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# Plastics Technology®

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# Plastics Technology®

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# Gearing Up for the Old Normal

## With 2020 in a rear-view mirror, likely adorned with a face mask, it's time to reflect on what we've learned and what's in store.

**Jim Callari**
***Editorial Director***

Is everyone ready to put 2020 behind them? Wait … is this even the year 2020? When do we close the books on this new normal? And what's been *normal* about it anyway? And what's with this line about "building the plane while we're flying it"? I never heard this expression until the coronavirus-induced lockdown. Look, I understand what it means, but as a literal person I know I am not booking passage on such an aircraft.

Sorry for my feeble attempt at being glib. As I sat down to craft this editorial, my main mission was to convey to the audience of *Plastics Technology* the editorial plans we have in store for you in 2021. I don't know about you, but for me—more than ever in my lifetime—I can't think about the future now without reflecting on the past.

And the immediate past has been the most chaotic, uncertain, unpredictable and unsettling period in my lifetime. Scary too. Full disclosure: I have a controlling type of personality, and since March, all of our lives have been inherently impossible to control.

So we adapt. We adapt because we must. We try hard to remain optimistic. We remain optimistic because, well, what's the point of the alternatives? We at *Plastics Technology* and parent company Gardner Business Media (GBM) adapted this year with the cancellation of our annual Molding and Extrusion conferences. We launched an interactive webinar series called Tech Days featuring live presentations from technology leaders in a wide range of disciplines. And it has resonated with our audience of processors, as nearly 2000 individuals have registered to attend these events.

Sister publications at GBM in moldmaking, metalworking, additive manufacturing and composites have made similar adjustments. We've all, well, built the plane while we were flying it.

These are pretty big adjustments, but there have been smaller ones too. I have an inventory of face masks. You? Do you have one in your car that dangles from your rear-view mirror? I do. And countless times I have parked my car and made my way to the front door of whatever store I was going to, only to scurry back to snap up my dangling mask.

I've been working from home exclusively for more than 10 years, so the lockdown, in its various iterations, hasn't impacted me that much there, save for plant visits that have been put on hold or the occasional claustrophobic feeling of being "trapped."

Still, I'm on camera more than ever, owing to the changing manner in which we in the editorial business deliver information, and the fact that I've been moderating a Tech Days session every Thursday afternoon since early October. So that means I need to actually comply with my personal grooming routine and make certain adjustments to my office décor (for example, some Seinfeld-related wall "art" has been replaced by some *Plastics Technology* swag).

Seven paragraphs into this—time to circle back to our editorial plans for 2021. There will be a series of articles beginning in January on adjustments you as plastics processors might be considering as we emerge from this new normal. We'll be addressing themes such as Industry 4.0, advanced automation, additive manufacturing (aka 3D printing), cross-training, reshoring and others. Likely none of these topics are altogether new to you, but maybe you'll be looking at them more carefully as part of a business and technology strategy that you've likely revisited many times since the emergence of COVID-19.

And, of course, throughout the coming year we'll have ample coverage of NPE2021, the triennial plastics industry trade show, May 17–21 at the Orange County Convention Center in Orlando, Fla. In fact, we'll be linking the topics referenced above to things that will be exhibited on the show floor in Orlando.

I've learned a lot about myself over the past year. I'm more flexible, adaptable, optimistic and open to change than I ever thought I was before. Good things. But I'm ready to get back to the *old* normal.

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## Priority Plastics Brings New Technology to U.S. for large PET Containers

Priority Plastics, a blow molder of stock and custom HDPE, PET and PVC containers, is expanding beyond extrusion blow into PET injection stretch-blow molding (ISBM). The company plans to install this month several machines that reportedly are the first in the U.S. to employ new single-stage ISBM technology that can produce PET containers from 1-gal handleware up to 25-gal drums. The machines will go into the headquarters plant in Portland, Ind. (The firm also has plants in Arizona, Iowa and Colorado.)

Priority Plastics declined to name the overseas source of these machines, but states that they offer several advantages new to the U.S. PET market. For example, they can produce jugs with integral handles, similar to extrusion blown HDPE jugs, but without any trim scrap.

Other capabilities reportedly include stackable bottles, rectangles, and wider necks than are available with competing ISBM technologies. Additional advantages are said to include quick change-overs and energy savings up to 40% by recapturing high-pressure blowing air for use in extrusion blow processes.

## HP Expands Ocean Plastics Program

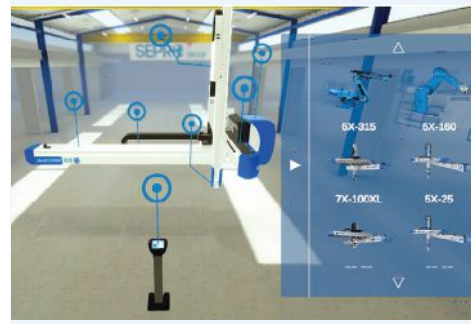
HP has invested $2 million in a new washing line in Haiti that produces clean, high-quality recycled material from ocean plastics for use in HP products, including Original HP ink cartridges and the company's sustainable PC portfolio. This additional recycling capacity also opens up new markets for HP in Haiti. The new washing line is fully functioning, thanks to the local Haiti engineering team and HP partner STG Group of Germany.

HP has been reclaiming ocean-bound plastic in Haiti since 2016, and these efforts have already collected approximately 1.7 million lb of materials—or more than 60 million PET bottles—from streets and canals, preventing this plastic from reaching waterways and oceans. Of that, more than 485,000 lb have been upcycled into HP ink cartridges.

HP is also expanding its Planet Partners return and recycling program to 68 countries, including Argentina, Chile, and Papua New Guinea. To date, the program has recycled over 875 million HP ink and toner cartridges.

## Sepro Group Launches Virtual Showroom

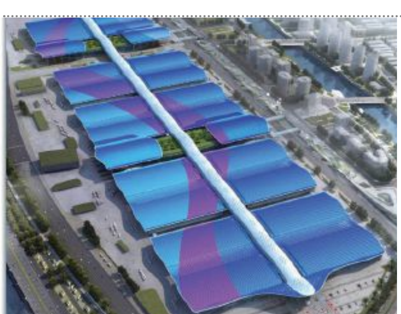
In response to the cancellation of all major plastics trade fairs this fall due to the coronavirus pandemic, robot and automation supplier Sepro Group has created a virtual showroom featuring on-demand technical expertise and robotics that can be viewed in 3D. The company plans to keep the showroom online at least until the end of 2020.




The entire Sepro robot portfolio is featured, including the completely redesigned Success range of 3- and 5-axis g-p robots. Also featured are 6-axis robots, co-developed with industry leaders Yaskawa Motoman and Stäubli, as well as Smart data services such as Live Support, the company's hotline support feature designed to reduce downtime.

Visitors can click into a 3D virtual display that allows them to rotate the displayed equipment through all angles and perspectives. These displays feature brief text descriptions of key features and capabilities.

Another section of the showroom allows visitors to schedule socially-distanced face-to-face discussions with Sepro technical experts on various topics about robots and automation in the plastics industry, or simply to share ideas about current and future projects.



## Chinaplas to Change Dates & Venues

In a bid to provide more exhibition space and avoid conflict with NPE2021 (May 17-21 in Orlando), Adsale Exhibition Services has announced a change of dates and location for Chinaplas 2021. Next year the annual show, which has until now rotated between Shanghai and Guangzhou, will be moved up to April 13-16 and be held in Shenzhen at the Shenzhen World Exhibition and Convention Center (SWECC).

Chinaplas 2019, which took place in May in Guangzhou, set a record for the show in that city, featuring 3622 exhibitors and 163,314 visitors. The SWECC, which opened in September 2019, offers 400,000 $m^2$ of exhibition space and is located near the Shenzhen Bao'an International Airport. The former venue in Guangzhou has a total indoor exhibition area of 130,000 $m^2$.

## Comprehensive Materials Database for Simulation

A comprehensive and high-fidelity materials database for simulation has been launched by Altair, Troy, Mich., a global technology provider of data analytics, simulation, and high-performance computing. The Altair Material Data Center includes accurate data and data lineage for plastics, metals, and composites, and directly connects with Altair's and other major simulation software.

Recognizing the key role materials selection plays in product development, Altair (***altair.com***) has invested significantly in the area of material modeling for several years and recently acquired M-Base, a leading German supplier of material databases and material information systems with a focus on plastics.

The database allows Altair to provide the critical material information and infrastructure needed to predict and optimize product performance through simulation. It enables designers, engineers, and scientists to explore materials—including structural, fatigue, fluid/thermal, and electromagnetic properties, as well as processing data—in a standalone application or through the interface of Altair simulation and optimization tools.

### Dow Launches Its First Recycled Resin for Shrink Film

Dow is expanding its circular technology portfolio by introducing its first post-consumer recycled (PCR) resin for collation shrink film in North America. The resin, designed specifically for retail and logistic shrink film, offers the ability to create shrink film with up to 40% PCR content. Earlier this year, Dow announced a partnership with Houston-based Avangard Innovative to secure a reliable, quality supply of PCR.

The recycled material in Dow's XUS60030.01 Experimental LDPE includes 70% film-based PCR. In Dow's all-PE film structure, this will yield up to 40% recycled content, which gives flexibility to customize PCR content for shrink films.

Dow is developing additional PCR grades for various applications in industrial and consumer packaging markets in the coming year.

## JSW America Opens New Offices, Tech Center & Large-Machine Assembly Plant

Japan Steel Works America (JSW) has been reconfiguring its physical footprint over the past year, with two offices moved to new locations and a brand-new machine assembly plant and technical center opened. These and other recent developments at JSW were detailed for *Plastics Technology* by Dale Bartholomew, JSW America's new national technical manager. He noted that the company has "fine-tuned" its U.S. operations by moving some regional offices to more convenient locations that were closer to customers and transport facilities. For instance, the California office, which is the national hub for spare parts, has moved from Corona to Ontario, closer to L.A. International Airport. And the Chicago-area office has moved from Lake Zurich to Wood Dale, very close to Chicago O'Hare International Airport.

In addition, JSW established its first assembly plant and a U.S. injection molding technical center in Ledgewood, N.J., near Newark Liberty International Airport. This facility of over 8000 ft² will stock base units—separate clamp and injection modules—for machines of 650 tons up to around 1000 tons, thereby reducing lead times for large machines by several months compared with shipping from Japan, notes Bartholomew. The Ledgewood plant will be able to mix and match clamps and injection units according to customer needs, and also apply options and customization. The assembly space is located in the same building as a company that specializes in transportation of large and heavy machinery.

The new Ledgewood location will also house a tech center and training facility (photo), which currently has on hand a 280-metric-ton all-electric press equipped with the special JS Drive. Introduced at K 2019, this is a servo drive developed by JSW for direct-drive injection units. It is said to provide high speed and responsiveness, and ability to maintain long hold times for thick parts. The tech center also contains a 100-m.t. machine designed for cleanroom use and featuring magnetic platens for mold mounting.

In the area of technology, Bartholomew says JSW has been "doing a lot of work" with iMFLUX on upcoming projects to utilize that firm's novel low-pressure molding technology, which promises faster cycles at lower clamp and injection pressures. "So many people are looking at it," notes Bartholomew. One repeat customer is AGS Technology, Batavia, Ill., which finds iMFLUX technology very helpful in molding automotive parts with virtually 100% recycled material (see May Recycling Supplement and August feature). Bartholomew adds that a machine with iMFLUX software integrated into the JSW controller will be installed at the iMFLUX training center in Hamilton, Ohio, in the first quarter of 2021.

## US Extruders Completes Plant Expansion

US Extruders Inc. has completed an expansion that nearly doubles its manufacturing space in Westerly, R.I., where it builds custom single-screw extruders, extrusion systems and screws. The machine builder says it has seen unprecedented growth—projected to be 25-30% over the last year.

The company now occupies just over 31,000 ft² at the Westerly facility, which runs 100% on solar power. The expansion includes overhead cranes allowing for easier and more efficient extruder assembly.

Despite the difficulties of the current pandemic, US Extruders says it has been working at full capacity. Cloud-based server and collaboration tools have allowed remote working, and digital communication platforms have provided the ability for virtual meetings, wet tests and lab trials. Extruders continue to be shipped on time (or even early in some instances), and have included equipment that directly serves the need of PPE and essential industries, the machine builder notes.

## Cincinnati Process Technologies Pursues Predictive Maintenance Offerings

Cincinnati Process Technologies (CPT), a supplier of machinery, parts and services for injection molders, has partnered with IoT Diagnostics (Chester Township, Ohio), a supplier of predictive-maintenance sensors and applications. CPT will represent all of IoT's products and services, which include PumpMD, for hydraulic axial-piston pumps; Estat for particulate removal from industrial fluids; and FluidMD for tracking industrial fluid quality.


IoT's predictive technologies monitor critical applications and functions within complex machines, predicting potential failures before they happen. Using proprietary sensors and software, IoT's system keeps facility managers informed through a custom dashboard and real-time alerts. The internet-connected devices collect and analyze large volumes of machine data from many points in the production cycle.

Several IoT Diagnostics experts will be joining CPT in its booth at NPE2021 (May 17-21, 2021 in Orlando, Fla.).

## Covestro Introduces Products Made from Recycled Plastics at Formnext Connect

During the virtual trade fair Formnext Connect 2020 (Nov. 10-12), Covestro presented products dedicated to the circular economy. This included products made from alternative raw materials, such as recycled plastics and resin feedstocks based on carbon monoxide.

New products in the testing phase include pellets and filaments made of partially recycled plastics. Some of the raw materials for the recycled plastics are post-industrial waste from Covestro's manufacturing facilities. One such product is a polycarbonate blend for applications that require high temperature resistance.

Also considered promising as building blocks for sustainable 3D printing products are polyols of the cardyon brand, in which CO replaces some of the petrochemical raw materials previously used. These can be used to produce TPU, which can be used as powders or filaments in additive manufacturing. Covestro is also currently developing partially bio-based products for 3D printing, in which almost 50% of the carbon content is derived from biomass.

## Bacardi Chooses Biopolymer to Replace PET

Nodax PHA bioplastic from Danimer Scientific has been chosen by Bacardi to replace 80 million PET bottles (6 million lb) currently produced by the company for its various liquor brands every year.

Bacardi plans to put the "world's most sustainable spirits bottle" on store shelves by 2023, through close collaboration with Danimer, a producer of biodegradable biopolymers derived from natural plant-seed oils such as palm, canola and soy.


The new spirits bottle made from Nodax PHA reportedly biodegrades in a wide range of environments, including compost, soil, freshwater and sea water, and after 18 months disappears without leaving behind microplastics. The material is already used for thermoformed trays, drinking straws, flexible and multi-layer film packaging, coatings and disposable cutlery.

Bacardi rum will be the first spirit to appear in the new bottle. Then, the plant-based material will replace single-use bottles across the entire Bacardi supply chain and the company's 200 brands and labels, including Bombay Saphire gin, Grey Goose vodka, Patron tequila, Martini vermouth and Dewar's Scotch whisky.

The versatility of this material is expected to help the Bacardi Packaging Development team crack one of the beverage industry's longest-standing plastic problems—the lining of bottle closures. Says Jean-Mark Lambert, Bacardi's senior v.p. of operations, "That may sound small, but add that up across every bottle produced globally and we're talking many tons of plastic every day. Once we've fixed the problem, we'll be open-sourcing the solution for the entire industry to use. This isn't about competitive advantage it's about doing the right thing for the planet."

In addition to the 100% biodegradable bioplastic spirits bottle, Bacardi is also creating a sustainably sourced paper bottle that also uses Nodax PHA to ensure the quality and taste of the spirit inside the paper bottle.

This announcement by Bacardi represents a major step towards achieving its goal of being 100% plastic-free in the next 10 years. The company has also committed to removing all its non-essential, single-use plastics, including gift-box and point-of-sale materials, in the next three years.

## EOS and Texas A&M University to Offer 3D Printing Professional Development Program

EOS has partnered with Texas A&M University to provide a professional development program for industrial 3D printing. Using a combination of virtual learning with conventional training methods, The new additive manufacturing (AM) training program offers a hands-on, expert-led training program to meet evolving industry needs and challenges.

In concert with EOS's applied engineering group, Additive Minds, the Texas A&M Engineering Experiment Station program trains participants in the latest powder-bed AM processes, such as Direct Metal Laser Solidification (DMLS) and Selective Laser Sintering (SLS), as well as understanding of other AM processes, metal and polymer materials for AM, design for AM, case studies, best practices and troubleshooting. The program is delivered by experts from Texas A&M (Alaa Elwany, associate professor of industrial and systems engineering and director of the metal AM laboratory) and EOS Additive Minds Consultants Maryna Ienina and David Krzeminski.

The partnership recently completed its first training session with NASA. The program's engaging open discussion, instructor interaction and enthusiasm, presentation of specific case studies and tools, and mixture of both theoretical and practical approaches were among the highlights noted by participants.

# Have You Considered the Sustainability Benefits of Liquid Color?

## Add less pigment to the solid-waste or recycling streams, save energy, and reduce waste to landfill, among other advantages.

By Matthew Naitove
*Executive Editor*

Whatever the color of your product, make it "greener" with liquid color. That was the message of a talk in a session on Green Molding as part of the *PT* Tech Days interactive webinar series on Oct. 22. This message was presented by Paul Maguire, CEO and president of Riverside Global, a leading supplier of liquid colors and additives.

Maguire said liquid colors reduce coloring costs by as much as 50%, provide more uniform dispersion, and enhance flow and throughput rates or cycle times. But liquid-color users see "green" in other ways, too, he stated. Here are the major advantages he cited on the environmental side of the ledger:

- **Use less pigment:** Liquid color reportedly produces fully developed color with less pigment (often 30% less) than in pellet masterbatches. The reason is easier and better dispersion with the liquid carrier, which serves as a processing aid. What's more, liquid colorant precoats the pellets in the feed section, starting the dispersion process even before the plastic melts, unlike the case with pellet concentrates. In addition, the enhanced accuracy of gravimetric metering of liquid color—a feature of dispensing systems produced by Riverdale's sister company, Maguire Products—saves 10% in colorant versus volumetric metering, according to Maguire. The end result: less color ends up in the recycle stream (or solid-waste stream if not recycled), and less additional pigment is required to overcolor the reground scrap.

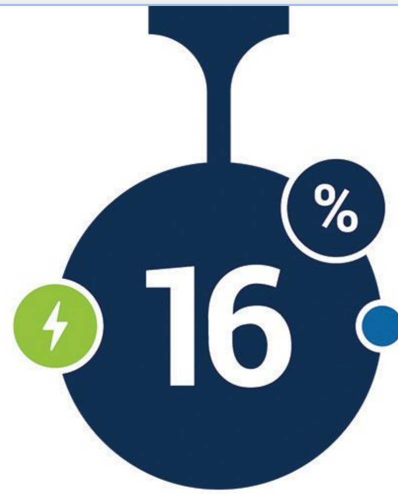
**Add up the energy savings in manufacturing liquid colorant, in transporting it to your plant, and in dispersing it in your process—plus zero waste to landfill after use—and the sustainability benefits could be substantial.**


- **Use less energy:** Use of the liquid colorant vehicle enhances melt flow, reducing screw torque, and potentially allowing for a lower melt temperature. That, in turn, can mean shorter cooling times and lower load on chiller systems. The end result is up to 16% lower total energy consumption in molding and extrusion, according to Maguire. That's in addition to 90% lower energy consumption by Riverdale Global in dispersing the pigment in the liquid carrier, as compared with producing a solid pellet concentrate. And, because an equivalent amount of liquid color weighs 75% less than pellet masterbatch, that means less freight expense and energy to transport the product to customers. (Liquid colors also occupy 80% less warehouse space than pellets.)

• **Send less waste to landfill:** Riverdale Global's "Return for Refill" program enables processors to send empty containers back to one of Riverdale Global's local satellite plants for refill at no cost except shipping. Any colorant left in the drum will be returned to the customer after refilling, so none is lost.

• **Make less waste in processing:** Maguire said that liquids cut typical color-change times in half, which translates into half as much purge waste. In fact, some users don't purge between colors, but simply start the next liquid color to push out the previous one. This reportedly can be a major advantage for blow molders with large accumulator heads, who are accustomed to long color-change times with conventional concentrates. Maguire also noted that reduced colorant waste stems from Riverdale's sealed "pump-in-drum" system, because customers never need to open the drum and risk having to clean up messy spills of highly concentrated colorant.

*Liquids cut typical color-change times in half.*




**16% energy savings** occur when coloring a product with liquid, versus pellet.

• **Use more renewable resources:** Most of Riverdale Global's products use renewable plant-based carrier systems, rather than petroleum-based chemicals.

**QUESTIONS ABOUT COLORANTS & ADDITIVES?**
**Learn more at PTonline.com**
Visit the Additives page under the Materials tab.

# Real-Time NIR Testing Can Slash QC Costs Up to 90%

## Using the right near-infrared (NIR) measurement devices for the job is key—whether for moisture, composition analysis, or full-spectrum testing.

**Portable NIR moisture analyzers such as the Kett KJT130 sell for about $16,000.**

By Lilli Manolis Sherman
*Senior Editor*

Once deployed mainly by resin companies and large compounders, real-time, near-infrared (NIR) measurement devices are increasingly finding homes in the labs of smaller compounders, as well as processors and recyclers. These devices have become more portable, cost-effective and easier to use.

So says John Bogart, managing director of Kett US, Villa Park, Calif., which currently offers nearly 200 instruments for moisture and composition analysis, including NIR devices. With its NIR moisture and/or composition analyzers, the company (*kett.com*) targets compounders and recyclers as well as molders, film and sheet extruders and thermoformers.

While traditional testing is critical in determining polymer properties from simple moisture content to complete chemical analysis, it is time-consuming and labor-intensive and has substantial costs for the purchase and disposal of consumables such as reagents and chemicals. Typically, it requires sample preparation, and can take 5 to 15 min for moisture testing and 24 to 48 hr for more complex chemical testing.

**Desktop moisture analyzers like model KB270F sell for $10,000 to $12,000.**

But Bogart says NIR spectroscopy can now provide immediate, real-time laboratory quality readings via a non-contact measurement method that can deliver moisture, composition analysis, and even full-spectrum composition readings for a fraction of the cost of conventional methods. "Changing from current direct methods to NIR analysis can slash testing costs by up to 90% due to the dramatic reduction in both 'people time' and the elimination of chemical reagents, scrap from testing, and 'people error' that creates the need to repeat the tests."

Additional cost savings are related to energy optimization, yield optimization and reduction in quality defects, says Bogart, who adds that these are generally very substantial but are difficult to predict up front. "As an example, if 'people costs' are $20/hr (very conservative), the total costs for 1 hr come to about $28. If we say that one or two 'moisture-only' tests are conducted per day, the cost is $28 if you budget 30 min for each test. The NIR test takes 6 sec or, if online, is continuous. Six seconds vs. 3600 sec is a reduction of 98.84%. The cost of a moisture-only desktop unit is about $12 per business day."

Bogart maintains that even with the cost of a new instrument, a customer saves money each day and the testing cost is reduced by at least 90%, given very conservative estimates for hourly pay and number of tests used in his example. "This why even 'small' companies should consider migrating to this technology."

He says, "Real-time NIR measurement enables continuous monitoring and optimization of polymer processes. It provides more timely quality-assurance data than a team of QA people using traditional testing methods, and 100% of the product can be inspected." Instant testing enables superior quality control and immediate adjustment if a process starts to drift out of the target range, he states. The results can improve batch consistency and yield, while helping to eliminate batch failure and reduce material waste.

## HOW IT WORKS

NIR spectroscopy bounces beams of light off a solid, slurry or liquid and measures how much light is absorbed in certain wavelengths—about 700 to 2500 nanometers. This produces an "optical fingerprint" of the sample's chemical composition, with the device calculating the desired measurements after it has initially been calibrated to a lab or production standard.

The equipment can be handheld, desktop, online or inline, and is versatile enough to work inside mixers, blenders, extruders, or pneumatic and vacuum transfer lines, as well as pipe-flow applications when utilizing fiber-optic accessories.

Bogart notes that not all processors have a need for the most sophisticated and costly NIR testing devices for every application. "Don't pay for a Lamborghini if you need a Ford, or for a Ford if you need a Lamborghini," he advises. "For many polymer applications, a moisture meter is all that is needed. A composition analyzer is a step up; and a full-spectrum machine goes beyond that when even more comprehensive or specialized testing is required."

While polymer manufacturers are more familiar with traditional methods, for those concerned not only with quality but also profitability, selecting the NIR approach that works best for the application can have a major impact on the bottom line.

## THE RIGHT DEVICE FOR THE JOB

There are two general categories of NIR devices: filter-based and full-spectrum. Filter-based devices are particularly well suited to most types of processing, according to Bogart.

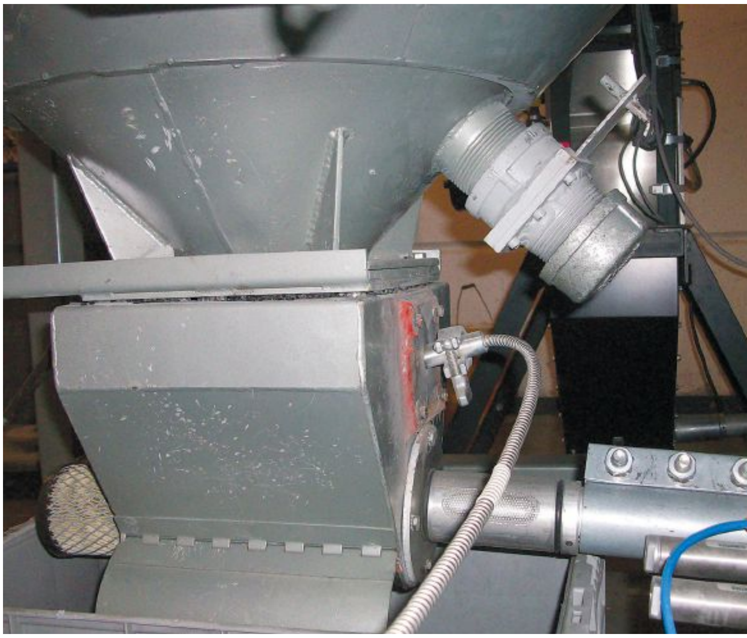
NIR filter-based equipment blocks visible light and allows only certain wavelengths of IR light to enter the device. Bogart notes that filter-based products, which include moisture meters and composition analyzers, are simpler than full-spectrum devices because they work with a limited range of wavelengths. However, the devices have some advantages.

***Changing from current direct methods to NIR analysis can slash testing costs by up to 90%.***

"Filter-based products are less expensive, easier to calibrate and maintain. The devices are also more robust and typically more stable for operators to use. The drawback is that the instruments are more limited in what they can test," says Bogart.

A loss-on-drying test, which measures the total material weight change after drying, is the traditional method of measuring moisture. However, such gravimetric tests typically require a sample to be prepared and brought back to the lab. The test takes at least 15 minutes to several hours to perform, which is too slow when more immediate measurements are required. Also, it requires the sample to be altered or destroyed.

As an immediate, real-time alternative, NIR moisture meters are the simplest and most economical type of filter-based devices. They are instant, non-destructive and they may even be non-contact. Often, NIR moisture meters are used to inspect incoming raw materials. However, the meters can be used anywhere in the production process where achieving a specific moisture content is important. These devices typically use only a couple of wavelengths for moisture measurement.

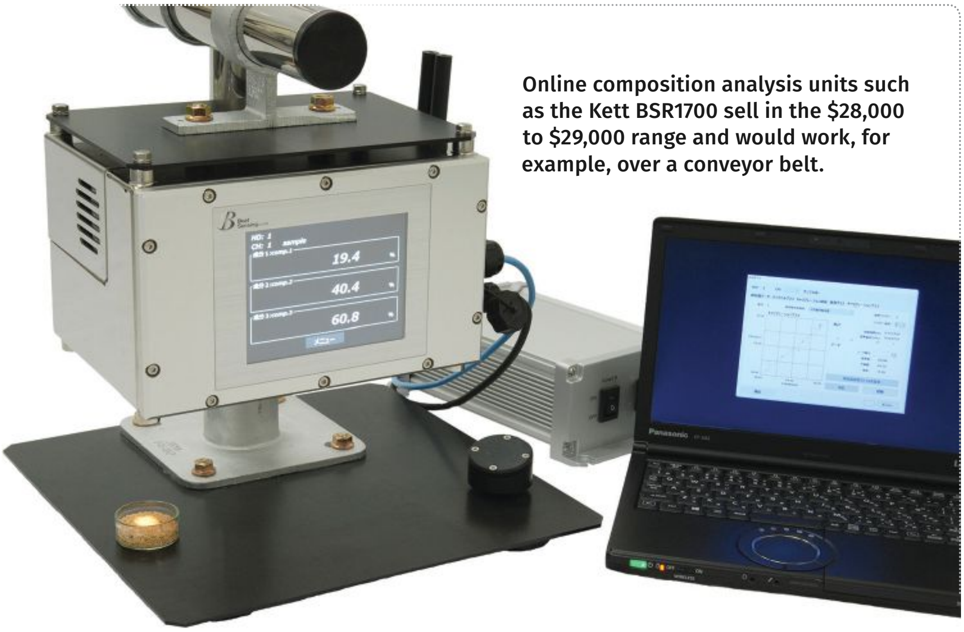


**Composition analyzers such as the Kett KJT270 inline units sell for between $28,000 and $29,000.**

Bogart relates an example of a polymer manufacturer that uses a NIR moisture meter to produce pellets for a medical-device company. The customer creates products that are inserted into the body. For this application, the polymer manufacturer needs to have extremely low moisture in the pellets before they are injection molded. If the moisture level rises above a certain amount, the molding process does not work well, which increases the part failure risk.

Says Bogart, "The polymer pellets must be precisely made and properly packaged with very little moisture; and the samples cannot be destroyed during verification. So, the manufacturer uses NIR moisture metering to cost-effectively ensure that 100% of polymer pellets safely meet the required criteria."

NIR moisture analyzers sell for $10,000 to $12,000 for a desktop unit, $16,000 for portable units, $12,000 to $25,000 for online units that would work well over a conveyor belt, and about $25,000 for inline units that can be used within an extruder, mixer, blender, grinder, pneumatic/vacuum conveyor or hopper. These are typically simple to calibrate and may need only two samples to get a reading.




**Online composition analysis units such as the Kett BSR1700 sell in the $28,000 to $29,000 range and would work, for example, over a conveyor belt.**

Because NIR composition analyzers are designed to detect moisture and additive residues, their cost and calibration requirements are a bit higher and more complex than for NIR moisture-only units. Their prices start around $18,000 for a desktop system to $28,000 to $29,000 for inline or online systems. Such systems operate similarly but differ only in the location at which the customer wishes to perform the test. These can simultaneously measure multiple organics such as water, total oil or fat, protein, sugar, fiber, and solvent or alcohol.

NIR composition analyzers are a step up in measuring capability and usually can simultaneously measure a few different chemical components in the polymer while being limited to about six to seven wavelengths of IR light. In addition to moisture, the devices may also be used to measure residual oils or solvents, which can cause contamination issues if not detected and removed. They are an alternative to traditional, time-consuming and labor-intensive loss-on-drying and Karl Fischer methods of moisture analysis; Soxhlet extraction for oil residue; and gas chromatography for solvent extractions.

Bogart points to another common use of such a device. “The industry often uses recycled plastic as a raw input, but does not always know where it comes from. So, manufacturers may want to measure total oil and solvent in addition to moisture, since any residual contaminants can disrupt the process and even cause a plant malfunction,” he says.

***With full-spectrum testing, the broadest number of targeted factors can be measured in real time.***

A third standard use of this type of device is to measure coating or film thickness. Both desktop and real-time online process measurements are possible in many cases. Generally, the price point of an NIR composition analyzer is substantially lower than for alternative technologies.

Because polymers are so widely used in a variety of industries, Bogart notes that composition analyzers are often used not only on incoming materials, but also on in-process materials, final products, and even to analyze external product failures and returns to help determine the cause of the problem.

## FULL-SPECTRUM TESTING FOR COMPLEX ANALYSES

In contrast to filter-based devices, NIR full-spectrum devices may measure over 500 wavelengths to determine whether certain substances or materials meet a wide range of criteria.

With full-spectrum testing, the broadest number of targeted factors can be measured in real time, once the device is specifically calibrated for their detection. In addition to moisture, for example, manufacturers may often measure polymer density, viscosity, melt-flow rate (MFR), and concentration of functional groups.

Such testing is commonly utilized during emulsion polymerization, which is used to produce latexes and synthetic polymer colloids for paint, coating, rubber, binder, and adhesive applications. This method is also helpful for carrying out suspension polymerization processes, which are often used to produce polymer beads.

These units sell in the $40,000 to $60,000 range and are more complex to calibrate than the moisture-only and filter-based composition meters. These units are a good option for those that want to measure multiple organic components or a special component—such as two solvents and one additive as well as moisture.

# MATERIALS

PART 2

## Tracing the History of Polymeric Materials

The invention of Celluloid got the ball rolling for future innovations in materials and processing.

By Mike Sepe

To someone living in the mid-19th century and involved in the world of materials, it must have seemed like a time of revolutionary development. In just one year, 1846, gutta percha was formed into the telegraph wire insulation mentioned in last month's article; rubber tires were fabricated for use on Queen Victoria's carriage; Alexander Parkes discovered a technique for vulcanizing rubber at room temperature; and an accidental but notable experiment started the technological development that led to Hyatt's billiard-ball material.

The experiment was performed by a chemistry professor teaching at the University of Basel in Switzerland, Christian Friedrich Schonbein. He had discovered ozone a few years earlier and had learned that a mixture of nitric and sulfuric acid was an excellent oxidizing agent. While distilling this acidic mixture in his kitchen one day, he knocked over the flask and quickly cleaned up the mess with the nearest available item, a cotton apron. When he attempted to dry the apron by hanging it over a hot stove, it promptly burst into flames and vanished. Nitrated cellulose, also known as gun cotton, had been created, and it would lead to a series of inventions that all capitalized on this modification of cellulose.

The discovery of gun cotton set off an 1840s version of an arms race, with patents being filed and countries that wanted to avoid paying licensing fees trying to reverse-engineer the invention. The extreme volatility of the material led to some spectacular accidents all across Europe and Russia in the late 1840s, which finally led to bans on additional development and a loss of interest in further experimentation.

*The discovery of gun cotton set off an 1840s version of an arms race.*

However, during that time one of the labs experimenting with cellulose nitrate found that it could be dissolved in a combination of ether and alcohol to form a substance that was named collodion. Once dried, the material became tough and transparent and could serve as a varnish or lacquer, a waterproof coating, or a thin film. It also showed potential as moldable solid. In many respects it exhibited the same capabilities as rubber and gutta percha but offered the possibility of lower cost.

An offer of a prize for a new material to replace ivory in billiard balls spurred the development of plastic materials and processing.

The same Alexander Parkes who developed the process of cold vulcanization was issued a patent for this moldable material in 1856. Known as Parkesine, it was displayed at the Great Exhibition, a world's fair that took place in London in 1862. Awarded the bronze medal at this event, the material was on display in the form of many different products that created great expectations. The material was even formed into a billiard ball, anticipating the more well-known development that would come at the end of the decade. Parkes used various vegetable oils as an agent that today we would call a plasticizer to achieve the needed balance of properties.

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But the promise of lower cost was never realized. The solvents used to produce collodion for its other uses, in medicine and photography, proved to be too expensive for mass production of a moldable material intended for more competitive markets. In an attempt to make the material competitive, Parkes resorted to using poor quality cotton waste to make cellulose and added such large amounts of the castor oil plasticizer that the material lost its mechanical properties and the products made from it lacked dimensional stability. The product suffered from a high degree of lot-to-lot variability that ultimately doomed it as a commercial venture. However, the invention is considered the first moldable plastic and it paved the way for the improvements that ultimately led to Hyatt's creation.

It was in this same time period that Michael Phelan, the master billiards player mentioned in last month's article, offered the $10,000 prize for a billiard ball made of a material that could adequately replace ivory. Phelan was also the inventor of a cushion material for billiard tables that was made of rubber and he owned an interest in a company that made billiard tables. He was acutely aware of the ivory shortage that endangered the growth of an increasingly popular pastime. John Wesley Hyatt, a printer, was attracted by the prospect of claiming the offered prize, and began experimenting with a different method of making billiard balls.

***Hyatt found the key to making Celluloid into a formable mass by using camphor as a plasticizer.***

The initial versions consisted of combinations of cloth, wood, and paper pieces held together with various glues, varnishes, shellacs, and other adhesives. Hyatt obtained his first patent for an imitation ivory ball in 1865 produced from linen cloth coated with shellac and ivory or bone dust and processed under heat and pressure. This creation was not an adequate substitute for ivory, so Hyatt continued to experiment and obtained a second patent in 1868 for another attempt that consisted of paper and wood pulp combined with shellac and again processed at high heat and pressure.

Hyatt would have been familiar with collodion since it was used extensively in healing wounds and was used in the printing industry to protect line workers from abrasions on their fingertips. In another one of those fortunate accidents, Hyatt one day discovered some collodion that had spilled from its bottle and had formed a hard film. He began coating his latest version of billiard balls by dipping them in collodion. Hyatt encountered the same problems that had plagued Parkes with creating a solid, formable material. So, he continued to work on increasing the viscosity of the material, finally developing a compound that could be formed around a wooden core under high heat and pressure. This generated yet another patent in April 1869 for this improved method of making billiard balls.

This invention was ultimately named Celluloid and is known as the material invented by Hyatt to replace ivory, although this name for the material would not be thought of until three years later. Interestingly, the Celluloid billiard balls were never made commercially and were never submitted to Phelan's company for consideration of the $10,000 award. Hyatt would continue to work on the billiard-ball problem into the early part of the 20th century without achieving the desired goal of a perfect replacement for ivory. That success would come in the first decade of the 1900s from an inventor who was born at the same time that Hyatt was beginning his experiments and whose career had some interesting intersections with Hyatt's.

Hyatt, by reviewing some of Parkes's old patents, found the key to making Celluloid into a formable mass by using camphor as a plasticizer. Parkes had employed camphor, but only in conjunction with other solvents. By focusing on camphor and continuing to employ his work with high pressure and heat, Hyatt converted Parkes's collodion into a versatile material that could have properties similar to those of rubber or gutta percha simply by varying the amount of camphor added to the mixture.

During the time when Hyatt had been working on creating improved billiard balls in the United States, a partner of Alexander Parkes named Daniel Spill had taken on Parkes's failed commercial venture in England and had also discovered the importance of camphor in making a formable material, which he called Xylonite. The parallel inventions led to the inevitable patent dispute, which was tied up in the courts from 1877 to 1884. It was ultimately decided that both Spill's and Hyatt's inventions could be traced back to the work of Parkes, who was deemed to be the original inventor of the material. It was also part of the ruling that all manufacturing of Celluloid products could continue.

In our next column we will follow the fortunes of Celluloid as it found increasing use in a variety of forms that led to the invention of another important plastic processing technique.

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INJECTION MOLDING

PART 2

# The Importance of Gauging Residence-Time Distribution

Each molecule in the molded product can have a different residence time. This variance is reflected in the residence-time distribution. Follow these steps to learn how this is calculated.

In Part 1 of this series in October, we discussed the theory behind residence time and why it is not easy to calculate. A widely used formula was presented, and a practical method of determining the residence time was discussed. Here, we focus on residence-time distribution.

By Suhas Kulkarni

Calculation of the actual residence time is complicated by residence-time distribution. The function of the screw is not just to convey the plastic to the front of the barrel, but also to mix the plastic molecules and additives among themselves to provide a homogeneous melt for processing.

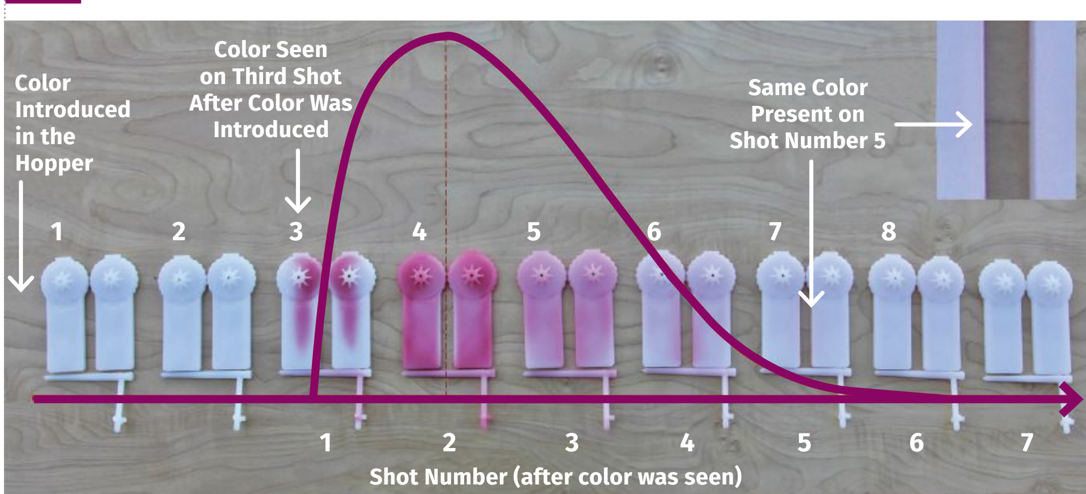
In an experiment, a red-colored pellet was dropped into the machine and the parts were collected sequentially. The color showed up on the third shot and was distributed in the next five shots. For our calculations, we used the number of two-and-a-half shots, since approximately half the part is colored. This shows that the molecules in the one pellet that weighed 0.18 g were now distributed into five shots that collectively weighed 147.51 g. In other words, the introduction of 0.12% additive caused the color distribution over the five shots—indicating pretty effective mixing.

This also indicates that there are molecules that resided in the barrel for just about two-and-a-half shots and some for about five shots. The cycle time on this part is 25 sec, and therefore a molecule entering the feed throat can be inside the barrel for anywhere between about 62 and 125 sec. So there is a distribution of time, meaning there is no one single time that we can truly consider as the residence time. This range is known as residence-time distribution and is shown pictorially in Fig. 1.

## SAME PARTS, SAME RUN, DIFFERENT RESIDENCE TIMES

The good news is that that this distribution is right-skewed, and most of the molecules are subjected to a residence time on the lower side. The number of molecules on the tail of the distribution curve are significantly lower than at the peak. They are also mixed in with a higher amount of material with lower residence time, which helps maintain properties.

FIG 1 Residence Time Distribution




In an experiment, a red pellet was dropped into the machine and the parts were sequentially collected, with color appearing on the third shot and distributed over the next five.


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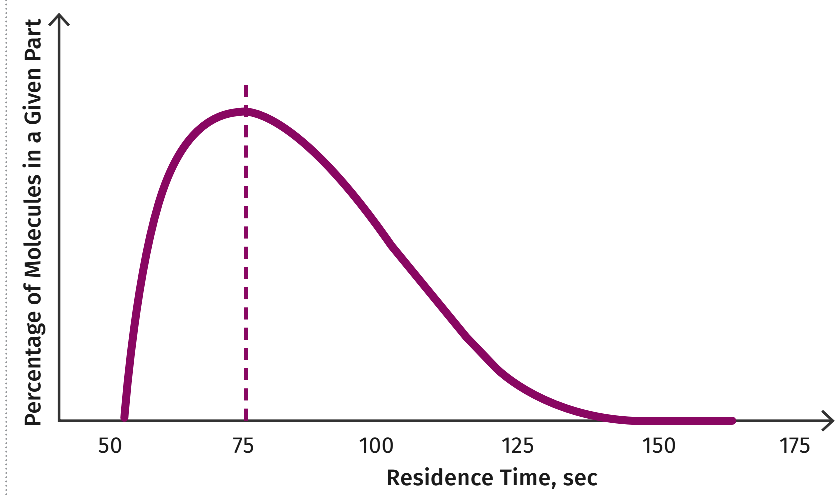
FIG 2 Percentage of Molecules vs. Residence Time




**Over a production run, molecules within the parts will experience different amounts of residence time.**

Again, consider the example of the parts discussed in Part 1 of this article, which had a cycle time of 25 sec. If you now take one molded part from the production run, then that part will contain material that had a residence time of 62 sec and a large amount of plastic with a residence time of 75 sec; and over the next three shots there is a tapering down of material with residence times of 100, 125 and 150 sec.

The number 62 is an approximation based on the assumption that half the part has color. There is clearly some material that has no mix of any color in it, unlike at the tail of the distribution. The numbers mentioned above are arbitrary numbers picked to represent the local distribution. In reality, it is a continuous distribution, as represented in Fig. 2.

The topic of residence time is complicated but must be understood since it plays a critical role in processing. The most common method of calculating residence time is given below in a formula that is effective and practical:

**Residence Time = Number of Shots in the Barrel × Cycle Time**
where the number of shots in the barrel = maximum machine shot capacity/shot weight.

In the above experiment, the material we used was PS, which has a density of 1.06 g/cc. A machine shot capacity of 100 g would mean that the machine is capable of holding 100 g of PS. However, if the material being molded is PBT, with a density of 1.33, the same volume in the barrel will now have a higher weight. That means the maximum shot capacity in grams of PBT will be higher. Thus,

**Shot Size in Material A = (Shot Size in PS ÷ 1.06) × Density of Material A**

In case of the PBT it would be :
**Shot Size in PBT = (100 ÷ 1.06) × 1.33 = 125.47 g**

For all calculations, barrel shot sizes must always be converted into the material that is being molded. Alternatively, the shot weight in the material being molded can be converted into the shot weight in PS.

## ACCOUNTING FOR HOT RUNNERS

If the mold in question is furnished with a hot runner, then residence time in the hot-runner system must be added onto the residence time in the barrel. Hot-runner manufacturers can supply the volume of the hot-runner system. Multiplying the volume by the melt density of PS will give the weight of PS in the manifold. The melt density of PS is 0.945 g/cc. Similar to the above calculations, the weight of plastic in the manifold is divided by the shot weight, giving the number of shots in the manifold.

***Calculation of the actual residence time is complicated due to residence-time distribution.***

If the info from the hot-runner manufacturer is difficult to acquire, a molder could place just one melt-compatible dark-colored plastic pellet in the machine nozzle-tip orifice and wait to be sure it is molten. With the pellet in place, start molding and count the shots until the first colored parts appear in order to calculate the number of shots in the manifold.

Note: Please exercise extreme caution while undertaking these experiments, including wearing hot gloves, long sleeves, eyewear and other required safety equipment before performing these studies.

**ABOUT THE AUTHOR: Suhas Kulkarni** is president of Fimmtech Inc., which specializes in services and training related to plastic injection molding. He earned his Masters in Plastics Engineering from the University of Massachusetts, Lowell, as well as a Bachelors in Polymer Engineering from the University of Poona, India. He has 28 years' experience as a process engineer and is the author of *Robust Process Development and Scientific Molding,* published by Hanser Publications, now in its second edition. He also works as a contract faculty member at U.Mass.-Lowell. Contact: *suhas@fimmtech.com; fimmtech.com.*

# EXTRUSION

## General-Purpose Screws on the Comeback?

They are being specified more often for recycling applications to increase flexibility. But there is still no such thing as a GP screw and recyclers need to consider other processing approaches.

By Jim Frankland

The "general-purpose (GP) screw" can trace its design back to the 1960s. The idea was to have one screw design capable of handling a range of polymers (except for rigid PVC). Back then, the number of polymers was limited compared with today and the competition for production efficiency was not as great. So the concept made some sense.

With the development of more advanced extrusion screw-design technology and new types of polymers, this concept had largely disappeared. Most processors today understand the need to have specific screw designs for each polymer to maximize output and melt quality. Yet requests for GP screws are being made more frequently as a result of the rapid growth in recycling. The demand for clean post-consumer reclaim is strong, and obtaining a steady supply to support a business requires constantly searching for new sources—unless one has an in-house source. Often the recycler processes several basic kinds of polymers and changes several times a week on an extrusion line—hence the increase in requests for GP screws.

***Tip: Try to run the same type of polymer on an extruder for as long as possible.***

Still, there is no such thing as a "true" GP screw, due to the myriad individual polymer characteristics involved for efficient processing. In the design of a high-productivity screw, the following list reveals some but not all the data considered:

- Viscosity at various shear rates and temperatures;
- Glass-transition temperature;
- Specific heat and heat of fusion;
- Melting point and processing temperature;
- Solid, bulk and melt density;
- Feeding characteristics.

As an example, if we compare a sheet-grade HDPE regrind to a sheet-grade PET regrind at equal volume of output (in.$^3$/sec), they require about the same energy input to reach a typical processing temperature. However, the typical viscosity for the HDPE in the screw will be almost double that of the PET. Keep in mind that the bulk of the energy input is done by shear stress in the polymer from the rotating screw—*not* from barrel heating. At equal screw speed, the resultant energy input is then largely proportional to the polymer viscosity.

**In reality, there's no such thing as a truly "GP" screw, even for recycle extrusion.**

As a result, the HDPE will absorb 50% more heat from viscous dissipation than the PET as it passes through the screw. If the screw was an ideal design for the PET, the HDPE would be well under its ideal melt temperature and only partially melted. If it was an ideal design for HDPE the PET would be overheated and possibly degraded.

Adjustments could be made to the operating conditions to try to better balance the energy input by building head pressure or reducing the screw speed. But both of these adjustments reduce

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output—an undesirable outcome. In addition to the energy input, the differences in feeding and melting rate could lead to plugging and surging because of the differences in the two polymers' viscosity and frictional characteristics.

## A BETTER WAY

A better solution is to run the same type of polymer on an extruder for as long as possible. In most cases, pretty broad differences in melt flow or melt index can be run on one screw effectively as long as it's the same basic polymer. If changeover between polymers is required for the recycle mix, the extruder should be set up with the items that minimize the time to change screws. Such items are a screw pusher, lifting equipment, quick-disconnect adapter/die, and easily movable downstream equipment such as the pelletizer, so there is space to easily remove the screw. Even though many may look at that as time lost, the improvement in processing rate and melt quality can easily make up the difference

***Don't forget about the purging time when trying to run different polymers on the same screw.***

Barrier screws tend to be less flexible on a variety of recycle polymer types than conventional single-flighted screws, because their basic concept is to be designed for a specific melting rate and energy input. Conventional single-flighted screws generally have a wider operating window, but it is still limited. A simple test is to run the types of recycle common to your business and compare the outputs. One type will always run at higher outputs, so simply compare the change in output to the time to change screws. When the proper equipment is available, screw changes can be kept to 1-2 hr, depending on the size of the extruder.

Don't forget about the purging time when trying to run different polymers on the same screw. The combination of the lost time and wasted polymer alone can equal the cost to change screws.

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# TOOLING

## PART 1 Get Better at Quoting Injection Molded Parts

Follow these detailed tips to get you the jobs you want. This installment focuses on various raw-material aspects of quoting.

By Jim Fattori

You may not think that quoting injection-molded parts is a relevant subject for the Tooling Know-How column of this magazine. I assure you it most definitely is. In fact, if you are not well versed in all areas of injection molding, which include part design, thermoplastic materials, additives, tooling, molding, automation, inspection, packaging and secondary operations, you should not be the one doing the quoting.

There is an age-old saying in our industry that the selling price of a molded part is roughly one-third the cost of the material, one-third the machine and labor costs, and one-third overhead and profit. The sooner you forget that saying the better. Many factors determine the true cost of a molded part, and each one has several important subfactors. In the first two installments of this series I will discuss part weight and material cost—in detail.

With the advent of solid-modeling software programs used throughout our industry, obtaining the part volume—used to calculate the part weight—is both commonplace and accurate. Calculating the part volume from a 2D drawing is becoming less and less common. Once the volume is determined, you will need to know the specific gravity of the molding material.

The part weight (g) = the part volume (in.$^3$) × 16.39 (g/in.$^3$ of water) × the specific gravity of the material (a dimensionless ratio). The specific gravity can vary a little with different grades of the same material, or it can vary a lot with different types of material. For example, a part having a volume of 10 in.$^3$ can weigh 167 g in ABS. The same part in rigid PVC can weigh 230 g—more than 38% heavier. If the potential customer is receptive to considering alternate types of material, you need to compare the cost per part in each material, not the cost per pound of each material.

For the sake of example, let's assume you can purchase rigid PVC at \$1/lb and ABS at \$1.25/lb. PVC has a specific gravity of 1.40 and ABS has a specific gravity of 1.02. The table on p. 34 shows how the less expensive PVC material actually results in a greater material cost per part.

The next thing you need to know is the expected annual quantity of parts to make per year—or at least the first year. Convert that quantity into the total pounds of material required, which is equal to the number of parts times the part's weight in grams, divided by 454 g/lb. The cost of thermoplastic materials will vary by both their type and the quantity purchased. Ask your material supplier for the price per pound for various quantities (tier pricing) and make sure they are delivered prices—FOB your facility—because freight costs can be high, especially for less than truckload (LTL) quantities.

The material price used in your quote should take into account the purchasing quantity, forecasted price and many other important factors.

### MATERIAL-BUYING STRATEGIES

The question now becomes how much material you should purchase. Enough for just one run? Three months' worth? Six months' worth? Once you decide that, then you know the correct tiered

**Colorants can add significantly to material costs. Your quote should consider order quantitites and the possibility of supplying the base resin for the part to the color compounder to make the masterbatch. Also consider changing "natural"-color parts to black to hide small cosmetic defects. (Photo: RTP)**

material price to use for quoting. Some molders will buy a large amount of material at a lower price, but use the smaller quantity tier price when quoting the job. That will add a little more profit to the part, but the molder's Accounting Department should calculate the savings vs. the cost of tying up the extra money and valuable floorspace in the warehouse.

Now let's consider material availability and volatility. Occasionally, a customer has an in-house polymer chemist specify a particular brand and grade of material, based on the dubious and often misleading physical properties listed on a specification sheet. The part drawing, or an email might state: "No substitute materials allowed." Material suppliers usually don't stock uncommon materials and the leadtime can be four to six weeks for them to compound it. That's going to be a problem if the customer is building a prototype tool with a two- or three-week delivery. In addition to the long leadtime, there is usually a minimum order quantity. That can be an issue if the part weight and annual order quantity are small. Discuss these concerns with your customer during the quoting process. Nobody likes surprises after the fact.

You quote a job based on current material prices. Depending on the complexity, it can take between 10 and 20 weeks to build a mold. What guarantee do you have that the material price will not increase during that time? Many materials have consistent prices. Others fluctuate daily, based on demand, as well as the cost of crude oil or natural gas.

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Post-industrial and post-consumer materials can have tremendous swings in both price and availability, especially with the recent push to "go green." Your material supplier will have a good idea on the future price and availability of a particular material. If he says it's volatile, you have two choices: You can either increase the material cost based on some future projection; or you can tell the customer what price was used to quote the job, and let them know that any future price increases will need to be passed on to them.

Ideally, the request for quotation is for a material that you currently use a lot of for other customers. A material that you purchase in large quantities, such as full truckloads or railcars. Then the question becomes what price you should use for quoting. Do you use the low price you currently pay to help ensure you get the job, or do you use a price somewhere in between your price and the higher price your competition will pay for a smaller quantity?

***Your material supplier will have a good idea on the future price and availability of a particular material.***

I suggest using the lower price for two reasons. First, you obviously want the business. Second, because the more material you buy from a supplier, the better your negotiating position. A negotiated lower material price will then add more profit to every job you have using that material. Purchasing a lot of a particular type of material also puts you in a better position in case the material supplier has to declare *force majeure* due to an accident, fire, natural disaster, or even high demand.

## CONSIDER COLOR COSTS

Colorant can add a lot to the cost of a part. This is where you need a knowledgeable color compounder; but more importantly, you need to communicate to the compounder what the intended end use of the product will be. For example, if it will be exposed to the elements, come in contact with food, or be used in a medical application, these all need special consideration.

The letdown ratio for a colorant can be anywhere from 200:1 to 10:1. I never recommend anything less than 50:1, meaning 50 lb of base resin for every pound of colorant. Most black colorants are extremely cheap, while primary colors and specialty colorants, such as fluorescents, are considerably more expensive. The letdown ratio depends not only on the compounder's formulation, but on the type of material and the wall thickness of the part. If you hold the molded part up to the light and you can see through it, or you see swirls, that is most likely going to be a rejected part. Achieving an opaque and uniform color distribution is controlled by many factors, such as the colorant formulation, the letdown ratio, the base resin, screw and barrel wear, backpressure, screw rpm, etc.

***Coloring natural material for several jobs is a good insurance policy to reduce the risk of running out of the base resin.***

The common work-around for poor colorant distribution is to use a high-shear mixing nozzle or mixing screw, increase the backpressure, run regrind, or the more common and least desirable method—increasing the letdown ratio. I've seen jobs where the floor personnel increased the letdown ratio so much that the owner of the company lost money every time the mold opened.

Just like the base resin, the cost of the colorant varies depending on the order quantity and freight costs—and they vary a lot. That's why you also need to obtain tiered pricing for the colorant—FOB your facility. When you calculate the annual poundage of raw material required, apply the same purchasing decision to determine the amount of colorant to purchase and its associated tier price for quoting.

Ask the compounder if you can send a sufficient amount of the base resin to be used as the colorant carrier. The reason is that materials have different natural colors—from crystal clear to chocolate milk. Using the same base resin the part is to be molded in as the carrier will improve the odds of a perfect color match on the first sampling. It will also guarantee that the colorant is compatible, and improve the physical properties of the part. The benefits of doing this far outweigh any initial cost savings from using a less expensive generic carrier.

How is the color mixed? Do you have a color feeder on the feed throat of the machine, or does someone have to manually load and unload a large stand-alone mixer? This is another cost directly associated with a specific job. Many molders don't like dealing with colorants. They try to purchase precolored material simply because of the convenience. That's rarely a good idea. They are forced to purchase smaller quantities at higher prices. ►

**Specific Gravity Cost Calculator**

| Volume | Material Type | Specific Gravity | Part Weight | | Material Cost | Material Cost |
|---|---|---|---|---|---|---|
| in.³ | | | grams | lb | $/lb | $/part |
| 10.0 | PVC | 1.40 | 230 | 0.506 | $1.00 | $0.51 |
| 10.0 | ABS | 1.02 | 167 | 0.368 | $1.25 | $0.46 |

Coloring natural material for several jobs is a good insurance policy to reduce the risk of running out of the base resin. Also, 10 small drums of different colorants take up a lot less space in the warehouse then 10 partially filled gaylord boxes of different colored materials. Cost-conscious molders go to the other extreme. They take advantage of all of the benefits of using liquid versus pelletized colorant.

If the specified color of the part is "natural," which is common for hidden internal component parts, such as gears, you might ask the customer if you could mold it in black. Yes, you will have to add colorant to the base resin, but black colorant is usually inexpensive. More importantly, black hides many defects that could otherwise be rejectable in a material's natural color.

For example, black specks of carbon can break loose from the screw and barrel, and will show up like a sore thumb on a natural part. That could be a concern, if not rejectable by the customer. The lower reject rate of black parts will typically outweigh the added cost of the colorant.

Quite often, the color of the part has to match a mating part produced somewhere else—for example, an extruded plastic profile, or a painted metal part. Not only can this require several mold samplings before the color is acceptable to the customer, it also requires tighter-quality-control inspections during production. You should consider adding a slight upcharge for a more demanding project like this.

### WHO PAYS THE BILL?

You might also consider asking, or even insisting, that the customer pay for the material and colorant up front. This is a common request when the materials are specific to that customer and there is concern about getting stuck with a lot of useless inventory if the program does not live up to the expectations of someone in their Marketing Department. Everyone thinks their product will sell like hotcakes!

The reality is—most don't. It's also beneficial to ask the customer to pay for these materials when there are minimum order quantities that end up being a six-month or longer supply. The only downside to having the customer purchase the materials is the loss of a small amount of profit added to the cost of the material when quoting the job, which leads to my next topic.

Some molders add up the cost of the material, press time, labor, etc. and then multiply the sum of these costs by a fixed margin or profit percentage. That is the best way to either lose a job or lose your shirt. Let's say a molder adds 20% profit to the combined costs. If he was quoting a heavy part in an expensive engineering-grade material, he will never get the job because his part price would be through the roof. Conversely, if he was quoting a small part, like a bottle cap, in an inexpensive commodity resin, and the estimated cycle time was 10 sec, but after getting the job the best cycle the processor could get was 14 sec due to poor mold cooling, now you are molding parts almost for free.

*Molders don't sell plastic parts. They sell press time.*

Ideally, you add a small amount of margin to the raw materials (actually all purchased items) to cover the administrative, handling and inventory costs, as well as the cost of lost interest on the money from the time the material is purchased to the time you are paid for the molded parts. This small percentage should be on a sliding scale—larger margins for small quantities and smaller margins for high quantities.

That may seem backwards, but the primary reason why is due to another age-old saying: "Molders don't sell plastic parts. They sell press time." This is very true. Mold sampling, debugging, establishing a process, and the overall learning-curve costs are far more expensive for low-volume jobs in terms of dollars per part produced.

Therefore, the goal is to get long-running jobs in order to spread these costs out. The best way to get long-running jobs is to use a very sharp pencil. Just to be clear, using a sharp pencil does not mean reducing your overall profit margin. It means you take a close look at all of the contributing factors and apply, or don't apply, an appropriate profit to each one that is specific to that particular part.

More on this topic next month.

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By Heather Caliendo
*Senior Editor*

# Betting Big on Recycled PET

## Distributor of virgin PET resins PolyQuest is also a growing manufacturer of recycled PET resins.

**PolyQuest's facility in Darlington, S.C., serves as both the flagship distribution center and the company's main PET recycling operation.**

Inside look at the Darlington facility. The company's total recycling capacity is approximately 150 million lb/yr.

Brand owners' commitment to sustainability has caused a rippling effect in the plastics industry. The demand is there for recycled plastics and companies are answering the call. This is one reason why PolyQuest, a large distributor of PET resins in the U.S. and Canada, is placing a greater focus on its recycling operations.

For 20 years, PolyQuest has sold virgin PET resin to basically every application there is for the material. "We've got a broad portfolio of PET resins that we can market to our customer base," says Tod Durst, president of PolyQuest. "So we go into the smaller bottle companies, we sell into the sheet extrusion market, which ultimately becomes thermoformed. We're very big into film, thin-gauge film, fiber, strapping, and even compounding. So we really sell to the entire market."

What first prompted the company to get involved in recycling was existing customers asking for solutions for their plant scrap. "We felt that if we were going to be in recycling, we had to have hard assets on the ground that could provide continuity of supply to our customers," Durst says, "and also put us in a position where we can control the quality of the product going through."

The company's first foray into recycling was on the post-industrial side in 2006. Durst recalls that when they started up the first line, it became wildly successful and they processed a lot of plant scrap for their existing virgin PET customers.

"And we grew from there. It really is a value-added proposition for us because we had customers that were looking for a solution they could not find elsewhere," he notes.

> *"We had customers looking for a solution they could not find elsewhere."*

The Wilmington, N.C.-based company produces recycled PET resins at its Darlington, S.C., facility. Using either post-industrial or post-consumer PET feedstocks, PolyQuest can manufacture amorphous, crystallized and solid-stated rPET resins that are either non-FDA or FDA-approved for food contact. Darlington serves as both the flagship distribution facility and the company's main PET recycling operation. The company also has a recycling facility in Farmingdale, N.Y.

The company's total corporate thermoplastics recycling capacity is approximately 150 million lb/yr, which includes post-consumer washed bottle flake, post-consumer pelletizing and solid-stating, and post-industrial pelletizing. Right now, recycling represents about 15% of its overall business.

## RECYCLING OPERATIONS

In 2013, PolyQuest purchased the former Pure Tech washing plant in Farmingdale and invested capital in the facility to get it up and running under the new name PQ Recycling. At that facility, PolyQuest is taking bottle-deposit redemptions and converting them into food-grade flake.

"We have the capacity in Farmingdale to supply washed recycled PET flake to our customers. Or, if we so choose, we can take that flake to our facility in Darlington, where we can pelletize it and turn it into a 100% post-consumer recycled pellet, with full regulatory approval including food contact. We can sell either the flake or the pellets to the same customer base that we sell virgin PET to," Durst notes.

In Darlington, where the company makes the PCR pellets, they can use the flake they make in New York or can be a merchant buyer of washed flake, which doesn't necessarily have to be from bottle deposit. Durst said it could come from MRFs, curbside collection, or even imported from Latin America—in which case, PolyQuest would be buying from another reclaimer or washing plant.

"We have a pretty broad portfolio of supply from different qualities and geographic regions that we can pull from," he says.

Ryan Nettles, v.p. of operations for PolyQuest, says key components of the company's post-consumer recycling operation are two Erema Vacurema systems. Darlington also uses two Erema machines for its post-industrial processing, which is kept separate from the post-consumer.

### QUESTIONS ABOUT RECYCLING?

**Learn more at PTonline.com**

Visit the Recycling page under the Processes tab.

The Darlington plant has shredders and grinders along with two Vacurema systems from Erema.

"Our customers will send us their waste streams and we will process them, whether they be PET, PETG, nylon, or polyolefins, whatever it may be. We convert their post-industrial waste streams back into a melt-filtered resin, which allows them to reintroduce it back into their process rather than going into a landfill," he notes. "That's more or less what Darlington is all about. We've got the Vacurema system for our post-consumer FDA business, and then we've got two other Eremas for our post-industrial applications."

Earlier this year, PolyQuest announced that it will invest further in its PET recycling operations at Darlington to meet growing demand for post-consumer recycled content. The plans call for building at least one additional FDA rPET line that is scheduled to be operational by Q3 2021. The company says the resin produced on this line will be suitable for use in the vast majority of PET applications.

"We have additional pelletizing capacity in Darlington as needed if we wish to 'bolt on' another IV-enhancement line, which we are considering as we grow our post-consumer recycle footprint in PET resins," notes John Marinelli, CEO of PolyQuest. "Consistent with our long-term vision, we would like to maintain the recycle share of our total thermoplastics business portfolio over time."

At Farmingdale, Nettles states, PolyQuest has first-class sortation capabilities to sort out the colors, other thermoplastics and



metals. “It’s older technology, but a very proven technology, and there are very few providers that have an FDA letter on their wash flake like we do,” he says.

### THE FUTURE

Durst says the big challenge for recycled PET in the past 20 years has been its cost. Low-cost virgin PET, he says, “has been kind of a cap on a lot of growth for recycled PET over the last 20 years.”

However, about three years ago, Durst says PolyQuest noticed the shift toward recycle from brand owners. PolyQuest is seeing more interest and activity from converters and brand owners wanting to find sustainable solutions. Even with COVID-19, 2021 forecasts for recycled PET are higher than this year. And PolyQuest sees nothing but continuous increases going forward.

“From the brand owners, whom we are either dealing with directly or we’re dealing with the converter that supplies them with bottles, we’ve seen a lot of activity, discussion and the commercialization of products that were historically in a 100%-virgin PET bottle and are now in a 100% recycled PET bottle,” Durst says. “We take a lot of pride in being a small part in the success of recycled PET growth in North America.”

PolyQuest is also considering stepping into the polyolefins post-consumer recycling realm shortly, specifically in recycled polypropylene. Even though the amount of recycled post-consumer PP pales in comparison with PET at present, the rapid growth of PolyQuest’s virgin PP distribution business is causing the company to study investing in post-consumer recycled PP in the near future. PolyQuest aspires to replicate its very effective virgin PET distribution/recycle model in the polyolefins market, possibly even in post-consumer PE.

**Packed pellets at the Darlington facility.**

# PPEs Are Here to Stay: Is Your Sheet Line Ready?

Follow these tips to evaluate your sheet extrusion lines to find out if you can expand into this market.

J-stack roll stand in an upstack arrangement. Recommended for rPET, PETG, GP-PS, PP.

By Steven DeAngelis
*Davis-Standard, LLC*

The COVID-19 pandemic has placed personal protective equipment (PPE) front and center. PPE devices such as face shields are critical in protecting healthcare and other essential workers from viral airborne particulates. These shields, made from FDA-approved clear sheet, are used in several industrial and laboratory environments, but have also proven their worth in many other environments during the pandemic.

Vertical downstack rolls. Well suited to PMMA sheet extrusion.

What extrusion equipment is needed to make clear PPE sheet? A typical PPE sheet line includes an extruder or extruders, adapter network, roll stand and winding system. Typical resins include PET, PETG, PMMA, PC, crystal (general-purpose) PS and PP, or a combination thereof. Rates vary based on extruder size and resin used (see Table 1). For the feed screw, a single-stage barrier type is ideal for PET, RPET, PETG, PP and PC; and a two-stage screw is recommended for PS and PMMA.

*General-purpose dies will operate with some sacrifice of performance.*

If you already have a sheet line or are looking to add a new one for PPE production, it's important to evaluate each component to ensure effectiveness, cost-efficiency, and the value proposition for your business. Here are some considerations for the primary components of a sheet extrusion line to produce PPE sheet.

## EXTRUDER REQUIREMENTS

Whether using existing equipment or buying new, the extruder must have sufficient torque to process the selected resin or possibly achieve a speed increase for improved rate.

For existing extruders:

- Evaluate motor horsepower, base speed and available over-speed capability, as well as existing gear-in speed.
- Understand available extruder torque versus required torque for resins to be processed.

- Know the rated torque limit of the existing extruder gearbox; do not exceed the rating.
- Belt-drive extruder gearboxes can be modified by changing the sheave ratio to meet the desired torque and/or gear-in speed.
- A direct-coupled motor gearbox may require a gear-ratio change.

***Roll-temperature control is critical to proper sheet formation.***

For new equipment:

- Ensure capabilities are engineered for a range of resins.
- Include extended-field-range motors.
- Consider vented and plugged extruder barrels for greater flexibility.
- Choose a flexible screw design for multiple materials as needed, or optimized screw designs to fit your requirements.

To support melt delivery from the extruder to the die on existing or new equipment, melt filtration is always a consideration. You can use a single slide-plate screen changer for virgin, or clean in-house regrind/resin blends. When looking to process rPET or other recycled materials, a continuous-type screen changer should be considered for uninterrupted runtime. Various styles of continuous units are available for sheet applications, with a dual-bolt rotary unit the most common for that application.

## MELT PUMPS

Since most sheet processes use a blend of regrind and virgin resin with variable bulk density, we recommend using a melt pump.

Here's why:

- Melt pumps reduce the output-pressure variability to the feedblock and die.
- They improve machine-direction thickness control.
- They support die performance for transverse thickness control (stable flow through die manifold).
- Melt pumps offer melt-stream bead stability in the roll-stand primary nip.
- They operate around 700 to 1000 psi inlet pressure and 2000 to 3500 outlet pressure.
- Special continuous-leaking pumps can control leakage flow and prevent contamination of clear sheet.
- Melt pumps are essential when using a two-stage screw design.

## DIE SELECTION

Dies built for the specific resin to be processed are always best. General-purpose dies will operate with some sacrifice of performance such as the need to adjust die lips more frequently due to resin pressure changes within the die. A restrictor bar may be required to allow processing a variety of materials, as this allows the operator a means of changing the die's internal pressure distribution.

However, with some resins the associated internal parting line becomes a hang-up point for potential material buildup and degradation, potentially resulting in black specs in the material (see Table 2). Another compromise to enable multiple-resin performance requires larger die bodies, which unfortunately push the die farther from the nip, creating other challenges.

Dies must be able to accommodate a sheet gauge of 8 to 32 mils and typical widths from 32 to 58 in. For die-lip radius, 25 to 50 microns are preferred versus the 150- to 200-micron standard.

## ROLL-STAND CONFIGURATIONS AND PURPOSE

Choosing the right roll stand is also important. Here is a summary of each type:

- *Vertical downstack*: Conventional arrangement; horizontal die-to-nip approach; improved operator visibility; equal web wrap; smooth sheet processing. Lower-melt-strength resins should use a smaller-diameter top roll. Recommended for PMMA.

- *J-stack:* Most flexible design with an angled die-to-nip approach; good for low-melt-strength resins; vertical top and center roll for improved operator visibility; increased web wrap and greater cooling. Recommended for rPET, PETG, GPPS, PP.

TABLE 1 **Average Values for Typical Sheet Systems**

| | Extruder Diam., in. | L/D Ratio | Output | Power Required |
|---|---|---|---|---|
| PP | 4.5 | 34:1 | 1400 | 300 hp @ 175/203 rpm |
| | 5 | 34:1 | 1800 | 400 hp @ 155/180 rpm |
| | 6 | 34:1 | 2500 | 500 hp @ 135/160 rpm |
| PET, rPET, PETG | 4.5 | 30:1 | 2200 | 300 hp @ 103/120 rpm |
| | 5 | 30:1 | 2900 | 400 hp @ 103/120 rpm |
| | 6 | 30:1 | 3800 | 500 hp @ 88/103 rpm |
| Crystal PS | 4.5 | 34:1 | 1460 | 250 hp @ 130/170 rpm |
| | 5 | 34:1 | 1885 | 300 hp @ 120/160 rpm |
| | 6 | 34:1 | 2600 | 400 hp @ 105/130 rpm |


High-speed extruders are an available option to process many PPE materials, and offer a smaller footprint and higher performance density for existing plant upgrade projects.

- *Horizontal stack*: Vertical die-to-nip approach; best for lower-melt-strength materials; typically used on thinner-gauge sheet; limited operator visibility; equal web wrap; difficult to string up. Recommended for PC.

In choosing a roll stand, evaluate what type of roll-gap control would be best for you. The three types are: manually actuated worm gear; gear motor; and hands-free. Here are the differences:

**Manually actuated**: Operator-dependent position control; manual sheet-thickness reading to determine gap; optional encoder feed-back for display only; adjustable only under reduced pressure.

**Gear motor:** Operator-initiated position change; encoder feedback; position control; adjustable under full load.

**Hands-free**: Servo-hydraulic precision roll-position control; linear transducer resolution of 1 micron; closed-loop force control; displays actual force and force-limit capability.

In addition, roll-stand systems can be equipped with a variety of features to support processing. These include individual roll drive, protective masking, edge trim, solution applicator, and gauging. New systems come standard with individual roll drive, individual roll-temperature control, and various edge-trim capabilities.

Whether on new or existing equipment, roll-temperature control is critical to proper sheet formation. In additional, roll-temperature ranges vary widely according to the material to be processed, and the TCU will need the ability to achieve and maintain the recommended setpoints listed in Table 3. Some resins and thickness ranges will require high-temperature synthetic fluid systems to achieve proper performance.

A required option in rPET production is protective masking equipment to allow application of a protective film to the sheet in order to deliver it damage-free to the customer. The type of laminate applied will dictate the required options for the let-off machinery. Dual stations are recommended to allow for smooth changeover

TABLE 2
### Die for Existing or New Equipment

| Resin | Close Approach | Heated Die Lip | Restrictor Bar |
|---|---|---|---|
| rPET | P | P | NR |
| PETG | P | P | NR |
| PMMA | P | NR | O |
| PC | P | P | O |
| GPPS | P | NR | O |
| PP | P | NR | O |

P = Preferred  O = Optional  NR = Not Required

TABLE 3
### Roll Temperature Range

| Resin | Top Roll, F | Middle Roll, F | Bottom Roll, F |
|---|---|---|---|
| PET, PET | 90-105 | 110-115 | 100-150 |
| PP | 80-150 | 100-175 | 80-150 |
| GPPS | 90-100 | 110-120 | 90-100 |
| PC | 220-255 | 255-275 | 265-290 |
| PMMA | 160-170 | 170-200 | 200-220 |

of laminate rolls as well as side-lay adjustment to ensure proper alignment with the sheet being produced. Quality tension control is essential and can be accomplished with a range of options, from air-clutch resistance to inverter drive control.

In some cases, solution applicators are also needed. A liquid solution is used as the medium to transfer anti-fog additives to the sheet surfaces. Applicators can range in design from the lower-value flood-coating types to higher-value models capable of application at a micron level, such as those used on PET applications.

Once formed, PPE sheet can either be wound on a fixed-station, turret-style winder for thinner material, or cut to length and stacked for thicker gauges. Winders, if not automated, should include accumulators to allow for safe cut and transfer of the web from a full to empty core.

It's important to have your machine builder come to your plant and do an on-site evaluation of existing capabilities and propose potential upgrades or line additions. For new sheet systems, defining the resins and application specifications helps the OEM properly size extruders, dies and rolls. We also encourage you to take advantage of any laboratory or trial opportunities offered by the OEM to test capabilities. PT

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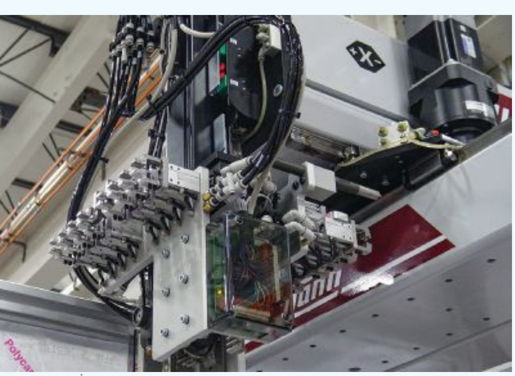
# How to Automate High-Precision 'Micro' Insert Molding

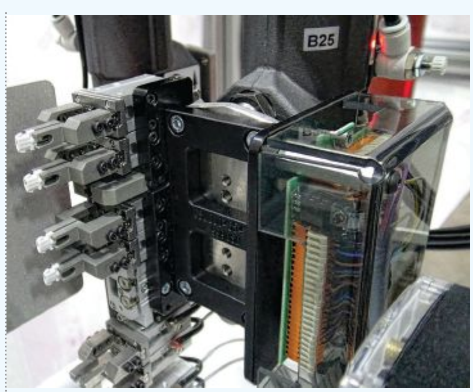
What does it take to automate a horizontal injection molding cell to handle micro-sized inserts and molded parts? General-purpose top-entry robots and tooling may not be up to the job.

By Joe Varone
*Wittmann Battenfeld*

Insert overmolding is an exacting technique in injection molding, but in its early days, it was not often handled by a robot—it usually required the assistance of human hands, especially for inserts with more difficult geometry. The robot technology and know-how of those days was not yet very capable for insert handling. Loading inserts into the tool was done—and sometimes still is—manually by workcell operators, especially for inserts that presented challenges in size, shape or the need for precise location and orientation. For years, horizontal machine operators would wait for the mold to fully open, let the parts fall, slide open the safety gate, carefully orient and hand-load the inserts into the mold, close the gate, and continue the overmolding cycle. It was an inefficient and labor-intensive method; the opening and closing of gates lengthened cycle times; and it was often prone to inaccurate insert orientation. Vertical molding machines had similar challenges, but this article focuses on horizontal-clamp machines, which are much more common among molding shops and are favored for higher production insert molding. And because top-entry robot design favors horizontal machines, vertical presses did not experience the benefit of technological advances in this type of automation.



Wittmann W822 robot with micro-insert EOAT. Most insert molders with higher production runs are using horizontal injection presses with top-entry robots.




EOAT presenting parts to a single Cognex camera at right.


Insert orientation check by camera.

**Two examples of micro-inserts that are increasingly common, but can challenge the capabilities of older automation systems designed for "normal" sized parts.**

Time is technology's friend, and robot technology has much improved, particularly for horizontal injection molding and top-entry linear robots. Nowadays, most molders with higher production runs for overmolded insert parts have automated the process with top-entry linear robots to streamline production, save direct-labor cost and improve quality control.

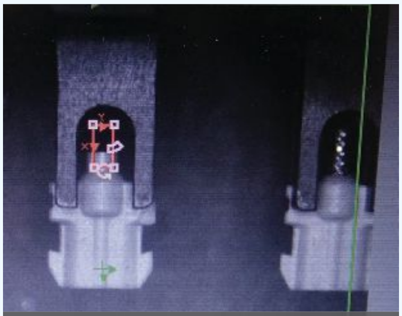
But what works for common overmolding applications with "normal" sized inserts and parts, is not necessarily sufficient for the micro-sized inserts and parts that are increasingly common in this era of miniaturization in electronics, medical devices and micro-mechanical systems. A dozen of these inserts might fit on a penny. This scale offers a much greater challenge to molders and robot suppliers alike.

## MICRO SIZE, BIG CHALLENGES

At the micro scale—say, less than 3 mm—insert overmolding is still often done manually (or not at all) because of the challenges of automated handling of such tiny inserts. This means the part design often defaults to a two-piece assembly rather than an integrated one-piece overmolding. Why? Because molders and part designers aren't always aware of the capability of the latest generation of injection molding robots or the capability of the suppliers' custom automation engineering groups to manage and successfully implement such workcells.

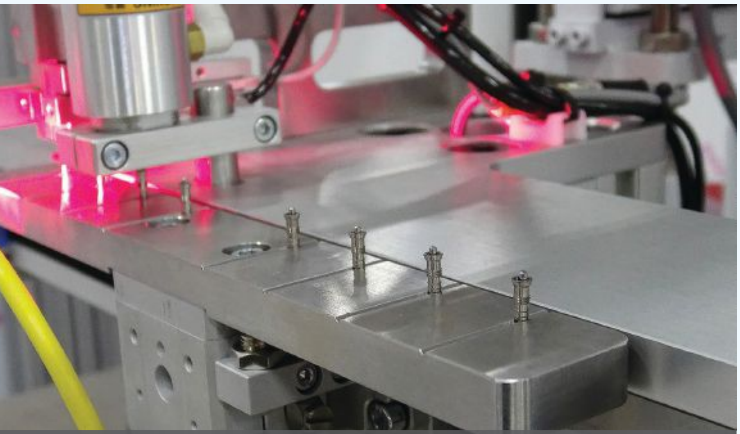
Micro applications may not be suited to your existing older-generation robot that still "goes through the motions." But today's top-entry linear robots feature such advances as higher precision (<1 mm) drive trains, multi-axis precision servo motors, and software control. When seen from a distance on a shop floor, today's higher-tech top-entry linear robots don't appear much different from earlier models of 20 years ago. But they are, in fact, more accurate, more programmable, more capable, and easily integrated with custom automation. Just as important, some robot suppliers' custom automation engineering capabilities have grown to match the more advanced-generation robots they supply.

In addition, "in-workcell" devices, sensors and quality-control technology have also improved for precise insert applications. An example is the use of more advanced, yet cost-effective modern vision sensors, proximity sensors and other technologies to ensure that inserts are present, in the correct location and orientation, with very high precision. Combine this with advances in the use of insert feeders, escapements, end-of-arm tooling (EOAT) technology, and workcells have evolved to become very efficient and cost-effective for overmolding even the most challenging of micro-inserts.

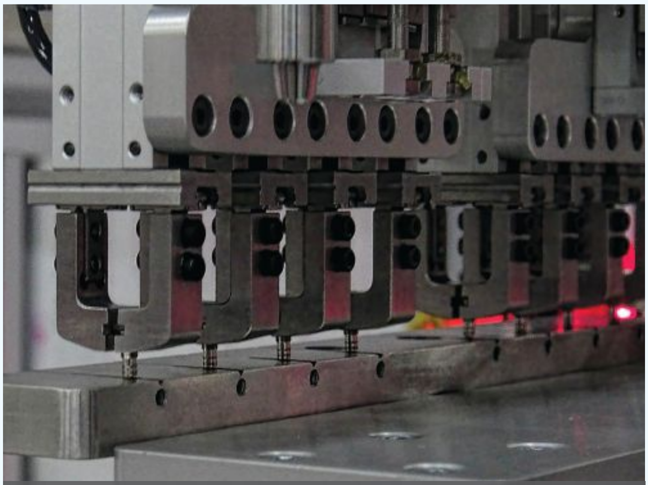


**Camera inspection shows insert missing (red box).**

And critically, in terms of project management, the molder can have confidence in a qualified primary robot supplier to take responsibility for the complete robot and automation workcell,



Micro-inserts loaded on pins on a shuttle prior to pickup by a robot. Red light is flash illumination for camera inspection.



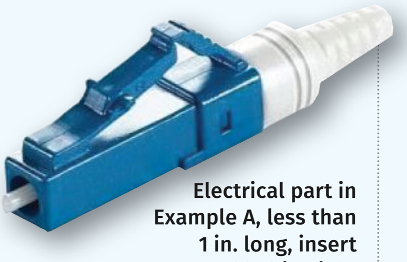
EOAT picking micro-inserts from nest.

so the molder does not have to go to a separate third-party integrator for special insert-molding applications. Managing a project with one supplier has to be better than managing two, right?

## REAL-WORLD EXAMPLES

High-precision micro-insert molding is now being implemented on precision horizontal injection molding machines in the 15-ton to 165-ton range with molds designed to facilitate automation from the outset for such applications before mold steel is cut. Here are two illustrative examples of micro-insert applications and the accompanying challenges:

**Example Project A** is a polyetherimide (Ultem) electrical part less than 1 in. long, with a cylindrical, ceramic polymer insert measuring 1.25 mm (0.0492 in.) diam. The mold has eight cavities, and the locational tolerance of insert placement in each cavity is 0.01 mm (0.0005 in.) The inserts must be oriented front to back.



Electrical part in Example A, less than 1 in. long, insert overmolded in eight cavities with Ultem PEI.

The cell includes a 110-ton press, a top-entry linear robot, and vision inspection to confirm that the insert is present and orientation of the substrate in the overmolded part. The robot places the parts on an exit conveyor that indexes by shot. The challenges for this project included:

• Ensuring the quality of the inserts—i.e., that they are consistently within tolerance and are very free of contamination such as dust, dirt, specs, static or moisture.

• Ensuring that the insert is kept at the correct orientation as it moves from the automated bulk feeding station prior to the overmold process, prior to mold insertion, and are correctly seated in the mold cavity before the mold closes. Robot-integrated cameras and vision sensors handle this requirement.

• Careful calculations of mold-steel thermal expansion, which could affect the tolerance of the cavities and seating of the micro-inserts and thus quality of the overmolded part. This is especially critical when processing at such tiny scales and high tolerances.

• Common insert application issues, such as the mold location on the platen has to be perfectly level, square and plumb. This is also required for the mating robot EOAT, even if the latter has mold-engagement alignment pins.

• Machining the EOAT to very high tolerances (±0.0005 in.) from high-quality stainless steel—instead of standard acetal, mild steel or rubber—for the "fingers" gripping the overmolded part. Also required are precision vacuum cavities in the EOAT for insert gripping. Other parts of the EOAT and feeding station are special anodized or hardened materials for wear-and-tear surfaces.

**Example Project: B** is another electrical part, this one of PBT with a cylindrical metal insert. The insert measures less than 2 mm and must be inserted into four cavities with front-to-back orientation and location tolerance of 0.03 mm. Vision sensors check insert presence and orientation. Cycle time is 15 sec in a 110-ton press.

The challenges for this metal micro-insert overmolding project were very similar to those of Project A. One difference is that metal inserts must be free of oxidation and coatings to avoid introducing contaminants. On the other hand, ceramic inserts may be more abrasive, and thus special consideration must be made for use


Micro-grippers (shown holding inserts) are machined to very high tolerances and are often made of special materials based on application needs.


Micro-insert feeding will require more than a "garden-variety" bowl feeder.

of hardened contact surfaces. Also, metal inserts tend to be less fragile and heavier than ceramic inserts, so gripping and handling metal inserts might be a tad easier, though there is nothing easy about handling objects the size of a grain of rice.

## LOTS OF FACTORS TO CONTROL

Other common technical considerations for automated handling of micro-inserts and parts include:

- **Static charge:** Even the tiniest static charges can affect the insert and part, and so tests must be made to determine whether the parts or inserts must be de-static washed or bathed in clean de-ionized air.

- **Environmental control:** Parts and inserts of this tiny scale are more consistently handled if managed in environments with controlled temperature, humidity and air flow. Ambient temperature changes might change the size of the insert, which is critical at precise tolerances. Humidity might negatively affect any hygroscopic polymers; and air flow (such as draft from a nearby vent or doorway) might push the tiny insert or part out of position. Well-designed enclosures and HEPA filters are often used to alleviate these risks and control particulate contaminants.

- **Micro-insert consistency and quality control:** Inserts must be very consistent and highly QC'd for dimensions, flash, debris, and other specs by the supplier for consistent inserting and handling.

- **Micro-parts detection:** The need for workcell vision cameras vs. simple vision sensors will be determined through testing. In all likelihood, more advanced vision technology will be needed for tasks such as orientation, inspection, mold-seating confirmation, and post-mold QC. The naked eye is usually not up to such small-scale inspections.

- **Micro-EOAT gripper precision:** The robot and automation grippers and fingers will be machined to very high tolerances and often made of special materials based on the application need.

- **Insert feeding:** This will not be your plain-vanilla, garden-variety bowl feeder; careful consideration will be made to the feeder design and materials of construction, tight tolerances, and creative orientation management with precision sensors confirming each step of the process.

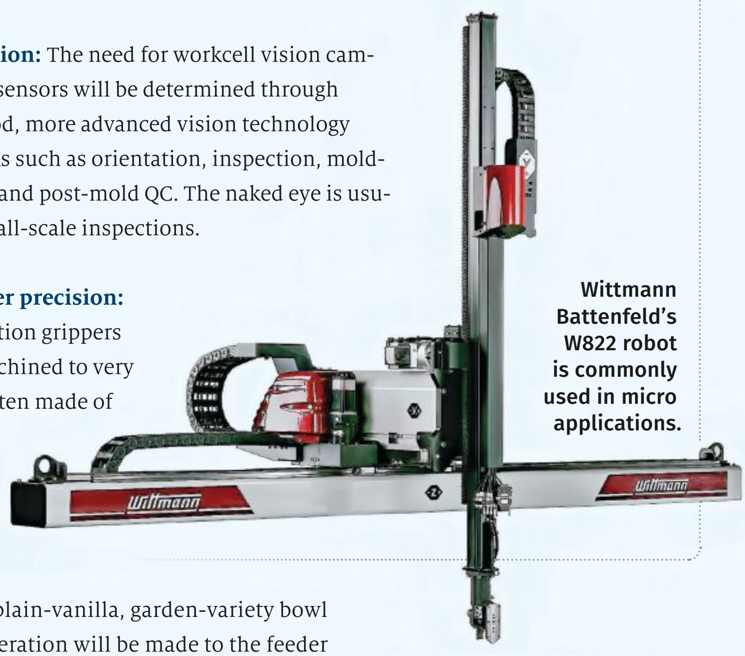
- **Mold seating and engagement:** To assist in making the initial setup easy, the robot EOAT often will include a docking feature to mate with the mold while locating the micro-inserts. This also ensures consistent inserting and demolding. The EOAT might not include common mechanical grippers, because the inserts are so small; rather, pneumatic tubes on the EOAT might be used to seat the micro-inserts into the mold cavities.

A plethora of other fine details to consider for optimized inserting, demolding and handling of micro-inserts and micro-parts will be familiar to an experienced robot supplier during the specification and design-review phase of the project.

## QUALIFYING AN AUTOMATION SUPPLIER

New robot and automation technology for micro-insert molding now offers the possibility of plastic product designs that were unheard of just a few years ago, and on a size scale that even the best 20-20 vision would struggle to make out. Now, a tiny part assembly can become a more robust single-piece design with insert molding/overmolding, thereby reducing post-molding assembly needs and reducing the overall part numbers in a finished product.

So, molders, be encouraged to reach out to your robot suppliers, interview them, inquire about the possibilities. If possible, get the customer's product-design/development specialist sitting in the same room with the qualified robot supplier and the mold-design manager; then discuss what is possible and plausible in your injection molding machines, do the economic math and move forward. This may very well be your competitive "edge" in your market segment.




Wittmann Battenfeld's W822 robot is commonly used in micro applications.

How do you select such a high-level robot supplier to collaborate on high-precision small or micro-insert molding? Consider such factors as these:

**The size and expertise of the custom automation engineering group:** It might be best to avoid overseas sources, as you'll want to partner domestically for complex projects. You'll rest easier with a U.S.-based robot and automation engineering group for years of technical support during the life of the project. Tour the robot supplier's facility for proof of its ability, size, scale and scope.

**The location and experience of field-service support:** Like the advantages of domestic custom automation engineering, it is just as important to have experienced local/regional "direct" field-service tech support for lower cost startups, workcell commissioning, and fast response to future tech-support needs as part of "uptime-management" assurance.

**U.S. and local project management for successful implementation:** The third layer of a successful high-tech automation project is the ever-critical project-management factor. It really should be domestic and regionally based to bring all the key project elements together without the time lags, communication issues and time-zone challenges of foreign contacts for such intricate, high-communication projects.

**Robot user-programmability, capability, and circuit limitations:** These micro applications involve more than basic pick-and-place or off-the-shelf automation. Thus, the top-entry linear robot must have all the latest technology to easily integrate with high-precision custom automation. The robot should be completely end-user programmable, and capable of 0.1-mm or better position accuracy. It should not require the molder to purchase custom programs, should not be limited to a limited choice of preset sub-routines, circuits and I/O. And robots with modular mechanical design offer the flexibility desirable for special custom applications. PT

ABOUT THE AUTHOR: **Joe Varone** has been involved with injection molding robots since 1991, and for the past 14 years he has been a regional manager for the Wittmann robot division in the Southeast U.S. He has worked with hundreds of injection molders on over 1000 applications with robots and automation in every market segment on molding machines from 15 to 4000 tons. Contact: *(615) 337-0155; joseph.varone@wittmann-group.com; wittmann-group.com.*

# Troubleshooting Pressure Fluctuations in Piston-Type Melt Filters

Piston filtration offers many advantages over other systems. While pressure fluctuations could be regarded as their weakness, there are many ways to avoid them, both from the mechanical and the process side. Small adjustments can make a huge difference in the overall performance and efficiency of the system.

This piston-type screen changer has two pistons (visible at far right), each bearing two screen cavities, for a total of four.

By Oliver Brandt
*Nordson Corp.*

There are many good reasons for selecting a piston-type filtration system. First, such systems provide a large filtration area, which is not only cost-efficient, but also ensures a soft startup, lower shear rates and lower differential pressure. This ensures good filtration because the lower forces prevent dirt particles from passing the filter element.

Another advantage of piston systems is the effective protection they provide against damage by foreign objects. There is enough room in the piston cavity so that metal contaminants, for example, cannot pass the screen barrier and cause damage during shifting movement of the screen-bearing piston.

> *In a piston filtration system, every movement of the piston comes with a change in pressure.*

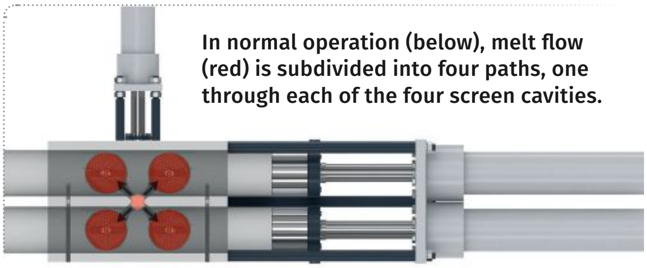
Another advantage is that the continuous flow during normal operation prevents melt stagnation and polymer degradation. Unlike other filtration systems, piston-type screen changers do not have dead zones where material remains and degrades.

Filtration systems are often designed for very specific processes. If the customer's materials or their characteristics change, adaptations must be made to get the same good results. Parameters that work very well for one material can be a bad fit for another one. This also applies to pressure fluctuations. Constant pressure at the extrusion die or pelletizing system is one of the most important parameters in a polymer processing system. Only a uniform, constant polymer flow will result in uniform product.

In a piston-filtration system, every movement of the piston comes with a change in pressure. Generally, this is not an issue and can be controlled in small ranges by the settings. But if these pressure fluctuations are too large, the product can be compromised by, for example, tears in film, thin spots in sheet, or pellets of irregular shape and size. In a well-adjusted system, where the piston movements for backflush and venting stops are set according to the process conditions, these fluctuations are kept to a minimum.

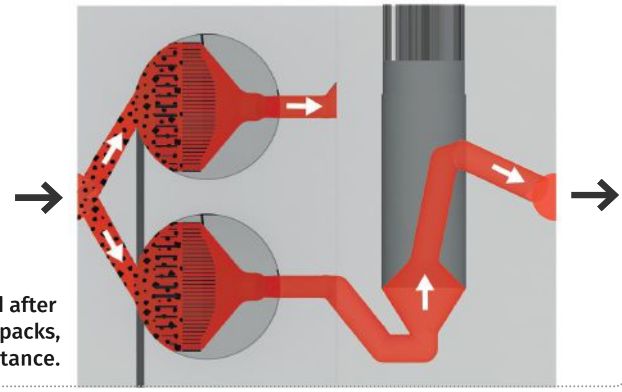
So, what can you do if pressure fluctuations occur nevertheless? Let's examine some solutions, looking at the key process variables:

**Material:** During troubleshooting it is always good to start at the beginning—in this case with the material. Is it lumpy or damp? Lumpy materials are very hard to meter, so that uneven polymer flow already starts at the extruder. Damp materials not only tend to get lumpy, but also the residual moisture can have a viscosity-reducing effect.



In normal operation (below), melt flow (red) is subdivided into four paths, one through each of the four screen cavities.

In normal operation (right), melt flow paths are reunited after melt filtration. As contaminants are deposited on the screen packs, differential pressure increases, resulting in an increase in flow resistance.



**Leakage:** As a second step, perform a visual check of the equipment. Are there any obvious leakages? The processing line is usually a sealed system to keep the polymer flow nice and even. If material escapes the system through leakages, pressure fluctuations are likely.

Leakages can be caused by insufficiently tightened adapter bolts. Due to thermal expansion, you must retighten the screws after the screen changer is heated up to operating temperature.

On the other hand, screws that are too tight can be the problem. If the system is under too much tension, the alignment of the single components can be compromised, and leakages might develop.

**Temperature:** Check whether the polymer process temperature is too high. This usually leads to a lower viscosity, for which the equipment and the sealing system might not be designed. Lowering the process temperature can solve this problem. In this context, it can also be beneficial to check the temperature sensors. If they don't work properly the system can overheat, without your recognizing it. Low temperatures can also be the reason for pressure fluctuations. Check the surrounding conditions. Is there any draft that cools down the machine?

***Sensitive venting is very important when processing low-viscosity polymers.***

**Sensor System:** Make sure that the overall sensor system is working properly. A misplaced or badly calibrated pressure sensor can show pressure peaks where there aren't any.

**The Process:** If the material is flawless, there are no detectable leakages, and the sensor system is working properly, then you must dig deeper. For efficient troubleshooting, it is important to know when the problems occur during the process. The first question you should ask yourself is whether there have been any changes in the process. For example:

- Are you processing a different material?
- Have the operating temperatures increased?
- Are you experiencing troubles every time the piston moves?
- Do they come up during the screen change?
- Or does every backflushing procedure cause pressure drops in the system?
- Do the fluctuations become visible when the extruder or gear pump reaches maximum speed?

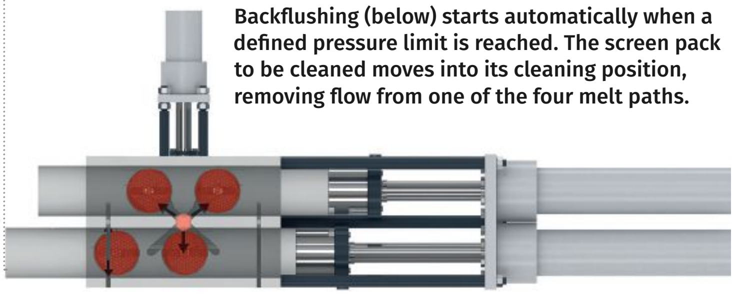
Always work closely with the operators. What observations have they made? If the system is equipped with a controller, check the pressure trends carefully. If there is no control system in place, almost every line has sensors to monitor the pressure. If the extruder or the pump increases its rotational speed in order to increase the material flow, then pressure is probably being lost somewhere down the line.

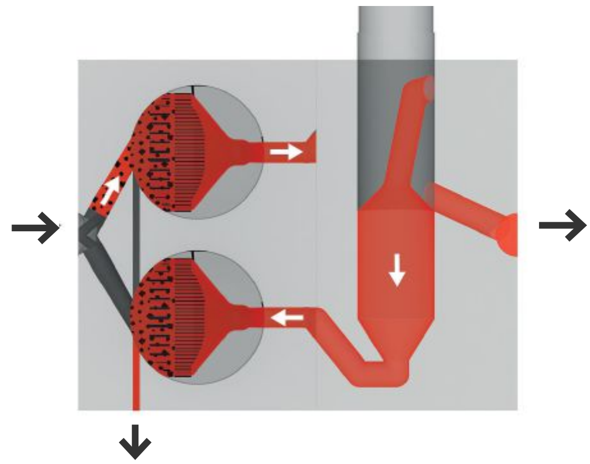
**Screen Change:** Every piston movement leads to a pressure change in the system. During a screen change, the piston moves out into screen-change position and shuts the cavity from the flow channel. The melt flows through the remaining cavity or cavities with an increased differential pressure. After filter change, the piston moves back into production position and the cavity is flooded with polymer in a so-called venting procedure. If this happens too fast and the cavity is filled too quickly, the melt pressure drops. Simply reducing the piston speed can solve that issue.

A sensitive filling of the filter cavity to prevent pressure fluctuations after screen exchange is especially important in processes where the extruder does not compensate for takeaway of material by increasing speed. This is also the case for very low-viscosity polymers.

**Venting:** When the cavity moves back into the flow channel after a screen change, it is important that no air is in there. If air bubbles get entrapped in the final product, they can cause holes and snap the line.

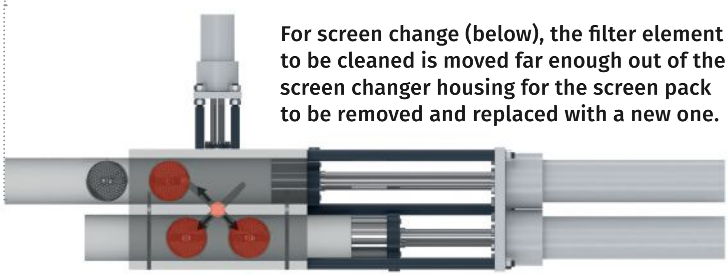
Backflushing (below) starts automatically when a defined pressure limit is reached. The screen pack to be cleaned moves into its cleaning position, removing flow from one of the four melt paths.

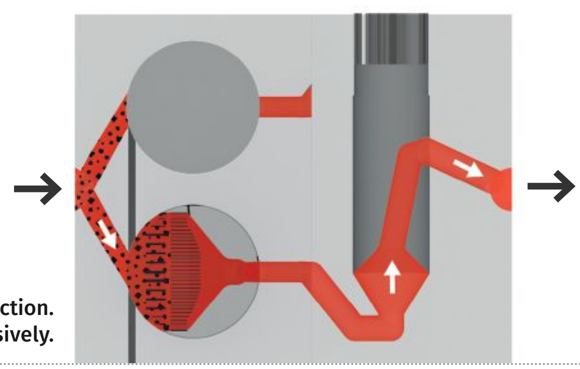




In backflushing (right), a displacing piston fills the melt reservoir to flush the screen cavity in a fast movement with hydraulic assistance. The contaminants peel away from the screen pack and pass through a flushing channel. After this, the adjacent screen pack on the same piston is cleaned in an identical manner. Throughout this cycle, three screen cavities remain in production.

For screen change (below), the filter element to be cleaned is moved far enough out of the screen changer housing for the screen pack to be removed and replaced with a new one.





During the screen change (right), three screen cavities remain in production. The screen-change procedure takes place for all four screens successively.

To avoid this, the pistons have venting grooves that allow air to escape during the filling process. Make sure that you clean these grooves properly after the screen change so there is enough space for the melt. The goal is that melt emerges from all venting grooves evenly and without any bubbles. Every material has its own perfect venting time and position and it takes some experience to find it.

Check whether the pressure is dropping at the first venting position. If this is the case, lower the piston speed so the cavity does not fill too quickly. The first venting position is the most important. If the timing is set right here, the other venting positions follow along and line performance can improve significantly.

*The goal in backflushing is to keep the material loss to a minimum without compromising the cleaning effect on the screens.*

Sensitive venting is very important when processing low-viscosity polymers. Pressure fluctuations are also a sign of turbulence within the cavity that needs to be filled. Turbulence caused by fast filling can result in so-called “champagne cream,” the distribution of small air bubbles in the cavity. This will lead to trouble in the final product. Therefore, it is always beneficial to adjust for smooth and sensitive filling, so that there remains a phase barrier between melt and air, which allows for a perfect venting effect.

Taking time for a sensitive venting procedure saves money in comparison with a “quick and dirty” venting. State-of-the-art piston filtration systems provide an automatic venting function, where no action by the operator is needed.

**Backflushing:** In systems that clean away contaminant by means of backflushing, the melt flow is reversed and flows through the screen against the extrusion direction. The dirt particles loosen from the screen and are diverted out of the cavity through a backflush pipe. This increases the lifetime of the screens and the overall process stability.

But again, every backflush changes the pressure within the system, since material is withdrawn. The goal is to keep the material loss to a minimum without compromising the cleaning effect on the screens.

If the backflush procedure causes pressure peaks that are too high and therefore impact the end product, try to reduce the material loss by adjusting the piston parameters. It can be beneficial to shorten the backflush intervals a bit. If the screens are too clogged and a lot of melt pressure is needed to loosen the dirt particles, more material is lost.

> ***A screen pack with high-quality weaves and a symmetrical design can help keep the differential pressure to a minimum.***

A sensitive adjustment of backflush settings is especially important in the case of low-viscosity polymers or processes where the extruder does not compensate for a takeaway of material by increased extruder speed. It is always beneficial to adjust for a smooth and sensitive backflush, so that dirt particles can get out via the backflush boring at low velocity.

**Screen pack:** The screen pack is where the filtration happens. It is also the place where the most pressure gets lost. The melt flow must pass a barrier, so the pressure before and after the screen packs are different and result in a pressure differential. The finer the filtration level, the smaller the open area of the filter mesh, or the higher the viscosity, the greater the corresponding pressure differential.

A screen pack with high-quality weaves and a symmetrical design, exactly fitted to the cavity, can help keep the differential pressure to a minimum and ensure a smooth process. The symmetrical design helps to even out the pressure differential before and after the screen. A high-quality screen and a good fit ensure the perfect distribution of the polymer over the filtration area. PT

**ABOUT THE AUTHOR: Oliver Brandt** has served the plastics industry for almost 20 years. He joined Kreyenborg (now part of Nordson Corp.'s Polymer Processing Systems business) in 2002, as a process engineer with a special focus on pump and filtration technology. In 2018, he took over the position of marketing development manager for Recycling. Brandt holds a degree in Plastics Technology from the University of Paderborn, where he focused on extruder technology, polymer rheology, and plastic machinery design. Contact: *49-251-26501-595*; *oliver.brandt@nordson.com*; *nordson.com*.

# PT Keeping Up With Technology

**PRODUCT FOCUS** **Auxiliary Equipment**

DRYING

## Wittmann Adds Compressed-Air Dryers

Wittmann Battenfeld's CARD series of Compressed-Air Resin Dryers is an expansion of its line resulting from its April 2020 acquisition of FarragTech, another Austrian company. These dryers, which were exhibited at K 2019, are available in a range of models and sizes, three of which have become particularly popular: CARD 6G/Fit, CARD 10S and CARD 20S. On these units, the desired drying temperature can be set via a touchscreen panel; and at the end of the predrying phase, a signal is sent to initiate automatic production startup. Material drying data can be exported via a USB port or OPC UA connection.

With the integrated week timer, the dryers can be adapted to production planning so that they are ready to run as soon as dried material is required. In the CARD S models, the compressed-air consumption is precisely adjusted to the actual demand by an intelligent digital air-volume control.

If a material loader is used to fill the dryer, and if the interval between two conveying cycles exceeds a certain period of time, this is interpreted as "no material consumption," and the dryer then lowers the drying temperature to protect the material and save energy.

CARD dryers can be mounted directly onto the machine feed throat. By means of a claw flange, the dryers can be moved into a parking or emptying position. Quick-change adapters can save time when transferring the dryers from one machine to another.

HEATING/COOLING

## Reusable Insulation Blanket for Processing Machinery

Designed to cut down on energy, retain radiant heat, and boost safety, the new model MT850SSi thermal blanket from Shannon Global Energy Solutions, N. Tonawanda, N.Y., can be used on any style extruder, as well as extruder barrels, heads and injection and blow molding machines (***shannonglobalenergy.com***).

The thermal blankets are removable and reusable, so maintenance workers and equipment operators can easily install and reinstall them after removing them from a component to adjust or service processing machinery. Shannon's latest design creates a thermal barrier and doubles as a safety feature for employees, while capable of insulating machinery at temperatures up to 850 F.

Shannon's reusable thermal insulation blankets come with an ID tag to describe the location and component to which each belongs. They also carry a hot-surface label to warn operators of high temperature. Shannon stores its insulation blanket production drawings on a CAD system, so processors can reorder blankets or request replacement parts for up to 10 yr.

HEATING/COOLING

## Direct-Cooled, Pressurized TCU

Building on the 2019 release of the Tempro plus D M100 pressurized temperature-control unit (TCU), Wittmann Battenfeld is introducing directly cooled, pressurized TCUs, including its first direct-cooled dual-circuit unit. As part of a virtual rollout of products it would have launched at the canceled Fakuma 2020 show, the directly cooled Tempro plus D M120 in single- and dual-circuit versions comes with a Wittmann 4.0 interface as standard, enabling integration of the TCU into the workcell control. The company said there was strong market interest in a directly cooled pressurized unit of the same size as the Tempro plus D M100.

With two independent temperature-control circuits, the new model features a durable piston-cooling valve to endure the high-wear demands of direct cooling. The company says this valve can withstand the high number of switching cycles with less maintenance, providing longer service life than a conventional membrane cooling valve.

As standard, the Tempro plus D M120 supplies direct cooling capacity of 80 kW with a $\Delta T$ of 75 C. In addition to the standard 9-kW heating capacity, models with capacities of 12 or 16 kW are also available. Stainless-steel pumps with wear-free magnetic couplings cover a range of maximum flow rates from 40 to 90 l/min.

A frequency-controlled pump with 1.1 kW, 50 l/min, and 9 bar capacity is also available. Wittmann says frequency control offers energy savings and flexibility to control by motor speed, pressure or flow rate.

RECYCLING/SCRAP CLAIM

## 'Hybrid' Shredder Can Cut & Size in a Single Pass

BCA Industries, Milwaukee, has launched a shredder- knife technology that reportedly can cut, screen and size in a single pass. The patented Triplus knife system changes a standard shredder into a hybrid with a dual-shaft rotary-shear shredder and a single-shaft granulator.

BCA (***bca-industries.com***) says this approach simultaneously does the work of both a typical shredder and granulator. The technology is flexible enough to be incorporated into any size of BCA shredder, from 10 hp to 800 hp and cutting chambers from 15 ×12 in. to 48 × 72 in.

The approach uses the precision grabbing action of the high-torque, dual-shaft shredder to cut the width of the material, while the bed-knife design of the shredder sizes the length. This is accomplished in one operation, which produces accurately sized material in one pass without a screen. The particle size is based on the size and geometry of the knives.

These shredders can be operated at high speed and low torque for higher production speeds. When more torque is required temporarily, the system automatically adjusts the rpm, and then resumes the higher-speed, lower-torque setting for faster production within seconds.

TESTING

## Test System for Healthcare & Food Packaging

A new package-integrity testing system reportedly can measure package leaks, burst pressure, and seal strength in all types of packages, with or without a modified atmosphere. The Dansensor Lippke 5000 from Ametek Mocon is designed for testing healthcare and food packaging either on the production floor or in the lab.

The system is said to feature the industry's first test head with the sensor probe located inside the needle. The integrated design reportedly provides improved consistency and sensitivity for more accurate pressure control during testing, so that leak, burst and creep test results are as accurate as possible. This system also features shorter fill times, an improved prefill process that prevents overshoot, and shorter overall test times.

A new touchscreen with a simplified graphical user interface is said to enable easy and intuitive data capture, storage, and export. For production QC, operators can easily set up data once and then simply transfer it from one instrument to another, making exact clones of the first units.

The unit supports numerous standard test methods, including ASTM F-1140, ASTM F-2054, ASTM F-2095, ASTM F-2096, ISO 11607 and enables compliance with 21 CFR, part 11 for data security.

MATERIALS HANDLING

## Drum Dumper with Safety Cage

Flexicon's new mobile Tip-Tite Drum Dumper with safety cage allows hands-free, automated dumping of bulk solid materials from 30- to 55-gal drums throughout the plant, with no dusting or danger associated with sudden shifting of contents. The three-sided carbon steel cage with safety-interlocked doors is mounted on a mobile frame with quick-acting jack screws for stability. A platform raises the drum hydraulically, creating a dust-tight seal between the rim of the drum and the underside of a discharge cone.

A second hydraulic cylinder then tips the platform-hood assembly, stopping it at dump angles of 45°, 60° or 90° with a motion-dampening feature, causing the spout of the discharge cone to mate with a gasketed receiving ring on the lid of an enclosed hopper that charges a flexible screw conveyor.

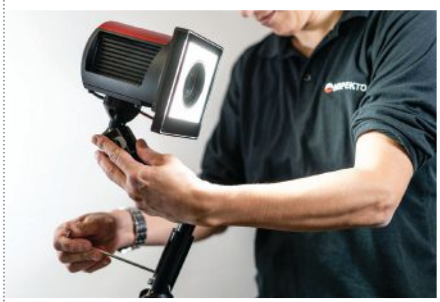
INJECTION MOLDING

## Self-Adjusting, Self-Learning Machine Vision

Inspekto describes its Autonomous Machine Vision (AMV) S70 technology as part of a new approach to quality assurance, where technicians with no previous knowledge of machine vision or artificial intelligence can set up an inspection system in hours, rather than in weeks, and without the aid of a systems integrator.

The company notes that in injection molding, machine vision is often impeded by the reflective surfaces of plastics, which are hard to illuminate, and the same production line can create items of different colors and shapes, while most machine-vision technology can only inspect one version of a product at a time.

Inspekto says its AMV S70 autonomously determines the number of samples the system needs to "learn" a part's key characteristics, and it self-adjusts the camera settings to obtain the best possible image of the item to be inspected. This allows a process technician to set up the system quickly, without the need to bring in a special integrator, according to Inspekto.



Standard machine-vision systems are designed to inspect one type of part at a specific point on the production line, making them ill-suited for injection molding, where the same machine can make various parts that come in disparate shapes and forms, over the course of one day.

Inspekto says its TYPES app can inspect up to hundreds of different products at that same location on the line. Because of the reflective nature of many molded parts' surfaces, or instances where the molded part and the mold itself can blend together because of a lack of contrast or illumination, proper lighting is required for inspection. And since molding machines are built to be as compact as possible, the daylight or full-open stroke of a mold can be limited, making it difficult to illuminate the tool cavity. Inspekto says its AMV S70 systems overcome these challenges by self-adjusting its camera parameters to obtain the best lighting, focus and contrast.

Inspekto says that because AMV can be installed by process technicians, it reduces its total cost so that plant managers could afford to have a quality-assurance machine-vision station at every junction on a production line, instead of just at the end.

An Israeli startup company, Inspekto is headquartered in Ramat Gan (***inspekto.com***). It established a training center and European headquarters in Heilbronn, Germany, in 2018. In April 2020, it announced it was seeking office space, staff and eventually an assembly facility in Detroit.

INJECTION MOLDING

## Lighter A-C Servo Wrist Boosts Robot Payload

During a virtual introduction of products it would have launched at the canceled Fakuma 2020 show, Wittmann Battenfeld introduced a new version of its A-C servo wrist for its Cartesian robots. Total weight of the A-, B- and C axes is 40% less than the previous version, making available an average of 6 kg more payload capacity. This was achieved through the use of direct drives to power the wrist's movements. Available for robots from Wx142 to Wx153 and comparable units from the W8 pro series, the new servo wrist can be retrofitted relatively simply to existing Wittmann Battenfeld robots.

From the outside, the company says hardly any changes are visible, as its dimensions are virtually unaltered, and the drive performance for the A rotation (0–270°) and C rotation (0–180°) remain unchanged.

INJECTION MOLDING

## 3D-Printed Hot-Runner Manifold

Previewed at K 2019, new hot-runner systems from Hasco feature a 3D-printed manifold, granting molders greater design freedom. Hasco says the market launch at K 2019 generated strong interest, and since then a number of successful customer projects have used the technology, which the company has now dubbed Streamrunner.

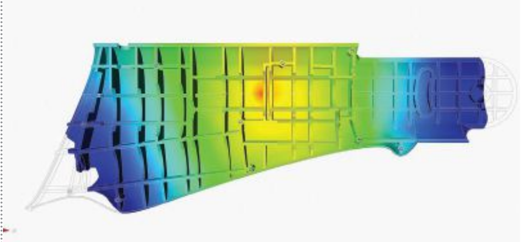
Using additive manufacturing to create the manifold allows flow channels to be configured with the optimum rheological layout, avoiding sharp edges, corners and areas with poor flow. By creating a smooth route through the manifold, the melt reportedly experiences much lower shear stress. Flow-optimized design also speeds color changes, since the melt can be divided and deflected over larger radii.

Hasco says the complete absence of diverting elements allows the Streamrunner to be produced with a compact design, with a height of 26 mm. Tight spacing down to 18 mm is possible for high-cavity systems. Hasco notes that the machine currently used to print the manifolds has a maximum build size of 250 × 250 mm.

INJECTION MOLDING

## New Simulation Platform Launches

Altair, Troy, Mich., a supplier of data analytics, simulation and high-performance computing, has launched Altair Inspire Mold, an end-to-end program for simulating injection molding. The company says the platform can determine the manufacturability of new components at the beginning of the development process, determining the risk of defects such as warping, sink marks and short shots before any investment of time or money in a mold.



The company (***altair.com***) says there are no requirements for specialized computing hardware to run Altair Inspire Mold. James Dagg, Altair's chief technical officer, says any modern Windows laptop can run Inspire Mold (Nvidia graphics cards are recommended). A minimum of 16GB RAM is required, and 32GB suggested. Users lease the software and run the simulation locally at present; but in 2021, Altair will enable simulations to run seamlessly "in the cloud" via Altair One or on Linux HPC servers.

Users can run not only the injection molding process, but also virtual testing with Inspire Mold, including structural simulations of the part using the nominal material properties of the selected plastic.

Users can validate, correct and optimize mold designs in a five-step workflow. Those steps include importing a part's CAD design or designing within Inspire; defining the gating system using smart parametric gate builders; designating mold components if imported from CAD or building your own; defining the injection molding process parameters; and running the analysis and viewing the results.

Utilizing 3D technology, simulations can include filling, packing, cooling, and warpage, as well as a complete simulation that combines all of those. In addition, users can look just at cooling and warpage; filling, packing and warpage; transient mold cooling; fiber orientation; and simulation of hot-runner systems.

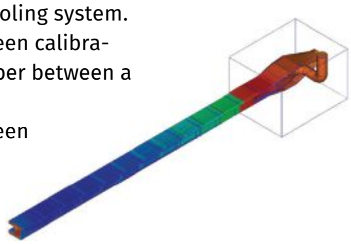
Data for 60 materials is embedded in Inspire Mold, and the Altair Material Data Center, a large plastics database recently acquired from M-Base of Germany, will also be integrated soon. Inspire Mold joins Altair's existing Inspire manufacturing simulation offerings, including programs for casting, forming, mold-filling, extrusion and additive manufacturing.

EXTRUSION

## Profile Die Design Software Simulates Cooling, Shrinkage

The new version of polyXtrue profile die-design software from Plastics Flow is said to accurately simulate extrudate cooling and corresponding extrudate shrinkage in the complete cooling system. It includes the following features:

- Twenty calibrators and sizers in the cooling system.
- Two different temperature zones between calibrators. One of the two zones can be a wiper between a water tank and the next calibrator.
- Ten different temperature zones between the die exit and the first calibrator
- Ten different temperature zones are allowed after the last calibrator.



With the software, calibrator profiles can be different from the die-exit profile. By gradually changing the shape of the profile in subsequent calibrators, the shape of the extrudate profile can be significantly modified after it leaves the die, allowing extrusion of complex profiles from relatively simple die geometries.

Die geometry files can be imported from SolidWorks, Inventor and Creo software. The new software allows users to import die geometries in native Creo file format.

MATERIALS

## New Compounds Prevent Cracking of Medical Devices

Two patent-pending BPA-free healthcare formulations boast improved chemical resistance over traditional flame-retardant thermoplastics used for medical devices, such as FR PC/ABS, FR

PC/PET and FR copolyester. Trilliant HC8910 and HC8920 healthcare grades from Avient (formerly PolyOne) were developed in response to today's intense disinfecting protocols.

The two new grades are available in both natural and custom colors. HC8920 grades are formulated to meet UL 94-5VA at 3.0 mm, V-0 at 1.5 mm, and V-1 at 0.75 mm. Avient has not disclosed what materials they are based on. Other Trilliant HC healthcare formulations are based on ABS, nylons 66 and 12, PEEK, acetal and Eastman's Tritan copolyester.

MATERIALS

## PC Copolymer Helps Prevent Stress Cracking in Medical Devices

A new semi-crystalline PC copolymer that is said to offer excellent environmental stress-crack resistance (ESCR) in molded medical devices is the latest addition to the family of LNP Elcres CRX copolymer resins from SABIC. This family of materials boasts exceptional chemical resistance to aggressive healthcare disinfectants and can help prevent premature failure from ESC in medical equipment housings and devices.

The new semi-crystalline copolymer features UL 94V-0 performance at 1.5 mm, good ductility, and this resin family's highest level of chemical resistance against leading hospital disinfectants. All current LNP Elcres CRX grades are opaque and custom colorable, and they meet the requirements of limited compatibility according to ISO 10993 (parts 5 and 10).

# Commodity Resin Prices End the Year Mixed

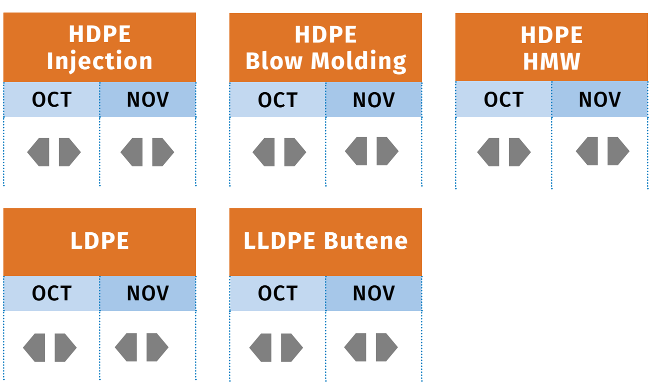
## Overall, processors will have more leverage in 2021 contract negotiations.

By Lilli Manolis Sherman
*Senior Editor*

Prices of the five large-volume commodity resins were generally on an upward trajectory through at least the end of the third quarter, owing to a combination of factors including planned and unplanned capacity interruptions that limited feedstock and/or resin inventories, spikes in feedstock costs and, in some cases, strong demand. Approaching the end of the year, the trajectory appears to be flat with potential for downward movement for PP, PS, and PET that could result from improved supplier inventories, lower feedstock costs and slowed demand. Overall, plastics processors were expected to have greater leverage in negotiating 2021 contracts.

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

### Polyethylene Price Trends




### Market Prices Effective Mid-November 2020

| Resin Grade | ¢/lb |
|---|---|
| **POLYETHYLENE (railcar)** | |
| LDPE, LINER | 111-113 |
| LLDPE BUTENE, FILM | 94-96 |
| NYMEX 'FINANCIAL' FUTURES | 39.5 |
| DECEMBER | 37 |
| HDPE, G-P INJECTION | 116-118 |
| HDPE, BLOW MOLDING | 109-111 |
| NYMEX 'FINANCIAL' FUTURES | 45 |
| DECEMBER | 43 |
| HDPE, HMW FILM | 123-125 |
| **POLYPROPYLENE (railcar)** | |
| G-P HOMOPOLYMER, INJECTION | 64.5-66.5 |
| NYMEX 'FINANCIAL' FUTURES | 57 |
| DECEMBER | 52.5 |
| IMPACT COPOLYMER | 66.5-68.5 |
| **POLYSTYRENE (railcar)** | |
| G-P CRYSTAL | 101-103 |
| HIPS | 103-105 |
| **PVC RESIN (railcar)** | |
| G-P HOMOPOLYMER | 95-97 |
| PIPE GRADE | 94-96 |
| **PET (truckload)** | |
| U.S. BOTTLE GRADE | 50 |

### PE PRICES FLAT

Polyethylene prices settled flat in October, despite suppliers' efforts to push through another 5¢/lb increase, which would have been the fifth consecutive increase. The 19¢/lb of hikes implemented so far this year resulted from tight inventories due to planned and unplanned outages and strong demand, according to Mike Burns, RTi's v.p. of PE markets, *PCW*'s senior editor David Barry, and The Plastic Exchange's Michael Greenberg. Summed up the latter, "Contract buyers are facing the same 5¢/lb increase nomination in November that did not take hold in October, and there are very few that currently seem worried."

RTi's Burns notes that year-end contract price decreases were unlikely due to tight inventory levels and sustained demand. Still, he saw signals of some market conditions—including new capacity—that would allow processors to have some leverage in negotiating 2021 contracts.

In the first week of November, *PCW*'s Barry reported PE spot prices trending lower amid efforts to boost exports: "The tightest grades have continued to be blow molding HDPE and LDPE for some buyers, but spot availability was expected to improve. Suppliers viewed November as a month for rebalancing, with inventory pressure likely to emerge in December. In the domestic secondary market, demand was quiet, and there were widespread reports of customers destocking in October, as buyers anticipated 4Q price relief. Domestic prime demand was expected to remain healthy, especially for consumer packaging applications that have thrived during the pandemic." Barry also noted that export offer volumes to China were 10% to 20% higher in November, and even more availability was expected later in the month as suppliers with inventory position for the year's end, with prices under pressure.

## PP PRICES FLAT TO LOWER

Polypropylene prices moved up 0.5¢/lb in October, in step with propylene monomer, and there did not appear to be any implementation of the attempted non-monomer-related price hikes of 3¢/lb, according to Barry, Greenberg and Scott Newell, RTi's v.p. of PP markets. In fact, Barry noted there was talk that some suppliers were pricing contracts more aggressively in a bid to secure sales volumes for 2021. All agree that domestic PP suppliers cannot afford to have the highest prices globally, as competitive imports were already making their mark.

RTi's Newell ventured that PP prices would drop this month, noting that any price moves would be linked solely to the monomer: "The balance of power is shifting from suppliers to buyers." He noted that things were starting to return to normal after an extremely tight market caused by planned and unplanned outages for both PP and monomer: "While the market was still tight through October, things were rebuilding slowly and price hikes were based on circumstances, not market fundamentals."

The Plastics Exchange's Greenberg reported after the first week of November that PP trading remained strong but was still somewhat slower than the extraordinary demand in the last couple of weeks in October. "Slightly growing supplies still found quick homes in the happy hands of buyers; monomer prices held steady; and PP prices ended the week flat but firm. Some PP buyers ordered another round of imported material to offset insufficient domestic supplies, with deliveries extended out through the end of the year."

*PCW*'s Barry characterized spot PP prices as largely unchanged while tight supply conditions prevailed. "Some loosening was seen in the wide-spec market, but spot prime offers were few and far between." He said the latest Commerce Dept. trade data showed U.S. PP imports (including propylene copolymers) totaled 64.3 million lb in September, a 50% increase from 42.7 million lb the prior month and the highest level since March. PP imports were nearly evenly split between homopolymer PP and copolymers.

### Polypropylene Price Trends

| Homopolymer | |
|---|---|
| OCT | NOV |
| ▲ 0.5¢/lb | ◀▶ |

| Copolymer | |
|---|---|
| OCT | NOV |
| ▲ 0.5¢/lb | ◀▶ |

## PS PRICES FLAT TO HIGHER

Polystyrene prices remained flat in October, but PS suppliers announced a 2¢/lb price hike for November, attributing it to higher benzene and styrene monomer costs, according to both Robin Chesshier, RTi's v.p. of PE, PS and nylon 6 markets, and *PCW*'s Barry.

In the first week of November, Barry reported that globally tight monomer supply resulted in a 7.5¢/lb jump in the U.S. Gulf styrene monomer spot market, with November transactions reported at 38.3¢/lb. Costs of both benzene and ethylene also spiked. Barry reported that the implied styrene cost based on a 30/70 ratio of spot ethylene/benzene was 21¢/lb, up 1.8¢ over a four-week period. PS spot prices were firm but with limited transactions. Both sources saw potential for PS prices to drop this month. Chesshier thought 2-3¢/lb could come off, as the PS market has not been growing, due to legislative bans and losing ground to PET and PP in the packaging arena. She did note that demand in the appliance sector has strengthened and appeared to be ramping up in automotive. She believed that processors would have leverage in 2021 contract negotiations.

### Polystyrene Price Trends

| GPPS | |
|---|---|
| OCT | NOV |
| ◀▶ | ▲ |

| HIPS | |
|---|---|
| OCT | NOV |
| ◀▶ | ▲ |

## PVC PRICES UP

PVC prices moved up a total of 12¢/lb between September and October, owing to tight supply from storm-related *force-majeure* actions as well as extremely high global demand, according to both Mark Kallman, RTi's v.p. of PVC and engineering resins and *PCW* senior editor Donna Todd. They both saw November prices as flat. As for this month, Kallman ventured prices could remain flat or possibly decline a bit.

Todd reported that some market watchers expected PVC suppliers to announce another price hike for November, primarily to keep pressure on the market and ensure their previously announced price hikes would succeed.

Both sources described the market as very tight, with Kallman noting supplier inventories had fallen to under seven days by November. He expected continued strong demand from the construction sector and also ventured that resin production rates would increase from under 80% in September as capacity is restored by year's end: "Expect to see improved operating rates and inventory rebuilding, which will give processors leverage in negotiating 2021 contracts."

### PVC Price Trends

| Pipe | |
|---|---|
| OCT | NOV |
| ▲ 4¢/lb | ◀▶ |

| Gen. Purpose | |
|---|---|
| OCT | NOV |
| ▲ 4¢/lb | ◀▶ |

## PET PRICES UP, THEN DOWN

PET monthly contracts ended October at 50¢/lb, up 4¢, the result of a surcharge tied by suppliers to increased feedstock costs. This was the result of storm-related unplanned outages, according to *PCW* senior editor Xavier Cronin. He predicted that by mid-November, prices of domestically produced PET for spot delivery would fall by a few cents. This would be due partly to a seasonal drop in demand for carbonated soft drinks and water, but also due to the abundance of well-priced PET imports

Still, he noted that PET demand for bottles, containers and packaging remains robust despite the seasonal slowdown due to demand tied to COVID-19—for example, bottled water and strapping tape for shipping medical and other supplies.

### PET Price Trends

| Bottle Grade | |
|---|---|
| OCT | NOV |
| ▲ 4¢/lb | ▼ |

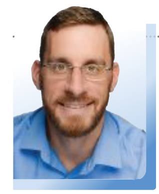
# Plastics Processing Index Hits Two-Year High

## Five of six business components show expanding activity as index hits 55.6.

By Michael Guckes
*Chief Economist/Director of Analytics*

The Gardner Business Index (GBI) for plastics processing closed October with a two-year-high reading of 55.6. Five of the six components of the Index reported expanding conditions (above 50), with only export activity contracting (below 50). The Index, which is calculated based on monthly surveys of *Plastics Technology* subscribers, moved higher thanks to a fourth consecutive month of expanding new orders and production activity. Strength from these areas likely contributed to the year's first expansionary backlog reading and a third month of expanding employment activity. As the Index moves into the final months of the year, concerns remain around the ability of shippers to maintain the sufficient flow of goods so as not to stymie production.

Gardner's Custom Processors Index indicated continued expansion but decelerated slightly to 53.1 due to a greater contraction in export orders and slowing expansion of new orders and production. Custom processors also reported slower supplier deliveries during the month, which may have partially influenced the lower production activity. Constraints along the plastics manufacturing supply chain have also manifested themselves in rising input prices. Gardner's tracking of material prices shows that beginning in July a swelling proportion of plastics processors began experiencing rising costs. The latest plastics prices index was the highest since the end of 2018.



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

### Gardner Business Index: Plastics Processing

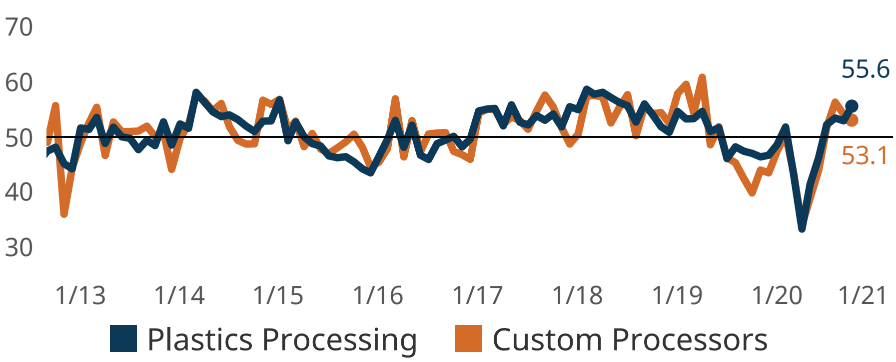



**FIG 1**

**The GBI Plastics Processing Index reported a quickening expansion in October business activity with the Index rising to 55.6. Custom processors also reported a fourth month of expanding activity. Both indices reported expanding production, new orders and employment activity.**

### Processors See Hikes in Material Prices

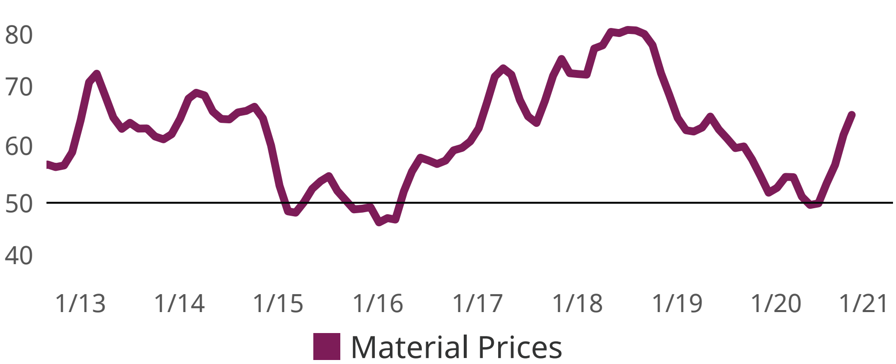



**FIG 2**

**The proportion of plastics processors reporting increasing material prices has grown quickly during the second half of 2020. This may in part be due to the disruption that the coronavirus has caused to supply chains.**

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# infoFILE

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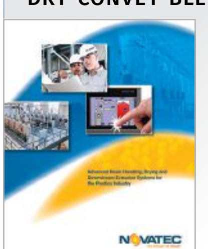


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PROTOLABS — MAPLE PLAIN, MINN.

# Custom Molder Enhances Disinfection Equipment With Novel Nozzle Design

Protolabs injection molded this two-piece HDPE nozzle protector with an undercut that snaps them onto the disinfecting spray wand.

Responding to the coronavirus pandemic, Protolabs' innovative nozzle protector successfully augments Foam-iT's flagship fog-mist disinfectant units.

By Lilli Manolis Sherman
*Senior Editor*

A unique nozzle protector designed and manufactured by Protolabs, Maple Plain, Minn., has enhanced two flagship products of foam-cleaning and disinfecting equipment manufacturer Foam-iT, Grand Rapids, Mich. With increased demand for this equipment brought on by COVID-19, Foam-iT needed to update it in order to make it less prone to damage.

Foam-iT turned to Protolabs, a 21-yr-old global custom injection molder and additive manufacturer for prototyping and on-demand short-run production. One of Foam-iT's engineers had previously worked with Protolabs and saw an opportunity to team up again, given Protolabs' reputation for speed and reliability. By using Protolabs' on-demand molding service, Foam-iT took advantage of their design analysis and easy online ordering, along with a helping hand from its in-house manufacturing experts to avoid delays.

Foam-iT's fog/mist disinfection unit in action with new nozzle protector that makes it less prone to damage.

Protolabs has 12 manufacturing facilities in the U.S., Europe and Japan, and serves a diverse range of industries including medical devices, automotive, lighting, technology, consumer products, and electronics. It currently has more than 1000 CNC mills, lathes, 3D printers, presses, press brakes and other manufacturing equipment for injection molding, 3D printing, CNC machining and sheet-metal fabrication.

Protolabs designed and injection molded the new HDPE nozzle protectors for Foam-iT's electric fog-mist disinfectant units. Two identical parts wrap around the nozzle's mount, protruding just enough to protect the nozzle. The two parts are joined using two screws on the mist side and a clever undercut snaps the protector onto the body of the wand. All new units are now available with a Protolabs-manufactured nozzle protector, and existing units can be retrofitted.

COVID-19 proved the trigger for Foam-iT to improve its equipment. Demand for the two electric fog/mist units sharply climbed and Foam-iT's customers—cleaning teams all over the country—were pressed to finish their work more quickly and efficiently than previously to keep workplaces safe. The Foam-iT disinfectant equipment's PVdF nozzles, which spray disinfecting agents, are very sensitive to damage. Due to their greater use during the pandemic, the nozzles were being banged around and began malfunctioning.

Protolab's innovative HDPE nozzle protector proved to be the solution. In just five days (three business days), Protolabs delivered the initial 250 prototype parts to Foam-iT. Before COVID, misting equipment accounted for 20% of Foam-iT's commercial sales, and after the pandemic hit in March, that surged to 80%. By onshoring its manufacturing through Protolabs, Foam-iT had the parts it needed in days, instead of months from an overseas supplier.

Leveraging a U.S.-based digital manufacturing company like Protolabs allowed Foam-iT to ramp-up its product supply very quickly to address the sudden shift in market demand. The Foam-iT team found the Protolabs experts exceptionally easy to work with and helpful with design suggestions to speed up Protolabs' already fast manufacturing processes. This enabled Foam-iT to sent out the new part to companies quickly to improve the lifespan of their products.

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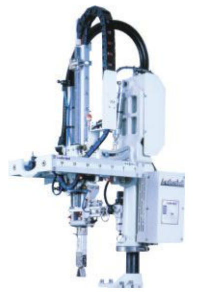

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