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# Plastics Technology®

DECEMBER 2019 № 12 VOL 65

# Recycling's 'Revolution'

## *How One Firm Closes the Loop in Agricultural Film Extrusion & Recycling*



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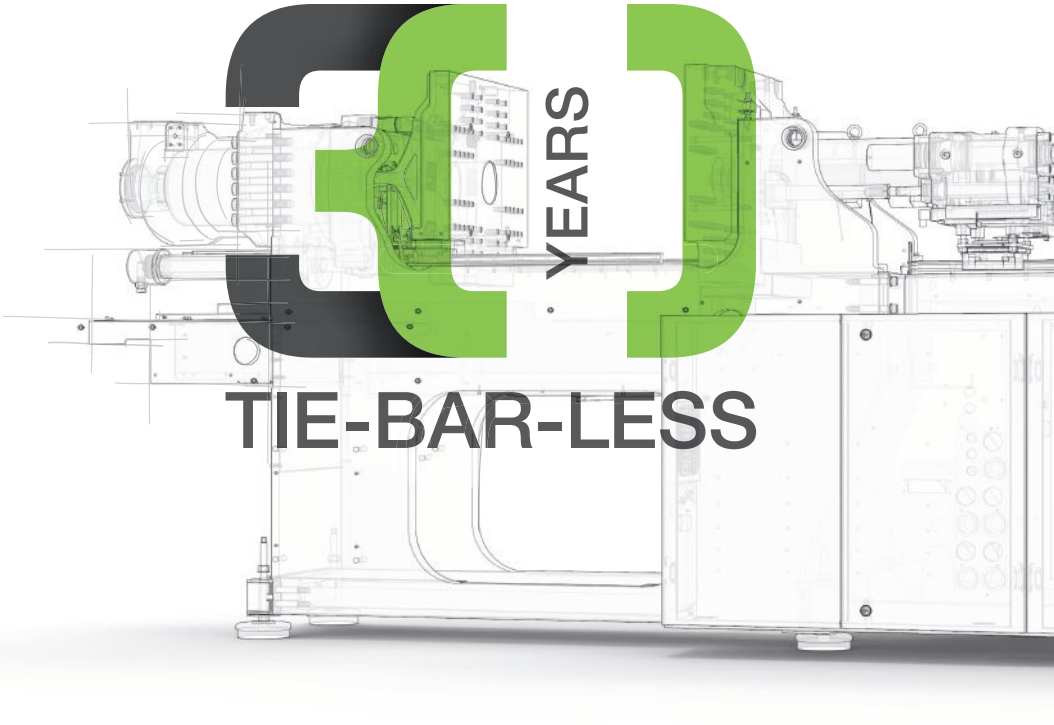


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Plastics Technology

On-Site

## An Agricultural Recycling 'Revolution'

Revolution combines expertise in recycling of agricultural film and manufacturing of plastic film, bags and irrigation tubing. The focus in all areas is to create sustainable closed-loop systems and use as much post-consumer resin as possible in all products manufactured.

*By Heather Caliendo*
*Senior Editor*

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

Now in its 30th year, Molding 2020 is a conference where industry leaders discuss the latest developments in various molding processes, equipment, materials and management techniques, with special emphasis on adding value to your business. A *Plastics Technology* event, this conference is widely recognized as the most important forum for technical information and business conditions in injection molding. In addition to a best-in-class technical program headed by *Plastics Technology* editors Matt Naitove and Tony Deligio, the conference offers attendees unprecedented opportunities to network with each other and with some of the top technical minds in the injection molding market.


With Molding 2020, our intention is to cultivate an experience that allows attendees to immediately apply the knowledge gained in their plants. In 2020, each day will begin with "Best Practices"—topics of practical value in defining best approaches to specifying or selecting equipment, organizing production, or addressing processing issues, as well as expert know-how on problem solving and troubleshooting. Afternoons will consist of three concurrent breakout sessions, including market-focus areas of technology such as medical or automotive.

We are also bringing out a new feature for this year's event—an injection molding parts competition we've dubbed Hot Shots 2020. Using a "People's Choice" model, all attendees at Molding 2020 will be eligible to cast a ballot. One winner will be chosen for Technical Sophistication and one for Achievement in Molding Efficiency and/or Economics, as well as an overall winner. The goal of this competition is to recognize and reward outstanding achievements in injection molding of plastics parts. Any type of injection molded part that fits roughly within 8 x 3 ft x 7 ft high qualifies.

> ***Our intention is to cultivate an experience that allows attendees to instantly apply their knowledge into their workforce.***

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And last—but certainly not least—click on Register. If you sign up through 1/31/2020, you'll save $200 from the full registration fee. Plan on sending three or more people? You'll be entitled to additional savings. Shoot an email to registrar Tara Rauch at ***trauch@gardnerweb.com*** to find out more about this discount.

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Last year's conference attracted 285 attendees and more than 45 exhibiting companies, breaking previous years' records. We're expecting more of the same with Molding 2020. Don't be left wondering what you might have missed.

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# The Recycling Partnership Calls for $500M to Transform U.S. Recycling System

The Recycling Partnership (***recyclingpartnership.org***) announced a roadmap aimed at addressing systemic issues in the U.S. recycling system and catalyzing the transition toward a circular economy for packaging. The Recycling Partnership is a nonprofit organization that seeks to transform recycling for states, cities and communities across the U.S., and to empower companies to meet their own sustainability goals. The 48 current funding partners range from major brand owners (Coca-Cola, Pepsico, Amazon, Procter & Gamble and others) to resin producers (such as Dow, ExxonMobil and Indorama), large processors (Amcor, Berry Global, Dart, Sonoco, Graham Packaging), industry associations (including the Plastics Industry Association), and one government agency (EPA).

The new report, "The Bridge to Circularity: Putting the 'New Plastics Economy' into Practice in the U.S.," says there is no single solution to transition to a circular economy—an economic system aimed at eliminating waste by design, keeping materials in use, and regenerating natural systems. To build a bridge between the current system and an optimized circular system, The Recycling Partnership is calling for a set of concrete actions based on three issues seen as currently undermining the U.S. recycling industry:

(1) The speed of packaging innovation has outpaced the capabilities of our recycling infrastructure. To meet the New Plastics Economy Global Commitment target that 100% of plastic packaging will be reusable, recyclable, or compostable by 2025, brands, organizations, and governments must align packaging with the realities of the current recycling system while also investing to advance the system.

*"Pathway to Recyclability":* The Recycling Partnership is initiating a more detailed process detailing how to move a package from "technically recyclable" to "commonly accepted for recycling "with partners such as the Sustainable Packaging Coalition and the Association of Plastic Recyclers. Collaboratives are also being launched with the goal of optimizing the system for multiple materials—not exclusively plastics—and packaging formats.

(2) The U.S. recycling system today cannot deliver the supply of recycled materials demanded by the Global Commitment. The report cites the case of PET bottle recycling and finds an annual gap of over 1 billion lb between the current U.S. supply and projected demand for recycled PET in bottles. It will be impossible for many companies to meet their ambitious recycled-content commitments without significant interventions in the recycling system.

*"Unlocking Supply"*: The Recycling Partnership will launch an industry-wide $250-million residential recycling intervention to capture more than 340 million lb of post-consumer plastics and over 2 billion lb of other packaging materials. The report identifies specific strategies to put the capital to immediate use to benefit U.S. communities.

(3) Intractable, underlying challenges create a difficult environment in which to develop a sustainably funded and responsive future recycling system. Bold innovation is critical to tackling the extensive issues within the current system.

*"Recycling 2.0"*: This initiative calls for $250 million over five years to design and implement the recycling system of the future by advancing technology, building more robust data systems and enhancing consumer participation. In early 2020, a new policy proposal will be launched to address the unique challenges in the U.S. packaging system with the goal of achieving a sustainably funded recycling system for all materials.

"Our current recycling system is fundamentally underfunded and incapable of delivering a circular economy without dramatic evolution. With this report, we are providing the clear roadmap to create a new and improved recycling system of the future," says Keefe Harrison, CEO of The Recycling Partnership.

## Plastic Systems Opens U.S. Headquarters

Pegaso Industries S.p.A. of Italy has established a U.S. headquarters for its Plastic Systems subsidiary, a supplier of auxiliary equipment for materials conveying, loading, granulating, drying and blending. Plastic Systems US occupies an 8000 ft² facility in Atlanta (***plasticsystems.it***), headed up by Michael Smith, v.p. of sales and service, whose resumé includes 20 years with Husky Injection Molding Systems, where he supplied Plastic Systems auxiliaries along with Husky presses.


Smith (pictured) also plans to offer products from sister companies in the Pegaso group: PET Solutions (PET resin and preform drying, storage, and handling systems); Blauwer (chillers, TCUs, heat pumps); and Ergomec (powder and pellet storage, conveying and dosing). For new products from Plastic Systems introduced at K 2019, see Keeping Up section.

## Nordson to Open Xaloy Tech Center in Ohio

Nordson Polymer Processing Systems has opened five new laboratories in Germany, China, Thailand, Chippewa Falls, Wis., and Hickory, N.C. A sixth lab is in preparation at the newly built Americas hub in Austintown, Ohio, for manufacturing Xaloy screws, barrels and front-end components. A Technology Center there will combine lab capabilities relocated from New Castle, Pa., along with additional equipment for process optimization. The lab will include an injection machine outfitted with Nordson's Twinshot screw-inside-a-screw technology that permits two-component molding with a single screw and barrel. There will also be various sizes of extruders along with BKG screen changers and melt pumps, EDI sheet die, and roll stack, winder, blender, feeder, chiller and dryer.

## The New Uniloy Plans Numerous Machine Developments

Barely four months after its separation from Milacron, the "new" Uniloy (***uniloy.com***) came to the giant K 2019 fair to show off one piece of new technology and to discuss a large handful of others in the works. The new development on display was the company's own barrier coinjection technology for injection-blow molding. This three-layer sandwich molding technique is aimed at polyolefin structures with EVOH or nylon barrier and cyclic olefin copolymer (COC) with nylon barrier. The latter, in particular, is said to be replacing glass in medical applications such as containers for vaccines and blood cultures.

Brian Marston, Uniloy CEO (pictured), says barrier coinjection is a harbinger of many things to come from a company he says is the only one supplying five different blow molding technologies—continuous-extrusion shuttle, accumulator-head, continuous-extrusion parison transfer, reciprocating-screw extrusion blow, and injection-blow. Developments in the pipeline include all-electric shuttle machines, reciprocating-screw machines with improved energy efficiency (also available as aftermarket upgrades), accumulator-head models with increased automation in part takeaway and improved control connectivity for remote support, and injection-blow enhancements for improved efficiency and lightweighting. Noting that Uniloy has machine production in Tecumseh, Mich., Italy and India, Marston also wants to "globalize" the parison-transfer technology used in Europe for accumulator-head and continuous-extrusion machines, as well as Uniloy's U.S. reciprocating-screw technology.


Marston notes that Uniloy's broad range of machine technologies, as well as its production of molds for reciprocating-screw, shuttle, and PET stretch-blow molding, offer unusual flexibility for customers. Uniloy also keeps close to its customers with a global footprint—machine building on three continents, as well as service locations in Mexico, Germany and the Czech Republic to support its more than 4500 machines in the field. Marston, who managed the extrusion and blow molding businesses for Milacron since 2015, has 35 years' experience in plastics and packaging, including 20 years with Berry Plastics (now called Berry Global).

## Industrial Blow Molder Goes Solar

Agri-Industrial Plastics Co., an industrial blow molder in Fairfield, Iowa, has invested in solar energy generation and storage to help reduce costs and manage expensive electrical peaks. AIP (***agriindustrialplastics.com***) operates out of a 340,000-ft² plant with 27 extrusion blow molding lines running 24 hr a day during the week. "These are huge utility bills," says company president Lori Schaefer-Wheaton, daughter of the founder. AIP specializes in barrier non-automotive fuel tanks, but also custom molds for a variety of industries from playground equipment to medical and hospital equipment (see May '17 feature). Its average weekday power load is 2500 to 3000 kW, which can drop as low as 100 kW on weekends when the plant is not busy.

Like many manufacturers, AIP pays demand charges based on peak power load. Such charges can amount to 30-70% of an average user's bill, according to Ideal Energy Inc. of Fairfield (***idealenergysolar.com***). Processors can cut those costs through a peak-shaving strategy, says Ideal Energy. To accomplish that, Ideal Energy installed at AIP this year a 517-kW array of 1345 solar panels on a South-facing roof. This is accompanied by a 430-kW Tesla Powerwall lithium-ion battery energy-storage system with artificially intelligent controls that automatically discharge stored energy at times of peak demand to avoid or reduce costly demand changes. The result has been a monthly reduction of peak load by 6% and of overall energy use by 4-5%. This system will save AIP an average of $42,477/yr, and net metering will send excess energy back to the grid during weekend shutdowns.

## Neste and Remondis Partner on Chemical Recycling

Neste, a provider of renewable diesel and jet fuel, and Remondis, one of the world's largest privately owned recycling, service and water companies, have agreed to collaborate on chemical recycling of plastic waste. The companies will focus on developing and accelerating chemical recycling with a target to reach an annual capacity to process over 400 million lb of waste plastics.

Chemical recycling of plastics breaks down plastic waste into a raw material for the plastics and chemicals industries to use in the production of new high-quality plastics, chemicals and fuels. By joining forces, Remondis and Neste combine Remondis' waste-collecting and sorting capabilities and Neste's experience in oil refining and processing of low-quality waste and residue materials. The companies wish to build an ecosystem around chemical recycling to enable other companies in the value chain to join the initiative and close the material circle for plastics that today are difficult or impossible to recycle mechanically.

# Opaque White Bottle-to-Bottle Recycling Proven with 100% rPET

Swiss masterbatch producer Sukano and French PET bottle machinery builder Sidel collaborated on a project to confirm the bottle-to-bottle recyclability of opaque white light-barrier PET dairy bottles. The firms report that white PET bottles could be made with up to 100% regrind from similar bottles with no detectable color change or loss of light barrier and at the same throughput rate.

Monolayer white bottles were made with a Sukano masterbatch and blown into bottles on Sidel's latest-generation EvoBlow two-stage rotary machine. The bottles were then recycled according to the European PET Bottle Platform (EBPB) protocol. This included melt filtration; no agglomerates were found. Solid-state polymerization (SSP) restored the IV to a level of 0.7-0.8. New bottles were made from 25%, 50% and 100% recyclate and additional Sukano white PET masterbatch (except for the 100% rPET bottles). In all cases, light barrier was confirmed for extreme conditions, such as less than 0.1% light transmission at 550 nm wavelength. "We saw no measurable difference in processing conditions or blowing output while processing the 100% recycled white PET material from Sukano white masterbatches, even under most challenging conditions," said Naima Boutroy, Sidel global packaging expert.

## Sumitomo Demag Adds Two New Tech Centers

As Phase Two of its 2019 Expansion Plan, Sumitomo (SHI) Demag Plastics Machinery North America has opened a new Tech Center in Buffalo Grove, Ill., and a Training and Demo Center in Anaheim, Calif. Phase One of this plan was moving its Norcross, Ga., headquarters in February to a larger office and Tech Center in Suwanee, Ga.

To expand customer support in the Midwest, Sumitomo Demag's new 15,300-ft² facility in Buffalo Grove includes a training room; offices for sales, service and processing support; and an 8000-ft² Tech Center, currently equipped with three SEEV-A and SEEV-AHD all-electric presses of 100, 180 and 385 tons for demos, mold tests, training and processing and application support and development. Training classes will begin there in Q1 2020.

In Anaheim, Sumitomo Demag has partnered with QTM Inc., a thermoplastic resin distributor, to open a center with a meeting room, offices and a demo center with a SE100EV-A electric machine. "Our other West Coast partners will also be able to use this facility for applications development without traveling cross-country," says John F. Martich III, exec. v.p. and COO of Sumitomo Demag's U.S. operations. He adds, "Our industry tends to rely on a major trade show once every three years to bring together the wide range of advances in new and complex applications and/or large machine cells—the types of demos that just aren't economically feasible to take to regional trade shows. We believe that molders shouldn't have to wait three years to see what's new." The new centers will give the company "the ability to demonstrate new and improved capabilities, *as they develop*, across a wider geography."

## UL Certifies Energy Savings in Molding Nucleated PP

Milliken Chemical has long said that its Hyperform HPN nucleator for PP offers significant energy savings to injection molders—a claim that has now been verified independently by UL. Four grades of Hyperform HPN were reviewed by UL Environment & Sustainability, a unit of the global UL group, which confirmed that the nucleators enabled an average of 5% to 8% energy savings in injection molding thin-wall container lids or similar PP products.

These additives reportedly also allow for faster molding cycles and improve performance of recycled PP, enabling greater use of rPP in various applications. Milliken plans to pursue UL certification of additional nucleators in other applications, such as in thermoforming.

## Hahn Group Acquires Another U.S. Automation Supplier

Germany's Hahn Group, a provider of factory automation and robotic systems, has expanded its footprint in the U.S. by acquiring REI Automation in Columbia, S.C. (***reiautomation.com***). Founded in 1990, REI Automation has 80 employees and $25 million revenue; it designs and builds custom assembly lines, robotic cells, and special-purpose machine systems, focusing on medical, electronics and consumer goods. The purchase gives Hahn a hub in the Southeast.

Hahn recently established Hahn Plastics Automation in Windsor, Conn. (***hahnplasticsautomation.com***), to coordinate the U.S. activities of Waldorf Technik, Wemo, and Geku.


Hahn also has now established Rethink Robotics GmbH to further develop the Sawyer one-armed collaborative robot (cobot) created by the former Rethink Robotics in Cambridge, Mass., and acquired by Hahn last year. At K 2019, Hahn exhibited the new Sawyer Black Edition (pictured), which boasts more durable hardware, quieter operation, and higher-quality components. Payload capacity has been upgraded to 4 kg, and customers are asking for even more, Hahn says, so it is working on a 10-kg version. Hahn is also offering an upgrade kit with new seals and mechanical components for existing Sawyer units under warranty.

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# Time for an Oil Change? It Could Cut Your Costs—and Headaches

## A big automotive molder found that switching hydraulic oils had a major impact on downtime, maintenance, and energy efficiency.

**TG Missouri is gradually converting over 100 hydraulic presses to a high-performance hydraulic oil—Mobil DTE 10 Excel 46—that saves energy, better protects valves, and keeps the system cleaner.**

By Matthew Naitove
*Executive Editor*

At a typical injection molding facility, the cost of hydraulic oil is less than 1% of operating costs, so it's not something molders think about every day. But that oil can have a big impact on operating costs—maintenance labor, machine downtime, and even energy efficiency. One large automotive molder discovered this the hard way and learned valuable lessons on the importance of choosing the right hydraulic oil and properly maintaining oil quality and components of hydraulic systems—humble things like filters, valves and tank breathers.

### MANAGING 'CHAOS'

> *"We are a JIT plant, so any downtime is huge."*

TG Missouri is part of Toyoda Gosei, a global auto-parts manufacturer with revenues of $7.8 billion and more than 39,000 employees worldwide. In Perryville, Mo., TG Missouri (***tgmissouri.com***) occupies a campus of 11 buildings. One of them is Interior & Exterior Systems, which molds and assembles grilles (and chrome plates them), consoles, bumpers, instrument panels, etc. Scott Abernathy is maintenance senior manager in that building and oversees 106 hydraulic injection presses from 55 to 2200 tons (with a 2450-tonner on the way) and 50 all-electric machines. Some of those machines are as old as 25 years, but most are in the 10-15 year age range.

About five years back, "Scott was managing a lot of chaos—small incidents of things breaking or not working," recalls Adam McMurtrey, a maintenance and reliability field engineer with Mobil Serv, the lubricants service of ExxonMobil (***mobil.com***). "It was like trying to keep 100 pots of boiling water covered with only 99 lids."

Abernathy elaborates: "For example, hydraulic valves often needed changing, pumps failed, and so did suction filters—which are one of the most common problem areas in molding shops. It was a long list of things. We experienced excessive noise, loss of pump pressure, functions like ejectors not working, and part-quality effects. We were putting a lot of labor into hydraulic issues, like having two or three people working on one large machines."

As Abernathy explains, OEE (Overall Equipment Efficiency) is a key metric for TG. OEE encompasses machine uptime availability, speed, and quality performance. So tension was mounting: How to manage the chaos?

Things started looking up for Abernathy and TG Missouri with the arrival of Brandon Barton, territory sales manager for Morgan Distributing, a lubricants supplier in Jackson Mo. (***mdilubes.com***). Barton, himself a certified maintenance and reliability professional (CMRP), visited TG Missouri as a new customer. Barton brought in new ideas on maintenance and reliability. Scott was receptive: "We are a JIT plant, so any downtime is huge."

"We needed data first, before we could decide how to proceed," recalls Barton. "So we pulled oil samples; they told the story of what was happening inside the equipment. Oil is a window into the machine." After a few months of data gathering and analysis—with the help of the Mobil Serv lubricant-analysis service lab in Kansas City, Mo.—the problem was evident. "There was a lot of oxidation in the hydraulic oil, and it was not clean to industry (ISO) standards," notes Barton. "Thirty percent of the machines were using oil that was at the end of its service life." Some of that oil was eight to nine


From left: Adam McMurtrey, Mobil Serv field engineer; Brandon Barton, territory sales manager for Morgan Distributing; Scott Abernathy, TG Missouri maintenance senior manager. Behind them is a 1450-ton press that went from 32 hr/yr of unscheduled downtime for hydraulic issues to zero problems in the year since switching to the new hydraulic oil.

Data-based maintenance management prompted other changes, such as using more efficient hydraulic filters.

years old, whereas one year is the standard oil service life.

Not only was it high time to replace the old oil, but Barton recommended that a higher performance oil could help prevent future problems. TG Missouri was already using a premium hydraulic oil, Mobil DTE 25. On Barton's recommendation, the molder started switching its presses to Mobil DTE 10 Excel 46.

McMurtrey explains that this oil has a high viscosity index, meaning that it retains its viscosity across a wide temperature range. Further, it is less viscous at low (startup) temperatures than a standard oil, but has higher viscosity at higher running temperatures. That means greater lubricant protection of valves and other hardware. It also improves energy efficiency—more on this below.

Another benefit of Mobil DTE 10 Excel 46 is its proprietary formulation "helps keep itself clean," McMurtrey says. "Simply explained, it grabs contaminants and conveys them to the filter and then drops them off at the filter."

## QUICK HEADACHE RELIEF

Abernathy's plant began changing over some machines to the high-performance oil in July 2017. About 15% of the presses in the plant have been converted so far. Barton cites the example of a 1999-model, 1450-ton Mitsubishi machine that received the new oil in October 2018. "We have data on that machine back to 2015, when it had 3.5 hr of unscheduled downtime for hydraulic issues. In 2016 it racked up 31 hr of hydraulic valve issues. In 2017, that press had 32 hr unscheduled downtime for end-of-life hydraulic oil, suction-filter failures, and pump issues."

The first step in the transition was to exchange the old oil with Mobil System Cleaner oil, which does just what the name says. Abernathy's staff put in 5 gal a day for a week. Then they changed the oil over completely to Mobil DTE 10 Excel 46 and changed every filter, too. "We've had no hydraulic issues on that machine since then," says Abernathy. "It runs so quiet, sounds like an all-electric machine. You can't even hear it run."

TG Missouri has not documented the energy efficiency of its machines before and after the oil change. However, Mobil Serv's McMurtrey expects a minimum of 3% improvement. A 2017 study at EVCO Plastics in DeForest, Wis., sponsored by Wisconsin utilities' Focus on Energy program, recorded 3.2% savings (see Jan. '18 Close-Up). Other plants have found at least 6% savings, McMurtrey reports.

There are other long-term benefits from this experience, Abernathy points out. One is continued oil monitoring. The plant sends samples from the machines to the Mobil Serv lab and gets a report in about 12 days. "With that data, we can compare machines here with machines operating around the world. We can get a sense of what is the industry standard for oil life and cleanliness."

Another benefit is getting a handle on "criticality." Explains Abernathy, "With hard data in hand, we can rally our resources to deal with the most pressing hydraulic issues. We can schedule and plan maintenance to make sure machines will be available now and five years from now. The data proves to management why we need to take this machine out of production now, and why it pays to buy a more expensive, high-performance hydraulic oil."

Barton adds, "The team here is very receptive to the idea of data-driven maintenance. They began looking at all machines to see where they can make improvements."

"That's right," says Abernathy. "With data gathering, we started seeing other problems that we added to the P.M. (preventive-maintenance) schedule. For example, we've started changing out tank breathers more often, after we saw the state they were in. We also changed the filters on the machines. The ones we had—3-micron beta 75—weren't the best for the job. Brandon did some research and found much better ones—5-micron beta 1000—that aren't any more expensive. So we switched to those.

***With data-based maintenance planning, we can compare the hydraulic performance of machines in different plants and different machines in the same plant.***

Abernathy and another manager took their new learning on the road. They visited TG sister molding plants in Indiana and Mississippi, where they trained the maintenance departments in oil analysis and data-based maintenance planning. "Now we can compare the hydraulic performance of machines in different plants and different machines in the same plant," notes Abernathy. PT


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# MATERIALS

PART 4

## Polyethylene Fundamentals

Injection molders of small fuel tanks learned the hard way that a very small difference in density—0.6%—could make a large difference in PE stress-crack resistance.

By Mike Sepe

Small gas tanks, the type used on equipment like lawnmowers and snowblowers, have typically been produced from high-density polyethylene (HDPE). Automotive gas tanks are subject to rigorous emission standards that require multilayer constructions employing barrier materials designed to prevent diffusion of gasoline through the tank wall. Small gas tanks are not required to conform to these standards. In addition, they are of a size that allows them to be produced, in most cases, by injection molding. The typical small tank is a two-piece design produced in a family mold. The two halves are thermally welded together before they have cooled completely. While the actual tank designs can vary substantially, the manufacturing process is generally the same.

In the 1990s the material of choice for small gas tanks for the entire North American industry was an HDPE with a melt flow rate (MFR) of 4.0 g/10 min and a density of 0.946 g/cm³. This is near the minimum density for materials classified as HDPE, and in combination with the average molecular weight associated with this MFR value, the material produced a good balance of load-bearing properties and ductility. Then, as often happens in the world of commodity plastics, a decision was made by the material's supplier to discontinue the grade. At that time there were no direct replacements. Grades with comparable densities generally had higher average molecular weights (lower MFRs). Available materials with the same MFR typically had higher densities.

*Internal stress is a fact of life in injection molding.*

The supplier of the discontinued material did produce, and continues to produce to this day, a material with the same density and a nominal MFR of 2.2 g/10 min. This would have been the ideal material to replace the obsoleted resin, and it is a grade targeted specifically for this type of application. However, as we have discussed when reviewing the industry understanding of MFR, many processors continue to believe that the pressures required to fill and pack a mold cavity are inversely proportional to the difference in MFR. All the processors involved in manufacturing these tanks expressed doubts about their ability to fill the molds with the higher viscosity material and they all refused to sample the material. Instead, they opted for a material with an MFR of 4.0 g/10 min and a density of 0.952 g/cm³.

**A widespread industry investigation of cracked fuel tanks resulted from a change of 0.006 g/cm³ in the density of the material being used to produce the tanks.**

The transition appeared to be seamless. However, in less than a year the first cracked gas tanks were discovered in the field. Investigations into the cause of the cracking went on for months and involved multiple analytical-services organizations as well as the end users who were putting these gas tanks on their products. The Consumer Product Safety Commission became involved, contributing the usual lack of scientific understanding that government organizations can be counted on to provide. Companies went out of business, others walked away from supplying the small gas tanks, deeming the risks too great. At least one end user dedicated a great deal of time and talent to understanding the interaction ►

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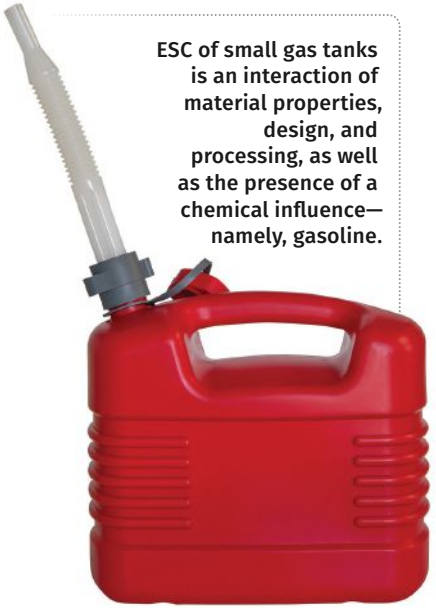
between material selection, part design, and processing conditions. All this activity revolved around a change of 0.006 g/cm³ in the density of the material being used to produce the tanks.

The analytical work established that the failure mechanism was environmental stress cracking (ESC). This is a mechanically driven process accelerated by the presence of a chemical influence. But to properly diagnose the factors that contribute to ESC it is essential to understand the interaction between material properties, part design, assembly methods, and the application environment.



**ESC of small gas tanks is an interaction of material properties, design, and processing, as well as the presence of a chemical influence—namely, gasoline.**

Internal stress is a fact of life in injection molding. The pressures and flow rates associated with filling and packing a mold and the volumetric changes that accompany the cooling process will produce several hundred pounds per square inch of molded-in stress even in a well-designed part. HDPE is the commercial polymer with the highest degree of crystallinity, and as the density increases the degree of crystallinity increases along with it. This increases the change in volume associated with cooling. In addition, assuming that a polymer is capable of crystallizing, there is a window of opportunity for crystallization to occur. The temperature of the material must be below its melting point but above its glass-transition temperature (Tg). The Tg of polyethylene is -130 C (-202 F). The lowest recorded temperature on our planet, occurring on the East Antarctic plateau, is -98 C (-144 F). This means that every polyethylene part in use anywhere on Earth is capable of crystallizing for as long as it exists.

Fortunately, most of the structural organization associated with crystallization in polyethylene is accomplished in the first 48 hr after the part is produced. Another measurable incremental change occurs in the ensuing four to six weeks. But at some level the process is always occurring and it will occur more rapidly in warmer environments. Hot-plate welding of parts that are only a few minutes old adds another layer to this picture. Once the housing halves are bonded, the continued cooling and shrinkage of the parts causes stress to build up locally near the weld zone, where movement of the polymer is constrained by the weld. And then there is the influence of the gasoline on the properties of polyethylene.

Polyethylene is a non-polar material and consequently it tends to absorb fluids that are also non-polar. These include anything made of hydrocarbons such as mineral oil, motor oil, and gasoline. Studies performed during the failure-analysis investigations showed that polyethylene can absorb 7-8% of its weight in gasoline and the strength and modulus decline by about 50% as a result. As would be expected, the parts also change dimensions as this absorption takes place. All these factors contribute to the development of stress.

In examining the failures some patterns emerged. First, cracks always appeared in the lower half of the assembly, where exposure to gasoline would be more consistent. Second, the cracks tended to originate near the thermal weld joint. Third, only a small percentage of the tank designs were susceptible to failure. Accelerated testing performed at an elevated temperature over a period of several months showed that most of the designs did not exhibit failures. This helped to distinguish between the mechanism of ESC and a pure chemical response of the polyethylene to the application environment. Chemical attack occurs independent of design.

***Polyethylene is more susceptible to ESC as the density increases.***

Polyethylene is more susceptible to ESC as the density increases. At lower densities the non-crystallized regions can absorb and manage the energy associated with increased levels of stress. As the density of the polymer increases, the amorphous content in the material decreases. This increases strength and stiffness, but reduces toughness. Lower-density polyethylenes can withstand higher levels of strain before they fail. But as density increases, the likelihood of brittle failure increases. The failure to understand the interaction between molecular weight and density resulted in a very costly performance problem that very nearly resulted in regulations mandating multi-layer construction of these small nonautomotive gas tanks. The problem was solved by a material supplier who recognized a market opportunity and developed a grade with an MFR of 3.3 g/10 min and a density of 0.945 g/cm³. Apparently, an MFR of 3.3 was close enough to 4.0, and the processing people were willing to try it. But it was the return to a lower density that was the key to solving the cracking problem.

In our next installment we will look at some secondary aspects of polyethylene properties that are part of the material selection options available today. These influence performance as well as processing. And, as is usually the case, as performance improves, processing becomes more challenging. PT

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

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INJECTION MOLDING

# How Can Molders Achieve Effective Process Monitoring?

You have developed a proper process; now you need to monitor that process to ensure its stability through a run.

By Robert Gattshall

Effective process monitoring is achieved through proper process development. To monitor effectively, you must ensure that the process is optimal and repeatable. Without repeatability, effective process monitoring will never be achieved.

Effective process monitoring does not simply mean setting upper and lower limits just before defects are created. This is what I call "defect limits." Although it is important to know the "defect limits" of any process, these limits are not typically tight enough to be considered effective for process control.

Effective process-monitoring limits should be set so that if any abnormality is discovered outside of the normal process variation of the machine, it is segregated from good product. The normal variation of your process should be well within the threshold of the defect limits. The goal of establishing process limits should be to monitor the process that has been proven to produce acceptable product and not to create process windows. Wide process limits that try to create process windows within which process adjustments can be made can often cause more harm than good.

The thousands of interactions taking place in a molding process make it very difficult to prove out every scenario. For this reason, it makes more sense to establish a robust process and use process monitoring to ensure that this process repeats itself each and every time and that abnormalities are caught.

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## DETERMINING NORMAL VARIATION

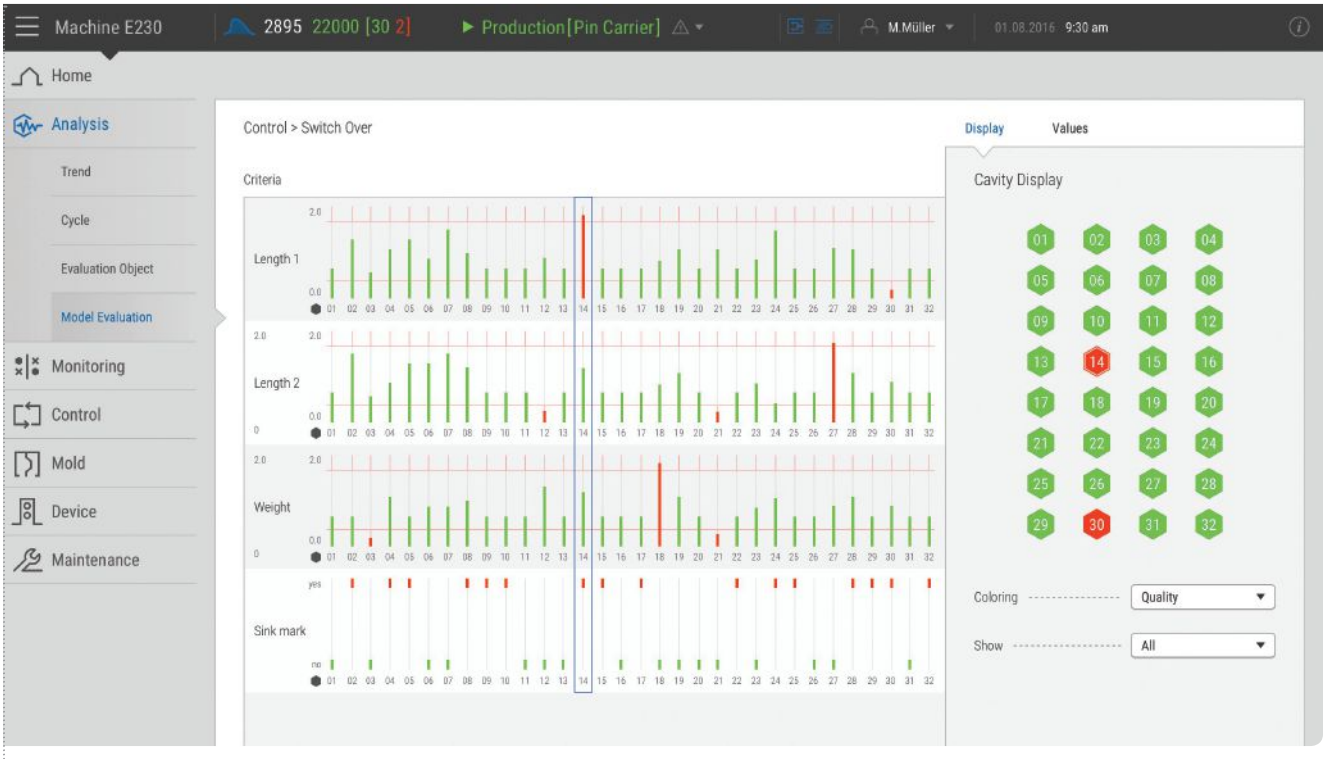
The process of identifying what is normal variation may differ depending on the product line, but I consider three 8-hr runs with complete shutdowns between each run to be a great start. It is extremely important to ensure no process changes are made during these runs, and you may want to undertake at least one with an alternate resin lot number. Process outputs should be recorded every 15 minutes, and the parts should be collected for that recorded process. Using this data, the effective process limits can be calculated, as long as all the parts collected are within specification.

You could set up stages of process monitoring so that any shot that is segregated would be considered suspect, if it is within the "defect limits," until further review of that part can take place. This may not be necessary if your monitoring is set up in such a way that the machine will alert when scrap thresholds are reached. If so, the amount of product at risk will be minimal, and focus can then be placed on troubleshooting the issue at hand.

***Effective process-monitoring limits should be set so that if any abnormality is discovered outside of the normal process variation of the machine, it is segregated from good product.***

Process monitoring can be accomplished using the machine's monitoring software; but in my opinion, third-party hardware is required for effective process monitoring. This will allow for independent verification of the machine outputs, as well as in-mold monitoring in the form of pressure transducers and thermocouples.

The ability to monitor the plastic and ensure that it reacts the same in the cavity from shot to shot is the ultimate form of effective process monitoring. We use the same methods for establishing the effective upper and lower limits for peak cavity pressure, pack rate, and cooling rate, as stated above. This establishes machine-independent, effective process monitoring, and regardless of the machine outputs, it can ensure the plastic was within established limits. ►




**In the author's opinion, third-party hardware is necessary for effective process monitoring, to allow for independent verification of the machine outputs. (Photo: Kistler)**

To monitor a process effectively, you must also have an effective means of part discrimination when out-of-process conditions arise. Automation options such as robots, reversing conveyors, and diverters can be used to accomplish this. If none of these is an option, the machine must be set up to shut down when any out-of-process condition is identified, and ejection must be prohibited, leaving the suspect parts in the mold. This is undesirable for several reasons, one of which being that a process interruption can cause instabilities in the process. Automating is the best option and will allow you to continue to mold, keeping the process stable. It is also critical to ensure you have built in effective reject logic in your monitoring to prevent the machine from running excessive scrap rates.

## FAILSAFE TO AVOID FAILURES

Is your process monitoring failsafe? Most monitoring systems are programmed to look for a reject signal. So, if the monitoring system doesn't receive a reject signal, parts are considered to be within process limits. So, what happens with a system crash? Remember, these systems are basically computers, and we all know that even the best systems have software issues from time to time. If the system is only looking for reject signals, that system cannot be considered failsafe, and if the system locks up, it can continue to run until someone discovers the issue. Most of the third-party process-monitoring systems I have worked with will also accept a good-part signal if you make that part of your system specification. A process-monitoring system that requires a good-part signal to be received and defaults to reject, is a system that is truly failsafe.

It is important to remember that regardless of how tight monitoring limits are set, the first step in effective process monitoring is the process development. Establishing limits for unstable processing conditions or tooling conditions will ultimately prove ineffective in preventing unacceptable product from escaping. Once you have mastered process development, effective process monitoring ensures you're always running to that process. PT

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

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EXTRUSION

# What You Need to Know to Get into Coextrusion

## Key considerations range from determining the right extruder sizes to tooling, matching material viscosities, and lots more. Take a look.

By Jim Frankland

Coextrusion requires far more polymer and extrusion knowledge than monolayer extrusion, so operating personnel need to be properly prepared. And there's lots to consider.

First, it's necessary to select polymers that meet a host of performance requirements in the finished extrusion and will also bond to form a strong structure. Bonding is largely dependent on the respective surface energies of the polymers. If the polymers selected for the performance requirements of the finished coextrusion do not provide adequate bonding strength, then it will be necessary to use tie layers, which will require additional extruders.

Among the many performance factors to consider—determined by the final use of the finished product—are flexibility, chemical resistance, permeability and ideal layer placement, to name a few. For sheet and cast film applications in particular, processors must choose between a multi-manifold die or a coextrusion feedblock. Coex feedblocks generally provide more flexibility as well as lower initial cost and less maintenance. Both have valves of various designs to adjust the layer flow rates, but melt pumps are typically used to precisely control the output of each layer. I suggest you evaluate and select from experienced coextrusion machine builders so they can provide you all the technical information necessary for the polymer selection, structure, and equipment design for a proposed coextrusion line.

However, the actual daily operation of the line depends heavily on the melt viscosity exiting the extruders, which depends on the melt temperature and shear rates in the downstream tooling as the various layers are combined. Mismatching viscosities can result in numerous quality issues with a new coextruded product—even if everything was designed properly based on a similar coextruded product. This part of the process depends on the on-site operating personnel and their understanding of polymer viscosity with varying temperatures and shear rates.

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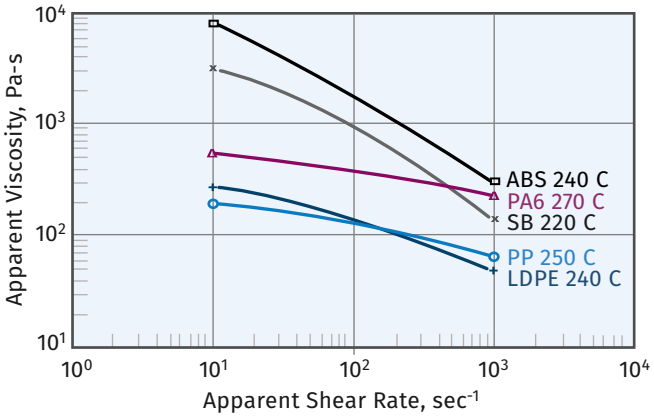
### The Shear-Thinning Effect




**The shear-thinning effect is different for every polymer and grade. The individual curves are also offset up or down as the temperature decreases or increases, respectively. How the shear rate and temperatures affect polymer viscosity in the tooling can result in considerable variations in pressure drop through the die.**

Polymer shear-rate/viscosity curves of different resins in a coex structure can actually cross over each other, resulting in a very narrow operating window, so the slopes of the curves or their power-law indexes should be considered when selecting layers. The glass-transition temperatures of the various polymers also need to be considered, as trying to match viscosities to avoid interfacial instabilities and layer distortion with a polymer that melts at 500 F layered with one that melts at 265 F will be problematic.

Also important is sizing extruders relative to their requirement in the structure, so they can develop similar melt temperatures without the need for special screws for every structure. I recently ran thin HDPE cast film on a line having three coextruders. The three machines (sized 3.5 in., 4.5 in. and 6 in.) generated greatly varying outputs—sometimes double. Because of this it was impossible to match the viscosities of the layers from all three extruders. And just about every kind of interfacial instability was present except at very low outputs, where the melt temperatures were relatively similar.

Extruder output stability is naturally essential, both with respect to melt temperature and output, although melt pumps can be used to eliminate output variation bypassing the tooling valves, which can have more effect on melt temperature. For a given screw design,

melt temperature is controlled primarily by the screw speed and head pressure, and generally to a lesser extent by the barrel temperature. However, the practice of adiabatic extrusion almost always helps stabilize the whole process. Adiabatic extrusion is seeking temperature settings where there is minimal thermal cycling of the barrel temperatures—i.e. no heat, no cooling.

Polymer viscosity mismatch leads primarily to distortion of the layers. However, excessive shear in any of the layers can lead to melt fracture, usually corrected by raising the melt temperature—but that results in having to raise the temperature of each layer. Non-uniformity of melt temperature causes zig-zag patterns or wave effects in the sheet, so the most stable system possible is needed. Die swell varies between polymers and is a function of temperature and shear rate for a particular polymer and may require changes in the layer thickness to meet profitable operating levels.

Even if designed for the same polymer, the screws are engineered for a certain melt temperature at a specific speed, which is usually at or near their capacity. Therefore, if you run one screw at one-third speed, another at two-thirds speed and the third at full speed, they will produce substantially different melt temperatures. Since polymers are poor conductors of heat and a good coextrusion block is designed to prevent intermixing of the layers, the layers will maintain their temperature through the coextrusion block and will thermally homogenize only in the die itself. It can take considerable time for the layers to stabilize at a single temperature. For example, in the case of the thin HDPE cast film coex line cited above, it was necessary to run all three extruders to prevent degradation in the coextrusion block of any extruders not being operated.

*Polymer viscosity mismatch leads primarily to distortion of the layers.*

These are meant only as words of caution to those not experienced in coextrusion processing; these issues are not present in monolayer extrusion. To have a "universal line" to process *both* various coextruded and monolayer structures you must add adapters and dies to allow you to shut off and disconnect any extruders not required, as well as to change out or eliminate the feedblock or multi-manifold die. The additional training of the operating personnel on how to deal with the issues noted—as well as some not noted—will be money well spent and save a lot of time and scrap. PT

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

TOOLING

PART 2

# The Basics of Tapered Interlocks

## When, where, and how to use them.

FIG 1
A cavity insert cracked at an inside corner.

In Part 1 of this series in September, we reviewed the various types of tapered interlocks and the pros and cons of each. If you are going to use tapered interlocks in a mold, there's a few additional things you should know. If they are not located, installed and maintained properly, they can be either completely ineffective or can be the cause of various molding issues. Tapered interlocks can do more than just prevent parting-line mismatch on a molded part. When used properly, they can help protect the mold from catastrophic damage.

By Jim Fattori

### FITTING THEM TO THE MOLD

It is not uncommon to buy interlocks whose flat faces touch, but the tapered surfaces have a slight gap. If you come across this condition, grind the face of the female interlock until the tapered surfaces mate—like they should.

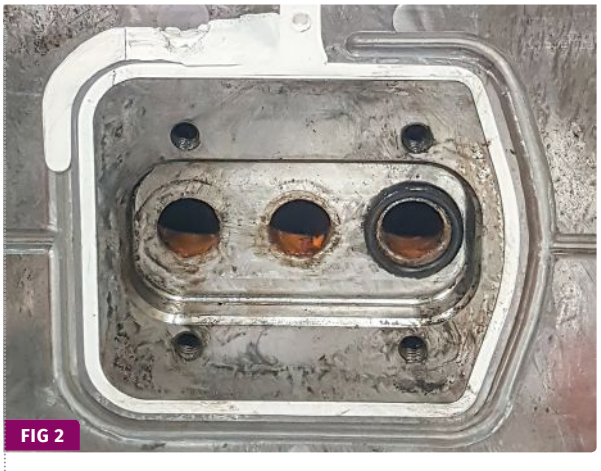


FIG 2
A core insert stuck inside a cavity.

The height of most conical interlocks intentionally comes with extra stock on both the male and female halves. The backs of these interlocks are ground to the correct height when fitting the mold, to adjust for variations in the pocket depths and insert heights.

There is no need to fit the ends of rectangular interlocks. In fact, the length tolerance on rectangular interlocks is typically ± 0.010 in. Any clearance on the ends will not affect the function of the locks and it makes them easier to remove. The width tolerance is typically +0.000/-0.001 in., but the height tolerance can be as much as ±0.005 in. for each half. Therefore, to avoid having to use shim stock in a brand-new mold, measure the height of the interlocks prior to machining the pockets. One of the nice features about rectangular interlocks is that they are easy to adjust. They can be ground and shimmed in any direction if they should ever wear, gall or lose contact.

***Measure the height of the interlocks prior to machining their pockets.***

### HOW MUCH PRELOAD?

There is disagreement among mold-component suppliers and moldmakers as to whether or not the front faces of interlocks should seat at the same time the tapered surfaces do. Some say they should and offer interlocks with all of the surfaces mating. Others say they shouldn't and offer interlocks with as much as a 0.040-in. gap.

I believe, as do other industry experts, that in order to function properly in the real world, tapered interlocks should have a slight preload. A preload of 0.0010 in. is common for interlocks with a 10° taper. You can use slightly more preload for tapers of less than 10° and slightly less for tapers greater than 10°. Do not confuse the amount of preload with the amount of gap between the faces. One has absolutely nothing to do with the other.

Too much preload can cause the interlocks to wear out faster. Wear is caused by surface friction and is proportional to the amount of contact pressure. It is independent of the amount of surface area. Therefore, you can use the same amount of desired preload for both conical and rectangular interlocks, regardless of their size. When there is too much preload, the female half can

potentially crack. Too much preload can also cause the interlock to "seat" into the mold base sooner. This is why I like to make the gap between the preloaded faces no more than 0.0005 to 0.0010 in.

## STEEL TYPES & HARDNESS

*In order to function properly, tapered interlocks should have a slight preload.*

Conical and rectangular interlocks are available in various types of steels and in various hardnesses. However, every mold-component supplier makes both the male and female halves of the same steel type and hardness. In theory, the faces of these interlocks do not rub or slide against each other. Therefore, there is no need to make them out of different types of steel with different Rockwell hardnesses. But in reality, if there is any misalignment—which there always is—the faces of these interlocks do, in fact, rub and slide against each other. A light coating of grease can help extend the life of an interlock. It would be beneficial to molders if mold-component suppliers offered tapered interlocks that are designed to withstand these frictional forces.

If you are going to make your own interlocks, you might consider making the male half, which is subjected to compression, out of a graphitic tool steel, such as A-10 or O-6, with a 58 to 62 Rockwell C hardness. The female half, which is subjected to tension, could be made of a tougher, more ductile tool steel, such as H-13 or 420 Stainless with a 48 to 52 Rockwell C Hardness.

## HOW MANY SHOULD YOU USE?

There is a rule of thumb that recommends using two conical interlocks for small molds, four for medium-sized molds, and six for large molds. You should know how I feel about rules of thumb. This is another one of those "rules" I disagree with.

Conical interlocks typically come in diameters of ½, ¾, 1, 1½, and 2 in. I recommend two relatively small conical interlocks for small molds, two medium locks for medium-sized molds, and two large locks for large molds. Two larger interlocks can provide better alignment and more longevity then four smaller ones because they can have more total bearing surface area. For example, two 1-in. interlocks have 30% more surface area than four ½-in. interlocks.

Also, if you have more than two conical locks, they all have to be perfectly positioned and there can't be any differential thermal expansion. Otherwise, they will just fight each other, which will cause them to either wear, break, or try to prevent the mold from closing all the way.

## INTERLOCKS SHOULD SUPPORT THE CAVITY

As plastic pressure builds within a mold during the packing phase, the side walls of the cavity will try to move outward. If the steel around the cavity isn't strong enough and the packing pressure is high enough, these can often result in one of four problems. The worst-case scenario is that the cavity cracks, typically starting at an inside corner, as shown in Fig. 1. The more common scenario is scuffing on the outside surface of the part, because the cavity wall tries to move back inward to its original relaxed position when the mold starts to open.

Then there is the scenario where the cavity walls apply so much pressure on the part that the bolts retaining the core in the B-plate break, as shown in Fig. 2. This is fairly common with tall parts and an overpacked condition. Lastly, there is the bewildering scenario where the bolts holding onto the core are sufficiently strong, but the press doesn't have enough force to open the mold. If you have ever had to heat up a mold, or use a hydraulic bottle jack between the platens, to get a mold to open, then you know what I'm talking about.

FIG 3

**Wear on a conical interlock due to misalignment.**

FIG 4

**Wear on the side of a cam due to plate misalignment.**

Interlocks can help prevent all these problems from occurring by providing a significant amount of lateral support. Rectangular interlocks have more surface area than conical interlocks and can resist larger lateral loads. However, in the scenario above, where the sidewall of a cavity tries to flex outward, a rectangular interlock mounted perpendicular to the sides of the mold will not help ►

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prevent this from happening. Rectangular interlocks would have to be mounted parallel to the sides of the mold. Then they would act as a heel and help prevent the plates or inserts from shifting. This is the only time you might consider mounting a rectangular interlock in a direction other than perpendicular to the side of a mold. Keep in mind that doing this could cause a problem if there is a large temperature differential between the mating surfaces.

If you think about it, proper interlocking allows you to minimize the size of a mold base when the cavity has a lot of outward projected area, such as in the case of a tall garbage can.

## MOLD SETUP

One very important trick I learned over the years is to clamp the mold under pressure before fully tightening the mold clamps. This ensures that the interlocks are seated and the two halves of the mold are aligned. See the June 2017 article, "How To Mount An Injection Mold."

## MAINTAIN YOUR INTERLOCKS

When you see signs of wear or galling on the mating surfaces of an interlock, it should be corrected as soon as possible. If not, the problem will only get worse. If the faces of the interlocks are rusty, they're not touching and therefore not doing what they were designed to do. This usually happens when the interlocks "seat" into the mold base over time. They need to be shimmed to their original height. If one side is rusty and the other side is shiny, you probably have an alignment issue, often caused by differential thermal expansion, as shown in Fig. 3. You should also periodically inspect the inside of the female half of the interlocks. You might be surprised at what you will find inside besides a little dirt or grease.

## MOLDS WITH CAMS

*Interlocks help prevent problems by providing lateral support.*

Interlocks are not always necessary to align the two halves of a mold. In fact, sometimes they can be a hindrance. For example, when a mold has two opposing cams, the heels and the angled back faces of the cams already act as interlocks and align the mold in one direction. Additional interlocks, working in the same direction as the cams, would fight one another and therefore are not required for alignment. This is why conical interlocks are not recommended in molds with more than one cam. They align a mold over a full 360°. Two rectangular interlocks are a much better choice in molds with two opposing cams. They can keep the cams centered, thereby protecting their sides from damage, as shown in Fig. 4.

Molds with four-way cams, which form a "plus" sign, typically do not require any interlocks at all. The four cams naturally align the plates in both directions. Adding interlocks would only make it difficult for the moldmaker to "time out" the cams and no additional benefits would be gained. Molds with just a single cam definitely require interlocks to align the mold in both directions. A single cam can apply a great amount of side load, causing the mold halves to misalign. This side load can be caused by preloading the heel that activates the cam, and by the injection pressure pushing against the face of the cam.

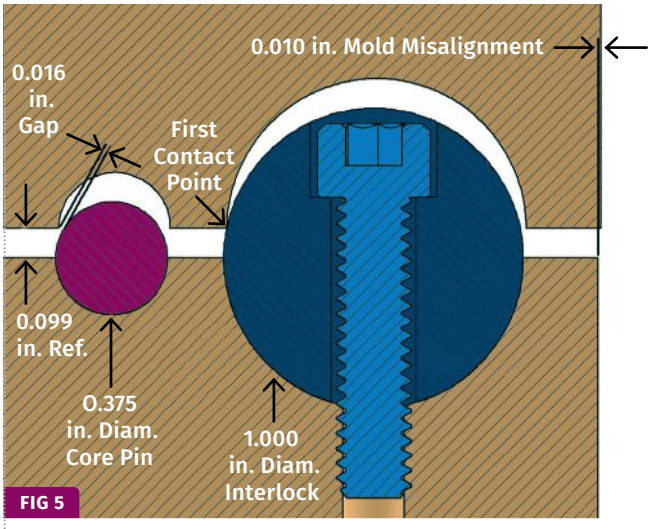


FIG 5

**A cylindrical interlock protecting a cylindrical core pin.**

## CYLINDRICAL INTERLOCKS HAVE THEIR PLACE

There is another type of interlock worth mentioning. It is probably one of the earliest types ever invented and is occasionally still used today. It is basically nothing more than a round shaft lying on, and parallel to, the parting line. The mold halves are assembled and a hole is drilled on the four sides of the parting line. Short sections of a hardened round shaft are then screwed into one side of the mold.

One application where this type of interlock is very beneficial is when a mold has a round core or core pin on the parting line, typically activated by a cam. Shutting off on a cylindrical surface is notorious for developing parting-line flash along the pin's centerline. As long as the diameter of the cylindrical interlock is larger than the diameter of the core pin, it will help protect the core pin from damage due to any misalignment of the mold halves. The female half of the interlock will hit the male half before hitting the core pin just before the mold is fully closed, as seen in Fig. 5.

This is another "old-school" trick that seems to have been forgotten over the years. Unfortunately, many people consider this type of interlock to be "cheap" and associate it with a poor-quality mold built offshore. But for some applications, this type of interlock can significantly reduce your repair costs. PT

**ABOUT THE AUTHOR:** Jim Fattori is a third-generation injection molder with more than 40 years of molding experience. He is the founder of Injection Mold Consulting LLC, and is also a project engineer for a large, multi-plant molder in New Jersey. Contact *jim@injectionmoldconsulting.com*; *injectionmoldconsulting.com*.

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Earning a PhD in Materials Science & Engineering at The Ohio State University, Hallee studied advanced nickel-based superalloys. She has worked in additive manufacturing at Honeywell Aerospace and at Blue Origin as Principal Technologist for Advanced Manufacturing & Materials. She serves as Secretary of the SAE AMS Additive Manufacturing Metals Committee.

**Dr. Charlie Wood** *Computational Engineering Lead*

Using advanced modeling techniques to create better products, Charlie has extensive expertise in both the mechanics of polymeric and composite materials and in computational tools for design and testing. Prior to Fast Radius, he was an engineer for Motorola. He holds a PhD in mechanical engineering from Northwestern University.

Revolution • Little Rock, Ark.

By Heather Caliendo
*Senior Editor*

# An Agricultural Recycling 'Revolution'

**Revolution combines expertise in recycling of agricultural film and manufacturing of plastic film, bags and irrigation tubing. The focus in all areas is to create sustainable closed-loop systems and use as much post-consumer resin as possible in all products manufactured.**

Despite the huge size and importance of its market, the agricultural plastics sector doesn't get the headlines like other areas of the industry. And when it comes to recycling, there's a perception that agricultural plastics aren't exactly preferred materials, due to a high level of contaminants and quite a bit of logistics involved. But not only is this area ripe for growth, one processor and recycler sees agricultural-plastics recycling as a driving force in working toward a circular economy.

**Sean Whiteley, CEO of Revolution, in front of gathered agricultural plastics.**

Headquartered in Little Rock, Ark., Revolution (*revolutioncompany.com*) is both a recycler and a manufacturer of film, bags and tubing. It markets a wide array of products for the agricultural sector, which it then recovers, cleans and processes into post-consumer resin (PCR). The company closes the loop by using this PCR to manufacture the same agricultural products again, along with other products such as trash-can liners, carryout bags and construction films. The company recovers and reprocesses more than 150 million lb a year and can manufacture products containing up to 97% PCR.

The company was founded in the late 1980s and from the outset focused on collecting, recycling and reusing PCR from agricultural plastics.

"The origin of our business is that we can use this raw-material feedstock—ag plastics—which is very plentiful throughout the U.S. and the world, and we use this great feedstock to make another plastic material

**As both a recycler and manufacturer, Revolution recycles irrigation tubing and processes it into PCR that is used for manufacturing agricultural, industrial and consumer end-products.**

and plastic products that feature a high amount of post-consumer content to make greener plastics possible," says Sean Whiteley, CEO of Revolution.

This is a growing company with plenty of moving parts. For instance, Revolution has two plants in Arkansas. Its plant in Little Rock produces Delta Plastics polytube and Revolution Bag can liners that use an average of 70% PCR. Its location in Stuttgart, Ark., is dedicated to recycling operations—in fact, it's one of the largest recyclers of heavily soiled and contaminated plastics in the U.S.

Since its start, the company has expanded into several different brands through organic growth and acquisitions. Besides Delta Plastics and Revolution Bag, these include Rodeo Plastics, an industrial plastic sheeting and bag manufacturer in Mesquite, Texas. A significant expansion came in 2018, when the company acquired Command Packaging and Encore Recycling. Command Packaging in Los Angeles is a manufacturer of sustainable plastic carryout bags for foodservice, grocery and retail markets. Encore Recycling in Salinas, Calif., makes PCR polyethylene film-grade resin and is integrated into Revolution's recycling unit. Encore's recycling facility provides Command Packaging with the material used in its bags and is the largest agricultural plastics collection operation in California.

This past October, Revolution acquired Pak-Sher, a carry-out bag manufacture in Kilgore, Texas, which will now be incorporated into Revolution's Command Packaging brand.

"The key theme and underlying premise in every strategic business decision we made is based on a closed-loop model," Whiteley says. "We want bufineffef that believe in closed-loop and believe in recycling. And we use our expertise in recycling technology and post-consumer resin to provide green solutions to consumers and communities."

**Revolution has a series of customized collection vehicles that are used to retrieve used plastics from farmers.**

## THE PROCESS

The two primary Revolution locations for recycling used and dirty ag film are at Encore's 125,000-ft² Salinas facility, which has been running since 2014, and Revolution's Stuttgart facility, in operation since the beginning of the original business almost 30 years ago.

**Revolution works with each farmer on recycling education so that the process is as efficient as possible. That involves procedures to leave the used plastics as clean as possible before pickup for recycling.**

There are several steps in Revolution's recycling process: the actual collection of used plastic material; washing the collected material; converting plastic flake to pellet; and then manufacturing new finished goods. For Revolution, collection is absolutely the key to producing high-quality PCR. Revolution provides on-farm pickup service to dairies, growers, almond hullers and other ag-related firms to collect film across the country.

Whiteley says that managing every segment is important to ensure a closed-loop system. It's imperative for the company to control collection, as the cleaning of plastics starts at the location where it was used. When the company picks up scrap, it is typically a mixture of 60-70% dirt and 30-40% plastic. Its wash process removes all the dirt.

For instance, in the South, Revolution enlists its collection vehicles, which are specially built semi-trucks with a 40-ft dump bed in the back. These trucks feature a specialized knuckle-boom crane to load rolled-up film on farms. The trucks are purpose-built according to the plastic they pick up in that area.

In the upper Midwest, Revolution has about 5000 dumpsters located at farms and dairies. Those plastics collected tend to cover silos used to feed cattle. A fleet of front-loading trucks pick up plastic from the dumpsters and transport it to one of the company's facilities for washing and pelletizing.

In California, Revolution uses knuckle-boom collection dump trucks like the ones in the South, but built a little differently as they are picking up other types of films such as drip film and solar film. The trucks pick up the plastic, shake off the dirt and place it into the trailer, where it will be taken for processing at the Salinas recycling facility. Revolution provides free pickup of agricultural plastics—mostly LDPE film or irrigation tubing—to more than 400 agricultural operations in California and is the largest agricultural plastic collector in the state.

"Regardless of the process of collection—the dumpsters or specialized collection trucks—we work with farmers on how to get plastic cleaner before they discard it," Whiteley says. "This is ►


**Revolution Bag uses a closed-loop recycling process in which agricultural films are gathered from farms and washed and recycled to produce high-quality resin for film/bag production.**

a partnership with the farmer and an education process to make sure that recycling is as efficient as it can be. We are fortunate to have great farmers to make it all successful. We couldn't do it without them—a lot of work on the recycling side relies on the willingness of the farmers to play an important part as well."

The material is eventually taken back to either of the recycling facilities in California or Arkansas and goes through a proprietary reclaim process. Whiteley says they use equipment from several different manufacturers based in the U.S, Austria, Italy and Germany. He did not disclose specifics.

"We are using that equipment, which is configured and unique, in proprietary ways that allows us to get plastic very clean. It's this system we have developed over 25 years that enables us to create a near-virgin-like PCR, which is why we can use it in many kinds of applications," he says.

End-products include irrigation tubing and other agricultural products. On the industrial side, Revolution Bag can liners are produced with an average of 70% and up to 97% PCR. Rodeo Plastics manufactures film, sheet and bags for the construction and commercial supply industry. And for consumers, Command focuses on post-consumer packaging for retail, food-service and grocery markets. The company services large brands such as Target, Chick-fil-A, McDonald's and Del Taco, and grocery stores likes Smart & Final and Vons.

## BRAND PARTNERSHIPS

One interesting recycling development with a brand owner involves the fast casual food chain Chipotle. That company has a goal of diverting 50% of its restaurant waste from landfills by 2020 and it conducted detailed waste audits to better understand its waste patterns. In doing so, the team learned that 95% of all gloves used in restaurants end up in a landfill. Upon discovering that the materials used in the gloves were the same as the recycled trash bags used in its restaurants, Chipotle partnered with Revolution to start a pilot program for upcycling its plastic gloves into trash bags. What started as a pilot in eight restaurants across Portland, Ore., is now expanding into 17 restaurants in Sacramento.

"If we truly want to be leaders in this space, we cannot just settle for the best available option," says Caitlin Leibert, director of sustainability at Chipotle. "There is no 'one-size-fits-all' solution for sustainability. We want to revolutionize the way people think about waste and the potential of everyday items like gloves and trash bags."

Another example is Toro, a provider of outdoor equipment, which partnered with Revolution's Command brand on a new drip-tape recycling service in California. "Recycling has become difficult for many growers because plastic recyclers in Asia have effectively closed their doors to foreign recycling," says Ralf San Jose, director of marketing for Toro's agricultural business. "This created a recycling challenge in the U.S. and other countries, making it nearly impossible for many growers to recycle their drip-irrigation plastic. Thanks to Toro's new recycling service with Revolution, Toro growers in California now have a reliable and sustainable outlet for their used drip tape."

Toro's drip-tape recycling service is part of a completely closed-loop production process. Rather than sending plastic waste to a landfill, Revolution picks up used drip tape, cleans it, and produces recycled PE resin. Toro then uses this recycled resin in other drip-irrigation products, ensuring sustainable and responsible environmental practices.

## THE FUTURE

Despite an increased focus on recycling worldwide, there remain substantial challenges for the industry to overcome. But Whiteley believes that's doable. "If you're thoughtful and strategic, you can solve the problem," he says. "That's really what our closed-loop system seeks to solve. We don't have issues using PCR in our manufacturing process because we work hard on the collection side to segment the material. So, we are making PCR that is of consistent quality and feedstock.

"We are confident that the amount of post-consumer content will increase over time as demand continues to accelerate for PCR in finished goods," he says. "It will only continue to grow, and as a plastics industry, we need to be committed and answer the call to finding a solution. That's what everyone at Revolution is focused on." PT

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# Is Your TCU Up to the Job? Mold Simulation Can Give the Answer

For realistic results, molding and cooling simulation must reflect the capabilities of the actual TCU to be used. Here's how simulation can help determine whether your TCU is up to the job.


**A cooling simulation that analyzes the flow and pressure requirements of all cooling channels can help ascertain whether your TCU can deliver what's required for a particular mold.**

By Yan-Chen (Thomas) Chiu
*CoreTech System*

In injection molding, we usually control the mold at a fixed temperature by making coolant flow continuously through the mold. If the coolant flow is not sufficient, or the coolant temperature is not as expected, the mold won't be kept at the desired temperature. Manufacturers of mold-temperature controllers (temperature-control units, or TCUs) calculate the appropriate specifications for their equipment according to the size of the mold and the part. However, it can be a challenge for engineers and analysts using molding and cooling simulation software to take into account the actual performance of a TCU. In this article, we'll share principles for using CAE simulation software—in this case, Moldex3D—to evaluate the performance of TCUs.

## RELATION BETWEEN FLOW & PRESSURE

In Moldex3D's flow-analysis settings, users can apply two types of boundary conditions for cooling channels: flow rate and pressure. When the coolant flows through the cooling channel, the flow rate at the inlet and outlet are equal. Users only have to measure the flow rate at one side of the cooling channel, which is "mirrored" to obtain the flow rate at the other side of the channel. Thus, using the flow rate as the boundary condition is easier to control.

In terms of pressure, the inlet pressure is higher than the outlet pressure, and the flow is caused by this pressure difference. In Moldex3D, the default value of the outlet pressure is zero. Users only have to set the pressure boundary at the inlet, and this value will be equal to the pressure difference between the inlet and outlet. If we create a plot to show the relationship between the cooling-channel flow rate and pressure, we can see that as the flow rate gets larger, the pressure difference also grows larger. The two parameters are approximately proportional (see Fig. 1).

Apart from the pressure difference, flow resistance is another factor that will affect flow. Flow resistance varies with some conditions, such as cooling-channel diameters, channel length, channel-wall smoothness, coolant properties, and flow rate. The Darcy-Weisbach equation shows the relations between these parameters:

$$\Delta p = f \times l/D \times \rho V^2/2$$

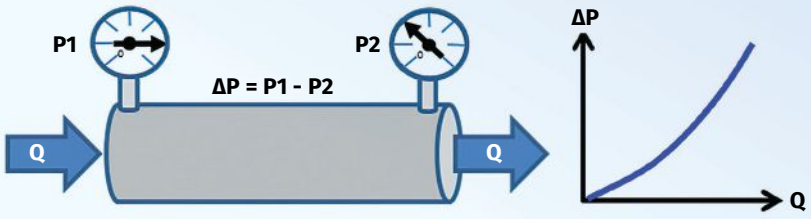
**p**: Pressure Drop
**f**: Friction Factor
**l**: Channel Length
**D**: Channel Diam.
**ρ**: Density
**V**: Flow Rate

***Simulation determines the total flow rate and minimum pressure the TCU must provide for a particular mold.***

The function of a TCU is to push the coolant to flow and stabilize the coolant temperature. The main function of the pump in the TCU is to push the coolant to flow. When pump pressure rises, the flow rate decreases; when the flow rate increases, the pump pressure decreases. We can see the maximum flow rate and pressure values on the TCU specification, but we have to note that the two conditions never exist simultaneously. We can see the TCU pressure is inversely proportional to the flow in Fig. 2.

## CHOOSING A TCU WITH MOLDING SIMULATION

Users can obtain the flow rate and pressure difference of every cooling channel through Moldex3D's cooling-channel analysis. The




**ΔP** Pressure Difference
**P1** Coolant Inlet Pressure
**P2** Coolant Outlet Pressure
**Q** Flow Rate

**FIG 1** The relation of cooling-channel flow rate and pressure difference.

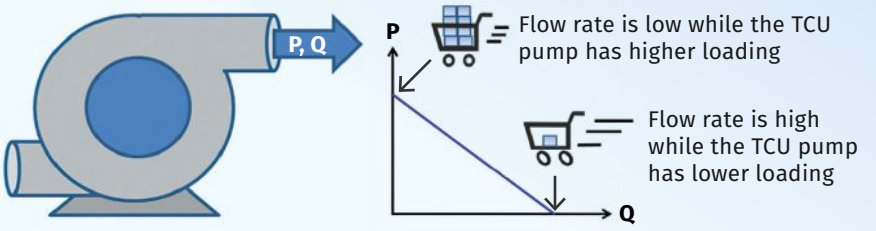



**FIG 2** The inverse relationship between flow rate and pressure from the TCU pump.

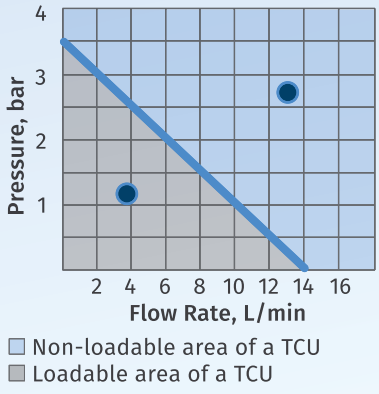



**FIG 3** The loadable area of the TCU, as determined by simulation of the total flow and pressure requirements of all cooling channels.

total flow rate of the cooling channels is the flow the TCU has to provide. The maximum pressure in the cooling channel is the minimum pressure the TCU must provide. Users can enter point coordinates of the total flow rate and maximum pressure differences in the line graph in Fig. 3. If the coordinate point is below the line, it means the TCU is able to provide enough flow rate and pressure. If the coordinate point is above the line, it means the TCU is not able to provide enough flow rate and pressure. The latest version of Moldex3D, R17, is now able to provide the data on maximum pressure drop, total flow rate, and heat dissipation. Users can evaluate the TCU's performance by adopting the pump performance curve.

| Inlet ID | Pressure Drop, bar | Inlet Flow Rate, $cm^3/sec$ | Inlet Flow Rate, L/min | Heat Removed, kW |
|---|---|---|---|---|
| 1 | 0.82 | 233 | 13.98 | -1.778 |
| 2 | 0.6 | 233 | 13.98 | 6.899 |
| 3 | 0.82 | 233 | 13.98 | -3.661 |
| 4 | 0.6 | 233 | 13.98 | 1.347 |
| 5 | 0.82 | 233 | 13.98 | 0.302 |
| 6 | 0.6 | 233 | 13.98 | 6.789 |
| 7 | 0.82 | 233 | 13.98 | -0.429 |
| 8 | 0.6 | 233 | 13.98 | 0.554 |
| | **Max. Pressure Required, bar** | **Total Flow Rate Required, L/min** | **Cooling Capacity Required, kW** | |
| | 0.82 | 111.84 | 10.024 | |

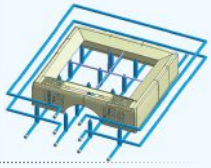


**FIG 4** Output of required cooling-channel pressure, flow rate, and cooling capability, as determined by simulation.

## THINGS TO KNOW BEFORE RUNNING A SIMULATION

In the injection molding simulation, users usually set high flow rate as the ideal cooling-channel condition. However, such a high flow rate may exceed the capabilities of the TCUs in the plant. Therefore, in order to shorten the gap between simulation and reality, it is better to set the channel boundary conditions based on the actual specifications of the TCU on hand.

In addition to flow pressure, it is also necessary to take the cooling and heating capabilities of the TCU into consideration in simulation. Users can check the heating load of the cooling channels and compare the values with the TCU's cooling and heating capabilities. If the cooling capability of the TCU exceeds the predicted heating load of the cooling channel, or its heating capability exceeds the negative heating load of the cooling channel, that means the TCU meets the requirement. Moldex3D also can export these crucial data gained from the cooling analysis as a .csv format. (Fig. 4). Simulation technology can provide critical data to help evaluate TCUs in your plant. PT

**ABOUT THE AUTHOR:** Yan-Chen (Thomas) Chiu is sr. architecture manager at the Product R&D Div. of CoreTech System in Taiwan, developer of Moldex3D molding simulation software. As a software engineer at CoreTech, Chiu has been devoted to the development of numerical methods for injection molding applications, especially in the heat-transfer field. Contact: *sales.us@moldex3d.com*; *moldex3d.com*.

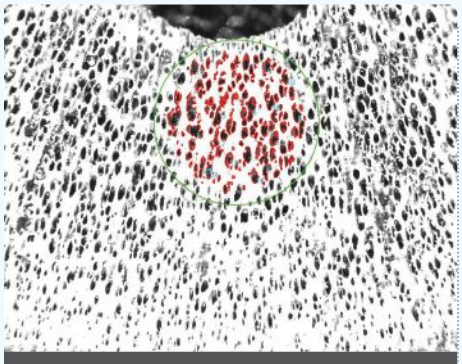
# Materials Knowledge Pays Off at Teel Plastics

## Well-equipped and well-staffed testing lab elevates competence of custom processor.


Known for its high-tech custom tubing and profile extrusion, Teel added injection molding capabilities five years ago while further advancing its testing lab operation.

There is no doubt that a good understanding of the properties and processing behavior of a variety of resins and compounds will advance a custom processor's business and bolster customers' perception of the processor's competence. Central to this achievement is having a well-equipped and well-staffed testing laboratory.

By Lilli Manolis Sherman
*Senior Editor*



A new microscope allows lab staff at Teel Analytical Laboratories to determine foam cell formations so they can optimally tweak their extrusion process

Such is the case with Teel Plastics Inc., Baraboo, Wis., a nearly 69-yr old, ISO 9001-certified processor that is best known for high-tech custom tubing and profile extrusion. Within the last five years, Teel also added injection molding capabilities, and was among *Plastics Technology*'s 2015 inaugural group of 25 World-Class Processors (now called Top Shops).

In 2010 the company launched a division called Teel Analytical Laboratories to support quality assurance and new-product development, and to troubleshoot manufacturing issues as they arise. With its certification to ISO 17025—marking the organization as a first-class laboratory in the area of material science and polymer analysis—Teel Analytical Laboratories offers confidential analysis services and consulting with a focus on polymer analysis, both for in-house use and for contractual business.

*Plastics Technology* asked lab manager Dan Clark to share some of the strong points of Teel Analytical Laboratories. To begin with, Teel has an extensive array of lab instruments to measure thermal, physical and mechanical properties of materials. For each of three key stages, typical tests include:

- **Raw Material**: Thermal analysis (DSC), physical analysis (density, melt-flow rate, particle size, durometer), chemical (FTIR).
- **In Process**: Chemical analysis (moisture, liquid chromatography), thermal analysis (TGA), physical (microscopy).
- **Final Product**: Mechanical analysis (tensile, flexural, impact, custom), chemical (liquid chromatography), physical (microscopy).

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The laboratory staff has chemistry and/or biochemistry degrees and previous experience in materials testing. The lab also includes an in-house tool room so the staff can put the final product through actual end-use conditions. Teel's engineers build the fixtures to allow for such testing with the appropriate instrumentation.

Says Clark, "Teel works with 75 to 100 resins per year—not necessarily all of which go into production. So we have this broad knowledge of materials ahead of time. We feel this puts us in a position to guide and assist our customers in resin selection. We also stress to our customers the importance of material characterization." Teel Plastics works with materials ranging from HDPE to PEEK and polyethersulfone (PES).

Clark describes Teel's typical material characterization protocol as utilizing such tests as differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), density, MFR, and Fourier-transform infrared (FTIR) analysis. Ideal frequency is five to 10 samples per lot, three-to-five lots of material. Data is collected, compiled and stored for future reference. Results show variation within a lot of material and the variation between lots of material.

***"Teel works with 75 to 100 resins per year, not necessarily all of which go into production. This puts us in a position to guide and assist our customers in resin selection."***

One of the latest acquisitions has been a microscope with software that measures foam cell size. "We have been using various chemical foaming agents in personal-care products we are producing. With the new instrument, we can determine foam cell formations and we can then tweak our extrusion process for optimal processing." Prior to acquiring this instrument, Teel had to rely on mechanical performance to test the functionality of the end-use part. Materials that Teel has foamed include PVC, HIPS, and acrylonitrile ethylene styrene.

Extruded core testing for film winding has led the Teel lab team to work on different cooling techniques—particularly with polyolefin cores—to counteract the annealing that occurs on the ID of the core.

## Teel's Testing Technology

Key testing/equipment at Teel Analytical Laboratories includes:

- Differential Scanning Calorimeter (DSC—ASTM D3418);
- Thermogravimetric analyzer (TGA—ASTM D3850/E1131);
- Fourier-Transform Infrared Spectrometer (FTIR—ASTM E1252);
- Melt Flow Rate Indexer (MFR—ASTM D1238);
- Moisture analyzer (relative-humidity sensor—ASTM D7191);
- Moisture analyzer (gravimetric loss on drying—ASTM E1868);
- Density analyzer (ASTM D792);
- Bulk density tester (ASTM D1895);
- Durometer hardness tester (Shore A and D scale—ASTM D2240);
- Brookfield rotational viscometer (ASTM D2196);
- Particle-size analyzer (uses a mechanical shaker with sieves ranging from 10 to 270 mesh—ASTM D1921);
- Microscopy (using one of two microscopes with the ability to capture images at 220X and make measurements down to 0.005 mm. Additionally, compound microscopes are available with 2000X capability with imaging—SOP053);
- Subcontracted testing (Teel Analytical Laboratories will subcontract tests that are outside of the ISO 17025 scope to another accredited laboratory upon request and couple those results with any produced at Teel.)

Additional testing capabilities, as well as chemical hoods, incubation ovens and freezers for conditioning, include:

- Tensile and compression tester: This instrument allows for up to 32 in. travel and has up to 1500 lb force. Aside from tensile strength and compression tests, such as three-point bend, this very versatile instrument and allows for unique configurations. Load holding, cycle tests and coefficient of friction are some of the options. Apparatus can be configured to fit uniquely shaped parts for a number of mechanical tests.
- UPLC (ultra-performance liquid chromatography).
- Pipe burst tester.
- Near-infrared (NIR) moisture analyzer.
- Chemical titration tester.
- Impact strength equipment.
- Colorimeter analyzers.
- Stomacher (paddle blender).
- Film thickness analyzer.
- 3D printer.

## TROUBLESHOOTING FAILING PARTS

Asked to give examples where Teel's materials' know-how solved problems of failing parts and processing problems, Clark offered the following:

A customer found that its industrial core for film rolls was not performing adequately and wanted the core's material, a PP compound, to be tested for abrasion resistance. Using its tool room, Teel's lab staff performed the abrasion test by building a fixture with grooves that simulated actual use. The material failed to perform up to par and Teel recommended a nylon 66 compound that proved well suited for this application.

Final product testing at Teel includes mechanical analysis such as tensile strength, along with chemical and physical testing.

The ends of a PP hollow core for water treatment, extruded for another customer, were turning inward—called "bell-in." Using DSC, the lab staff determined that the material in the inner diameter (ID) had higher crystallinity, which made that area more dense and "pulled-in" the outer diameter (OD) or whole wall. The solution was cooling the ID and the OD in such a way that crystallization was the same for both. "The ID had to be cooled faster due to the residual heat within the material, which continued to have an annealing effect," explained Clark.

He says that while this processing example involved PP, this is an industry-wide issue for polyolefin-based materials. "From the results of our testing, we are working on different cooling techniques to counteract the annealing that is occurring on the ID of the pipe from the residual wall heat that is, in part, producing the bell-in event on the ends of the pipe."

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# Follow These Steps to Determine Your Water Bath Length

Use heat-transfer equations as a shortcut to get you in the ballpark of how long your pelletizing water bath should be.

By Bruce Spencer III
*Sabic*

In strand pelletizing, determining how long the water bath should be is probably one of the more overlooked matters in the initial system design. The length of a water bath usually ends up being decided not by a theoretical approach or practical experience, but by how much space is left over on the production floor. This can lead to processing issues if the water bath is too short, or wasted space if the water bath is too long.

Some processors are fortunate to have prior experience to give them an indication of how long a new water bath should be. Others should consider using a theoretical approach based on unsteady-state heat-transfer equations to come to a theoretical length for a water bath. These theoretical methods have been explored by many extrusion experts over the years. The purpose of this article is to provide a shortcut to get you in the ballpark of how long your water bath should be.

**Water-bath length usually ends up being decided not by a theoretical approach or practical experience, but by how much space is left over on the production floor.**

***Polymers are generally poor thermal conductors, strands are thin, and there's a steady flow of water going through your water bath.***

First, you need to know your line speed. Once you have that, you need to find a Heisler chart like the one in Fig 1. There are different Heisler charts for different extruded shapes, so make sure you pick the correct one. These Heisler charts are readily available via Google searches. Figure 1 is a Heisler chart for a cylinder, much like the strands in a strand pelletizing operation.

Those blue lines are all inverse Biot numbers (a dimentionless quantity used in heat-transfer calculations) for the object you're trying to cool. To get a ballpark number for how long your water bath should be, use the blue line designated with a 0. Why? Because polymers are generally poor thermal conductors, strands are thin, and you have a steady flow of water going through your bath.

If one of those situations doesn't apply, you'll have to find the hydraulic diameter of your water bath; Reynolds, Prandtl, and Nusselt numbers for the water cooling your strands; and the convective heat-transfer coefficient to determine the right line to use. If that sounds scary, just use the blue line designated 0.

Then we calculate the approach temperature Θ*. This is basically the ratio of the temperature of your plastic coming out of the die head and the temperature you want for the plastic before it gets cut into pellets. If you need guidance on what your desired plastic temperature should be, you can search online for "softening points" of the polymer you are interested in and subtract 20° F from that. For polypropylene, 192 F has been found to work well, but the desired temperature depends on the particular polymer and pelletizer capabilities. For example:

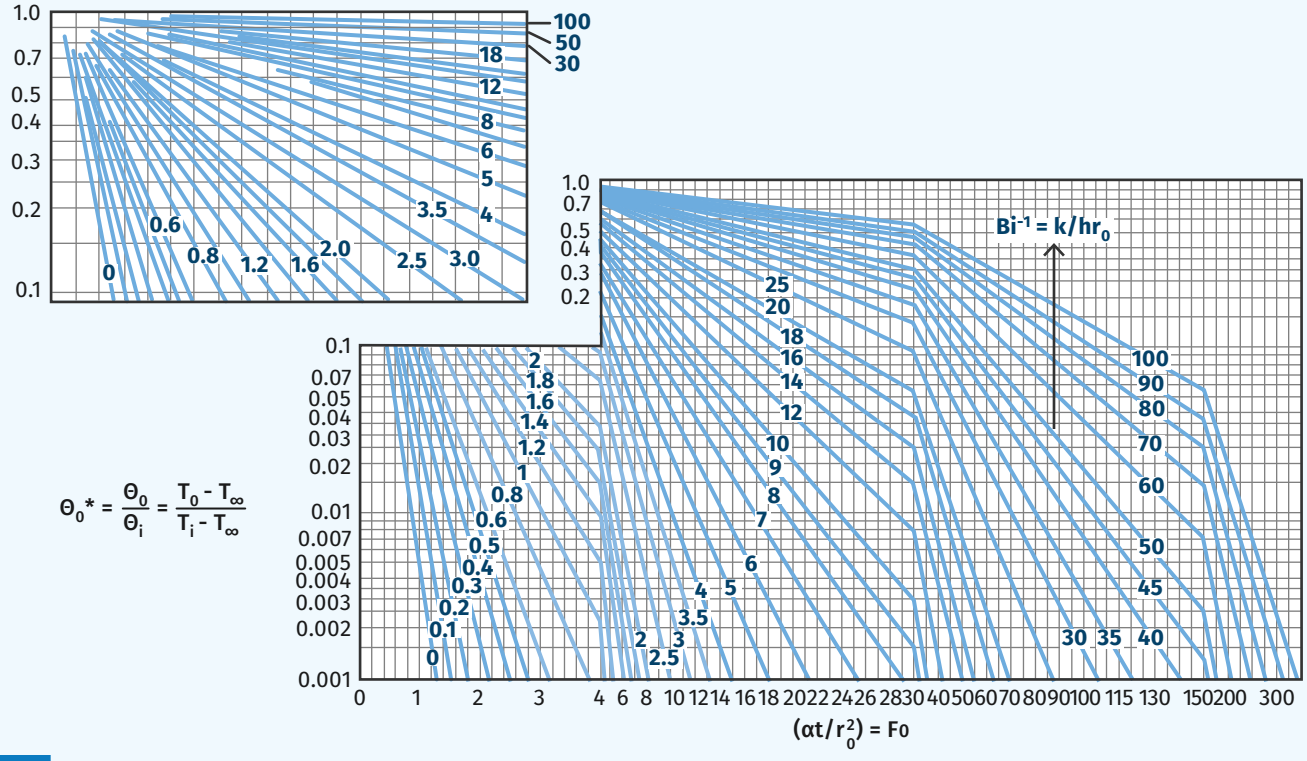



**FIG 1** You can find all types of Heisler charts on the internet, so it's important to pick the right one for your calculations. This one can be used for strand pelletizing.

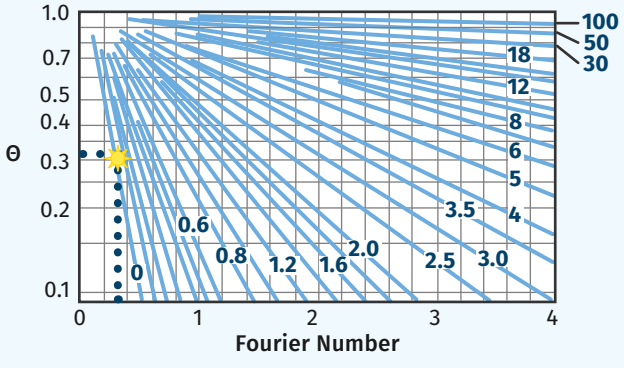
$\Theta^* = (T_{plastic,\ desired} - T_{water}) / (T_{plastic,\ initial} - T_{water}) =$
$(192\ F - 78\ F) / (420\ F - 78\ F) = 0.31$

Now with that blue line number 0 and approach temperature, we can determine our Fourier number from the Heisler chart. You take your approach temperature $\Theta^*$ on the left and go to the right until you hit the blue line that represents your inverse Biot number. As shown in Fig. 2, the Fourier number is around 0.32.

*Verify first-hand the thermophysical properties of the plastic you're trying to cool .*

With the Fourier number, we can now calculate the time required for the plastic strands to reach the desired temperature. I used PP in this example, with a radius of the PP strand I'm trying to cool at 0.00239 m (which I got from my die-hole diameter).

**FIG 2**



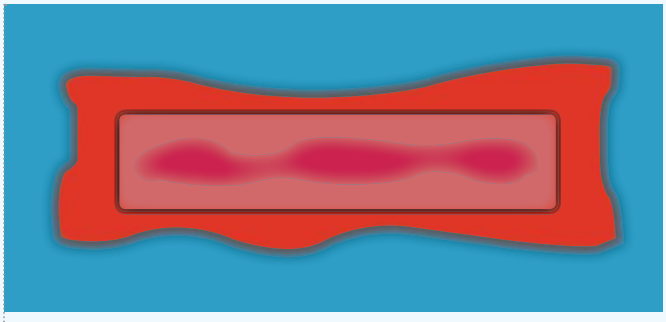

**With the blue line numbered 0 and approach temperature, you can determine your Fourier number from the Heisler chart. You take your approach temperature Θ* on the left and go to the right until you hit the line that represents your inverse Biot number. As shown here, the Fourier number is around 0.32.**

**α = thermal diffusivity of PP = 9.6 x $10^{-8}$ $m^2$/sec**
**t = $(Fo \times r_0^2)/\alpha$ = (0.32 x 0.00239 $m^2$) /(9.6 × $10^{-8}$ $m^2$/s) = 18.77 sec**
Now that we know the time required in the water bath, we can use the line speed calculated earlier to calculate the predicted water bath length.

**$L_{water\ bath}$ = t × Line Speed = 18.77 sec × 2.500 ft/sec = 47 ft**

If your calculated water bath is longer than the space you have in your facility, you could attempt the following:

- Purchasing or renting a chiller to lower the incoming water temperature if your cooling-water temperature is above 72 F.
- Using spray bars to take advantage of evaporative cooling to cool the strands more. ►



**When a plastic strand enters the water bath, it heats the water around it or forms a steam jacket. As a result, the water bath is trying to cool that hot water layer before it can cool the strand. This delays the cooling effect of the water bath. In the absence of any turbulence, you're basically left with trying to cool hot plastic strands with warm water—a sub-optimal cooling situation. (Photo: Conair)**

- Adjusting water-bath roller setup to make multiple passes in the water bath either length-wise or height-wise.
- Using multiple water baths instead of a single bath.

Remember that this is a method just to get you in the *ballpark* of how long your water bath should be. In the interest of full disclosure, there are some drawbacks to utilizing this technique, as it ignores the effects of these factors:

- The number of strands;
- Crystalline polymers' heat of fusion as they transition from molten to solid;
- The changing values of constants (i.e. heat capacity of the polymer) as temperature changes;
- The number of times strands leave and re-enter water bath;
- Use of additives or fillers and their effects on physical properties.

I recommended that you verify first-hand the thermophysical properties of the plastic you're trying to cool, or else you may be unpleasantly surprised when your plastic doesn't behave like textbooks or technical articles tell you it should.

**EDITOR'S NOTE**: This article is based on a presentation the author made during *Plastics Technology*'s Extrusion 2019 Conference, held in September in Rosemont, Ill.

**ABOUT THE AUTHOR: Bruce Spencer III** is a process engineer for Sabic in Bay St. Louis, Miss. He has held various positions in the plastics industry since 2014, including EHS and production roles. He holds a BE in chemical engineering. Contact: *(228) 466-3023; bruce.spencer@sabic.com.*

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MATERIALS HANDLING

## Drying, Blending, Conveying News at K 2019

Plastic Systems, an Italian-based supplier of plastics auxiliaries that has just established a U.S. headquarters in Atlanta (see Starting Up), introduced several new products at October's K 2019 show in Dusseldorf.

The most prominent new entry is a modular system of one to 10 honeycomb-rotor desiccant dryers, each with its own hopper. A single PLC control system, described as very user-friendly, allows for drying different resins simultaneously via independent, self-adaptive control for each hopper of material level and drying-air temperature, dewpoint and airflow. The compact system can be mounted on a trolley (as shown here) or stationary.


Also new is the Gamma batch gravimetric blender for up to eight components. It has new PLC controls for use in extrusion or injection molding.

New receivers for a central conveying system have PLC controls that can be monitored or controlled remotely via smartphone or tablet. (This capability is being made available for all the company's products.)

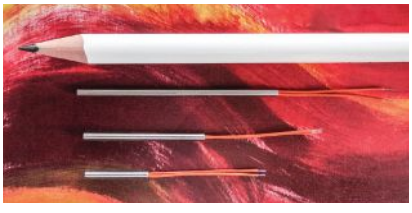
A new automatic manifold distribution system has an optional weighing system that calculates resin usage.

New Easy Way 4.0 supervisory system collects and stores operating data for all injection machines and auxiliaries in a plant—including auxiliaries from other suppliers. The display can be customized to reflect the machine layout. This PC-based system also provides remote control capabilities, such as start, stop and reset.

HEATING/COOLING

## World's Smallest' Cartridge Heater

Turk+Hillinger introduced at the K 2019 show in Düsseldorf (Oct. 16-23) what it calls "the world's smallest heating cartridge for standard voltages." The new heating elements are available in lengths of 10 to 150 mm, with a diam of 2 mm, max. surface load of up to 70 W/cm², and max. sheath temperature up to 750 C (1382 F). These cartridges are offered for both low-voltage and standard voltage up to 250 V. One potential application is in small hot-runner nozzles.



FEEDING/BLENDING

## New Feeders, Blenders for Regrind and Wire/Cable at K 2019

Movacolor of the Netherlands, distributed in North America by Hamilton Plastic Systems, Romax and others, introduced three new gravimetric feeding and blending systems at K 2019 in October. First, MCHigh Output 2500R is a high-capacity dosing unit for low-bulk-density regrind such as bottle flake. Utilizing a screw-type force feeder, it can be mounted directly on top of a molding machine or extruder. The water-cooled neckpiece with integrated mixer can handle materials at up to 180 C/356 F and reportedly can provide up to 75% flake content in the feed mixture. The horizontal mixer exerts a downward force to push material into the machine throat. The unit has an integrated drawer magnet and the neckpiece can accept additional feeders for additives. Throughput capacity is 50 to 2500 kg/hr (110 to 5500 lb/hr).

Also new is the MCTwin system for reprocessing colored regrind in the form of injection molding sprues and rejects. The system is designed to save on costly colorant or other additives by automatically adjusting the feed of color/additive in proportion to the amount of regrind being fed. The system comprises a pair of gravimetric feeders, a master unit that feeds regrind and a slave unit for the color/additive. Both feeders have integrated low-profile hopper loaders. Capacity is 0.07 to 180 kg/hr (0.15 to 396 lb/hr). The system can be supplied with Movacolor's new MCNumera unit that totalizes throughput of all materials.

In addition, Movacolor showed off its new MCContinuous Blender for wire and cable extrusion. This modular in-line blender system (pictured) utilizes gravimetric feeding/dosing of pellets, powders, regrind, and liquid from 0.5 kg/hr (1.1 lb/hr) up to 2000 kg/hr (4400 lb/hr). The system can feed two different colors and make changes on the fly. The controller with 8-in. color touchscreen is described as Industry 4.0-ready and can control up to 15 components on one or several extruders. It has integrated loader control, a new onboard manual, new installation/configuration wizard, and new always-available Info button that explains what is displayed on the screen and defines technical terms.

FEEDING

## Micro Feeder Allows Pellet-By-Pellet Dosing

The new TrueFeed Micro Feeder from Conair can count and dispense standard and micro pellets on an individidual basis at rates as low as five pellets/sec. This precision feeding can apply to small injection molded parts and laboratory or filament extruders, as well as feeding and blending ultra-low doses of additives.

Users input the number of pellets per gram into the controller, together with the required dosing (in grams), calculated production rate, and operating mode (injection molding, extrusion, or batch), and the Micro Feeder automatically creates the required dosing profile. Standard or micro pellets are captured on the feeder's proprietary dosing wheel, where they are optically counted using a light signal and dispensed with single-pellet accuracy, Conair says.

TrueFeed Micro Feeders feature an 8-in. graphical touchscreen that can operate one or two feeders, either two Micro Feeders or one Micro Feeder paired with a larger, standard TrueFeed model.

TrueFeed Micro Feeders measure less than 8-in. long. Standard models have a clear hopper suited to hand feeding. They can accept a mini loader atop the hopper.

INJECTION MOLDING

## Optimize Screw Recovery for Better Melt Quality, Less Wear

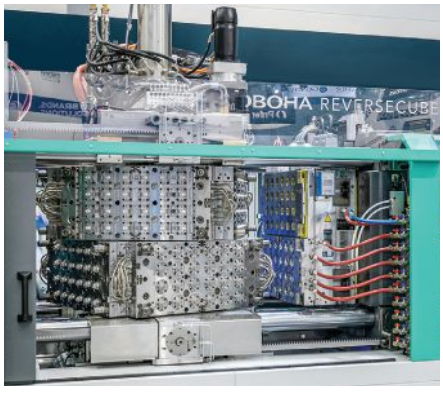
A new addition to Engel's "smart factory" software was introduced at October's K 2019 show in Dusseldorf. Its latest "intelligent assistant" is iQ melt control, which optimizes the plastication or screw-recovery time for the current application. Because slower plastication improves melt quality and uniformity, and minimizes screw and barrel wear, iQ melt control makes full use of the in-mold cooling time for plasticating. Instead of plasticating at the maximum possible speed, the software uses all the time available without extending the cycle. Reduced noise is another claimed benefit.

For this to happen, the operator needs to enter only the screw type and the material being processed. Along with optimum plasticating time, the software displays recommendations for optimizing melt temperature and back pressure.

INJECTION MOLDING

## 'Reverse Cube' Puts New Spin On Two-Component Molding

One of the most eye-catching tooling exhibits at K 2019 was the debut of the Reversecube from moldmaker FOBOHA. This system divides the rotating cube mold in half horizontally, with the two halves turning by 90° increments in opposite directions. The first commercial system was running at the show, molding and assembling a PP socket and an acetal (POM) roller for a Bosch dishwasher. The innovative 24 + 24 cavity mold ran on a 290-metric-ton Arburg Allrounder Cube 2900 press.

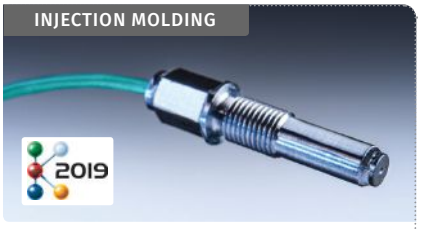



The rationale for splitting the cube is to thermally isolate the two mold halves, one of which molds PP at a mold temperature of 15-20 C (59-68 F) and the other molds acetal at 80-85 C (176-185 F). What's more, the PP part is relatively thick, so the mold is designed to provide each component with two cooling stations after injection, with the fourth station reserved for assembly and ejection. With the two materials injected into mold faces 180° apart, the only way to provide two cooling stations for each, and to eject on the same side of the machine, was to split the mold into sections rotating in opposite directions. In the fourth mold station (on the non-operator side of the machine), a six-axis robot demolded the parts while assembling them with a snap fit. In this way, the same cavities and components are always combined, making it easier to track problem cavities.


The result, says FOBOHA, is 20% higher output, up to 40% shorter cycle time, and around 40% less floorspace than a conventional system. The single-machine system replaces four standard injection molding systems and two assembly lines. (See it in action at ***short.ptonline.com/RevCube***).

FOBOHA also introduced its Compactcube, a simplified "plug-and-play" system for use on standard machines with extended stroke. The system is tailored for shorter runs, because it cuts the time for mold removal and maintenance from five days for a conventional cube mold to a single day. That's because the Compactcube has no top and bottom shafts for media supply. Instead, there's an integrated shaft and housing for media supply to the center block. This cube is mechanically driven, like a stack mold, rather than hydraulically or electrically driven like a standard cube. The new system is currently available for machines from 120 to 450 m.t.

INJECTION MOLDING



## Tiny Cavity-Pressure Sensor Shrinks Further

At the K 2019 show in Düsseldorf in October, Kistler displayed a smaller version of its ultra-compact cavity-pressure sensor, model 9239A. The new version of this non-contacting sensor has a 2.5-mm front contact surface, trimmed down from 3.0 mm previously.

EXTRUSION

## Flexible Coex Line for Barrier, Non-Barrier Structures


At K 2019, Bandera introduced the Barrier Flex Seven line, which can accommodate barrier, high-barrier, and high-throughput non-barrier polyolefin film production. For energy efficiency, the line is furnished with low-energy drives and reluctance motor systems said to minimize noise and simplify maintenance requirements. Bandera also redesigned its line-control system to improve process management and optimization. The enhanced system maximizes communication with industrial equipment and systems for data collection and monitoring; open connectivity with corporate information systems reportedly offers fast and efficient data collection and management.

The line is equipped with what Bandera calls "IoE" (Internet of Extrusion), a user interface that is said to offer simplified diagnostics for drive and motor predictive maintenance and increased process-control parameter accessibility. A wide and bright display offers a one-glance overview of machinery and system status, as well as options to view remotely from a tablet or smartphone.

EXTRUSION

## High-Output Stretch-Film Line

In operation at October's K 2019 show in Düsseldorf, the new PowerCast XL stretch-film line from SML has a net film width of 4500 mm. Without increasing the trim ratio, the line can produce 400- to 750-mm-wide rolls, said to be a key advantage to serve varied market requirements. The 13-layer system running at K was equipped with eight extruders, a 5435-mm-wide Cloeren Reflex die, 1600-mm-diam. chill roll that's 5500-mm wide, and a double-turret winder (W4000 4S 2T) with four shafts per turret.

SML's newly introduced "hands-free" operation of the extrusion die reportedly makes product changes on the PowerCast XL line fast and straightforward. With Cloeren's new Reflex die, used in combination with SML's "Booster" regulation, the line operator no longer needs to make manual cross-profile adjustments during product changes. Using a conventional system, it sometimes takes 30-45 min until the required product quality is reached. Hands-free and Booster regulation can do this in approximately 10 min, completely automatically, SML states.

Automatic mapping of the diebolts is another innovation from SML to minimize both labor costs and waste production. With conventional equipment, the operator has to do a manual die mapping at every product change to ensure good regulation of the thickness gauge. With SML's new automatic version, special software constantly regulates the expanding and contracting of the diebolt at a defined position on the film. The thickness-measuring unit recognizes the position of the bolt and automatically readjusts the mapping.

All of SML's stretch-film lines can measure the temperature of the extruded film directly on the chill roll. This feature gives processors the ability to predict the quality of the film with regard to its elongation inline during production. The operator then knows immediately whether to modify or readjust anything to achieve the right properties.

EXTRUSION

# Modular Control System for Blown Film

During October's K 2019 show in Düsseldorf, Maguire Products displayed a new control system for blown film that can be deployed in a new production line as part of a total system providing single-point supervision of all line components, or retrofitted to an existing line to increase productivity and reduce material cost.

For a new blown film line, there are three basic components at the heart of the Maguire + Syncro extrusion control system: the Maguire WXB Weigh Extrusion Blender, which incorporates a gain-in-weight weigh bin and a loss-in-weight mix chamber; the Maguire 4088 controller, which controls loading, blending, and metering of raw material to the extrusion process; and the Syncro controller, which uses the material-consumption data from the 4088 controller to control line speed. Modes of extrusion control available with the Maguire + Syncro system include lb/hr or kg/hr; weight per length of extrudate; and product thickness in microns.


The Maguire + Syncro system is the product of a partnership between Maguire and Italy-based Syncro srl that began in 2016 with Maguire's investment in Syncro, which specializes in controls for all types of extrusion. If the blown film processor seeks single-point control of the entire production line, Syncro has developed the Syntrol supervisory system, which allows multiple line controls to be visualized and synchronized from one touchscreen. These controls include those for extruder temperature and pressure, air ring, IBC, thickness gauge, cage, and haul-off.

Along with the Syntrol controller, Syncro supplies key line components, including air ring and auto profiler, IBC and layflat controls, gauging systems, and winder.

A turnkey system that includes these components plus Maguire's loading and blending equipment is available directly from Syncro and can also be ordered through Maguire representatives. In addition to the WXB blender and 4088 controller, Maguire produces the compact MLS "mini-central" loading system; FlexBus plantwide conveying system, which can operate up to five vacuum pumps and 240 receivers; and the FlexBus Lite system, allowing local control of a single pump and up to 10 receivers.


For an existing production line that includes a standard Maguire Weigh Scale Blender instead of the WXB unit, the processor can obtain the new extrusion control capability by installing the 4088 controller, a loss-in-weight hopper, and the Syncro controller.

THERMOFORMING

## Next-Generation Cup Former

Kiefel has enhanced its KTR 5.2 Speed cup-forming machine to provide higher output, lower energy consumption, and an intuitive user interface—all at the same machine footprint. The system was on display in Düsseldorf at the K 2019 show in October.

In the forming station, Kiefel has taken steps to improve the rigidity of the machine's drive train while reducing vibration throughout the system. The new motor-gearbox combination permits speeds up to 50 cycles/min and increases the punching force to 44 tons. The new backlash-free upper-yoke adjustment rounds off the new forming station. Enlargement of the usable forming surface increases the number of cavities in the tool, while optimized fast tool change reduces downtime.

Flow-optimized forming-air lines fill the cavities consistently and reduce the filling time by 25% and the venting time by 30%, Kiefel says.

A long heater ensures precise heat distribution for PP and multilayer films. Nominal heater wattage has been reduced by about 15% while maintaining the same heat input, according to Kiefel. The new tool cooling system is fully automatic and sensor-controlled, reducing energy losses while improving tool life and product quality. The KTR 5.2 Speed utilizes two separate cooling circuits for the upper and lower tools. Two high-pressure pumps and mixer valves supply the two circuits with cooling water; the integrated temperature control ensures optimal tool protection. Startup automation is sensor-controlled, reportedly preventing overshooting of the lower tool.

The new, gentle film guide avoids scratches, particles on the film, or loss of contact heat. Threading of the film is greatly improved thanks to excellent ergonomics and new geometry at the infeed table. Linear guides ensure optimum film spreading, and strain relief is provided by separable movements. Manual height adjustment and position control are also provided. New lubrication points for tabs and chains, as well as continuous lubrication of the chains, prevent lubricant from reaching the film.

The stacking system, called Speedstacker, is designed for a wide variety of formed parts. Operation and maintenance of the stacker are reportedly simple; format changes are quick, safe and ergonomic. One operator panel controls the entire forming system, including the stacker.

COMPOUNDING

## Beefed-Up Controls for Mixing

At K 2019, Farrel Pomini featured a Compounding Tower with a Synergy Control System that offers control of feed systems from the operator touchscreen; integrated control of support equipment upstream and downstream; automatic startup of downstream processes; automatic shutdown under normal and fault conditions; and remote monitoring and support capability.


In addition, Farrel Pomini's parent company, HF Mixing Group, showed its new Advise 4.0 Mixing Room Automation system. This modular system covers every process within a mixing room: materials storage, manual and automated weighing of small components, mixing processes, downstream equipment and storage of mixtures. Standard interfaces enable easy connection to ERP systems and laboratory equipment.

RECYCLING

## Innovations in Low-Speed Granulation

During K 2019, Rapid Granulator unveiled what it calls "the biggest innovation in low-speed granulation in years." The new OneCut Pro gives injection molders the flexibility to adjust the speed range when granulating at slow speeds—from the standard 25 rpm to a range of 15-35 rpm.


Running the new machine at the low end of the speed range helps improve regrind quality for highly brittle materials by minimizing dust generation, Rapid says. Reducing rotation speeds from 25 rpm to 15 rpm also reduces noise levels by as much as 3-5 dba. Running the machine at higher speeds improves cutting of soft materials and allows molders to increase capacity by 30-40%. The torque level of the machine is maintained regardless of the speed at which it is running.

Additional benefits of the new machine include the "Open Hearted" design, which facilitates access for cleaning and maintenance. The OneCut Pro also uses a new system that reportedly can cut energy usage by 80%. Operators can stop the machine when accumulating materials, rather than having it run continuously. With Rapid Stop & Go mode, the granulator will stop and go at intervals, so there is zero energy consumption and no noise during pause mode.

The company also presented its new line of ThermoPRO granulators for in-line processing of thermoforming skeletal waste (photo). Its new heavy-duty roller-feed system also can handle startup scrap with formed cups up to 200-mm deep in the web. It operates at a noise levels below 80 dba.

RECYCLING

## New Metal Detector & Material Analysis System

Sesotec GmbH showcased its new Rapid Pro Sense 6 metal detector at K 2019. It is equipped with a new reject mechanism designed for compounders that have frequent color changes or process abrasive materials. Also new at the show was the Flake Scan plastic flake-analysis system, designed for laboratory use. Companies looking to turn recyclates into new granulate can use Flake Scan to inspect incoming goods.

Another new product is the ASM Quasar optical sorting system, which can be used for granulate quality assurance to ensure, for example, removal of granulate with black specks. Along with color, the system can analyze surface, shape and size.

Using the new Visudesk visualization program, all Sesotec devices in a plant can be monitored and controlled, using an OPC-UA machine communication protocol.

TOOLING

## External Double-Ejection Systems

New double-ejection systems, launched at K 2019 by CUMSA, control the sequence of double ejection or plate openings. There are three types—EX, EY, EZ—and each version controls travel, which is determined by the processor, so that they stop at the selected plates in a locked position while the other plates continue to move.

CUMSA says all three styles feature external setup, simple maintenance, easy installation, robust design; and four different rod diameters: 14, 20, 32 and 50 mm. The EX External Superior Plate Separator is available in four sizes and can be used in two different situations—a pre-opening plate movement of the mold and a double-ejection system. In this setup, the EX controls two sets of ejector plates so that when the machine actuates, the upper ejector plates are set. The first opening width is customizable up to 250 mm for the two smaller EX sizes. For the two larger versions, width ranges up to 375 mm.

The EY External Double Ejection line, which is also available in four sizes, was designed for molds where the upper set of ejector plates are separated, and the machine actuates the lower set of ejector plates. The upper set stops at the core plate, while the rear plate continues to travel until it reaches the upper plate. This series can customize the first opening from 30 to 80 mm.

The EZ External Plate Synchronized model is available in four different sizes as well, and was designed to allow synchronized mold plate openings, regardless of their location. With this design, once the first stroke is defined, the selected plates will open at the same time, and then the rest of the mold will open freely. The first stroke is customizable up to 250 mm for the two smaller sizes, and up to 375 mm in larger sizes.

CUMSA also notes that extension rods are available for the EX, EY and EZ lines, enabling the use of the external double-ejection systems in taller molds.

MATERIALS

## High-Flow ABS for Thin-Walled Large Housings

The latest addition to the Novodur family of ABS resins from Ineos Styrolution boasts high flow with a melt volume rate (at 220 C/10 kg) of 60 cm³/10 min (ISO 1133). According to the company, which featured the new Novadur P4XF at K 2019, the material has been shown to allow processors to optimize their molds for faster manufacturing by reducing the number of injection gates for large parts and by increasing the number of cavities in multi-cavity tools.

Large parts for air conditioners, vacuum cleaners and coffee machines are just some targeted applications. It reportedly can offer faster cycles, shorter cooling times, lower warpage, higher stiffness, higher surface quality and scratch resistance, and less dust attraction/electrostatic charge. Ability to use lower injection pressure allows for smaller injection machines with this ABS.

# 2019 Ends with Lower Prices for Commodity Resins

## Global demand slowdown and oversupply end the year with a buyers' market.

By Lilli Manolis Sherman
*Senior Editor*

The fourth quarter of this year has been widely viewed as a buyers' market for the five volume commodity resin markets, whose prices are nearly all on the downslide. Key drivers include a global slowdown and lower prices abroad, a drop in prices of key feedstocks, and more than ample supply in many cases.

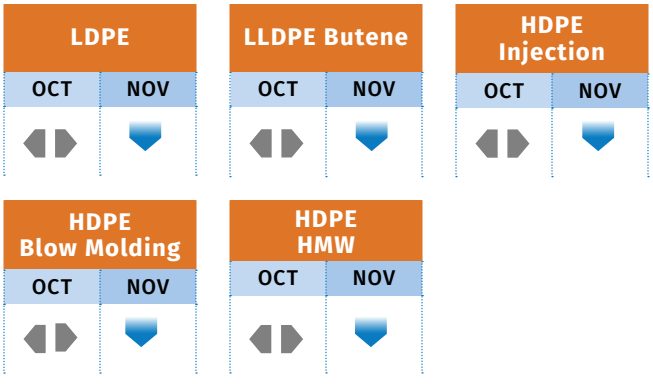
Meanwhile, demand for bales of recycled material is going through the roof—particularly for HDPE and PP, with consumer brands demanding more recycle-content products—a trend that will only grow faster.

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

### PE PRICES SOFT

Polyethylene prices were flat in October after the September 3¢/lb increase, but a change was afoot. The 3¢ hike was largely expected to evaporate by November's end, according to Mike Burns, RTi's v.p. of PE markets, *PCW*'s senior editor David Barry, and The Plastic Exchange's Greenberg. They also predicted a further drop this month. Burns advised that processors delay purchasing, and Barry suggested that further price erosion, on the order of 3¢/lb, was possible before year's end.

**Polyethylene Price Trends**




These sources say this buyers' market ought to be helpful to processors in 2020 contract negotiations. They base this on weak global market demand, along with the impact of trade tariffs. According to Barry, this "new normal" with all the new PE capacity has pushed suppliers to move material out quickly. "There is more sustained high-volume export activity from North America than ever before to areas such as Southeast Asia, Europe and Africa, a trend that will need to continue as domestic demand for 2019 is likely to end in negative growth," he noted. Barry cited American Chemistry Council numbers for the third quarter, which show sales of HDPE down by 5%, LDPE down 6%, and LLDPE up 1%—for a cumulative drop of 3%. In the first week of November, Greenberg reported that spot PE prices were lower in the face of lackluster domestic demand.

**Market Prices Effective Mid-November 2019**

| Resin Grade | ¢/lb |
|---|---|
| **POLYETHYLENE (railcar)** | |
| LDPE, LINER | 95-97 |
| LLDPE BUTENE, FILM | 78-80 |
| NYMEX 'FINANCIAL' FUTURES | 33 |
| NOVEMBER | 30 |
| HDPE, G-P INJECTION | 100-102 |
| HDPE, BLOW MOLDING | 93-95 |
| NYMEX 'FINANCIAL' FUTURES | 33.5 |
| NOVEMBER | 30 |
| HDPE, HMW FILM | 107-109 |
| **POLYPROPYLENE (railcar)** | |
| G-P HOMOPOLYMER, INJECTION | 68-70 |
| NYMEX 'FINANCIAL' FUTURES | 45 |
| NOVEMBER | 41 |
| IMPACT COPOLYMER | 70-72 |
| **POLYSTYRENE (railcar)** | |
| G-P CRYSTAL | 108-110 |
| HIPS | 112-114 |
| **PVC RESIN (railcar)** | |
| G-P HOMOPOLYMER | 82-84 |
| PIPE GRADE | 81-83 |
| **PET (truckload)** | |
| U.S. BOTTLE GRADE | 47-51 |

### PP PRICES DROPPING

Polypropylene prices went up 1¢/lb in September in step with propylene monomer contracts and then followed October monomer contracts down 1.5¢/lb a month later. (Monomer settled at 37.5¢/lb.) However, both *PCW*'s Barry and Scott Newell, RTi's v.p. of PP markets,

### Polypropylene Price Trends

| Homopolymer | |
|---|---|
| OCT | NOV |
| ↓ 2¢/lb | ↓ |

| Copolymer | |
|---|---|
| OCT | NOV |
| ↓ 2¢/lb | ↓ |

reported that additional PP price cuts of 2-3¢, and as much as 5¢/lb, were being negotiated by some buyers in the fourth quarter. The Plastic Exchange's Greenberg said spot PP availability was good. "Weaker feedstock costs are pointing to lower November PP resin contracts, and suppliers got ahead of the game by offering cheaper spot PP prices, down about 2¢, which spurred better buying."

According to Newell, demand for PP has been disappointing all year, with supplier inventories in October at an all-time high of 39-40 days. He expected that processors' inventories were also high as they felt the "headwinds of low demand" at the start of the second half of this year. "So I see suppliers needing to cut production rates. Both domestic and export sales were down, although exports are the one thing that has kept the PP market from going negative by end of the third quarter—it was actually up 1.1% overall."

## PS PRICES FALLING

Polystyrene prices were flat in October, but the tide was fast changing as benzene prices dropped along with demand, according to both *PCW*'s Barry and Robin Chesshier, RTi's v.p. of PE, PS and nylon 6 markets. These sources thought that November PS prices would drop 2-3¢/lb, with the potential for another 2¢/lb decline this month.

### Polystyrene Price Trends

| GPPS | |
|---|---|
| OCT | NOV |
| ◀▶ | ↓ |

| HIPS | |
|---|---|
| OCT | NOV |
| ◀▶ | ↓ |

Both sources noted that October benzene contract prices held at the lowest level of the year, $2.60/gal; but spot benzene prices had dropped to as low as $2.10/gal, and nominations for November contracts were for $2.23-2.25/gal. Barry reported that November spot PS prices were down 3¢/lb, driven by lower benzene costs and demand that was slow even by seasonal standards. He noted that by the end of the third quarter, PS demand was down 4%, year-to-date.

## PVC PRICES FLAT TO DOWN

PVC resin prices held even in September and were likely to stay put in October too, despite suppliers' 3¢/lb increase for that month, according to both *PCW* senior editor Donna Todd and Mark Kallman, RTi's v.p. of PVC and engineering resins. Suppliers attributed their price move to ethylene prices, which rose a total of 6.25¢/lb from July through October.

However, both sources noted that PVC prices did not drop in the spring when ethylene prices fell 10.25¢/lb. "They can't have it both ways," says Kallman. Ethylene prices were projected to be flat in November and sink lower in December.

Kallman predicted that PVC prices would likely be flat to down by about 1¢/lb in November-December. He also said suppliers will need to be competitive in their 2020 contract negotiations, with lower prices at the start of the new year. He projects that 2020 will be another challenging year for PVC, noting that total demand, domestic and exports, through the third quarter, was down by 3% (with domestic down 4%, and exports down 1%). Todd reported that pipe makers would rather not see a price drop, as they have been struggling to push pipe prices up prior to the winter slow season, without much success. But, she added, "Converters in the other downstream markets definitely want to see PVC prices decline, and are telling their suppliers that if it doesn't happen they will come after the reduction in contract negotiations as resets."

### PVC Price Trends

| Pipe | |
|---|---|
| OCT | NOV |
| ◀▶ | ◀▶ |

| Gen. Purpose | |
|---|---|
| OCT | NOV |
| ◀▶ | ◀▶ |

## PET PRICES DOWN

PET prices ended October as a rollover in the 47-51¢/lb range. By early November, domestic PET resin buyers were bidding at the low-to-mid 40¢/lb range for delivery on the West Coast. Selling interest by distributors was firm at the high 40s-low-50¢/lb range, according to *PCW* senior editor Xavier Cronin.

### PET Price Trends

| Bottle Grade | |
|---|---|
| OCT | NOV |
| ◀▶ | ↓ |

He reported that November was expected to remain a buyers' market for PET, with plenty of penciled-down resin (normal-spec resin priced lower to liquidate surplus inventory) and offgrade PET due to bloated supply. As for this month, it was largely expected that PET prices would drop 2-5¢/lb due to the supply factor and the holiday demand slowdown. Cronin noted that there is plenty of resin available from domestic producers and their distributors; with plenty of imports available from around the world throughout the country—from the Eastern Seaboard to the Gulf Coast, Great Lakes locations, the Pacific Northeast and the Golden State. PT

# Index Dips on Weak Exports, Employment

## October's number drops from September, despite expansion in new orders.

By Michael Guckes
*Chief Economist/Director of Analytics*

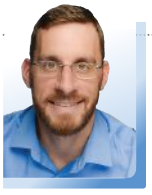
At 47.1, Gardner's Plastics Processing Index moved marginally lower in October due to weaker export and employment activity. (Readings above 50 indicate expanding activity while values below 50 indicate contracting activity. The farther a reading is from 50 the greater the change in activity since the prior month.)

Analysis of the underlying components of the Index during October reveals that new orders expanded for the first time since June. Despite this improvement, all other components of the index registered contracting activity. The October reading was weighed down by an accelerating contraction in exports, backlogs and employment.

After recording a very mild contraction in September, employment activity contracted sharply during October. Employment readings often shed light on the mid-term business outlook of manufacturers, given the time and challenges associated with hiring new talent. For this reason, manufacturers tend to retain employees when conditions are only briefly challenging; however, in case of expectations for a prolonged downturn, managers are more likely to reduce payrolls.

October's expansionary reading for new orders, coupled with an accelerating contraction in exports, implies that domestic new orders expanded strongly during the month. The implied strength in domestic orders may in part account for higher backlogs than in recent months. Although the latest backlog reading registered below 50, it was the highest in several months, indicating slowing contraction in backlogs.

The Index is based on monthly surveys of subscribers to *Plastics Technology* Magazine.



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

### Gardner Business Index: Plastics Processing

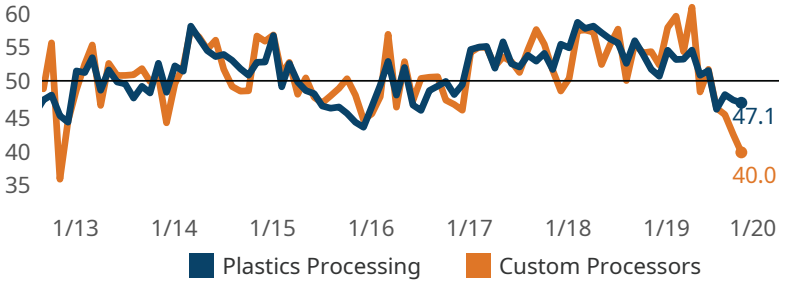



FIG 1

**Both the overall Plastics Processing and Custom Processors Indices contracted during October. Both indices have been weighed down by strongly contracting backlog and export conditions.**

### Plastics Processing: Employment & Exports

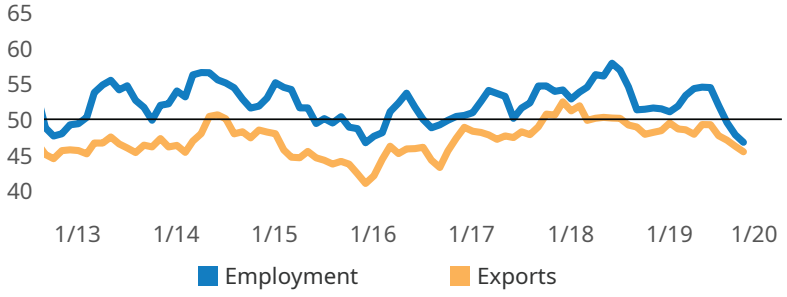



FIG 2

**The trend in export activity since March has been accelerating contraction. This enduring trend may be affecting the long-run view of managers in the industry, causing processors to change their employment levels.**

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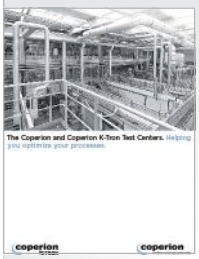


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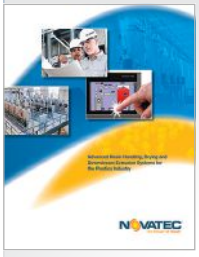


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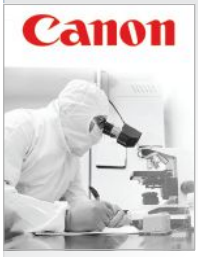


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POLYMER FILM & BAG INC. — MASSILLON, OHIO

# Packaging Converter Launches Film Extrusion Business

## Polymer Film & Bag Inc. will start with three-layer capacity of more than 20 million lb/yr, with additional expansion plans already firmed up.

By Jim Callari
*Editorial Director*

A firm with long-established roots in the converting industry—among other businesses—is branching out into blown film extrusion. Conversations with customers that started a year ago convinced Polymer Packaging Inc. (PPI) that consolidation in the film extrusion business had created a need for fast, nimble, customer-centric suppliers of high-end films, and the firm has responded by launching a new entity, Polymer Film & Bag Inc. Both firms are based in Massillon, Ohio.

PPI was founded in 1986 by Larry L. Lanham, its current CEO. Since its inception, it has evolved from a brokerage firm buying and selling PE-based film into a company that offers a range of full-service manufacturing and converting operations. These include pouch making, protective packaging, and a patented process called Inno-Lok that applies a recloseable zipper to film webs for use on vertical form-fill-seal packaging machines. Major end markets served by PPI include food, industrial, medical and pharmaceutical.


**Polymer Film & Bag is starting with two three-layer lines from W&H, one an Optimex and the other a Varex II (photo).**

Late last month, Polymer Film & Bag was scheduled to start up the first of two three-layer blown film lines from Windmoeller & Hoelscher Corp. It is a W&H Optimex line, and it will be running coextruded film in layflat widths up to 71 in. By January 2020, the second line should be up and running. This will be a W&H Varex II line to produce three-layer film in layflats up to 87 in. This line will be equipped with W&H's Turboclean technology, a system that is said to reduce the time it takes for full job and format changeovers from 30 min to about 12 min.

The new lines will make bags on rolls, individual clean-cut flat bags, gusseted bags, converter-grade three-layer sealant sheeting, and stretch-hood and shrink films. Beyond this initial capacity of over 20 million lb/yr, four additional lines are projected to be installed in 2020 and 2021, says Chris Thomazin, PPI president. "While our initial capacity is three-layer, we will let our success with the new lines dictate where we will go, from a technology standpoint, with the additional lines," Thomazin added.

He says Polymer Film & Bag will make multi-layer films that are stronger than conventional film but also thinner, as a result of both resin technology and superior gauge profile, which significantly reduces the consumption of raw materials during production.

The new film and bag business is located in an existing 100,000 ft² section of the Polymer Packaging plant that was previously used for warehousing, This first-phase extrusion section was set up and designed to house initially up to six lines with room to expand to 18 lines. Polymer Film & Bag will employ 20 people, some of whom are currently with PPI in other roles, while others with experience in blown film were hired from the outside.

While some film capacity will be used internally by its sister company PPI, Thomazin characterizes the firm's expansion into blown film as "a true opportunity for growth, and not just vertical integration." He elaborates, "The process for us started about a year ago. We'd visit customers and ask them, 'Where are our opportunities for growth?' Often their answer was the same: 'Get into film production.' The film extrusion industry has experienced a lot of consolidation over the years, and we felt that provided an opportunity for a fast, flexible company like us to get in with high-quality films produced on very sophisticated equipment."

Adds Lanham, "In order to service the diverse needs of our customer base, we decided to install a very wide range of film and construction capabilities, allowing future market needs to mandate what the expanded capabilities will be. W&H uniquely offered the best solution to accommodate this need today and into the future. We've invested in our future by expanding with the latest in equipment and material technology to provide engineered film solutions that offer source reduction, increased throughput and improved film performance." PT

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