to figure out a way. It's the unique issues that training doesn't often prepare new process technicians to resolve on their own. We can't always stop a job and address a root cause or afford to spend hundreds of thousands of dollars replacing an old machine. We do have to deal with expectations that the job stays running and our process technicians are charged with ensuring that happens.

John Bozzelli conducts training at the Polymers Center of Excellence in Charlotte during Molding 2017. Photo Credit: *Plastics Technology*

Over the years as we run these jobs, we find workarounds for them and we know that, for example, when issue "A" arises on job "B" in machine "C," I need to make an adjustment to the "D" setting. Some molders do an excellent job of documenting that A,B,C and D, but most don't do it well enough. Instead, it becomes tribal knowledge because workarounds typically don't get documented. Training generally doesn't focus on what would be classified as workarounds. Most third-party training provides knowledge on how to establish a process and how to identify root causes.

If you have mold damage that is causing flash on a part, you want your process technician to identify that and have it addressed. We don't want to start the "Chase" and spend the entirety of the run time making adjustments between shorts and flash. What happens when it's a 2-cavity mold and the issue rears its head at 2 a.m. with no toolroom to address it and the order is shipping out in 6 hours?

Training can definitely help a process technician understand what process changes could potentially help reduce the part from flashing, but with experience that technician will know what is needed to get those parts within acceptable tolerance to ship to the customer. Experience gives them the "What" and their training helps them identify the "Why."

When I was first introduced to scientific injection molding, more years ago than I'd like to admit, I was all in and defiantly wanted to shut every job down that had something preventing it from running as robustly as possible. ►


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I recently sent a team member to the AIM Institute and talking with him upon his return brought back some memories. We all leave training with a new perspective because we begin to understand the reasons why our jobs aren't running well and learn ways to make them better.

But once we enter leadership roles and become responsible for budgets and on-time deliveries, we understand that we are sometimes forced to run under less-than-ideal circumstances. That's why it is important to have practical internal training that is as specific as possible to the products you make and to the equipment you make those products on.

Ideally, we're pairing external training programs with one developed internally to ensure that our process technicians know how to address common issues in our plant, but can also understand what is needed to address the root cause at a juncture when both time and money are available to do so.

There are actions we can take to help make things a bit easier for all our process technicians. When we develop workarounds for issues, documenting them is critical. I recently put together what I've called the "Know Issues Guide" for our process technician group. It's a list of any issues we have for each job, specific to the machine it runs in and the exact action taken. These aren't issues that arise every single run that require the same process change. If that was the case, then we would just evaluate the process itself and permanently adjust it. In many cases, it isn't even a process adjustment; it could be specific to an area of the mold.

Say it starts burning after a few shots, and there is a specific area — and method — for cleaning it. This is the kind of issue that they would learn over time with experience, but my goal with this guide is to speed that process up.

This isn't a troubleshooting guide that gives them seven ways to fix shorts, either. It is a specific, known issue we've had in the past and the exact way it was addressed. It is an extension of the practical side of their training.

Both training and experience are critical for a well-rounded process technician. Although we can help the inexperienced catch up quicker, the only way to get more experience is with time. Even those with decades of experience see something new all the time. PT

ABOUT THE AUTHOR: Robert Gattshall has more than three decades of experience in the injection molding industry and holds multiple certifications in Scientific Injection Molding and the tools of Lean Six Sigma. Gattshall has developed several "Best in Class" Poka Yoke systems with third-party production and process monitoring such as Intouch Monitoring Ltd. and RJG Inc. He has held multiple management and engineering positions in automotive, medical, electrical and packaging production. In January 2018, he joined IPL Plastics as process engineering manager. Contact: *262-909-5648*; *rgattshall@gmail.com*.


COLOR


MAGUIRE

EXTRUSION

Is a Gear Pump Right for Your Single-Screw Operation?

As with everything else, there are pros and cons, but more of the former. They provide processors higher rates while decreasing the temperature of the extrudate while enabling downgauging.

By Mark A. Spalding

A gear pump positioned between an extruder and downstream equipment can improve the performance of a line. The advantages include the mitigation of pressure surges and, as a result, flow surges from the extruder; plus, a decrease in the discharge temperature by generating part of the pressure required for the die by the pump, which reduces resin consumption and enables rate increases.

For example, if the extruder is operating with low-frequency discharge pressure oscillations, the gear pump and control algorithm will provide a nearly constant outlet pressure and flow rate to the downstream equipment such as a die. Stable operations with a gear pump enable plant personnel to operate at the lower thickness specification limits for sheets or films, and thus reduce the resin consumption per unit of product.

If a gear pump is contributing to the generation of the discharge pressure for the downstream equipment for a single-stage extruder, the metering section of the screw will operate with a higher specific rate compared to a process without a pump. Extruders that operate at a higher specific rate will generally operate at a lower discharge temperature. A gear pump used with a two-stage, vented screw can enable higher operating rates while not causing material to flow out the vent port.

Gear pumps can enable higher rates for two-stage, vented extruders.

Gear pump-assisted extrusion does have some disadvantages, including higher capital costs and operational complexity for the line. The increased complexity is the control of the process. Here, the rate is set by the speed of the gear pump, as shown by Figure 1. Gear pumps are designed to operate at a specific volumetric rate or cm^3/(hr rpm). The specific volumetric rate or volume per revolution is a design specification for the pump. Setting the speed of the pump and knowing the melt density of the resin sets the rate for the line.

To maintain the same rate from the extruder, the controller on the pump adjusts the screw speed to maintain a set point pressure on the inlet side of the pump. The inlet pressure is often referred to as the suction pressure. If the inlet pressure becomes less than the set point pressure, the controller will increase the screw speed.

Likewise, if the pressure becomes too high, the controller will decrease the screw speed. For properly designed systems, the screw speed will only have relatively small changes to compensate for slight changes in the pump inlet pressure. But for extrusion processes that are not operating properly and show severe flow surging, the screw speed will have large variations. The discharge pressure from the

FIG 1

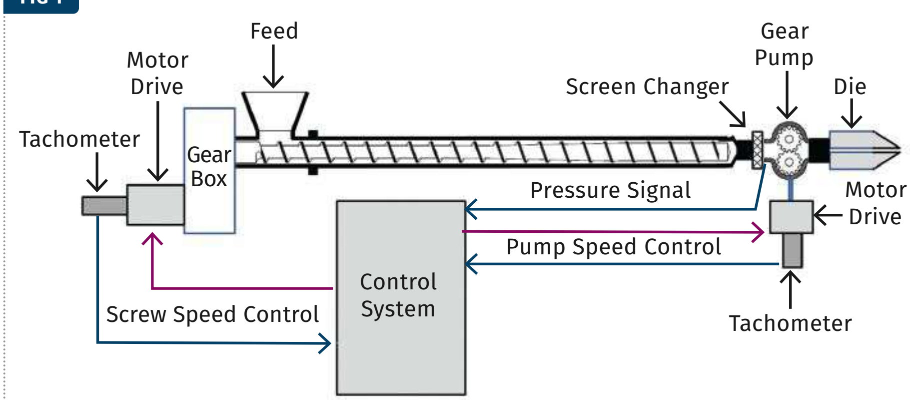
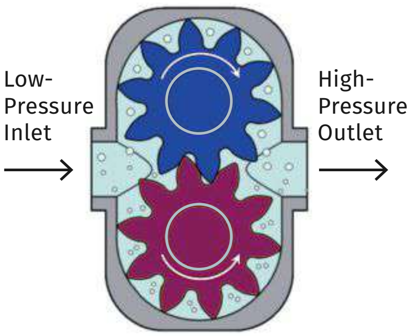


Diagram of a typical gear pump installation for a single-stage extruder and a screen filtering system, showing the rate-controlling scheme. Photo Credit: M. Spalding

pump is higher than the inlet pressure and is controlled by the pressure requirements of the downstream equipment.

Gear pumps operate by metering molten resin from the low-pressure inlet side of the pump, and then discharging at a higher pressure to the downstream equipment, as shown by the schematic in Figure 2. The inlet pressure is high enough to force resin in between the gear teeth. As the gears are rotated, the material between the teeth is trapped between the teeth and the body of the pump. At the discharge side of the pump, the intermeshing gears displace the resin and force it out through the discharge flange.

FIG 2

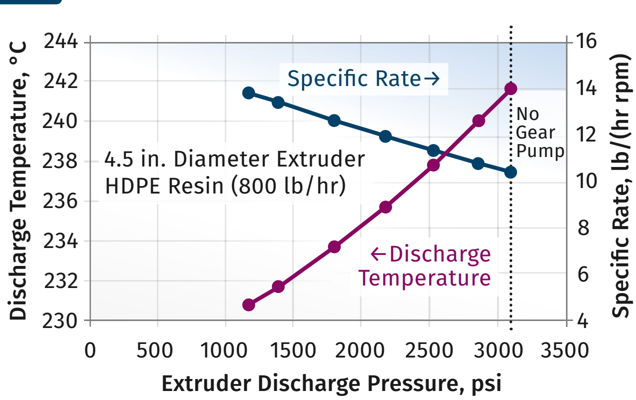


Schematic of a gear pump.

A gear pump is a common method to decrease the discharge pressure from the extruder, especially if the discharge pressure required by the die is relatively high. Decreasing the discharge pressure from the extruder will cause the specific rate to increase and the discharge temperature to decrease for a single-stage extruder, as shown in Figure 3.

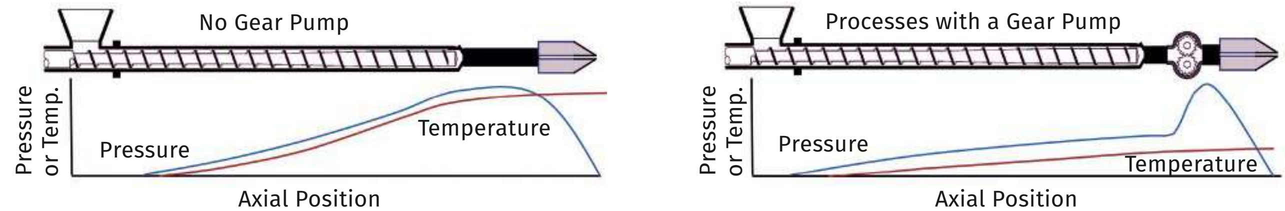
For example, a process and die required a pressure of 3,050 psi for operation at a rate of 880 lbs/hr for a high-density polyethylene (HDPE) resin with a melt index of 0.08 dg/min (190°C, 2.16 kg). If all the pressure is provided by a single-stage 4.5 inch diameter extruder (screw design fixed), the discharge temperature will be about 242°C, as shown by the operating curve in Figure 3.

FIG 3



Operation of a 4.5 inch diameter extruder running an HDPE resin at 880 lbs/hr as a function of discharge pressure.

FIG 4

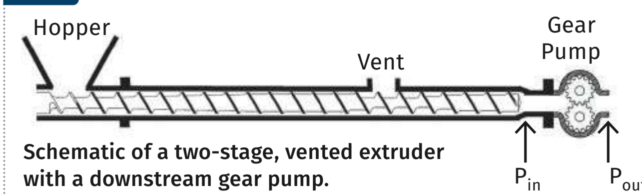


A schematic of the axial pressures and temperatures for processes with and without a gear pump. The rates for both processes are the same, but the discharge temperature for the process with the gear pump is less than that for the standard process.

Here, the specific rate for operation is 10.4 lbs/(hr rpm). But if a gear pump is positioned between the extruder and the die such that a portion of the required pressure is generated by the pump, then the specific rate for the screw will increase (causing the screw speed to decrease at a fixed rate) and the discharge temperature will decrease.

If the inlet pressure to the gear pump (discharge pressure from the extruder) was 1,200 psi, the extruder would discharge at 231°C and operate at a specific rate of 13.9 lbs/(hr rpm). Thus, the discharge temperature could be decreased by 11°C and the specific rate increased by 3.5 lbs/(hr rpm), as shown in Figure 3. The axial pressure and temperatures for the two cases are shown schematically in Figure 4.

FIG 5



Schematic of a two-stage, vented extruder with a downstream gear pump.

HIGHER THROUGHPUTS

Gear pumps can enable higher rates for two-stage, vented extruders. A schematic of this process is shown in Figure 5. Because the vent is at atmospheric pressure or under a vacuum, all pressure required to operate the die and screen pack for a system without a gear pump must be generated in the second-stage metering section of the screw. If the pressure required to operate the downstream components is higher than what the second-stage metering channel can develop, then molten resin will flow into the vent port, especially for a poorly designed screw.

A gear pump, however, can enable higher rates while eliminating vent flow by decreasing the discharge pressure of the extruder. For this case, the second-stage metering section only needs to generate enough pressure to operate the pump safely, a pressure typically about 300 to 1,200 psi. This pressure level is high enough to keep the pump channels completely full of resin and maintain lubrication in the bearings. The pump will then increase the pressure to a higher level as required by the downstream equipment.

Moreover, if the gear pump is generating most of the pressure required for the downstream equipment, then the screw and extrusion process can be optimized to a lower discharge temperature.

Gear pump-assisted extrusion can provide processors higher rates while decreasing the temperature of the extrudate. Moreover, a gear pump can enable a processor to operate at a lower thickness for sheet or films, reducing the amount of resin in the product, especially for extruders that operate with a minor oscillation in the discharge pressure. PT

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TOOLING

PART 3 How to Design Three-Plate Molds

There are many things to consider, and paying attention to the details can help avoid machine downtime and higher maintenance costs — and keep the customer happy.

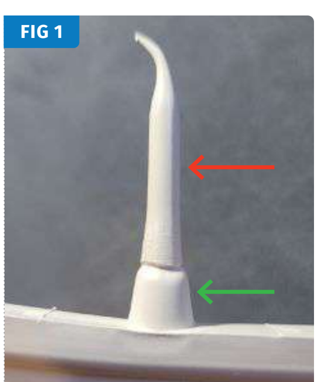
By Jim Fattori

One primary goal in any three-plate mold design is to minimize the length of all the parting line openings. Three-plate molds have a taller stack height and at least two additional parting lines. Therefore, they require a much longer opening stroke. It's often necessary to put a three-plate mold into a higher tonnage molding machine only because a higher tonnage machine has the capability for a longer opening stroke.

But larger machines have a higher hourly rate and are often a little slower, which will cut into your profits. Larger machines usually have larger barrels, which could create a material residence time issue, as well as less control of the shot size, which can increase your reject rate. Other than increasing your machine utilization, there is absolutely no benefit to putting an injection mold in a machine larger than is required to fill the cavities and prevent flashing.

When the machine's clamp decompresses and starts to open, parting line #1A, which is between the front of the runner stripper plate and the back of the A-plate, "breaks" a short distance (assuming you use urethane or compression springs). Then parting line #2 — which is the main parting line between the cavity and the core (or A and B-plates) — usually starts to open. I say usually because on occasion the part may have a lot of surface area, low draft conditions, a textured surface and other factors (such as overpacking) that can cause the molded part to stick firmly in the cavity. So firmly, the parting line between the runner stripper plate and the A-plate continues to open before the cavity and core plates do. And that's fine.

FIG 1



Machine nozzle tip cold slug. Photo Credit: Jim Fattori

There are only two parting line opening sequences that really matter: (1) The initial break between the A-plate and the runner stripper plate must be first (as previously discussed); and (2) the parting line between the runner stripper plate and the injection clamp plate cannot start to open until the opening between the runner stripper plate and the A-plate is fully open. Otherwise, the runner may not have enough room to fall freely out of the mold.

The amount parting line #2 needs to open depends on the molded part. It typically needs to be the height of the part, plus the height of the core above the parting line, plus some safe amount for the part to fall freely. Most parts tend to rotate when they are ejected. That rotation can be anywhere between zero degrees and 90 degrees, depending on the center of gravity of the part. The speed at which the molding machine ejects a part can also affect how it falls, as well as how much room is required. It's a good idea to make this opening stroke a little longer than expected, but have a simple method to possibly reduce that amount after the initial sampling, and potentially get you into a smaller molding machine, as well as a slightly reduced cycle time.

Minimize the length of all the parting line openings.

Once you have estimated what the total parting line #2 opening should be, that's when some type of mechanism engages the A-plate and creates, what I call, parting line #1B — the full amount of opening between the A-plate and the runner stripper plate.

The amount the parting line between the A-plate and the runner stripper plate needs to be is typically equal to the combined distances of:

1. The amount required to pull the entire length of the cold runner drop(s) out of the A-plate.
2. The amount the runner stripper plate needs to advance to strip the runner off.
3. The length of the short, solidified, sprue inside the extended sprue bushing, as indicated by the green arrow in Figure 1. This cold sprue length for a ½-inch spherical nozzle seat can range from 0.265 inch to 0.390 inch, depending on the inside diameter of the bore. The cold sprue length for a

Scan for more expert advice in tooling.

¾-inch spherical nozzle seat can range from 0.265 inch to 0.453 inch, depending on the inside diameter of the bore. This is yet another of a long list of reasons why you should not be using machine nozzle tips with a ¾-inch radius.

4. Whatever the possible length of any cold slug that is pulled out of the machine nozzle tip, as indicated by the red arrow in Figure 1.
5. Some safe amount of additional clearance. There is a rule of thumb that says the open distance between the runner stripper plate and the A-plate should be 1.5 times the overall height of the runner system. That is a horrible rule of thumb and should be completely ignored. That rule is meant to overcome the common problem of the runner curling as it cools, but completely ignores all the reasons why a runner may or may not curl. It also ignores how cold and rigid or how hot and malleable the runner may or may not be. Nor does it consider if the runner is small and light or thick and heavy.
6. There may be some additional clearance required if the runner is going to be removed by a robot or picker.

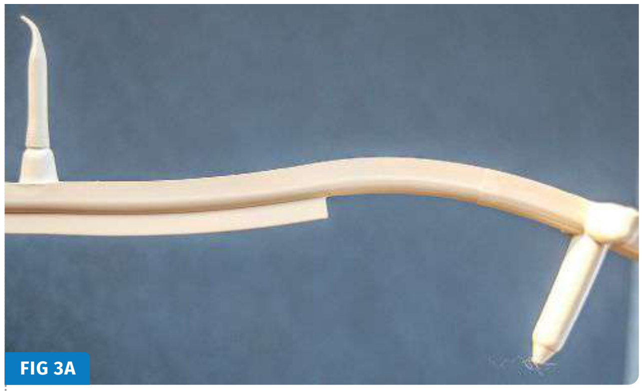


FIG 3A

Thin stiffening ribs help prevent bending and curling. Photo Credit: Jim Fattori

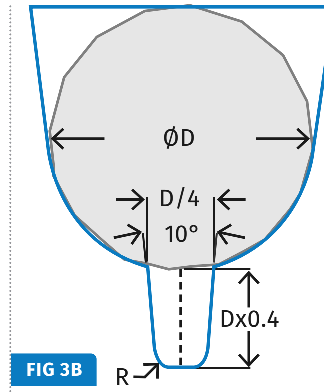


FIG 3B

Guideline for sizing stiffening ribs. Photo Credit: Jim Fattori

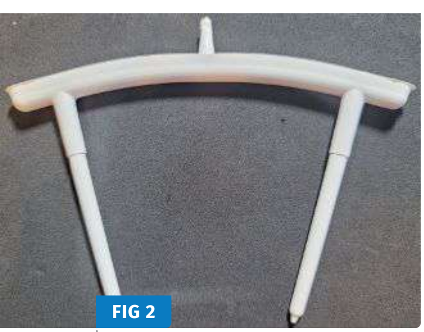


FIG 2

Curled three-plate runner. Photo Credit: Jim Fattori

That's a long list of lengths to add up. This is when you double-check the maximum daylight and maximum opening stroke of the intended molding machine.

Regarding number 5, the "safe amount" can vary a lot. If the material has a filler in it, such as glass or calcium carbonate, it tends to be rigid and usually will not bend or curl very much when it's ejected. Unfilled materials and thick runners tend to curl a lot, especially when the runner is not completely solidified when the mold opens, as shown in Figure 2. This can require longer opening strokes for the runner to fall freely.

It's best to use a safe amount of opening, but make it easy to adjust after the first mold sampling. Even if the mold functions fine with the longer stroke — minimizing the amount of stroke afterward can shave a little time off the molding cycle.

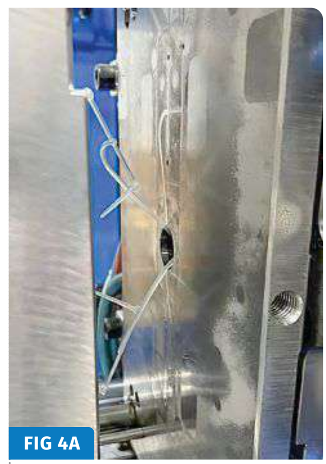


FIG 4A

A thin runner being retained by the molding machine's nozzle tip. Photo: Westfall Technik

FIG 4B

Adding a center disc to the runner will help it eject. Photo Credit: Jim Fattori

It is important for processors to notice the direction the runner curled in Figure 2. It has nothing to do with the geometry of the runner; it is due to the mold cooling. Runners, as well as parts, will warp or curl toward the hotter sides or areas of a mold. Figure 2 is a good example of the runner stripper plate being colder than the A-plate, which is why it curled inward. The amount and direction a runner (or a part) warps can often be influenced by the temperature of the cooling lines in the various plates.

To help prevent the amount a runner curls and reduce the required opening distance, a thin stiffening rib can be added as shown in Figure 3A. Figure 3B is a guideline for the size of a stiffening rib.

The runner stripper plate bushing has a 1¼-inch diameter opening in the center. If the cold slug in the machine's nozzle tip has sufficient force to pull a flexible runner through this opening (as shown in Figure 4A), the runner will not eject. One method to help eliminate this problem is to add a center disc to the runner as shown in Figure 4B.

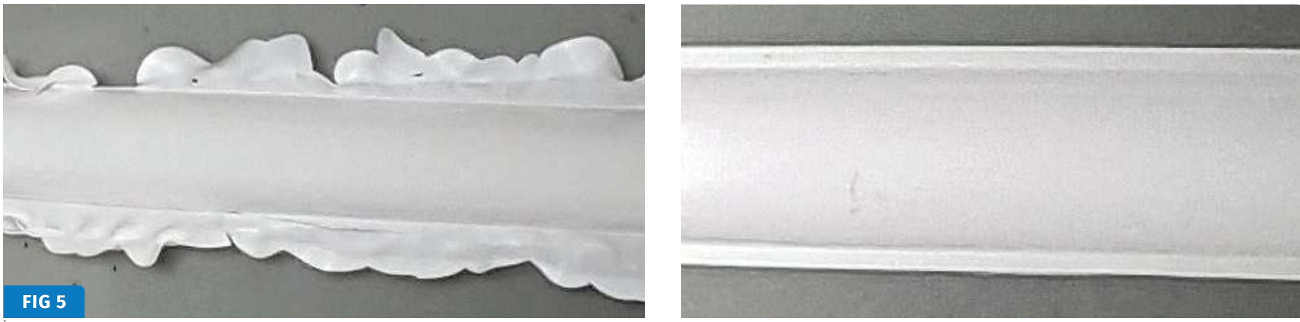
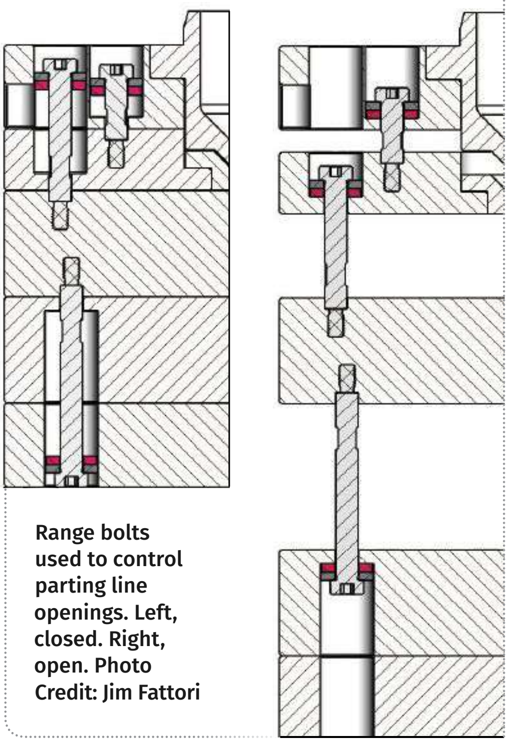


FIG 5

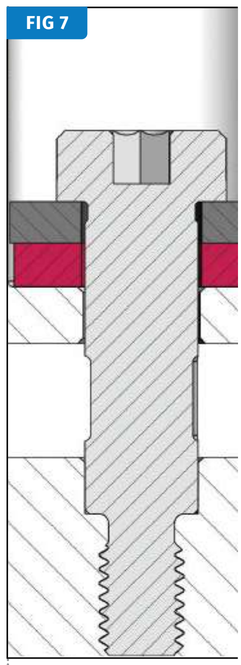
Flash traps on runners (left, before; right, after) prolong the life of a mold. Photo Credit: Jim Fattori

FIG 6



Range bolts used to control parting line openings. Left, closed. Right, open. Photo Credit: Jim Fattori

FIG 7



Close-up of a range bolt. Photo Credit: Jim Fattori

Flash traps on a runner will dramatically help reduce the amount of mold damage caused by flash, as shown in the before and after pictures in Figure 5.

When the molding material is injected into the mold, the flash trap fills and solidifies before the injection pressure starts to significantly build up. That's what prevents the flash from extending beyond the flash trap. As a bonus, the flash trap helps prevent the runner from curling a little.

I like to make the flash trap depth and protruding width about 20% of the runner depth. For example, if the runner depth was ¼ inch, the flash trap would be 0.050 inch deep and protrude 0.050 inch on either side of the runner. And, yes, flash traps are beneficial on all types of cold runner molds and all types of runner shapes.

PULLING PLATES

There are several methods that can be used to pull the various plates. The more common methods are range bolts, range bars, latch locks and plate locks. For small- to medium-size molds, I like to use range bolts. For larger molds, I like to use external range bars. I tend to avoid any mechanism that uses springs or has components that can wear or require grease. Range bolts and range bars can also have their stroke easily adjusted.

The first opening must be between the A-plate and the runner stripper plate.

Figure 6 shows range bolts being used for all three parting line openings of a three-plate mold. Whatever method you choose, just make sure the components will not prevent the runner from falling freely out of the mold.

Figure 7 shows some of the finer points about range bolts, such as how they should be mounted in a recessed or counterbored hole ¹⁄₃₂ inch to ¼ inch deep to help resist damage from any

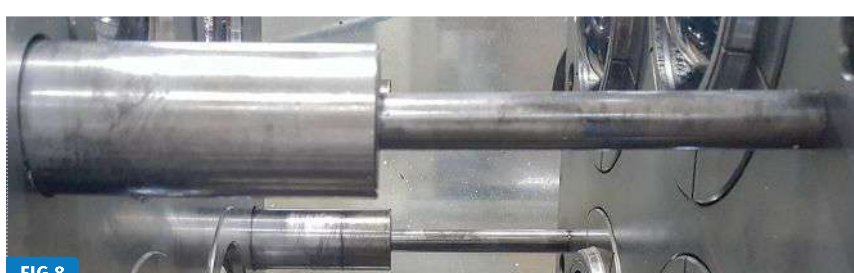


FIG 8

Range bolt mounted in a telescoping cylinder. Photo Credit: Jim Fattori

FIG 9

Range bolt mounted in a telescoping cylinder. Photo Credit: Jim Fattori

FIG 10

A basic range bar. Photo Credit: Jim Fattori

lateral loads. They should always have a thermoplastic washer, such as urethane, with a flat steel washer under their heads to absorb shock and dampen the noise. This shock absorption also helps prevent the threads of the bolt from stripping out. Often, the head of the range bolt is inaccessible for maintenance when the mold is in the press. Machining opposing flats on the range bolt so that a wrench can be used to remove it can be very helpful. Hence the term "wrench flats." For more detailed information on range bolts, see my June 2019 *PT* article.

Flash traps on runners dramatically reduce the amount of mold damage.

Sometimes you can't install a range bolt within a mold that is long enough to obtain the desired parting line opening. In a case like this, you can use a telescoping range bolt, such as in Figure 8. This design uses a standard range bolt mounted inside a floating cylinder. The cylinder has a shoulder on the end to limit the stroke of the assembly.

Other times you don't have room to install all the range bolts within the mold base. In that case, you can mount a range bolt on the outside of the mold, such as in Figure 9.

An alternative to range bolts are range bars, which are almost always mounted externally. They are a little noisier, unless you incorporate some type of snubbing feature, but they are very simple and ➤

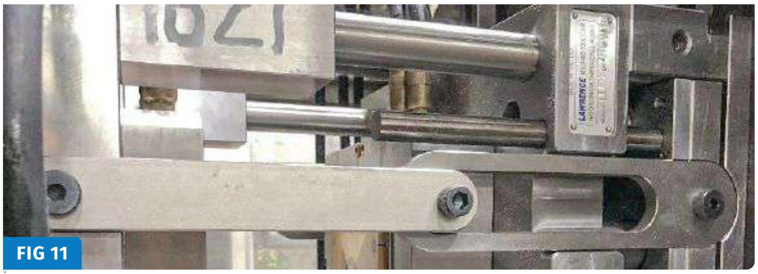


FIG 11

A telescoping range bar. Photo Credit: Lawrence Mold and Tool.

FIG 12

Range bars for very long opening strokes. Photo Credit: Jim Fattori

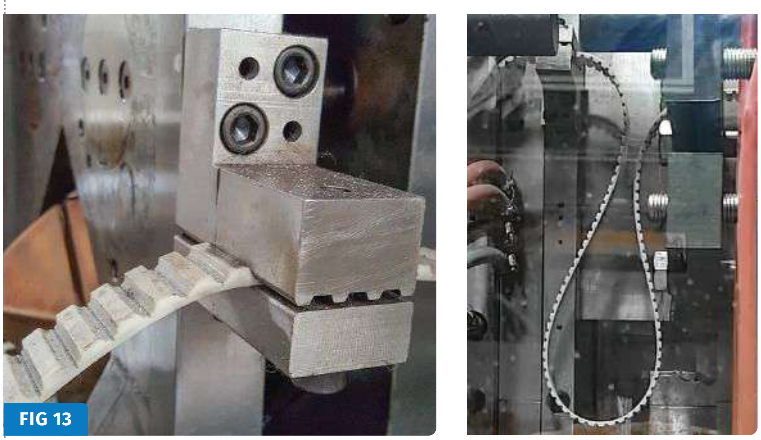


FIG 13

Timing belts used for pulling mold plates. Photo Credit: Jim Fattori

effective. The most basic design is shown in Figure 10. A telescoping design is shown in Figure 11. And a design for maximum opening strokes is shown in Figure 12. Notice how a spacer was added to one of the range bars in Figure 12 to reduce the opening stroke after the initial mold sampling.

Figure 13 shows an excellent method of achieving a parting line opening stroke that exceeds the stack height of the mold without the use of the notorious metal chains. It's the same premise as metal chains, but uses low-stretch, reinforced timing belts — the kind used on servo motors and motorcycles. They are extremely strong and have very high shock resistance.

For small to medium size molds, I like to use range bolts.

Another benefit of timing belts is that the belt length and corresponding opening stroke can be adjusted in the press in a matter of minutes. I have had success with this little-known design, particularly on very large molds.

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By Tony Deligio
Executive Editor

The Whole Package

US Merchants' Ontario, California, injection molding facility features 46 1,200-ton LS Mtron injection molding machines. Photo Credit: US Merchants

In less than a decade in injection molding, US Merchants has acquired hundreds of machines spread across facilities in California, Texas, Virginia and Arizona, with even more growth coming.

Jeff Green, president and CEO of US Merchants, grew his business alongside the warehouse club stores that emerged in the '80s. Photo Credit: US Merchants

A showroom displays just some of the totes, containers and shelving US Merchants produces at molding facilities across the U.S. Photo Credit: *Plastics Technology*

Now the owner of hundreds of injection molding machines, Jeff Green speaks frankly about his company's molding knowledge when he acquired his first presses in 2014. "We didn't know anything about injection molding," Green says. "I knew as much about injection molding as you know about flying a 747 airplane."

In a second-story conference room at US Merchant's Beverly Hills, California, corporate headquarters, I'm seated across from Green at a glass-top table. I've just met the president and CEO of US Merchants, but his assessment of my aviation abilities is accurate. Nowadays, Green does know injection molding, and what he's always known is retail — from sourcing, packaging and merchandising to shipping and logistics.

"When you have to farm things out to third parties, you're only asking for issues with delivery and excuses why something can't be done."

In the hallway leading to the conference room, the walls are decorated with two of Green's formidable collections: sports memorabilia and patents for his packaging and product display concepts that are now ubiquitous at retailers, including the warehouse club stores that he grew alongside starting in the 1980s.

Beginning in retail himself in 1979 with a tennis store in Beverly Hills dubbed with the pun-intended name — The Merchants of Tennis — Green grew into the wholesale business at a time in the early '80s when warehouse club chains were just getting started. One of Green's patents is for the Pallet Program he devised as a means for those retailers to turn pallets of shrink-wrapped and boxed-up goods into ready-to-go, point-of-purchase displays with nothing more than a box cutter.

Over the years and owing in part to Green's desire for maximum control, US Merchants vertically integrated everything from graphic and package design to thermoforming and thermoform die manufacturing to shipping and logistics with his own fleet of trucks. "Our business started to grow, and not just in packaging," Green says, "but now we offer a nice menu of items that a manufacturer or retailer can select from, be it packaging or logistics or transportation or buying the product and reselling it, which a lot of manufacturers like. We're really a turnkey solution for them."

Back in 2014, one of those manufacturers requested something that wasn't on the menu, asking US Merchants if it could make it a better 27-gallon storage container. "I do have engineers in my packaging and machine area that understand what injection molding is and they said to me, 'Jeff, this product requires different equipment than what we currently have,' and so I said, 'Will you look into it and let me know what the cost is,' and I went back the very next day to the customer and said, 'If you give me a commitment...' — because we don't do anything unless we have a firm commitment — and that customer gave me a commitment, sight unseen. I guaranteed that the product would be better than what they were currently selling. I went ahead and I bought some equipment, and that's how I got into the injection molding business."

Today, US Merchants operates seven facilities in California, with additional sites in Virginia, Texas, Canada and Arizona, as

US Merchants molds several million of the familiar black-and-yellow totes every week. Photo Credit: LS Mtron

well as a planned expansion into the U.K. The company has standardized on LS Mtron injection molding machines, and it credits the Korean press maker and several other vendors with helping it transition from a molding newbie to an old plastics hand.

Specifically, Green and US Merchants credit Shingo Hirate, president of equipment distributor Hirate America Inc., Anaheim, California, with helping the company understand what would be needed to get started in injection molding. Green and Larry Khemlani, US Merchants VP of Operations, met Hirate while walking a plastics trade show, and Hirate's willingness to get into the nuts and bolts of starting a molding business from scratch won him a new and prodigious customer. US Merchants would order four full molding machine cells from Hirate shortly thereafter and then another three in quick succession.

> ***"We don't make mistakes because we're trying to cut corners to make a larger margin. If I give you a better price, it's coming out of my margin, never out of the quality of the product."***

Working closely with Steve Gwon and his machinery distribution company E Solution Inc., Hirate and US Merchants soon switched over to LS Mtron injection molding machines. Eventually, Gwon and Hirate would help US Merchants not only source machines but molds, hot runner controllers, auxiliaries, robots, chillers, material handling systems, gantry cranes, mold tilters and more. Beyond sourcing, they also gave the rookie molder advice on everything from part design and employee recruiting to laying out and commissioning new plants.

In June 2023, US Merchants opened a facility in Glendale, Arizona, covering nearly 640,000 square feet, which will have 69 LS Mtron presses when fully commissioned, including 2,500-ton and all-electric machines. A second facility is coming to Houston, and the company will be opening its first international molding facilities in Montreal and the U.K. The molding operation we tour in Ontario, which was purchased in 2017, has 46 1,200-ton LS Mtron presses divided into three rows.

"This is where companies like LS Mtron and E Solution have really made a difference," Green says, "because these people are professionals and experts, and we've kind of put ourselves in their hands to help us and direct us in the right direction."

CONTROLLING INTEREST

As US Merchants' business has grown, so has its capabilities, driven by Green's intense interest in maximum control over everything that can impact his business. "You could say I'm something of a very controlling individual," Green says. "I always felt that we need to control our own destiny. When you have to farm things out to third parties, you're only asking for issues with delivery and excuses why something can't be done."

The resulting vertical integration propelled by this mindset extends into some unexpected areas. To wit, the company's original 245,000-square-foot facility in Ontario, California, includes a carpentry shop that designs, builds and installs all the office furniture for all of US Merchants' facilities. Outside the shop, an "Arizona Project '22" poster hangs, marking its recent work to fully furnish the company's newest outpost. US Merchants sent its own carpenters to the new facility where they took measurements for all its furnishings before coming back to California to build all the desks, shelving and more, and then return to Arizona to install it. When it's not building furniture for the company, the carpentry shop also designs and constructs trade show booths for US Merchants, as well as store point-of-purchase displays.

"I can give a customer a delivery date," Green says, "and I know that I can meet that date. Why? Because we control the entire process. We do all that in-house and we control it, so I know that if I give somebody a promise, I'm going to be able to deliver because we do everything in-house."

US Merchants' newest Glendale, Arizona, facility covers nearly 640,000 square feet and will have 69 LS Mtron presses when fully commissioned.

A HIGHER STANDARD

At the end of the three rows of machines at the Ontario injection molding facility, some totes and other molded products are marked NCM (nonconforming materials) and will be scrapped. Khemlani notes NCM represents less than 1% of the company's output, with the parts in question not meeting US Merchants' rigid and rigorous standards, which are another core tenet of Green's business philosophy.

"My personal belief is quality stands the test of time," Green says, "and so we as a company don't cut any corners. I believe that making the highest quality product in the industry, you have the longest staying power." With its molded products, that ethos extends to the removal of any flash and, if need be, longer cycle times if they mean avoiding warp and producing a tote that closes cleanly and securely off the press.

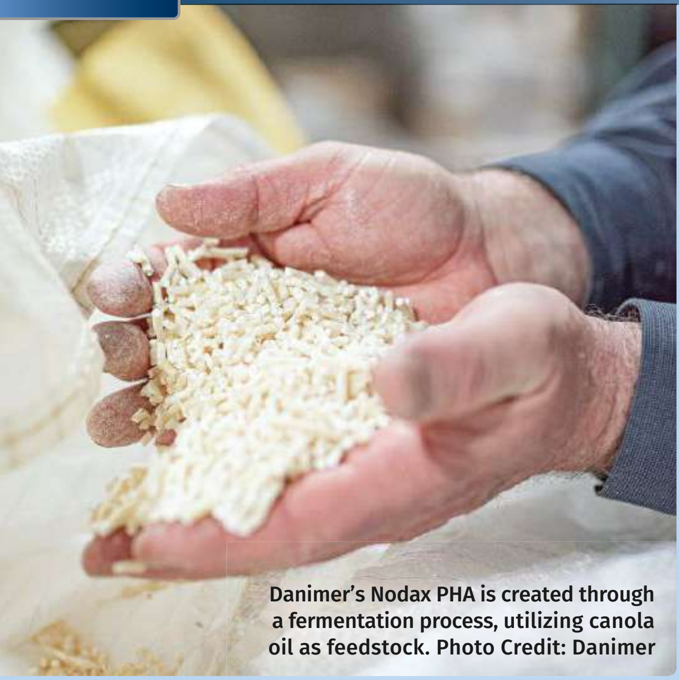
"I don't say I have the best standard in the world, but we live or die by what our standard is, so we don't cut corners. That doesn't mean we don't make mistakes — we make mistakes like everybody else. We try to learn from our mistakes and not let them happen a second time, but we don't make mistakes because we're trying to cut corners to make a larger margin. If I give you a better price, it's coming out of my margin, never out of the quality of the product."

Another guiding principle for Green and his wife, Marie, who is also his business partner since the tennis shop, is to use that reputation for attention to detail and quality to secure order commitments prior to taking on new jobs or new markets. "Our formula, my wife and mine, has not changed since we started our business with our little tennis store," Green says. "We don't really do anything unless we have a commitment. Typically, a customer of ours will come to us and say, 'Can you make...?'"

Nowadays, many of those new requests make use of the company's now extensive injection molding capabilities, including new sizes of totes and a line of molded plastic glassware. "If you ask me: have I ever made a drinking glass before — the answer would be no. Do I feel that the drinking glasses that we're going to be coming out with are going to be exceptionally good and very well received? Absolutely."

When *Plastics Technology* visited US Merchants' original Ontario facility where those first seven injection molding machines are still molding totes, the packaging/logistics side of the operation was packing up everything from skateboards and boots to batteries and bags, with finished pallets marked for delivery to New Zealand, Japan, China and destinations beyond. Forklifts navigated a towering maze of shrink-wrapped pallets ready to be loaded onto trucks, including Green's own. The full scope of the operations is a bit overwhelming, but it all makes sense to Green. "To an outside person," Green says, "it looks very convoluted, but the truth of the matter is it's like a jigsaw puzzle — everything fits into place."

In the foreground, rows of shrink-wrapped pallets are ready for delivery. In the background, US Merchants in-house thermoforming lines. Photo Credit: *Plastics Technology*



Danimer's Nodax PHA is created through a fermentation process, utilizing canola oil as feedstock. Photo Credit: Danimer

How to Optimize Your Molds and Hot Runners for Processing Bioresins

Demand for bioresins is growing in molded goods, particularly as a sustainability play to replace fossil fuel-based materials, but these materials are not a drop-in replacement for traditional materials. Molds and hot runners need to be optimized for these materials.

By Sheldon Alexander
Husky Technologies

Across multiple industries and applications, bioresins have become increasingly popular alternatives to the traditional resins used in injection molding. The global market for bioresins has risen steadily over the years and is expected to continue that growth at an impressive rate. Over the next five years, the market is expected to double in size, with a compound annual growth rate (CAGR) of 17% in the U.S. and 13% in Europe.

What's driving the growth in bioresin adoption? First are consumers who want to know that the product they purchased, as well as its packaging, is sustainable. Because bioresins are derived from relatively sustainable materials and can be engineered to biodegrade, many consumers feel bioresins are a more sustainable choice.

The second driver is environmental, social and governance (ESG) initiatives. Brands and molders are under increasing pressure to adopt an ESG strategy. Using bioresins for injection molded products and packaging can help organizations meet their ESG objectives and signal to consumers that they're doing their part for the environment.

The final driver is legislation. New legislation and regulations are placing pressure on manufacturers to reduce post-consumer waste and plastic pollution. In July 2021, for example, the European Commission implemented new laws that ban or restrict single-use products made from fossil fuel-based polymers.

PUTTING THE "BIO" IN BIORESINS

Bioresins — sometimes called bioplastics, biopolymers or biomaterials — refer to several categories of commercially available materials that can be used in injection molding and other processes. So, what makes these plastics "bio"? The materials are made in whole or in part from renewable biological resources. These biological resources can include

Commercial Bioresins and What They Replace

Bioresin	Raw Material	Process	Substitutes
PLA (Polylactic Acid)	Starch (corn, tapioca roots, sugar cane)	Polyester is derived from renewable raw material resources.	LDPE, HDPE, PS, PET, PP
PHA (polyhydroxyalkanoate)	Starch (corn, potatoes, maize, tapioca, vegetable oils)	Polyester is derived from microorganisms through bacterial fermentation.	PP, PE
PHB (polyhydroxybutanoate)	Starch (corn, potatoes, maize, tapioca, vegetable oils)	Polyester is derived from microorganisms through bacterial fermentation.	PP, PE
Cellulose base	Cellulose (wood pulp)	Extensively modified thermoplastics or cellulosic fibers.	PP

There are a number of commercially available bioresins that can replace traditional plastics in a number of everyday applications.

corn or maize, potato starch, tapioca starch, vegetable oil, sugar cane starch and wood pulp or cellulose, among other feedstocks.

When planning to use bioresins, it's important to note a few distinctions in related terminology and features. Biobased refers to the fact that biomaterials are used to create the resin. Biodegradable means the item will eventually break down in the natural environment. Not all biobased resins are biodegradable. Compostable means the material is biodegradable and breaks down within three to six months in an industrial composting facility, releasing nutrients and leaving no toxicity in the soil. Not all biobased and biodegradable materials are compostable.

WHAT TRADITIONAL MATERIALS CAN BIORESINS REPLACE?

In most applications, high- and low-density polyethylene (HDPE, LDPE), polystyrene (PS) and PET can be replaced by polylactic acid (PLA). PLA is one of the first bioresins to be commercialized, and its feedstock options include corn or maize, tapioca and sugar cane.

PE can be replaced with polyhydroxybutyrate (PHB) or polyhydroxyalkanoates (PHA), which are relatively newer resins on the market. These bioresins have more processing options and can offer compostability. PHA and PHB can be produced from corn; tapioca or potato starch; and vegetable oil. Many of the polypropylene (PP) parts molded today can be replaced with a cellulose resin made from wood pulp.

Non-Bioresin	Bioresin Alternative	Raw Material Options
LDPE, HDPE, PS, PET →	PLA	Corn/Maize, Tapioca, Sugarcane
PE →	PHA, PHB	Corn/Maize, Tapioca, Potato, Vegetable Oil
PP →	Cellulose	Wood Pulp

Derived from a variety of sustainable feedstocks, bioresins can be processed in various ways to meet the needs of many applications.

BIORESIN CHALLENGES AND BEST PRACTICES

Bioresins come with unique and challenging physical properties that can make them difficult to incorporate into the injection molding process. For example, many bioresins are highly viscous and require high pressures to fill the mold cavities. They're also prone to weepage and leakage. In terms of manufacturability, some bioresins are very temperature sensitive, so the manufacturing process must avoid exceeding temperatures above a certain threshold.

One of the most frequent mistakes we see is people thinking because bioresins replace PP and PE, they process similarly to those resins. Bioresins are more thermally sensitive and their process window is smaller, so running them requires equipment that's designed to deal with those constraints.

Weepage and leakage can pose issues in bioresin molding applications.

Any new materials also bring unknowns, especially in performance, and many bioresins may not perform as well as traditional materials in terms of product preservation, longevity, safety and other key metrics. These unknowns need to be addressed to achieve a successful bioresin adoption. Bioresins are not a straight replacement for PP and PE. Even within petrochemical-based PE and PP, there is a wide variation in performance among the numerous grades. Make sure that the bioresin you're choosing matches the requirements of the product that you're bringing to market.

Equipment impact is another area where bioresins may not initially meet the same standards as traditional materials. Molten bioresins tend to be corrosive, especially in the case of PLA, which can compromise machinery and lead to quality issues, performance variation and even component failure.

This may require more frequent equipment inspection and maintenance to ensure consistent and predictable uptime. PLA can cause damage to not just the hot runner and the mold but the screw and barrel as well. Basically, anything that touches the melt needs to be stainless steel or have a nonreactive coating.

Weepage and leakage are also an issue. This is partly due to the material's corrosive nature, but also its molecular structure tends to weep or leak. In the case of a valve-gate system where there are moving parts, weepage is possible. When there are moving parts ►

like valves, stems and bushings, their design needs to take into consideration the possibility of weepage.

Bioresin preparation includes drying to a moisture content of less than 250 parts per million (ppm) to prevent viscosity impacts and resin degradation. Bioresins are usually supplied in foil-lined bags or bags that are dried to less than 400 ppm in moisture. These resins should not be exposed to atmospheric conditions after drying.

The corrosive properties of bioresins, particularly as they degrade, require melt-contact surfaces to use specialized coatings or be in stainless steel.

In processing, the pre-sealed bag is ideally opened and loaded directly into the dryer. The bag should not be left open for an excessive amount of time, and users shouldn't drain the resin from the dryer after it has been dried and leave it out. Errors in drying and handling can have a particular impact on mechanical performance.

If a color change will be required, the channels must be sized so the shear rates are on the high side, which results in proper scrubbing of the melt channels, expediting color switchovers. With these inputs and using the output from several software packages, the optimum geometry for the melt channel (including its layout and channel diameter) can be determined.

APPLICATION REVIEW

Conduct an in-depth review of the application and the bioresin itself prior to any manufacturing. This review ensures the hot runner and controller are optimized for the specific application and bioresin. This should include optimizing the manifold design for consistent preparation of the bioresin.

To optimize the application, an in-depth review of the component and the bioresin should be conducted, including a cavity-fill analysis of the part design to verify all features are compatible with the rheology of the chosen bioresin. The bioresin supplier should be able to characterize flow characteristics and ideally the simulation will model the actual resin and not a substitute material. The need for a resin trial can also be evaluated — a step that is usually recommended for resins with limited performance data or in particularly challenging applications.

Stainless steel hot runner systems can resist the corrosive nature of degraded bioresins. Photo shows Husky's UltraMelt design. Photo Credit: Husky

Husky is currently working with many of the bioresin suppliers to test and validate their materials, including new formulations as they go to market. In its lab, Husky has about 45 different molds with different part configurations to test an assortment of resins and help customers determine if a particular bioresin is right for a specific application. Compostability testing with the bioresin you've chosen is possible and required for commercializing a product with a compostability certification.

PINPOINTING PRESSURE

The pressure requirements for processing the bioresin need to be evaluated because viscosities for these materials can be very different from standard polyolefins. Determine if the machine and hot runner being used can generate adequate pressure to process the material. In general, Husky recommends machines that can achieve pressures of at least 28,000 to 32,000 psi.

In addition, the resin melt temperatures are relatively low and there is a comparatively low Delta T or difference between the melt and mold temperature. The next step is optimizing the hot runner and the controller for the bioresin, including using corrosive-resistant components and high-level melt management.

Individual tip control is highly recommended for bioresins, as it would be for all temperature-sensitive resins. Improved heat distribution is required to control any overshoot, and the controller should be designed specifically for low-variation, high-temperature control to eliminate overshoots, if possible.

In addition, it is best for the hot runner controller to be tied into the injection molding machine's control. This is recommended because if the machine goes down for a predetermined amount of time without an operator, when the molder restarts the press, it's best to have the controller automatically put the heat in standby on the hot runner to prevent material degradation during the idle.

Also, remember that the corrosiveness of the resin goes up almost exponentially as it degrades, making the ability to flush any degraded resin out important. Degraded bioresins will attack the steel components in the hot runner and can also damage the mold if injected.

Ensuring the manifold design is optimized for bioresin includes applying geometrically balanced channels so the melt traveling from the sprue bushing to every cavity, whether there are two or 96, experiences the same, if not similar, rheology profiles.

Remember: The corrosiveness of some bioresins goes up almost exponentially as they degrade.

Remembering that the melt channel size and distance covered help determine the shear rates, molders should consider and optimize these for low pressure, reduced shear and minimal residence time, bearing in mind that the smaller the channel, the higher the shear rate and the lower the residence time.

The counterpoint to that setting profile is pressure drop. Molders need to ensure that for some specific bioresins, the channel is not too small and there isn't too much pressure drop, which could prevent the parts from filling. Each manifold should be engineered specifically to the application and then balanced between pressure drop, shear rate and residence time requirements.

The performance characteristics to be expected — including pressure drop; shear rate in the hot runner; shear rate at the gate; and the temperature — increase as a result of that shear rate. For thermal uniformity, a Finite Element Analysis (FEA) is a good predictor of manifold temperature variation due to the design of the hot runner.

By adjusting the design — including the number of heater zones, thermocouple placement, melt channel layout sinks and manifold profile — the designer can optimize the thermal uniformity of the manifold prior to manufacturing. PT

ABOUT THE AUTHOR: Sheldon Alexander is hot runners business manager for Husky. He has more than 20 years of global industry experience, traveling the world to help optimize injection molding applications for customers in more than 40 countries. Alexander has experience managing highly skilled teams across many functions in the injection molding value chain and holds several technical patents in the industry with specific expertise in hot runners. Contact: *905-951-5000; salexand@husky.co; husky.co.*

Temperature Control: What You Need to Know to Comply With New Cooling-Fluid Regs

Beginning the first of this year, 12 states are following EPA bans on potentially damaging cooling fluids. Chiller suppliers have adjusted equipment designs to accommodate the new regulations. Here's what all this means to processors.

By Mark Johansen
ACS Group

New state bans on industrial refrigerants that are potentially harmful to the environment went into effect Jan. 1 in 12 states. These mandates effectively prohibit plastics processors from purchasing new chillers that do not use refrigerants with low Global Warming Potential (GWP) — but current cooling equipment based on previously legal refrigerants can be used through the remainder of its life cycle.

Equipment manufacturers have found that newly required refrigerants provide comparable cooling capacity as those being banned. What's more, processors should notice product improvements from their suppliers well beyond simply accommodating the new refrigerants, as the shift in coolant media triggered some to redesign their units.

Plastics processors must make critical operational and budget decisions about when and how to purchase new chillers to comply with these new rules.

So far, 12 states have enacted bans on refrigerants that the EPA's Significant New Alternatives Policy (SNAP) program designates as having high GWP. These include the R-134a and R-410A refrigerants which are widely used in chillers and other temperature-control units. On the heels of federal legislation to regulate the production and use of hydrofluorocarbon refrigerant, these states have enacted their own legislation that aligns with — or includes even stricter regulation than those set out in — EPA SNAP Rules 20 and 21.

QUESTIONS ABOUT CHILLING?
Learn more at PTonline.com
Navigate to **Heating & Cooling** by clicking on **All Topics** in the top navigation bar.

WHO IS AFFECTED IN 2024

The most affected plastics processors on New Year's Day are in the following states (see chart on next page):

- **States with GWP Laws Stricter than EPA SNAP:** California, New York, Washington
- **States with GWP Laws Equal to EPA SNAP:** Colorado, Delaware, Maine, Maryland, Massachusetts, New Jersey, Rhode Island, Vermont, Virginia
- **States with Refrigerant Legislation Pending:** Connecticut, Hawaii, New Mexico, Oregon, Pennsylvania.

Effective Jan. 1, states that have enacted GWP laws are not letting businesses located within them to purchase new units that use high-GWP refrigerants. Plastics processors in those states can continue to use existing equipment that relies on those refrigerants until that equipment reaches its end of life — but going forward, those businesses must purchase new equipment designed to use low-GWP refrigerants like R-454B and R-513A.

HOW WE GOT HERE: THE EPA AND STATE LAWS

The refrigerant ban that just went into effect stems from an EPA rule the agency announced in December 2016 and went into effect on Jan. 3, 2017. And on Oct. 5, 2023, the EPA announced a federal regulation that will further limit the GWP of refrigerants in new systems and equipment.

Pursuant to SNAP, the rule detailed more than 25 refrigerants deemed unacceptable in new centrifugal chillers and positive displacement chillers.

The EPA's criteria for evaluating substitute refrigerants included atmospheric effects, exposure assessments, toxicity data, flammability and other environmental impacts, according to a comprehensive explanation of the rule in the Federal Register.

FIG 1

U.S. Plastics Industry Employment by State

Rank	State	Total Plastics Employment, thousands	% of Total U.S. Plastics Employment
1	Texas	75.9	7.5%
2	Ohio	75.3	7.4%
3	**California**	**74.1**	**7.3%**
4	Michigan	64.8	6.4%
5	Pennsylvania	52.9	5.2%
6	Illinois	52.7	5.2%
7	Indiana	50.8	5.0%
8	Wisconsin	44.2	4.4%
9	North Carolina	39.5	3.9%
10	Georgia	34.4	3.4%
11	Tennessee	33.7	3.3%
12	**New York**	**30.3**	**3.0%**
13	South Carolina	28	2.8%
14	Kentucky	26.4	2.6%
15	**Virginia**	**24.8**	**2.4%**
16	**New Jersey**	**24.5**	**2.4%**
17	Florida	23.6	2.3%
18	Minnesota	22.1	2.2%
19	Alabama	21.9	2.2%
20	**Massachusetts**	**20**	**2.0%**
21	Missouri	19.2	1.9%
22	**Washington**	**14.4**	**1.4%**
23	Iowa	14	1.4%
24	Kansas	12.7	1.3%
25	Louisiana	12	1.2%

Source: PLASTICS Industry Association *2023 Size & Impact Report*

Six of the 12 states (highlighted in blue) with SNAP (or SNAP Equivalent) laws in place effective January 1, rank in the top 25 of plastics industry employment and combined account for nearly 20% of total U.S. plastics employment. Including the remaining six states (Colorado, Delaware, Maryland, Maine, Rhode Island and Vermont) not highlighted, new cooling fluid regs will impact close to 25% of total U.S. plastics employment.

The SNAP program "evaluates the potential contributions to both ozone depletion and climate change" and "considers the ODP (Ozone Depletion Potential) and the 100-year integrated GWP of compounds to assess atmospheric effects," the EPA explained. Furthermore, the program "uses exposure assessments to estimate concentration levels of substitutes to which workers, consumers, the general population and the environment may be exposed over a determined period of time. These assessments are based on personal monitoring data or area sampling data, if available."

According to an EPA spokesperson, the agency's final Technology Transitions rule under the AIM Act is applicable nationwide. Some states may have their own regulations in addition to EPA's rules, and these regulations may differ from the recently released EPA final rule, the representative explained, adding that the EPA regularly communicates with its state-level partners on this and other topics. The EPA recommends reaching out to state-level officials for questions on state enforcement strategies and determinations.

ACCEPTABLE REFRIGERANTS BY THE NUMBERS

Different refrigerants have different thermodynamic properties and potential for flammability. Because of this, equipment must be designed from the ground up specifically to use these refrigerants; using a different refrigerant is not simply a matter of changing a compressor in an existing chiller.

GWP, which represents the capacity of a pollutant to harm the environment, is measured by how much more damaging the emission of one unit of a gas is compared with the emission of one unit of carbon dioxide. With CO_2 being assigned a value of 1, it becomes quite clear how much more damaging current refrigerants can be when considering the EPA's desired limit of 750 GWP or less.

Comparing the GWP of previously acceptable refrigerants with the specifications of their suitable replacements, we find:

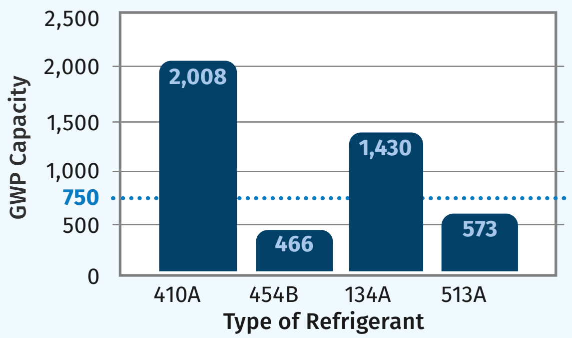
- 410A: GWP of 2,088 versus 454B, with GWP of 466
- 134a: GWP of 1,430 versus 513A, with GWP of 573

Notably, 410A — the most commonly used refrigerant in 5-ton to 60-ton chillers — had been the "new green refrigerant" prior to this rule. Along with 134a (used primarily in small or very large chillers), 410A was classified as an A1 refrigerant, meaning it was neither toxic nor flammable. But with those refrigerants running afoul of the law in the previously noted states, plastics industry equipment manufacturers like us have had to respond by offering new chillers to comply with the latest GWP laws.

WHAT THIS MEANS TO YOU

These new refrigerant bans mean equipment makers and plastics processors have decisions to make. For chiller makers, these rules mean equipment redesigns to incorporate new compressors and other components that run with low-GWP refrigerants. The opportunity therefore exists for chiller makers to refine various aspects of their

FIG 2 **GWP Refrigerant Capacity**



How the new and old refrigerants stack up to EPA suggested limits. Source: ACS Group

products besides just making them compatible with low-GWP refrigerants. Upgrades can include:

- Simplified designs that can improve access to chiller components, thereby eliminating service difficulty, maintenance time and upkeep costs.
- Improved design geometries that can reduce chiller proportions — perhaps even reducing excessive shipping costs and making these units easier to install.

For plastics processors, this means making critical operational and budget decisions about when and how to purchase new chillers to comply with these new rules. Processors will be allowed to use their existing chillers with now-banned refrigerants until the end of that equipment's life cycle. But as of Jan. 1, they will no longer be able to purchase chillers using those potentially damaging refrigerants. However, with newly redesigned chillers coming on the market, this could be a good time for processors in states not yet affected by these bans to get a jump on restrictions likely to be enacted in the future.

One final consideration for units that will use R-454B refrigerant: This is classified as an A2L refrigerant, so it is slightly flammable but nontoxic. So when purchasing these types of chillers:

- Make sure they are equipped with A2L leak detectors.
- Ensure areas where these chillers are used also have A2L leak detectors
- Follow proper safety procedures, including operating these chillers with good ventilation.

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Keeping Up With Technology

RECYCLING

Recycling Extruder Handles Highly Contaminated Materials

The E-GO R single-screw extrusion line from Bausano enables highly contaminated materials — such as HDPE residues from containers for milk, motor oil, shampoos and conditioners, soap, detergents and bleach — to be fully reintegrated into production processes. The line can also handle PP waste from lunch boxes, yogurt jars, syrup and medicine bottles, caps; and LDPE waste from cling film, shopping bags and squeezable bottles.

According to Bausano, E-GO R extruders are well suited for recycling both light and highly humid materials, as well as heavy films and materials with low water content. Following crushing, the flaked and ground plastic is conveyed directly into the extruder by a force-feed system designed specifically for this application. In the process, volatiles and moisture are removed by a high-performance degassing system, which prevents the development of defects in the granule, such as "air bubbles," which are caused by gases in the starting compound or formed in the extrusion steps.

The extruded mass is then filtered and directed to the granulation head. In addition, constant speed, combined with advanced screw design, ensures the highest standards of product quality. A liquid ring or immersion pelletizing system completes the line.

MATERIALS

Line of PFAS-Free Process Aids Extended

Ampacet has extended its range of PFAS-free polymer processing aids (PPA) to include two globally compliant additives that are said to perform as well as fluoro-based PPAs in blown film extrusion, and at the same let-down ratio as most common Ampacet PPAs.

Perfluoroalkyl and polyfluoroalkyl substances (PFAS) have been found to present potential health hazards and face increased regulations for their use. As more government agencies restrict the use of PFAS, Ampacet notes it's important to consider using a PFAS-free PPA that is globally compliant for food contact.

In addition to the FDA food contact-compliant PPA previously introduced, the line has been extended to include a new globally compliant PFAS-Free PPA and one that is globally compliant and siloxane-free. Like fluoro-based PPAs, they eliminate melt fracture, reduce die buildup for less downtime and offer increased throughput.

BLOW MOLDING

Revamped All-Electric Shuttle Machine

At the recent IPF Japan show in Tokyo, Tahara Machinery Ltd. (part of the JSW Group) introduced a redesigned lineup of all-electric shuttle machines for mass-production applications. The Innovarex400D machine at the show was an eight-head, double-station machine for three-layer coextrusion. Several new features add up to a more compact layout, easier maintenance and new control features for performance monitoring and remote maintenance.

The Innovarex400D has a 44-ton clamp, 1,300-mm mold stroke, up to four extruders (including one for a view stripe) of 35- to 90-mm diameter, and a dry cycle of 4 sec. It can produce products from 0.5 liter to around 10 liters.

Among its key new features is a clamping mechanism that eliminates the need for both tie bars and the company's "bend stopper" to prevent platen deflection.

The new design is said to save time on clamp maintenance and adjustment.

Changing the direction of bottle takeout to the back rather than to the side reduces the machine width by 35%, while retaining sufficient space for flash and bottle conveyors, and making the unit more easily accessible than before.

The revised die-head design utilizes a "comb" style rather than the former "tournament" style, while keeping the head compact and enabling flexibility for installing from one to 12 heads.

RECYCLING

Flake Sorter Relies on NIR to Boost Recovery

Tomra's Innosort Flake sorting machine is said to enable recyclers to meet demand for higher quality recyclate by providing better value recovery from mixed waste streams. Innosort Flake uses a near-infrared (NIR) spectrometer to identify flakes of different polymer types, enabling recovery of recyclables from contaminated infeed.

Mixed plastic fractions that have been shredded and washed can be sorted into clean fractions of PET, PP and PE, and other materials that meet quality requirements for extrusion and the creation of postconsumer recycled content.

The machine also features optical sorting with dual-sided, high-resolution cameras and a changeable color background. According to the company, the new system is capable of detecting millions of colors and creating single-color fractions. The high-contrast imaging is capable of differentiating white opaque and natural, transparent and translucent flakes.

The Innosort Flake comes with up to four chutes and a changeable illumination background. This flexibility makes it possible to run multiple sorting and recovery steps in a single machine, thereby reducing time and material handling, Tomra says.

ADDITIVE MANUFACTURING

3D Printer for the Factory Floor

Markforged Holding Corp. unveiled the FX10 3D printer at the FormNext trade show. The printer is designed to be used on the factory floor, supporting production operations by minimizing downtime by fabricating replacement parts as needed.

According to the company, the FX10 enables manufacturers to shorten lead teams and reduce costs associated with replacement parts. The printer features a modular design, facilitating upgrades. The heated chamber enables print speeds that are nearly twice as fast and print sizes that are up to twice as large as previous Markforged industrial series printers, enabling the replacement of metal parts with advanced composites.

The printer also features a touchscreen interface, with new automation and quality assurance technologies. Printhead-mounted optical sensors automatically verify the dimensional accuracy of the part. A laser micrometer in the FX10 scans parts during printing and assists with the machine's automatic calibration. Inspection software interprets the data from the sensors for dimensional verification, providing users with quality assurance as soon as a print finishes.

MATERIALS

Pine Tree-Based Titanate

Kenrich Petrochemicals has announced that Ken-React KR PTOA, a plant-based pine tree oleic acid titanate, is available for R&D sampling.

The material was originally conceived as a dispersant for zinc oxide (ZnO) in naphthenic oil and mineral fillers in polyolefins. Kenrich says applications for this coupling agent have expanded to thermoplastic color concentrates; increased strain energy of golf balls; dispersion of TiO_2 and ZnO in cosmetics; finer and more uniform cell structure of exothermic and endothermic foaming agents; comonomer for inks; -17°C cold temperature PVC flexibilizer; increased adhesion of acrylic to slate; PE and PET resin catalyst; and more.

"There is market pressure to use domestic plant-derived sustainable materials," says Sal Monte, Kenrich owner and president, who invented the product. "We chose the American pine tree as an oleic acid raw material source for our new titanate as it is widely available and eliminates any supply logistics concerns."

COMPOUNDING

Lab Extruder Easy to Operate, Performs Better

The ZE 28 BluePower laboratory twin-screw extruder from KraussMaffei is now available with shorter lead times and a more attractive price. The machine was relaunched last October at the Fakuma show in Germany.

The new high-performance, laboratory-scale extruder offers a free volume of OD/ID=1.65 and high torque density of 13.6 Nm/cm³. Depending on the specific requirements, the processing section can be configured within a length range of 32 to 64 L/D, and equipped with up to three side feeders.

Just like the other extruders in this series, the ZE 28 BluePower is available in three material variants to provide the wear resistance and corrosion protection required for customer-specific applications.

The laboratory extruder is designed to accommodate customized process solutions because it offers a wide variety of configuration options. These include processing section elements in a high-temperature design with a thermal resistance of up to 420°C. In addition, the automatic screw removal toward the drive — called UltraGlide — further expands the range of applications for this machine, KraussMaffei says.

KraussMaffei adds the machine offers high energy efficiency, excellent temperature control within the processing section, improved surface cleaning, enhanced power electronics protection and an optimized strand extrusion die. The processing sections, including the screw configurations, are still customized.

MATERIALS

PC Copolymer Formulated With PCR Content

SABIC launched a new portfolio of 10 LNP Elcrin copolymer resins. According to SABIC, adopting these polycarbonate (PC)-based copolymer materials, which contain up to 75% certified postconsumer recycled (PCR) content, can help customers advance their sustainability initiatives without sacrificing key attributes. Depending on the grade, they may provide low-temperature ductility, chemical and weathering resistance, processability, transparency, a broad color space, UV stability and thin-wall flame retardance.

Compared with SABIC's existing portfolio of materials made with PCR content, the new LNP copolymer resins contain higher percentages of PCR content (50-75%) than previous products, and this content is certified by SCS Global Services. Also, they offer a wider color range for opaque materials, several transparent options and more flame-retardant choices. All flame-retardant grades in the new portfolio have received UL Solutions Yellow Cards.

Based on internal life cycle assessments, the LNP EXL1484RCC grade, containing 75% PCR content, can lower global warming potential by 53% compared with virgin material. The LNP EXL7284RCC grade, also containing 75% PCR, can reduce global warming potential by 55%.

Prices for All Volume Resins Head Down at End of 2023

Flat-to-downward trajectory for at least this month.

By Lilli Manolis Sherman
Contributing Editor

Prices of volume resins were all heading downward by year's end, and projections for at least the first month of first quarter 2024 are generally for flat or lower pricing, particularly for the five commodity resins as new year contract negotiations were underway. All this, with the caveat there are no major production disruptions caused by inclement weather or other unplanned feedstock, and/or resin shutdowns.

In general, 2023 was ending with processors having more leverage than resin suppliers, with the latter having had a year of profit margin compression. Key factors included a drop in feedstock prices, with exceptions such as propylene monomer and benzene; though price corrections were underway for both as availability recovers. An overall underwhelming demand for all resins characterized most of last year, this despite resin suppliers' efforts to throttle back production, in some cases significantly. Lowered export prices were also underway by fourth quarter due to slowed global demand which indirectly influenced unpublished market discounts domestically.

These are the views of purchasing consultants from Resin Technology Inc. (RTi); senior analysts from Houston-based PetroChemWire (PCW); CEO Michael Greenberg of The Plastics Exchange; Scott Newell, executive v.p. polyolefins at distributor/compounder Spartan Polymers; and resin pricing expert Robin Chesshier.

PE PRICES DOWN, THEN FLAT

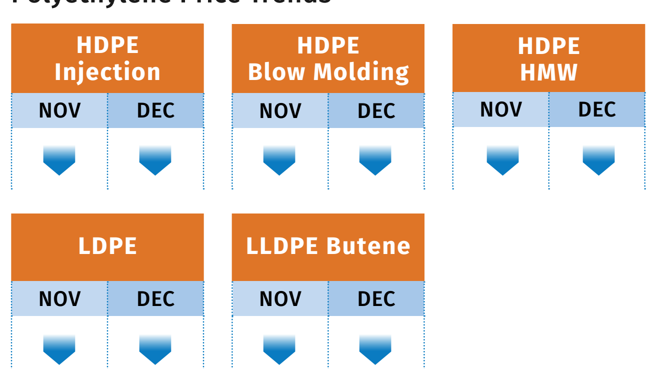
Polyethylene prices were largely expected to drop by 3¢/lb within November-December, which would nix the September 3¢/lb increase, which brought the total increases this year to 12¢/lb. This according to *PCW's* David Barry, The Plastic Exchange's CEO Michael Greenberg and resin pricing expert Robin Chesshier. As for this month, these sources would not be surprised to see suppliers issuing a new increase as is typical at year's end, but note that barring any major adverse production event, such an increase would likely take a couple of months to implement.

Says *PCW*'s Barry, "There has been a lot of nonmarket adjustments being made so that most processors did not incur the full 12¢/lb. It has been a challenging market as buyers need to stay alert and not rely on published industry indices." Chesshier notes that for November, the indices showed flat pricing for at least November. Moreover, all three industry pros note that in 2024 resin pricing contract negotiations, the buyers are definitely in the driver's seat. Barry and Greenberg noted that suppliers have dropped export prices in order to move material, which contributed to the bearish ►

Market Prices Effective Mid-December 2023

Resin Grade	¢/lb
POLYETHYLENE (railcar)	
LDPE, LINER	55-57
LLDPE BUTENE, FILM	52-54
HDPE, G-P INJECTION	52-54
HDPE, BLOW MOLDING	50-54
HDPE, HMW FILM	55-57
POLYPROPYLENE (railcar)	
G-P HOMOPOLYMER, INJECTION	63-65
IMPACT COPOLYMER	66-68
POLYSTYRENE (railcar)	
G-P CRYSTAL	74-76
HIPS	81-83
PVC RESIN (railcar)	
G-P HOMOPOLYMER	51-53
PIPE GRADE	49-50
PET (truckload)	
U.S. BOTTLE GRADE	63.5-65.5

Polyethylene Price Trends



sentiment. Adds Barry, “Exports are improving since the September-October time frame and that is due to domestic suppliers lowering prices. As an example, blow molding PE was selling at 33¢/lb to 35¢/lb in early November, from the previous 38¢/lb to 39¢/lb.”

Greenberg characterized the spot market as having ample PE grades across-the-board and reported that despite suppliers aiming for a November increase of 3¢/lb in November, the market has lost its upward momentum and larger buyers have been clamoring for a decrease. “We think that PE contracts will roll flat at best and would not be surprised to actually see 3¢/lb peel off.”

PP PRICES UP, THEN FLAT-TO-DOWN

Polypropylene prices in November moved up once again by 5¢/lb in step with propylene monomer, according to *PCW*’s Barry, Spartan Polymers’ Newell, and The Plastic Exchange’s Greenberg. As for the December-January time frame, these experts somewhat differed slightly in their predictions, all of which were based on how *quickly* monomer supplies recovered. All, however, project that barring a major disruption event, that some correction was underway for propylene monomer.

Polypropylene Price Trends

Homopolymer	
NOV	DEC
5¢/lb	

Copolymer	
NOV	DEC
5¢/lb	

Barry and Greenberg venture that PP prices could remain flat through December and possibly this month, noting that while monomer supply issues appear to have improved going into the last two months of the year, it was not yet evident on the market. They are more likely seeing January 2024 as the time for monomer price correction. Newell ventures there is potential to see a price drop in PP in December and perhaps more so this month. All three note that PP inventories are quite tight as suppliers have done a good job to throttle back production due to lackluster domestic demand.

In fact, total demand for PP in 2023 appeared to be slightly positive, all owed to some exports activity. Says Barry, “PP suppliers are facing some challenges as a large number of PP imports are coming through in December from places like the Middle East and China.” These sources also note that some downward PP resin price adjustment is likely as ‘new kid on-the-block’ Heartland Polymers — as well as capacity increases from Invista and Formosa in second quarter — will make it a more competitive market. But, adds Greenberg, “Keep in mind though, any further upstream production issues could easily sway this market again since PP inventories throughout the supply chain are still considered tight.”

PS PRICES DROP

Polystyrene prices dropped by 4¢/lb in November, having risen by a total of 10¢/lb between July and October, driven by higher benzene prices, according to *PCW*’s Barry and resin pricing expert Robin Chesshier. Both saw the potential for prices in December to drop by at least another 4¢/lb, as benzene prices were heading downward.

Polystyrene Price Trends

GPPS	
NOV	DEC
4¢/lb	

HIPS	
NOV	DEC
4¢/lb	

While Barry ventures prices in January would likely be flat, Chesshier saw the potential for another, but smaller dip due to poor demand and improved benzene supply. Barry reported the implied styrene costs based on a 30% ethylene/70% benzene spot formula dropped by 1.7¢/lb within November, and further decline was expected in December.

PVC PRICES DOWN

PVC prices were expected to drop by 1¢/lb to 2¢/lb within November-December, after remaining flat in October, according to Paul Pavlov, RTi’s v.p. of PP and PVC, and *PCW’s* senior editor Donna Todd. Pavlov notes that suppliers’ margins and domestic sales across-the-board on PVC market sectors in 2023 decreased in comparison to both 2022 and 2021. He ventures that January prices are likely to be flat and perhaps a bit up depending on some market recovery, noting that suppliers’ plant operating rates were in the low-to-mid 80s percentile with inventory days at 16, versus a more typical 12-13 days.

PVC Price Trends

Pipe	
NOV	DEC
1¢/lb	

Gen. Purpose	
NOV	DEC
1¢/lb	

Reported Todd in late November, “A market pundit changed its prediction for November prices from down 2¢/lb to 1¢/lb,” and noted that Formosa Taiwan dropped its export prices a total of $140/mt, resulting in domestic suppliers having to drop their export prices.

PET PRICES DOWN

PET prices were expected to drop by another 2¢ to 3¢/lb in the November-December time frame, after dropping 4¢/lb in October. This based on raw material formulation contracts, according to Mark Kallman RTi’s v.p. of PVC, PET and engineering resins. He ventured that prices in January would most likely be flat. He characterized demand as static and the market as well supplied with continued better-priced imports.

PET Price Trends

Bottle Grade	
NOV	DEC
2¢/lb	

EDITOR’S NOTE: Log onto *PTOnline.com* for news on pricing trends for engineering resins.

Plastics Processing Activity Drops in November

Dip driven by a return to accelerated contraction for three closely connected components.

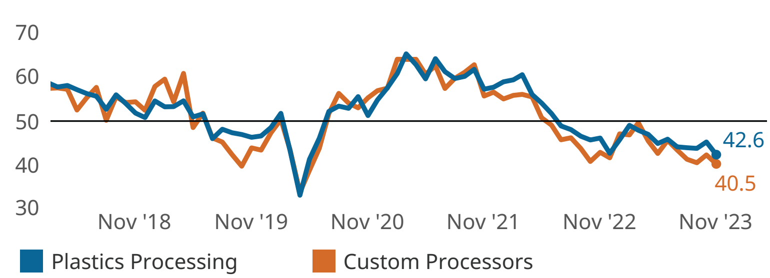
The Gardner Business Index (GBI) for plastics processing contracted faster in November, tumbling to 42.6, in line with the index about the same time a year ago but lower than October's 45.4 reading and below any reading this year.

By Jan Schafer

The drop appears to be driven by a return to accelerated contraction for three closely connected components: new orders, production and backlog. The trend *direction* is consistent with recent months for new orders and production, but the *degree* of drop was greater in November. Backlog's drop in November is on the heels of what appears to have been normal variability presenting as a one-month slowing of contraction in October.

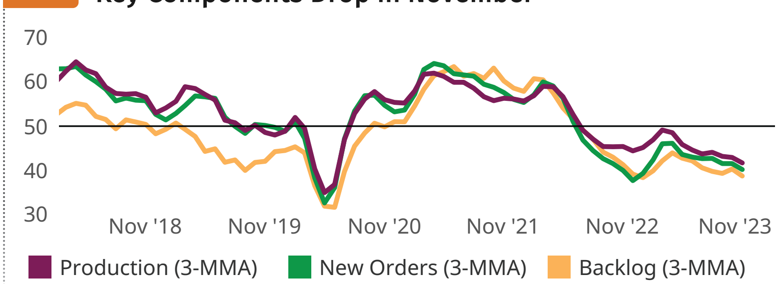
Overall business activity for *custom* processors was down two points versus October 2023, and one-half point relative to the most recent low in October 2022.

FIG 1 **Gardner Business Index (GBI): Plastics Processing**



Plastics processing activity continued to contract in November, landing at about the same index as a similar time a year ago. Custom processors fared a little worse.

FIG 2 **Key Components Drop in November**



New orders, production and backlog drove the November drop.

ABOUT THE AUTHOR: Jan Schafer is director of market research for Gardner Business Media, parent company of both *Plastics Technology* magazine and Gardner Intelligence. She has led research and analysis in several industries for over 30 years. She has a BA in psychology from Purdue University and an MBA from Indiana University. She credits Procter & Gamble for 15 years of the best business education. Contact: *(513) 527-8952; jschafer@gardnerweb.com.*

Numbers in Perspective

While the U.S. economy grew at 5.2% in the third quarter, the latest manufacturing activity suggests that this strong economic momentum might not extend into the year's final quarter. Monthly data for GBI's production component the last six months signaled weaknesses in plastics processing and displayed a recurring pattern — upticks followed by swift downticks, dashing hopes of a turnaround. For instance, November's 41.4 GBI followed October's 42.4, mirroring the September drop to 41.8 from 45.0 in August.

By Perc Pineda
Plastics Industry Association

Elevated inventories provide insight into this trend. Plastics and rubber products inventories increased by 2.5% year-on-year in the third quarter, with work-in-process stocks rebounding only 1.6% in October after a 5.6% decline in September. Industries dependent on plastics packaging (like food) show high inventories, indicating decreased packaging production needs.

Thinking about packaging, an increase in consumer spending on off-premises food and beverage consumption would generate both upstream and downstream economic activity.

Over the last 12 months ending in October, the monthly change in value of Personal Consumption Expenditure on these items, adjusted for inflation, averaged at zero, which explains the increased inventory in food manufacturing.

ABOUT THE AUTHOR: Perc Pineda, Ph.D., chief economist of the Plastics Industry Association (PLASTICS), is an industry thought leader and PLASTICS' primary expert and spokesperson on the U.S. and global economy, industry research, statistics, trends and forecasts. He produces PLASTICS' two annual flagship publications — *Size & Impact* and *Global Trends* — and trademarked the Global Plastics Ranking. Read his views and insights on the economy and the plastics industry at *plasticsindustry.org*.

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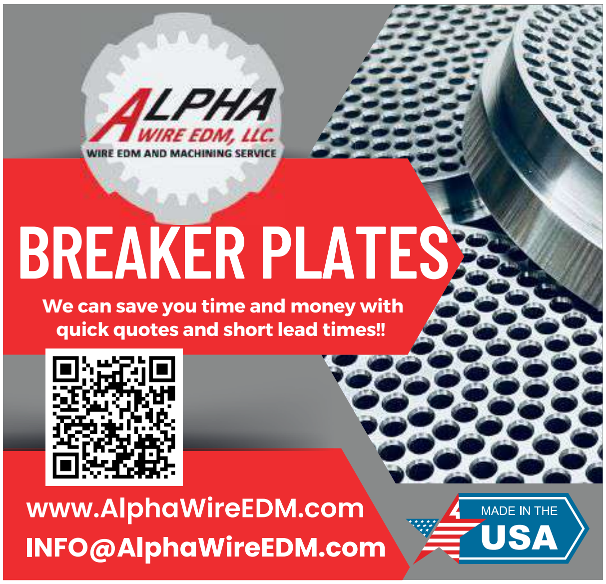

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Michael Fischer is responsible for the business development of electrical mobility and smart panels at Engel Austria, a position that he has held since 2023. He was formerly in various roles responsible for technologies in the automotive field. As part of Engel's global automotive and mobility team, Michael works with OEMs, Tier suppliers and partners to innovate the production of new and existing components. He is supporting cooperation projects and the development of turnkey solutions in the industry with a focus on new technologies and cutting-edge applications.

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LIGHTNINGCATH — MAPLE GROVE, MINNESOTA

Catheter Specialist Finds Sweet Spot Serving Small, Medium-Sized Concerns

Medical-component specialist LightningCath has carved a niche meeting the needs of small to medium-sized customers with complex catheter designs and extrusions ... quickly.

By Jim Callari
Editorial Director

When you have the word *lightning* as part of your company name, it's likely your customers will expect products quickly. That's a critical part of the mission at LightningCath, a manufacturer of catheter components based in the "medical alley" of Maple Grove, Minnesota. Spun out of medical-device manufacturer Switchback Medical in May 2022, LightningCath quickly filled a niche for helping small- to medium-sized companies bring medical device products to market quickly.

"Our typical customer could just have an idea for a medical device," says Matt Osten, a principal and co-founder of the company. "They don't have a print; they're just getting started. So, we'll brainstorm with them, spend a lot of time up front, bring them to our facility, and walk them through and teach them the process. And usually that helps us both understand what's necessary to bring their idea to market."

LightningCath's facility is equipped with two extruders from US Extruders, including this new medical line. Photo: LightningCath

The medical component market is a huge, sophisticated and fast-growing space with room for entrepreneurs — some of them companies, while others clever engineers or even doctors — with nothing more than a concept sketched out on a napkin. That's LigthningCath's sweet spot, and it's filled a need because these companies or individuals with ideas usually can't get the bigger medical device firms interested in their projects.

SwitchBack Medical experienced this firsthand. Over the years, Brady Hatcher, Switchback CEO and co-founder of LightningCath, had received many requests from innovators deemed too small or too discreet for the bigger companies. Says Hatcher, "We saw a large unmet need in the medical device development and component manufacturing space. Innovators that need prototypes or extrusions were having challenges getting the service they would like from the large company options, and there are not enough small companies with these capabilities to support them."

So, when Switchback moved to a larger facility, LightningCath was able to utilize most of its original plant: 19,000 square feet with an ISO Class 7 certified 5,000-square-foot cleanroom. There, LightningCath runs two lines with extruders from US Extruders, one purchased brand new that is dedicated to FEP heatshrink and a second that runs thermoplastic materials used in most catheters.

LightningCath processes extruded tubes in a range of materials, notably PEBA, TPU, nylon and PE at ODs ranging from 0.010 inch to 0.500 inch at tolerances down to ±0.0005 inch. Additional capabilities include multilumen and bump/taper tubing. It also has a wide range of catheter assembly, metal processing and finishing capabilities, as well as complete catheters in steerable or fixed-shape formats.

Says Osten, "Our value proposition right now is prioritizing smaller and mid-size companies that can't necessarily go to the bigger contract manufacturers because the bigger companies are working for the top-tier medical OEMs. LightningCath's in-house catheter process equipment, thermoplastic and FEP heatshrink extrusion capabilities, experienced R&D and process engineers give us vertical integration and speed not typically seen by the smaller to mid-sized contract manufacturers."

He adds, "The additional resources of Switchback's 100-plus people, many of them catheter development engineers, along with its strong operations team, give us additional stability and security." LightningCath plans to add PTFE etched liner extrusion capabilities in 2024, where Osten says it has particular expertise. Osten notes the company will soon be expanding into Costa Rica, where costs are lower. He states, "LightningCath is a well-rounded company with a great base. We're excited to help our customers wherever they are — with quality and speed."

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