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Precision Decisions

Midwest Precision Molding's Growth Strategy

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CONTENTS

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Plastics Technology

ABOUT THE COVER Larry Austin (left) and Patrick Austin (right) of Midwest Precision Molding stand in front of their newest equipment addition, a vertical overmolding cell from Sodick. See story on page 24.

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Open Press/No Operator

Order for parts? Check. Material…machine…mold? Check…check…check. Operator? Operator…?

Ask a plant manager what four words they never want to hear and more than a few would say: open press/no operator. It's shorthand for when lack of a machine operator is the only thing preventing a manufacturer's capital equipment from running — and making the company money. Open press/no operator is the unfortunate scenario many injection molders find themselves in as they struggle to keep their shop floors fully staffed.

Tony Deligio
Editor-in-Chief

At PTXPO's Workforce Development Workshop, John Williams, plant manager at Plastikos and Plastikos Medical, Erie, Pennsylvania, shared that his company's ERP system actually has a downtime code for that particular scenario. Thankfully, due to its efforts to recruit, train and retain employees, it's not a code it inputs very often.

At the workshop, Williams was joined by Todd Shackett, Southern Union State Community College (SUSCC); Hannah Belmont, Westminster Tool; and Alex Beaumont, Beaumont Group.

Prior to becoming the president of SUSCC, Shackett came from manufacturing and molding, with stints at General Motors, Becton-Dickinson and Baxter over his more than 30 years in industry. He was actually still in industry in Alabama working on an advisory panel for SUSCC when the school approached him about becoming its president.

That interplay between local manufacturers and area schools of all levels — from elementary to college — was a recurring theme in the workshop and at the PTXPO event. Westminster Tool hosted STEM classes of fifth-grade students each day of the week for all of October to honor Manufacturing Day in 2024; while Williams at Plastikos acts as a mentor at the local high school's automation program, regularly meeting with 12th graders as they prepare their senior project. SUSCC and AIM both have industry advisory boards they confer with to learn what area businesses are looking for in new hires and how that might impact curriculum.

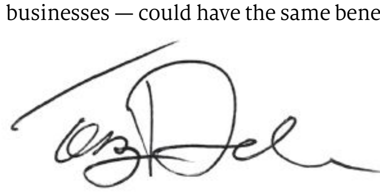
While at PTXPO, I met with Doug Pauley and Karl Anderson, who came to the show from Nebraska's Central Community College (CCC). CCC's Columbus, Nebraska, campus initiated a plastics training program in 2018 in conjunction with the city's biggest employer — Becton-Dickinson — as it sought to create a local pipeline of skilled workers. CCC was awarded a grant to help it promote the training among English-as-a-second-language populations.

Pauley, Anderson and the workshop panelists noted there are grants available at the state and federal level to help finance such efforts, but finding them, as well as willing partners, can be challenging.

Finding willing students and employees is also difficult. Every week at SUSCC Shackett has lunch with students and he always asks them what they're interested in doing after school. Nearly every time he does at least one responds: crime scene investigator — no doubt a result of the long-running TV show. But for Shackett, that's the point, it's the familiarity with that field that sparks interest. He wonders how many of those same kids drive by the very high-tech manufacturing facilities in their own communities and have no idea what happens inside (or that they're hiring for high-paying jobs). A hit TV show about injection molding might not be on the horizon, but efforts by manufacturers to engage with schools — both to introduce their students to the local successful business and also to make sure those schools help prepare potential future employees for those businesses — could have the same beneficial impact.

Todd Shackett, president of SUSCC, at PTXPO's Workforce Development Workshop. Source: Gardner Business Media

(left to right) Karl Anderson, Doug Pauley, of Nebraska's Central Community College (CCC), alongside Tony Deligio at PTXPO 2025. Source: Central Community College



Husky Buys Advanced Multishot Technology from MGS

Husky Technologies has purchased a secondary injection unit and rotary platen technologies from MGS Healthcare Manufacturing (MGS), a global provider of health care manufacturing solutions. In a release, Husky says the acquisition further strengthens its position as a leading provider of integrated multimaterial solutions across key industries, including medical, packaging and consumer electronics.

This move enables precision secondary injection units and rotary platens to be integrated with Husky's industry-leading Altanium mold controller technology. Integrating these advanced multishot technologies enhances Husky's ability to provide comprehensive, high-performance, turnkey solutions tailored to the production of multimaterial and multicolor applications.

These technologies also enable Husky to expand its offering of fully integrated, multimaterial solutions, improving manufacturing efficiency and performance, the company says. What's more, it creates new opportunities for growth in the packaging, medical, personal and home care markets, enabling producers to benefit from a more complete range of innovative, high-performing solutions, according to Husky.

"This acquisition reinforces our commitment to innovation and excellence," notes Robert Domodossola, Husky's president of systems and tooling. "By bringing these complementary technologies into our portfolio, we are enhancing our ability to serve customers with integrated, high-performance solutions that drive efficiency and growth."

Adds Shawn Krenke, chief technology officer of MGS: "MGS is pleased to announce the divestiture of its Multishot product line to Husky. As a global leader in injection molding technology and a key strategic supplier to MGS, Husky is the ideal organization to take over and continue advancement of the Multishot product line. This divestiture allows MGS to concentrate on being a world-class contract development and manufacturing partner to our health care customers and we are dedicated to working closely with Husky to ensure a seamless transition and integration for all future and existing customers."

Engel Opens Injection Molding Machine Manufacturing Plant in Mexico

Engel, the Austrian manufacturer of injection molding machines and automation, has opened a new production facility in Querétaro — the heart of the manufacturing area of Mexico located in the Bajio Region, 130 miles from Mexico City. This is the company's newest injection molding machine manufacturing facility on the American continent and its tenth globally, demonstrating its focus and commitment to providing faster delivery times and greater availability of injection molding machines for customers in all the Americas.

In an exclusive interview, Stefan Engleder, CEO of the Engel Group, says that this expansion enables the company to significantly accelerate the start of production and ensure greater machine availability for customers throughout the region.

The Querétaro plant has the capacity to produce between 180 and 200 injection molding machines per year and offers space for future expansions. Thus, Engel plans to increase production over the next two years, strengthening its capacity to supply injection molding machines to customers across the American continent.

In addition to increasing production, Engel is also expanding its workforce. It currently has 205 employees and plans to increase this number to 300 over the next 12 months.

"We have a very elaborate training scheme," Engleder says. "We hire engineers and logistics specialists directly from universities and technical schools. They are then sent to Austria to receive intensive training for several weeks, which can extend up to three or four months. They return to continue with practical local training. This is the basis to ensure the quality standards we have in Austria."

Engel will initially manufacture two series of injection molding machines at this plant: the e-mac series (a fully electric machine) and the WINTEC t-win (a large two-platen hydraulic machine), as well as robots and customized automation offerings. The goal is to develop vertically integrated production and a comprehensive solutions center for automation and technical support.

According to Vanessa Malena, president of Engel North and South America, the strong connection with the corporate office in York, Pennsylvania, enables seamless support across the Americas for its customers with plants in both countries.

AIM Institute Continues to Grow Plastics Education and Training on 10th Anniversary

Not many 10-year-old educational institutions can attain both the growth and achievements accomplished by the American Injection Molding Institute (AIM). Since its founding in 2015, the organization has provided accessible, collegiate-level training to thousands of individuals who are involved with the design, development and manufacture of injection molded plastic parts.

According to AIM Institute Director David Hoffman, the institute has witnessed remarkable career transformations in its students and is proud to continue shaping the future of this vital industry.

Some of AIM's first decade of key achievements include expanding from two to 35 courses, and establishing the first and only education and training programs that are ANSI/ASTM accredited. It has also collaborated with educational institutions to broaden apprenticeship and degree program opportunities. And, in honor of one of its founding supporters, it established the "Mike Sepe Memorial Gift," providing educational assistance to high school students beginning their journey into the world of injection molding.

AIM was created in response to the rising need for skilled injection molding professionals. Founded on the principles of research, engineering, technology and practical experience, AIM evolved from Beaumont Technologies' efforts to provide clients with a fundamental understanding of plastic rheology and plastic flow through a mold.

Over the past decade, AIM has continued developing its injection molding education and training programs, cultivating critical thinking skills to empower students to drive innovation, leverage technological advancements and develop root-cause solutions.

Moldmakers Honored at PTXPO 2025

Members of the moldmaking community were recently honored for excellence at the Plastics Technology Exposition (PTXPO) 2025. The Mold Technologies Division of the Society of Plastics Engineers presented the following awards at PTXPO in the SPE Mold Technologies booth.

These four international awards are presented annually for individual expertise as well as individual contributions to the industry and community.

Edward Duignan (pictured below) of Thermo-Fisher Scientific, Rochester, New York, was named the 2025 Moldmaker of the Year, sponsored by Hasco America. Duignan is a 47-year veteran of the moldmaking industry having started his career at the Rochester Institute of Technology (RIT).

Jim Fattori, Injection Mold Consulting, was named the 2025 Mold Designer of the Year, sponsored by Progressive Components. Fattori is a third-generation moldmaker/designer with a degree in industrial engineering from Northeastern University in Boston, Massachusetts. He has written more than 60 articles for *Plastics Technology* and *Moldmaking Technology* magazines throughout the course of his career.

Markus Woeste, Molded Precision Components, in Shanty Bay, Ontario, Canada, was named 2025 Mold Repair Technician of the Year, sponsored by MoldTrax. Woeste is a 37-year veteran of the moldmaking/repair industry.

Nick Paxon, Thermo-Fisher Scientific, Rochester, New York, was named the 2025 Apprentice of the Year – Moldmaking, sponsored by PCS Company. Paxon completed his New York State Certified Apprenticeship in January 2025. His scholastic achievements include carrying a 3.8 GPA through the related theory program in advanced CNC programming.

Also, *MMT* Editorial Director Christina Fuges was honored when the board unanimously named her an honorary moldmaker and presented her with her own Gerstner toolbox. Fuges is a 28-year veteran and proponent of all things moldmaking and

Precision Concepts Buys Meredith-Springfield

Precision Concepts International announced in March that it had acquired Meredith-Springfield Associates Inc. (MSA) of Ludlow, Massachusetts. Meredith-Springfield specializes in design and blow molding of PET and HDPE bottles and containers, especially those presenting technical challenges. It was co-founded in 1983 by Mel O'Leary, president and CEO. Precision Concepts says Meredith-Springfield will continue to be led by its existing leadership team.

Based in Huntersville, North Carolina, Precision Concepts is a diversified manufacturer of rigid packaging — jars, vials, bottles, closures, spouts and deodorant sticks — as well as laminate tubes. It employs extrusion, injection molding (including two- and three-shot), extrusion blow molding, and one- and two-stage stretch-blow molding of PET, HDPE, PP and PS. Primary markets include food and beverages, personal care and nutraceutical industries.

Precision Concepts was launched as Intra-Pac Group in 2003 when it was spun off from CCL Industries. The current name was adopted in 2022. It has around 1,200 employees and nine manufacturing plants located in Georgia, North Carolina, Florida, Indiana, Arizona, and Costa Rica, as well as Ontario and Alberta, Canada, and now Massachusetts.

Meredith-Springfield is the firm's eighth acquisition. "This acquisition extends our footprint in the Northeast and continues our strategy of partnering with world-class, founder-led businesses," says Ray Grupinski, Precision Concepts' CEO.

SPE Is Accepting Nominations for 54th Annual Automotive Innovation Awards Gala

The Automotive Division of the Society of Plastics Engineers (SPE) is now accepting nominations for its 54th annual Automotive Innovation Awards Gala, the oldest and largest recognition event in the automotive and plastics industries. Originally established in 1970, this year's Awards Gala will be held Wednesday, Nov. 5, 2025 at the Laurel Manor in Livonia, Michigan.

Innovation Award winners will be selected in 10 different categories, and the teams that developed them will be honored with a "Most Innovative Use of Plastics" award. Categories include: Aftermarket and Limited Edition/Specialty Vehicles, Body Exterior, Body Interior, Chassis/Hardware, Electric and Autonomous Vehicle Systems, Sustainability, Materials, Power Train, Process/Assembly/Enabling Technologies, and Safety. One "Grand Award" winner will be chosen from the winning teams from all category award winners. The Innovation Award nominations are due by Sept. 13, 2025.

SPE is also accepting nominations for its Hall of Fame (HOF) awards, with those nominations due by May 31, 2025.

These awards recognize those who have made significant and lasting contributions to the application of plastics in automotive vehicles. Additional criteria for an HOF award is that the nomination be: game-changing; very successful worldwide; innovative in materials, process and application; and still being used. The HOF committee consists of engineers, managers, executives, technical experts, SPE fellows, SPE honored service members and automotive industry technical experts who have served at least 30-plus years in the industry.

Nominations must be submitted online.

"Plastics are driving cutting-edge innovations in electric transportation, powering advancements across electric, autonomous and next-generation mobility solutions," says Jeffrey Helms, global automotive director at Celanese Corp. and returning 2025 SPE Automotive Innovation Awards chair. "With this year's theme, 'Leading the Charge,' we emphasize the vital role plastics play in enabling, enhancing and advancing all mobility applications and powertrains."

Circular Plastics From Cyclic Molecules

Macrocycle is pioneering an approach to PET recycling via cyclic oligomers.

By Matt Stonecash
Associate Editor

The molecular structure of polyesters enables a wide spectrum of recycling approaches, both mechanical and chemical. Somewhere in the middle ground between solvent-based extraction approaches and advanced recycling technologies that break down molecules all the way back to the monomer level, sits a company called Macrocycle.

Macrocycle, founded by CEO Stwart Peña Feliz and CTO Jan-Georg Rosenboom, is developing a process based on the phenomenon of ring opening polymerization.

The process uses specialized solvents, catalyst systems and thermodynamics to convert polymer molecules into macrocyclic oligomers, selectively extract them and then upgrade them to a linear PET structure.

Macrocycle is looking at both packaging waste and textile waste as feedstock materials, and is processing both at its pilot facility. While mechanical recycling is well established and effective at processing clear bottle flake, other feed streams are more challenging. "We're not going after those clear flakes, we're going after the bad stuff, stuff the mechanical recyclers don't want. And we are going after the emerging supply of textile waste," Rosenboom says.

CTO Jan-Georg Rosenboom and CEO Stwart Peña Feliz compare their upgraded PET to postconsumer waste samples. Source (all images): Macrocycle.

Textile waste is not widely collected, mostly ending up in a landfill or incinerator in the United States, so the polyester textile waste that is widely available is postindustrial. But that could change. In 2022, Massachusetts enacted a law that makes it illegal to dispose of textiles in trash.

"I think collection of textiles will emerge, and there are folks looking at that waste stream coming online and becoming viable, but they need to figure out how to upgrade the polymer quality and how to remove the impurities that are present," Rosenboom says. Macrocycle is working with its partner Helpsy, a waste collector that brings in textile waste from various brands. Macrocycle analyzes the waste for contaminants before and after recycling to confirm its process removes them.

According to Rosenboom, the process is inherently purifying, such that even if a feedstock contains unwanted or nonintentionally added substances (NIAS), these are removed by the Macrocycle recycling process itself. Testing conducted thus far has found the resulting rPET product to be free of BPA and to have only low levels of acetaldehyde.

Rosenboom's work in ring opening polymerization began as part of his Ph.D. research at ETH Zurich. At that time, the focus was on finding processes for polyethylene furaonate (PEF), a bio-based polyester. Later, this technology formed the foundation for Macrocycle, which Rosenboom formed with Feliz at MIT. "Soon enough I realized this fascinating ring opening-ring closing chain equilibrium chemistry is applicable not only to bioplastic waste but also to existing plastic waste which is already out there," Rosenboom says. Instead of PEF, Macrocycle focuses on recycling processes for PET, going after a polyester already ubiquitous in the market.

In discussions with potential customers, Macrocycle has found that requirements such as viscosity can vary, especially between textile and packaging applications. Macrocycle can produce materials of different chain lengths to meet

Macrocycle's processing system with engineer Dr. Andrés Granados Fócil.

these needs. "We can tune our process very well, and are excited to offer our tailored solutions to industries," Rosenboom says.

Based on technical and economic analysis, the company expects to see both environmental and economic benefits from skipping the repolymerization steps necessary in competitive technologies which go completely back to monomer. According to Rosenboom, much of the energy demand lies in heating and cooling the solvent systems, whereas depolymerization methods incur significant costs in the purification of monomers. "We believe we can be competitive with fossil-grade PET," Rosenboom says, "so, the breakthrough is: lower energy demand and lower cost." Even customers that are not otherwise incentivized to use recycled materials may take notice at the prospect of cheap resin.

Macrocycle recently raised $6.5 million in funding to commercialize its PET recycling technology, which the company will use to expand operations and scale up pilot capacity. With the completion of this round, Macrocycle will be producing larger quantities of material so it can work with customers to develop products such as packaging and textiles. Currently, the company has more requests to test material than it can supply. Before moving to industrial scale, another fundraising round will need to be completed, currently targeted for 2026 or 2027.

Cork Compounds for High Strength, Low Weight Performance Composites

Amorim Cork Solutions enable bio-based designs for injection molded products.

By Matt Stonecash
Associate Editor

Amorim is well known for producing cork stoppers for wine, which it has been doing since 1870. In 2018, the company started up its i.cork pilot factory in Portugal to design new materials and develop technologies. The program has led to a recycled material application for leftovers of wine stopper manufacture as well as post-consumer materials, which are incorporated into Amorim's cork polymer compounds.

The company has found that cork, which is comprised of natural polymers such as suberin and lignin, can be used to offset as much as 70% of synthetic polymer content in some consumer product applications. Cork material can be compounded with three families of polymers: prime (PP, PE, TPU), recycled (PP & PE), and even bio-based (PLA, bio-HDPE, thermoplastic starch) for an all bio-based composite. The resulting cork polymer compounds (CPCs) are compatible with injection molding, blow molding and thermoforming with standard equipment. Converters of traditional polymer compounds should need no new investment in additional processing equipment or tooling to transition to the use of CPCs.

Lisete Moutinho, global technical manager for cork polymer composites at Amorim, describes cork as acting as a natural foam in the compounds. The cellular structure of cork gives it a weight advantage over other particle fillers. Keeping this structure intact during processing is key to leveraging this advantage. Amorim provides recommendations on process parameters, which can include reduced temperature, low packing pressure and reduced injection speed, depending on the type of polymer and size of the product. "We are always part of the industrialization process, there at the first injection molding trials in customers' plants," Moutinho says.

Adding cork to produce CPC will increase the crystallinity degree of the polymeric matrix.

The product line originated from Moutinho's research, which investigates the effect of compounding cork with bioplastics. A 2023 paper in the journal *Materials Science & Engineering*, authored by Moutinho along with Eduardo Soares and Martinho Oliveira, describes experimentation with the injection molding of expanded cork polymer composites produced with PLA, cork powder and expandable microspheres (EMS) used as a blowing agent. Results showed reduced density and lower crystallization temperatures compared with PLA controls.

"Adding cork to the compound increases the crystallinity of the polymer matrix, acting as a nucleating agent," Moutinho says. The increase in crystallinity of the polymer compound enables higher tensile and flexural strength, modulus and impact resistance, along with thermal and chemical resistance.

Amorim cork polymer compounds. Source: Amorim Cork Solutions

Modular storage container molded by Codil from a composite of cork and potato starch polymer developed by Amorim. Source: Jean Luc Adranasolo

Due to the natural resilience of cork, the compounds are suited for applications which require shock absorption such as footwear and sporting goods. Sound absorption is another property beneficial for some applications.

An Amorim cork-based composite with potato starch polymer was used to fabricate part of a modular household storage system called Jack & Jenny. Puzz'le design studio in Switzerland designed the storage system with a goal of making the product as sustainable as possible. Requirements stipulated the product had to be washable, sturdy and biodegradable. "I explored various options including PET felt, bioplastics and recycled plastics. However, each presented challenges — I wanted something entirely eco-friendly, and CPC met all my requirements," says Julien Garnier, industrial designer at Puzz'le.

According to Garnier, the process of developing customized injection molding techniques for the CPC material took time as well as the instrumental collaboration and expertise of both Amorim and injection molder Codil.

"The material choice ensures a minimalist environmental footprint while maintaining high quality and functionality," Garnier says. "It also gives the product a distinctive aesthetic, visually highlighting its natural origins." The Jack & Jenny design won an iF Design Award in March.

MATERIALS

Polymer Science for Those Who Work With Plastics: Why Entanglements — Not Just Molecular Weight — Drive Plastic Performance

Ever try running your fingers through tangled hair? Yeah ... that's not fun, but that's what happens at the molecular level when polymer chains reach the right length. They wrap around each other, intertwine and ... get stuck. Those tangles are the real reason plastics perform the way they do.

This is the third article in my series about applying polymer science to plastic materials (read about repeating units in October 2024 *PT* and molecular weight in January 2025 *PT*).

By David Rhoades

Last time, we looked at molecular weight in the January 2025 issue: what it is; how it's calculated and why it matters. It's a simple concept on paper: just add up the atomic weights in a polymer chain, and you've got its molecular weight. In reality though, while that number is tiny by everyday standards, it's huge at the molecular scale. Polymers are "giant molecules," after all. And they don't come as single chains, either. They're made as a distribution — some short, some long, with most in between.

So far, so good. But to really understand what changes as molecular weight increases, we need to go one layer deeper than just understanding the molecular weight, and that's where the idea of entanglement comes in.

When polymer chains get long enough, something important happens — they start to tangle.

WHAT REALLY HAPPENS WHEN MOLECULAR WEIGHT INCREASES?

Let's step back and consider this: Increasing molecular weight increases the length of the polymer chain, and it's that increased chain length — not just the weight — that causes the real shift in polymer properties.

When polymer chains get long enough, something important happens — they start to tangle. This phenomenon, known as entanglement, refers to the physical interlacing of long chains with one another, much like when a fishing line or long hair gets knotted together (see Figure 1). These are not chemical bonds, but physical interactions that significantly restrict chain movement. Once entangled, the chains are difficult to pull apart, and the material undergoes a dramatic transformation in both its molten and solid states. Entanglement gives rise to strength, elasticity and viscosity — key performance traits driven by these molecular-level constraints.

FIG 1

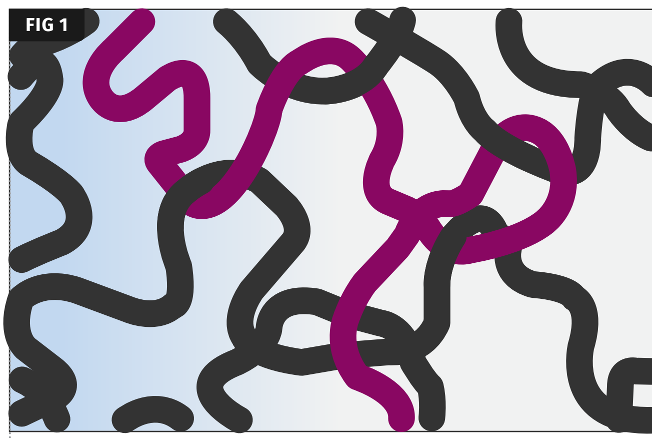


Illustration of polymer entanglement. Source (all images): *Plastics Technology*

HAIRCUTS AND TANGLED CHAINS

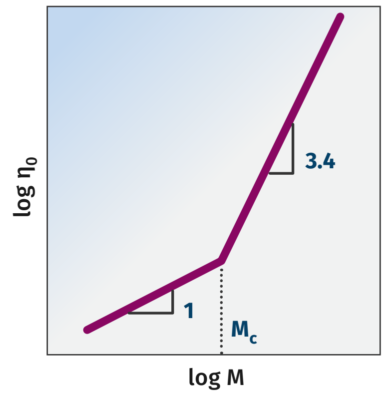
Let's take a step back to consider the idea of tangled hair. Imagine the difference between a buzz cut and long hair. A person with a buzz cut doesn't worry about tangles, right? But someone with long hair — say, down to the mid-back — absolutely does. The longer the hair, the more it is prone to tangle. People with

Scan for more expert advice in materials.

long hair spend time brushing and conditioning it to prevent those painful, damaging knots.

The idea is that when polymers are short (low molecular weight), they don't entangle. But as chain length increases, there's a tipping point where entanglements become unavoidable. That tipping point is what polymer scientists call the critical entanglement molecular weight (M_c). Polymers undergo a kind of metamorphosis at this point — like a caterpillar turning into a butterfly. Before entanglement, the polymer is free-flowing and easier to process. After entanglement, it's dramatically different — it's stronger, tougher and harder to melt, flow and deform. A good way to visualize this is by plotting viscosity versus increasing molecular weight, as seen in Figure 2. Notice how the curve steepens at a particular molecular weight — that's the point of critical entanglement.

FIG 2



Molecular weight vs. zero-shear viscosity, highlighting the point at which molecular weight is high enough for entanglements to begin.

REAL-WORLD EXAMPLES OF ENTANGLEMENT IN ACTION

At low molecular weights — below the critical entanglement threshold — polypropylene (PP) does not have the mechanical strength it needs for structural integrity. It behaves more like a soft, waxy material with poor mechanical strength and limited use in structural applications. As the molecular weight increases and passes the entanglement threshold, PP transitions into what we typically think of as a thermoplastic. It gains toughness, impact strength and ductility, making it suitable for fibers, automotive trim and rigid packaging.

For each application, the molecular weight of the polymer is carefully tuned to achieve the right balance of strength and processability. Caution: too much of a good thing will spoil it, as increasing molecular weight too high makes it more and more difficult to process, as seen in Figure 2 where viscosity steadily increases with molecular weight.

POLYETHYLENE: HDPE VS. LDPE

Polyethylene (PE) offers another useful illustration of the entanglement effect. Both high-density polyethylene (HDPE) and low-density polyethylene (LDPE) are made from the same repeat unit, but their molecular structures differ significantly, see Figure 3.

HDPE is made of relatively linear polymer chains — long, straight molecules with few branches. These chains pack tightly, crystallize easily and create a stiff, dense material. LDPE, on the other hand, has many side branches extending off the main chain. These branches are often hundreds of carbon atoms long — long enough to behave like polymer chains themselves.

The key idea here is that molecular weight matters because of what it causes: entanglement.

And what do those LDPE branches do? They entangle and far more than the linear chains in HDPE. These long side branches create a tangled network within the melt, increasing the number of entanglements. That network gives LDPE greater elasticity, helping it resist sagging and necking during processing. This is why LDPE has significantly higher melt strength than HDPE.

As the material cools, the same entangled network interferes with the polymer chain's ability to align and crystallize. The tangled chains can't easily disentangle, which increases the amorphous content; and because the amorphous phase is what gives a plastic its flexibility, LDPE ends up much softer and more pliable than HDPE.

FIG 3

Molecular diagrams of HDPE and LDPE, illustrating the difference in branching and entanglement.

FINAL THOUGHT: IT'S NOT JUST THE WEIGHT — IT'S THE TANGLE

The key idea here is that molecular weight matters because of what it causes: entanglement. Once chains are long enough to entangle, the polymer's behavior changes dramatically. Toughness, viscosity, elasticity and even thermal properties are all influenced by this molecular-level phenomenon.

But there's a trade-off. If you increase molecular weight too much, the material becomes difficult to process. That's why molecular weight must be carefully tuned for each application — to strike the right balance between mechanical performance and processability.

So the next time you're troubleshooting a plastic material or selecting a resin for a specific application, don't just ask about molecular weight. Consider how entanglements influence the properties you care about.

ABOUT THE AUTHOR: David Rhoades is a lecturer in polymer science and plastics engineering at Penn State Behrend. With a doctorate in polymer science and engineering from the University of Southern Mississippi, he helps students connect classroom learning with real-world applications in the plastics industry. David also consults and guest lectures, using his knowledge to solve practical challenges in plastics engineering. Contact: *814-898-6153; dwr131@psu.edu*.

INJECTION MOLDING

When Injection Molding Simulation Can Be a Great Troubleshooting Tool

Injection molding simulation can serve as a powerful tool not just for design but also for ongoing production optimization.

By Erik Foltz

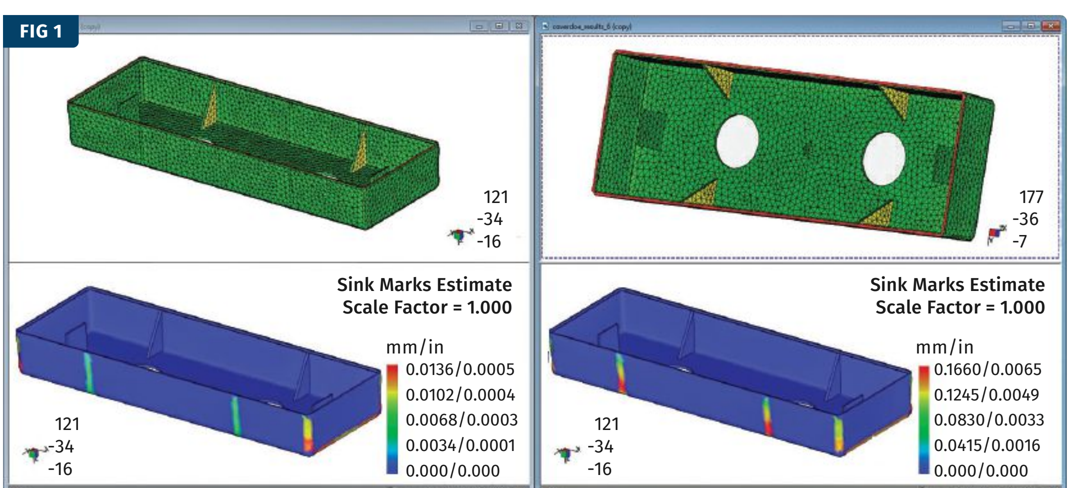
As plastic product designs become more intricate and customer demands continue to rise, the challenges for designers and manufacturers grow significantly. Parts are being designed with thinner walls, and more complex features are being integrated into compact assemblies, pushing the limits of traditional plastic part design. These advancements often lead designers to break established design rules, creating new risks and complexities. In response, molders and toolmakers are tasked with finding innovative solutions to address these challenges while preserving the original design intent.

Injection molding simulation tools, such as Autodesk Moldflow, have become essential for identifying potential risks early in the design process, enabling designers and OEMs to explore effective solutions to mitigate these risks. While simulation is traditionally viewed as an upfront tool used during the design phase, its value extends well beyond that. In fact, injection molding simulation can be an invaluable trouble-shooting resource during initial mold qualification and for addressing persistent manufacturing issues. This article will explore how injection molding simulation can serve as a powerful tool not just for design but also for ongoing production optimization.

Injection molding simulation creates an opportunity to build a digital twin of the mold and process, enabling stakeholders to get a peek inside the tool.

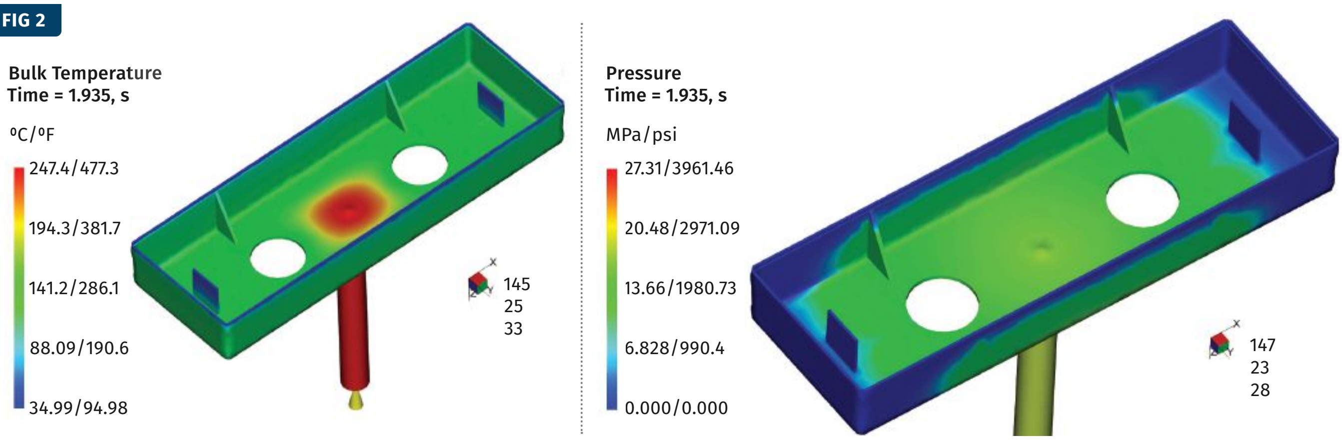
Considerable time and effort are invested on a given design to ensure it will be able to perform its intended function. This includes selecting the right material for the application, designing robust attachment and stiffening features, and ensuring ease of assembly. However, once the design has been finalized and turned over to the manufacturing partner, the timeline is often compressed and leaves little margin for error. When issues arise during the mold qualification process, a solution needs to be identified quickly.

FIG 1



Injection molding simulation can expand the variables of a DOE to geometric features, like rib thickness, to see how the part quality might be influenced. Source (all images): The Madison Group

FIG 2



Injection molding simulation enables monitoring of the plastic conditions of the molten polymer throughout the entire cavity, which provides more information for troubleshooting problems. Images above show the temperature (left image) and pressure (right image) throughout the entire cavity at a specific time in the molding cycle.

Oftentimes, a molder will resort to developing a physical design of experiments (DOE) where many different populations are generated that vary the conditions under which the parts are made. These populations will then need to be tested or measured, which leads to long delays and significant additional costs to find a solution. Moreover, many times the molder has limited data it can collect and utilize to find an end solution. Injection molding simulation creates an opportunity to build a digital twin of the mold and process, and enables the stakeholders to get a peek inside the mold and gather significantly more data to help them identify potential root causes and make decisions.

Simulations create thousands of nodes that act as virtual in-mold sensors, recording data about temperature and pressure history through mold filling and packing.

SIMULATION EXTENDS INVESTIGATIONS BEYOND PROCESS VARIABLES INTO GEOMETRIC VARIABLES

While a physical molding trial can investigate process variables related to the molding operation, it cannot easily account for geometric features within the part or mold design. As stated previously, while an issue may be identified during the manufacturing of the component, manufacturing may not be the root cause of the rejected parts. Rather, the issue may be related to a misalignment between the mold construction and part design. Many of the injection molding simulation packages available today enable not only the process variables to be investigated but can efficiently examine how modifications to features like rib or part wall thicknesses, gate size or even gate location can affect the part quality (Figure 1). All these changes can be performed in CAD, which helps minimize costs and reduces the time to quantify the potential benefit.

SIMULATION CAN GENERATE MORE DATA POINTS BY LOOKING INSIDE THE MOLD

In addition to increasing the scope of an investigation, injection molding simulation enables the analyst and designer to gain insight into what is happening to the plastic material as it flows into the mold. The simulation creates thousands to hundreds of thousands of nodes that essentially act as virtual in-mold sensors, recording data about the temperature and pressure history through the mold-filling-and-packing stages.

Therefore, we are not limited to a few select points where a pressure or temperature may be measured in a mold by a sensor, or the values at the injection unit. Rather, we can quickly investigate the distributions within the cavity, and how the conditions may change based on either time or distance from the gate. This can be invaluable data for troubleshooting cosmetic issues such as splay, flow lines or sink formation.

SIMULATION CAN BREAK DOWN THE CAUSES OF PART WARPAGE

The benefits for simulation have been well documented for optimizing the mold-filling parameters of a given component and mold design. However, as the technology has evolved and the material data fidelity has improved, simulation increases its utility in helping better identify the driving factors for part warpage. Injection molding is attractive because of its ability to produce dimensionally stable parts. However, warpage is dependent on numerous variables and their interaction with one another. When performing a physical DOE, it can be difficult to capture the influence of all the variables, like mold temperature, plastic temperature and

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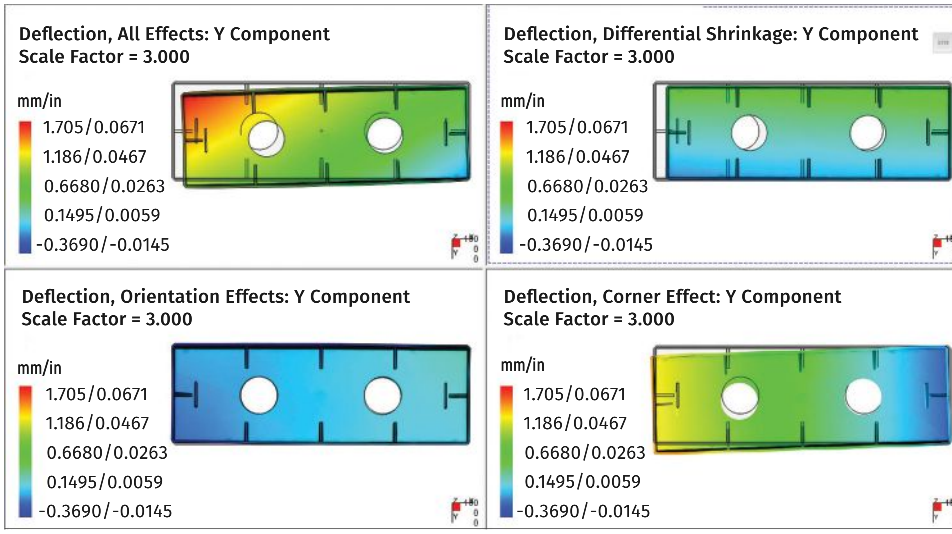
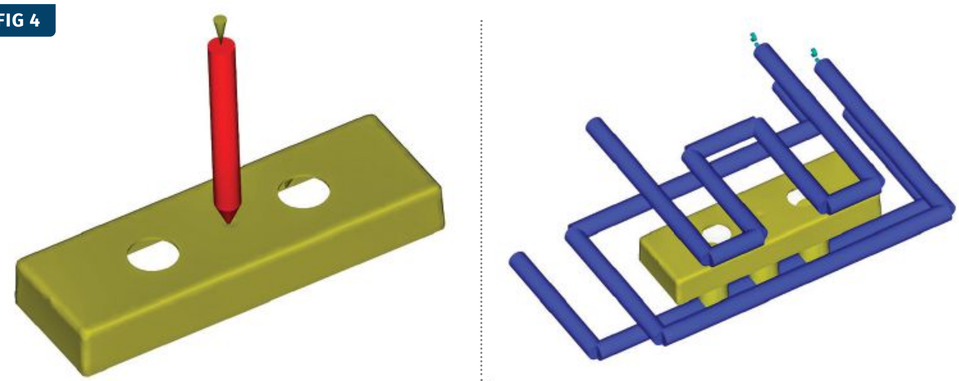
volumetric shrinkage distribution. However, simulation enables all these variables to be investigated, and can help isolate the driving variable(s) that are causing warpage (Figure 3). Finally, by integrating injection molding simulation as a part of the troubleshooting process, a molder or toolmaker could significantly reduce the number of the variables they may look at in a physical DOE, again saving time and money.

FIG 3



Injection molding simulation can help isolate the causes of warpage, and help molders minimize the number of variables they may investigate during a physical DOE.

FIG 4



It is important to model in as many systems of the mold as possible and get accurate processing and material properties conditions to fully realize the benefits of simulation.

SETTING YOURSELF UP TO SUCCESSFULLY USE SIMULATION FOR TROUBLESHOOTING

While the promises of injection molding simulation can be realized, it is important that the proper information is provided so the system is as complete as possible. To obtain the greatest benefit, it is important that the feed system and cooling line layout be incorporated into the simulation model. It is important that the actual plastic processing conditions — such as melt temperature, coolant inlet temperatures and flow rates — be captured to best represent the thermal history of the material through the molding cycle.

It is important that the actual mold-filling time and packing-pressure profiles be captured to ensure the pressure history is properly captured in the simulations. We should not blindly use machine parameters as surrogates for our simulation parameters. Doing so could lead to inaccurate conclusions that may lead our team down the incorrect path. Finally, it is important that the plastic material data used in the simulation is for the exact grade we are using in our application. Simply selecting a resin that has a similar melt flow rate or glass-fiber loading within the same family may not be sufficient to get the processing insight we are looking for. If care is taken to capture these details, then it is possible to create a very good digital twin of our mold which, in the end, can save us time and money. That isn't to say that if you don't have all the systems and parameters for your mold and molding process simulation, it is not a good tool. It is simply stating that the results should be scrutinized a bit harder when picking a path forward.

So, the next time you are having trouble with molding good parts, or you have a narrow processing window for making those parts, I encourage you to consider taking a step away from the machine and see if simulation may be the tool that can help get you the data you truly need to help keep you moving forward.

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EXTRUSION

How Compression Ratio Impacts Extruder Performance

Let's investigate how compression ratio affects performance of an extruder processing LLDPE.

By Lin Jin

By Mark A. Spalding

Single-screw extrusion at high rates and high qualities, and discharging at the proper temperature and pressure depends on numerous process features, including operational set points and the screw design.

Two very important screw design parameters are the metering channel depth and the compression ratio. If the compression ratio is too low, low rates and low specific rates can occur. If the ratio is too high, melting rate limitations and high screw wear can occur. In this article, we'll show how the compression ratio affects the performance of the extruder for a linear low density polyethylene (LLDPE).

Solid polymer fragments are likely to be discharged from the extruder at high screw speeds because of the processes governing solids conveying, melting and the metering sections. For example, if the screw speed is doubled, the capacity for solids conveying and metering sections will also double. The melting flux, however, will only increase by a factor of about 1.4 times. The melting flux has units of kg/(hr m^2) where the unit area term is the area near the barrel wall where melting is occurring. The melting capacity is defined as the melting flux × the melt film area adjacent to the barrel wall which is available for melting.

As the screw speed is increased — and because the melting flux does not increase at the same rate as solids conveying and metering — additional area at the barrel wall is needed for melting. Thus, the solid bed is forced downstream such that more area near the barrel wall will be used to melt the additional resin. Because of limited barrel surface area, eventually some solids will not be melted and will instead be discharged with the extrudate. Solid bed breakup is very common and decreases the melting capacity of the extruder and can contribute to solids in the discharge. Solid bed breakup is more likely to occur at high screw speeds when the solid bed enters the metering section. The most effective short-term solution to mitigate these fragments is to decrease the extrusion rate.

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Screws with compression ratios near 2.8 are preferred for commercial extrusion of LLDPE pellet feedstocks to produce film and sheet.

The melting and extruder performance depends on many screw design and process parameters. These include the metering channel depth, section lengths, lead length and compression ratio. For most screws, the compression ratio is simply the feed channel depth (H_f) divided by the metering channel depth (H). This simple ratio (H_f/H) assumes that the lead length in the feed and metering sections are the same.

The compression ratio specifies the feed channel depth needed to keep the metering channel full of resin and pressurized. The proper ratio depends on the bulk density and the solids conveying ability of the feedstock resin. For LLDPE pellet feedstocks, the optimal compression ratio is about 2.8. Here the bulk density of the feedstock is about 0.59 g/cm^3. If a moderate level of film recycle is added to the pellets which causes the bulk density of the feedstock to decrease substantially, then a compression ratio of 2.8 might not be high enough to keep the metering channel full of resin and pressurized. Instead, the feed channel depth would need to be increased to compensate for the lower bulk density of the feedstock.

CASE STUDY: FIVE SCREWS COMPARED

The performance of five screws with different compression ratios will be presented here for LLDPE using a highly instrumented, 2.5-inch diameter extruder. The screws only differed in the depth of

Summary of the Screws Used in This Study

Screw	Feed Depth, inch	Compression Ratio
CR2.0	0.250	2.0
CR2.4	0.300	2.4
CR2.8	0.350	2.8
CR3.2	0.400	3.2
CR3.6	0.450	3.6

the feed channel. The metering channel depths were the same at 0.125 inch, providing a specific rotational rate of 0.61 kg/(hr rpm). The specific rotational rate is historically known as the specific drag flow rate (the rate due to just the rotation of the screw without an imposed axial pressure gradient). The screws were labeled by their compression ratio. That is, the screw with a compression ratio of 2.8 was labeled CR2.8. A list of the screws is provided in the accompanying table above.

A schematic of the extruder and the die are shown in Figure 1. Extrudate logs were collected and sectioned perpendicular to the flow axis and examined for solid polymer fragments. Photographs of the cross sections are shown in Figure 2 as a function of compression ratio and screw speed. The feed resin was a blend of LLDPE pellets and a black masterbatch at a 100:1 letdown ratio. Because the black colored masterbatch was only one part in 100 parts natural resin, statistically a solid fragment would be natural in color (translucent white). Resin that was discharged in a molten state would be mixed with the black pigment and tinted black.

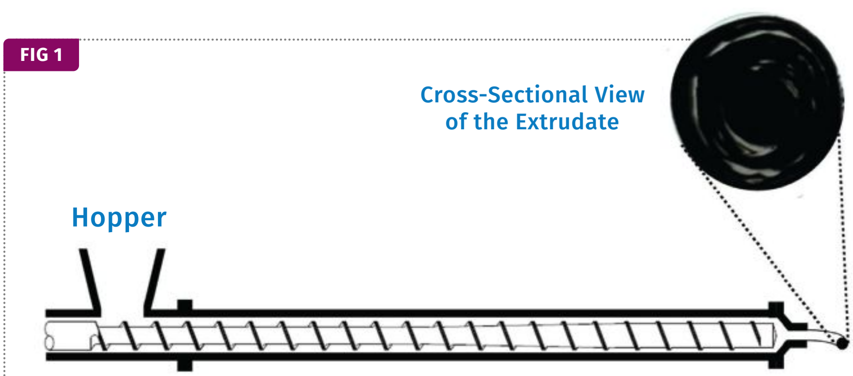
At low screw speeds of 30 to 70 rpm, the sample logs were well mixed and only a few very small white streaks were observed for all screws, indicating the extrusion process was operating within its melting capacity. For screw speeds of 90 to 130 rpm, some low levels of white streaks were observed for the screws with a compression ratio of 2.0 and 2.4. For screws with compression ratios of 2.8 and higher, and screw speeds of 110 rpm and higher, larger levels of solid polymer fragments were observed.

This occurred because the melting capacity was less than the rate of the extruder. At high rates, the solid bed is forced downstream, using more barrel area to melt the resin. When the solid bed approaches the end of the barrel, the melting capacity is exceeded and solid polymer fragments are discharged from the extruder. Moreover, solid bed breakup is more likely to happen at high screw speeds, contributing to discharged fragments.

At screw speeds of 90 rpm and higher, the level of solid fragments depended on the compression ratio of the screw and screw speed. For example, for the CR2.0 screw, the cross sections at all screw speeds were well mixed with very few white streaks. As the compression ratio increased for screw speeds of 90 rpm and higher, the level of solid polymer fragments increased.

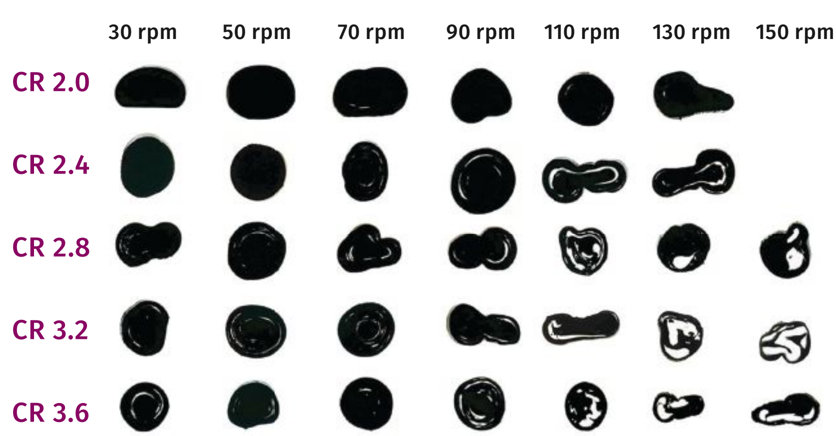
The cross sections shown in Figure 2, however, only show the level of solids at a moment in time. The level of solids in the discharge, however, varied with time. Once more, the melting flux and thus the melting capacity depend on pressure, temperature and velocity between the solid bed and the barrel wall. As the compression ratio increased, the feed channel became deeper and the solids conveying capacity increased. Once the ►

FIG 1



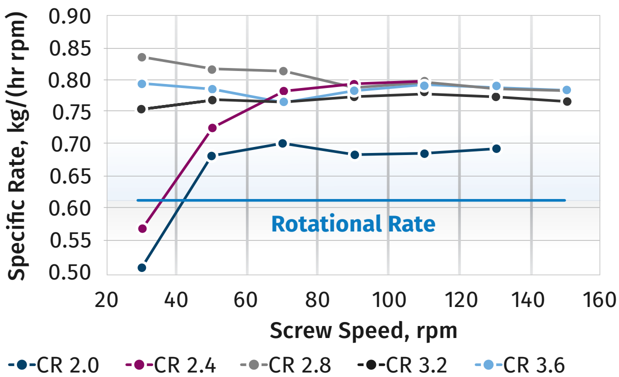
Schematic of the extrusion log sampling process, and an axial cross section of an 11-mm diameter log.

FIG 2



Schematic of the log cross sections as a function of compression ratio and screw speed.

FIG 3



Specific rates as a function of compression ratio and screw speed.

rate exceeded the melting capacity, solid polymer fragments appeared in the discharge, creating defects in the final product.

The specific rate as a function of compression ratio and screw speed is shown by Figure 3. The specific rate is simply the rate divided by screw speed. Furthermore, the calculated specific rotational rate of 0.61 kg/(hr rpm) is also displayed. The specific rate for the CR2.0 and CR2.4 screws at 30 rpm was 17% and 7% less than the specific rotational rate, respectively.

For these screws, the low compression ratios limited the ability of the screws to develop pressure in the downstream direction. That is, the feed section was not deep enough to maintain the metering section completely full of resin and pressurized. At higher screw speeds, the specific rate increased to 11% higher than the specific rotational rate for the CR2.0 screw and to 30% higher than the specific rotation rate for the CR2.4 screw. For the CR2.8 screw, the specific rate was the highest among all the screws and was 28 to 37% higher than the specific rotational rate.

For a commercial process, an optimal screw for most LLDPE pellet resins will have a compression ratio of 2.8. The specific rates for the CR3.2 and CR3.6 screws were lower but still in the similar range as that for the CR2.8 screw. Overall, larger compression ratio screws with deeper feeding sections can have higher solids conveying capacities.

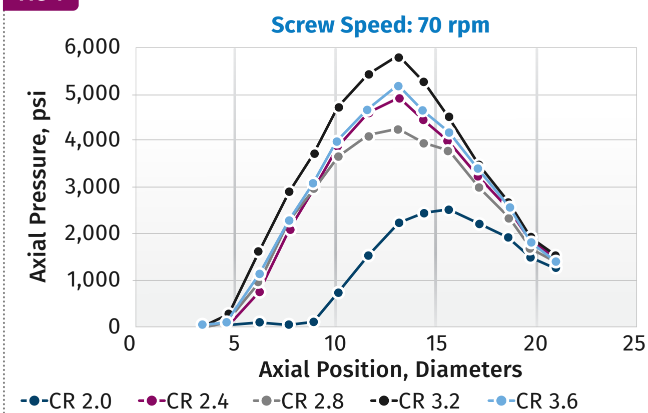
The axial pressure profile for the extrusion process at 70 rpm as a function of compression ratio is shown in Figure 4. A screw speed of 70 rpm was selected as it is in the range normally used for commercial processes, such as blown film.

In general, the channel pressures increased with increasing compression ratio. For the extrusion process with the CR2.0 screw, the pressure at diameter 9 was only around 100 psi and the highest pressure developed was 2,500 psi at diameter 16. This indicates the screw had limited ability to develop pressure. The other screws showed the highest axial pressures in the range of 4,200 to 5,800 psi at diameter 13, which is near the end of the transition section.

For all screws, a trend of negative axial pressure gradients in the metering sections was observed. The axial pressure gradients in the metering section were essentially identical for the CR2.4, CR2.8, CR3.2, and CR3.6 screws, consistent with the nearly identical specific rates shown by Figure 3. Moreover, the negative axial pressure gradients indicate that specific rates would be higher than the calculated specific rate due to just rotation, consistent with Figure 3.

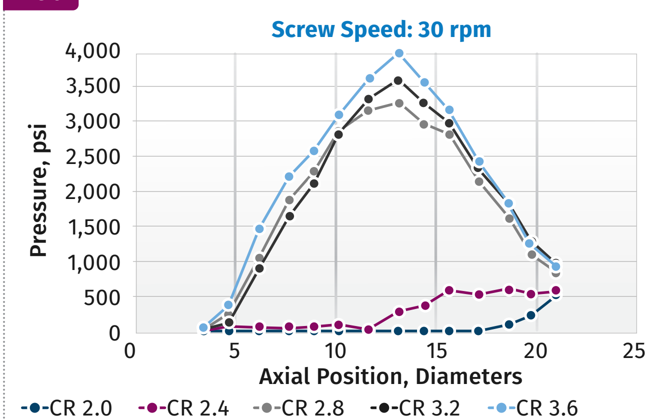
The axial pressure profile for the extrusion process at 30 rpm as a function of compression ratio is shown by Figure 5. A screw speed of 30 rpm was selected because the specific rates for the screws at this low screw speed were significantly different than those shown by Figure 4 at 70 rpm.

FIG 4



Axial pressure profile at a screw speed of 70 rpm as a function of compression ratio.

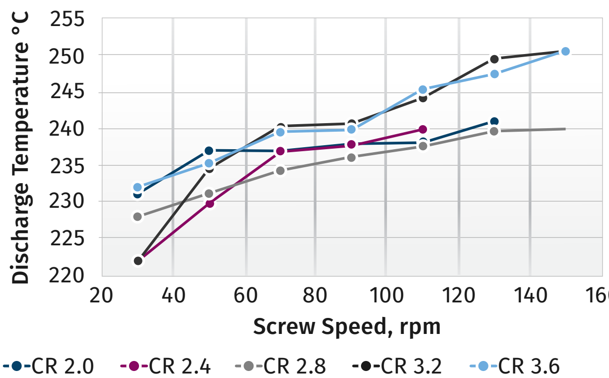
FIG 5



Axial pressure profile at a screw speed of 30 rpm as a function of compression ratio.

For the extrusion processes with the CR2.0 and CR2.4 screws, the pressure started at zero and became positive at diameters 18 and 13, respectively. The highest pressure developed was 600 psi at the end of the screws. All the other screws showed the highest axial pressures in the range of 3,200 to 4,000 psi at diameter 13, which was consistent

FIG 6



Discharge temperature as a function of compression ratio and screw speed.

with the trend for those screws at 70 rpm. For the CR2.0 screw, the axial pressure gradient near the exit was positive, consistent with the specific rate being less than the specific rotational rate shown by Figure 3. The compression ratio was not high enough to maintain high pressures in the metering sections for the CR2.0 and CR2.4 screws at a screw speed of 30 rpm.

The discharge temperatures for the extrusions are shown in Figure 6. They were measured using a handheld thermocouple in the discharge stream. Because the thermal conductivity of the metal in the transfer line and thermocouple sheath are 200 times higher than that for the molten resin, thermocouples positioned in transfer lines are highly influenced by the temperature of the transfer line and can provide measurement errors. This topic was discussed in the December 2024 issue of this magazine. Handheld measurements are considerably more reliable.

The discharge temperature for all screws increased with increasing screw speed as expected. This is consistent with larger energy dissipations under higher shear rates with increasing screw speeds. In addition, the discharge temperatures from screws with higher compression ratios (CR3.2 and CR3.6) were 5 to 10°C higher than those from screws of lower compression ratios (CR2.0, CR2.4 and CR2.8) at 110 to 150 rpm. This is related to high levels of dissipated energy caused by the higher pressures at the end of the transition section.

The axial pressure data clearly shows that at least a compression ratio of 2.4 is required for LLDPE pellet extrusion. For these screws, the pressure was high at the entry to the metering section and the specific rates were nearly the same and higher than the specific rotational rate, except for a screw speed of 30 rpm. This was expected based on the negative axial pressure gradient in the metering channel. The screw with a compression ratio of 2.0 could not convey enough solids, causing relatively low channel pressures at the entry to the metering section and low specific rates, especially at a screw speed of 30 rpm. Screws with compression ratios near 2.8 are preferred for commercial extrusion of LLDPE pellet feedstocks to produce film and sheet. Screws with compression ratios higher than 2.8 can cause high flight wear rates at the end of the transition section. PT

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By Tony Deligio
Editor-in-Chief

MPM's Second Act

Larry Austin's 35 years at a highly successful injection molding company inform much of what he does and doesn't want in his second act in plastics owning an injection molding company.

Midwest Precision Molding's (MPM) facility in Lake Geneva, Wisconsin, covers 60,000 ft^2. Source: MPM

By Tony Deligio
Editor-in-Chief

Larry Austin's first act came at Miniature Precision Components Inc. (MPC), in Walworth, Wisconsin. Founded as a family business in 1972, MPC grew to more than 1,500 employees, with multiple facilities in the U.S. and Mexico, and revenues in excess of $200 million. Austin, whose background is in accounting, advanced along with the business, becoming part of the management team that led the company. MPC was eventually acquired by the Novares Group in February 2019 for an undisclosed amount.

Austin left MPC in 2010 and began searching for a plastics company he could purchase. "It was a good run [at MPC]," Austin says. "It was a real textbook version of growing a company from nothing — a really good operation."

Austin's search targeted shops in an hour-and-a-half radius of his home. Sending inquiries to business owners via FedEx, he eventually heard back from and visited around 10, including Craig Ferguson, the owner and founder of Plasti-Coil, based in Lake Geneva, Wisconsin. At first, Ferguson wasn't interested in selling the company, which he originally founded in Woodstock, Illinois, before moving to Wisconsin and building a new facility in the Lake Geneva business park in 1998. In July 2015, however, Ferguson did opt to sell to Austin, whose plans for the business were shaped by his experience at MPC.

"My goals were not to grow it to a $200-million company," Austin says, "because I went through that, and it wasn't fun

MPM's newest machine is a vertical press from Sodick, which is the center of a new lights-out manufacturing cell. Source: Sodick

— it was crazy. My goals were just to get a company here in the U.S. in Wisconsin and try and keep jobs here because manufacturing was going away."

In November 2016, Austin also acquired Tri-Tec Corp. in nearby Darien, Wisconsin. A 20,000-square-foot addition was made to the Plasti-Coil building in Lake Geneva, creating space to bring Tri-Tec into the same facility, which would now include a full tool room. In 2021, the combined companies completed a rebrand to become Midwest Precision Molding (MPM). "We put everybody together," Austin says. "Everybody works for one company now, and it works really well. All the customers have switched over, and it wasn't a big deal at all."

The hand-painted script in the hall reads, "Cheers to the People Who Make It Happen Every Day."

In addition to sharing a combined space, many of the employees share a common background and local ties. C.J. Garecht, director of tooling at MPM, came over from MPC and actually began his career with Tri-Tec where he started as an apprentice. "[Garecht's] dad and I were both on volunteer fire departments and rescue squads here because that's what you do," Austin says. "We know a lot of people, and we get a fair amount of people that came from my previous company that want to come and work here."

Scott Mercier, currently the director of manufacturing at MPM, is another old hand with long ties. "We have a great core group of people here," Austin says. "[Mercier], our plant manager, runs all the molding machines, and he was here when they opened the building. [Garecht's] a really, really good toolmaker, and [Mercier] can get a molding machine to do whatever we want, so it works out really, really well." Austin notes the other members of MPM's leadership team, like Alec Buccanero, director of quality; Kyle Ketterhagen, director of sales and marketing; and Luke Jacobson, controller, all have years of experience in manufacturing.

Overmolded in a reel-to-reel automation cell, the fuel injector components exit the Sodick press and head toward automation which will separate and test them. Source: Sodick

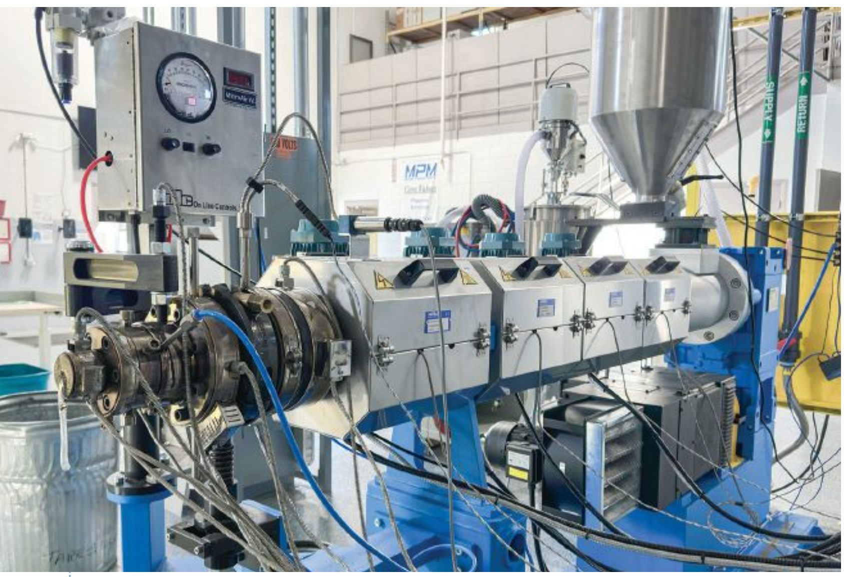
MAKING IT HAPPEN EVERY DAY

The main hallway in MPM's front office space is adorned with two things: photographed portraits of all the company's employees taken by Austin, who counts photography among his hobbies, and hand-painted script reading, "Cheers to the People Who Make It Happen Every Day."

Upon entering the shop floor off that hallway, visitors are greeted by two very different work cells that call back to Plasti-Coil's past while reflecting MPM's future. Installed in February, a Sodick VLine VT506 vertical press insert overmolds an automotive aftermarket fuel injector component, featuring 25% glass-filled nylon and metal terminals. The metal terminal component is fed from a press-side spool through the 8-cavity tool via reel-to-reel automation. A type of bobbin, the component runs lights-out, save ►

an hourly check on any diverted reject parts, thanks to a complete automation cell created in conjunction with Sodick. As the name suggests, the original Plasti-Coil enjoyed much of its success creating high-precision bobbins, gears and similar components.

Behind the Sodick cell is another turnkey production and inspection system centered on a Bausano tubing extrusion line. The Type E-GO 60/30 series 60-mm single-screw extruder features a 30:1 L/D ratio. Bausano provided tooling as well as downstream cooling/sizing, pulling and cutting technology. A Zumbach



MPM installed this Bausano Type E-GO 60/30 series 60-mm single-screw extruder to help a local customer reshore a tubing product. Source: MPM

inspection system verifies the tubing's inner and outer diameter. The customer, which reshored production of the tubing to MPM, hails from nearby Walworth, Wisconsin, and is a manufacturer and distributor of breeding equipment and supplies for livestock and companion animals.

Patrick Austin, MPM's president and son of Larry Austin, says the company maintains some ties to the gears and bobbins which were its hallmark, while pursuing new, broader prospects. "We've kind of diversified, not necessarily intentionally, away from former markets," Patrick says. "Opportunities arise in different industries that make sense for us, and I think a big thing that we look for is: What's a good fit? We're not going to go chasing after every potential sales opportunity. It has to make sense, and it has to be a company we want to work with who's going to treat us with respect and vice versa."

That sense of mutual respect and win-win relationships extends to MPM's supplier base. The company initially encountered Sodick at NPE2018, purchasing its first press from the Japanese supplier at the time and adding 12 more since then, including the new vertical cell. "Sodick has become one of our most valued and important partners," Larry says, "and we look forward to continuing that going forward."

MPM names its presses and the machine at the heart of the newest cell is dubbed "Dragon" after the nickname of one of the Sodick team members who spent a week installing the system and training MPM's employees on its operation. The inspiration for the cell came while Patrick visited Sodick's facility in Japan and saw some of its automation capabilities in its Future Technology Center.

In addition to the press, Sodick provided tooling for the vertical overmolding cell. Source: Sodick

Sodick built the machine, tool and automation for "Dragon." In addition to the automation feeding the reel of metal through the mold for overmolding, a robot on the backside of the press removes the sprue and runner system. Postmolding, additional automation performs quality inspection and cuts terminals. If a terminal is bent, the system rejects it, and probes are used to test connectivity, with finished parts coming out the other end. The cell runs lights-out, with the only human intervention being someone from quality checking once an hour to see if any parts have been rejected. Patrick notes rejects are usually a result of a bent connector from the original metal reel.

MPM's facility covers 60,000 square feet with more than 40 injection molding machines ranging in clamp force from 17 to 360 tons and approximately 50 employees. The fully equipped tool room, which can build and repair molds, features sinker and wire EDM equipment, as well as grinders and mills. Including modular inserts, MPM has around 1,000 active tools.

The quality lab features multiple pieces of equipment especially designed for gear testing, including a Vari-Roll unit to determine concentricity of gears, a Keyence unit for quick dimensional checks on parts, as well as a Mettler Toledo moisture analyzer used in some jobs to determine if resin has been completely dried, among other technologies. Beyond gears, many of the parts MPM molds feature threading and other precision elements. Across the floor, automation is deployed liberally for many postmolding operations, minimizing employee engagement with repetitive tasks.

Where a cell to hot stamp foil onto a water softener gear once required three people to handload the parts, only one is needed now. The gears are placed in a 6-station turntable that sounds an alarm if they're loaded incorrectly, with a vacuum in place to suck up any loose foil postapplication.

KEEPING MANUFACTURING IN WISCONSIN

For the people in the portraits being saluted in MPM's hallway, Larry Austin has one objective. "Our goal is to keep manufacturing in Wisconsin, while keeping co-workers employed, and it's going well," Larry says. "We've kept our employees going, and we've kept them even through slow times so that when we start growing now, we have a good group of people."

Targeting "organized, controlled growth," Larry says MPM's business in the first quarter is already up over 2024, but it needs to keep moving. "You can't stay still," Larry says. "You're either shrinking or you're going to be growing. We've got to get on a steady path of growth."

Part of that growth path includes succession planning. Patrick spent 10 years in manufacturing at four different midwestern companies while earning his MBA at Marquette University. He then came to work full time at MPM in 2017, originally as the CFO, but has been involved in all aspects of the manufacturing process, including adoption and integration of an Epicor ERP system. Starting in 2022, Patrick took over the day-to-day running of the business. "I want to make it so that if anything happens to me, the operation continues," Larry says. "I feel that MPM is structured to succeed and grow for years, and will help maintain manufacturing in Wisconsin and the U.S."

The day after *Plastics Technology* visited, MPM was planning a pizza party for its employees in honor of Pi Day (March 14; 3.14) with a sign where they clock in reminding employees of the event. A busy business, but one where pizza parties are still possible, is the sweet spot where MPM wants to be. "With the equipment we've added, we want to be steadily growing, if we can, and without driving everybody crazy," Larry says. "A lot of us have been through that, and it's not fun. I'd much rather have a pizza party on Friday and keep growing and getting work done, than be stressed and having to figure out who's running your third shift." PT

The Recycling Collaboration That Is Making Circular Film a Reality

Nova's large warehouse in Connersville, Indiana, has space for storing recovered film. One month of operational capacity is approximately 12 million pounds. Source (all images): Matt Stonecash

Nova Chemicals and Novolex are commissioning a large mechanical recycling facility for film to film.

By Matt Stonecash
Associate Editor

In 2023, Nova Chemicals announced its plans to develop a mechanical recycling plant with Novolex, at a former Ford manufacturing site in Connersville, Indiana. The idea was to build a sophisticated system which would reprocess film, at a scale of over 100 million pounds per year, and produce high-quality recycled polyethylene for Nova customers, thus bringing recycled material back into high-value film applications.

Today, the facility is alive with activity as the new equipment is being installed and commissioned. Already, reclaimed film is being shredded, sorted, washed, dried, densified, extruded and pelletized as processes are tuned and sorting optimized, with more equipment still to be added. The mechanical recycling operation occupies about one-third of the 1.3 million-square-foot Connersville site, including enough space to store about 12 million pounds of recovered film bales. The amount is equivalent to one month of operation at the plant's anticipated full capacity.

AN EXPERIENCED RECYCLING PARTNER

The Indiana facility, called Syndigo One, is a collaboration between Nova Chemicals and Novolex, a packaging manufacturer, that will operate the facility.

"The question was: how do we do this quickly? This is new for us," says Nova CEO Roger Kearns. "To make sure that we can bring this to fruition and be successful quickly, we looked to partnerships, and it's great to have Novolex here with us to make that happen."

Nova brings its experience as a producer of polyethylene resins for high-value applications, and Novolex brings experience in operating mechanical recycling facilities.

“We’ve been a recycler for 17 years, so we’re excited about the opportunity because we know we can do this. The opportunity to participate in a facility like this, making these phenomenal products, is tremendous,” says Stan Bikulege, Novolex CEO.

FILM-TO-FILM RECYCLING STARTS AT THE SOURCE

The feedstocks for making Nova’s recycled PE are classified as postconsumer, but they don’t come from material recovery facilities. Rather, the consumer in this case is the user of film which is not primary product packaging but used at other points along the supply chain.

To make sure we can bring this to fruition and be successful quickly, we looked to partnerships, and it’s great to have Novolex here with us to make it happen.

“We try to avoid any multilayer films, says Adrianne Tipton, Novolex CTO. “We source films like stretch wrap or pallet wrap, materials that have gone through their useful life.” Recovered material comes from distribution centers, “back-of-house” retail operations or from transfers of parts between manufacturers. These sources can provide feedstock of sufficient quality and consistency to be made into high-grade pellets, both their design and cleanliness make them more suitable for recycling than post-retail films would be.

The objective is to capture film that might today be processed with other materials to make durable goods, or may not be recycled at all. This can mean working with generators of waste film that have not previously been part of a collection program, to put processes in place to separate film from other waste materials.

According to Tipton, changing processes can take some work, but often retailers are quite willing to do it when they can see the upside. This means not only being paid for material that was previously only wasted but potentially creating a circularity story for the brand.

“They really like it if we can close that loop. They can get their own waste back as packaging and that’s a great story for them,” says Greg DeKunder, vice president of Nova Circular Solutions.

FROM BALE TO PELLET AUTOMATICALLY

Once a bale is loaded onto the first conveyer, operations proceed automatically. A series of conveyors carry the plastic from station to station, while strategically placed bunkers hold materials for the next step. The washing systems govern the process — they speed up the shredding lines when they are ready for material and push into extrusion as the material builds up.

Bales first pass through a Cross Wrap bale opener, with an integrated saw that automatically cuts the wires. This eliminates manual bale opening, a potentially dangerous operation. Initial shredding by Lindner Jupiter shredding machines reduces size to about a square foot. The film then passes over a shaker table, which ensures that it is spread out appropriately across the surface to ensure line-of-sight for sortation, the next step.

A bale is loaded onto the feed conveyor for the bale opening machine in Connersville, a rare hands-on step in an operation that is largely automatic.

Pellenc ST sorters use both optical and near-IR sorting to remove unwanted materials like polypropylene or PET, colored materials, paper or other contaminants. The system is also a data source, providing data on how much of different types of contaminants are present. This data can then be used to work with suppliers on improving the starting material.

Prime materials are separated on one conveyor while rejected materials follow another conveyor which brings them back into another sorting machine. This secondary sorting step further classifies material, with lower grades of usable plastic going for sale to asphalt producers, composite lumber manufacturers and chemical recyclers.

From there material moves on to a second shredding station, which reduces the size down to about 1-2 square inches. This enables the material to be washed in the next step.

The Lindner washing system uses friction and water to remove contaminants from the surface of the material. “We like to say ‘we sip water here, we don’t gulp’,” says Alan Schrob, director of mechanical recycling at Nova Chemicals. Used water from the washing process is treated and recirculated back into the process. After washing, the material is dried and delivered to a large bunker. The bunker ensures continuous production, as separate segments of the plant turn off and on automatically as needed.

Before the film can be fed into an extruder, it must be densified. The densification system takes irregular film pieces and turns them into small clumps reminiscent of packaging peanuts. These are dense enough to go into the recycling extruder. Intarema Duafil systems from Erema provide two filtration steps to further purify the melt before it is made into pellets. After pelletization, the material goes into Intarema ReFresher vessels. Pellets will spend 8 hours circulating, to remove any residual volatiles that may otherwise give the product an unwanted odor.

Syndigo recycled LLDPE pellets from Nova Chemicals.

SECONDARY RECOVERY CAPTURES VALUE

At each step of this automated process, recovery is designed in. There is metal from the debaling and demetallizing steps, cardboard (also from debaling), fines that are captured after initial shredding, filtrate from the extrusion process and, of course, all the plastic material which is not suitable for making prime recycled pellets. This will include any traces of colored polyethylene, polypropylene, PET or other polymers that stow away on incoming bales. “Every piece of film that enters this warehouse will not go to landfill,” Schrob says. In all, the plant will have a total of 12 sorting systems when fully operational. Materials “rejected” from the initial sort for Syndigo-worthy material pass through subsequent stages to identify and isolate material to capture the maximum possible value.

Every piece of film that enters this warehouse will not go to a landfill.

PRIME GRADE, THE PRIMARY TARGET

In the end, the completed material is stored in one of 13 silos. Of these, 12 are for prime material, 6 of which are blending silos. Only one is for storing off-grade material. “We don’t intend on making a lot of off-grade,” Schrob says.

The process results in a pellet suitable for the high-value applications that Nova is targeting for its Syndigo PE products. The facility’s lab is equipped with a small film extrusion line with an inline optical system scanning for gels, in order to verify functionality of the finished product. “Our objective is to take material that has been going to landfill a good portion of the time, and turn it into something that you’re finding not just in plastics but in really high end use,” Kearns says.

These can include even food grade applications, as Nova has already received a no objection letter (NOL) from the FDA for the Connersville operation. Schrob attributes this to two key processes: rigorous auditing to ensure the incoming product is suitable for food-grade use, and the ability to remove contaminants such as paper, glue and labels from used film. “This facility is designed specifically for that,” Schrob says.

The new facility is expected to create 100-125 jobs and produce 100-120 million pounds of prime grade recycled resin per year when it reaches full operational capacity, sometime in 2026. Nova is already working on a design for a subsequent plant, in anticipation of the successful proof of viability at Syndigo One.

What You Need to Consider Before Adding a Compounding Line to Your Operation

Material volume, extruder size, facility space and power, and vendor expertise drive equipment choice.

By Al Bailey
ENTEK

Introducing a compounding extrusion line into your manufacturing operation is a complex undertaking that can pay great dividends. Choosing the right vendor with the right expertise is the difference between success and failure.

Depending on what business need is driving your decision to purchase an extruder alone or components to build an entire extrusion line, a full analysis of your project — including the space, budget and personnel required—begins by selecting a knowledgeable partner.

Consider a vendor that has the necessary expertise to not only sell you a system but help you get the most out of it over time.

To be sure, if you already have in-house experience building and running a compounding extrusion line, that expertise is a significant advantage in installing another line. However, even experienced compounders will seek expert input.

For example, if you've developed a new formulation and never produced pellets with it, starting that line carries significant risk. Creating pellets with biodegradable polymers containing PHA or PLA presents still more unique challenges, primarily in shear issues and ignition temperatures. Having additional outside experts on hand to ensure production kicks off smoothly is a worthwhile investment.

Producing pellets can create unique challenges. For instance, when compounding biodegradable polymers containing PHA or PLA, shear issues and ignition temperatures need to be considered. Having outside experts on hand to ensure production kicks off smoothly is a worthwhile investment. Source: ENTEK

BUSINESS CASES

Business cases for building a compounding extrusion line run the gamut from making small masterbatches to supplying a high volume of material for a new product.

Depending on the material volume required and the level of in-house expertise, a manufacturer might simply buy an extruder and assemble the rest of the compounding line itself. Another option is to purchase a turnkey system, including feeders, material handling equipment and more, from one source.

The complexity of the mixing process is a key determinant. For instance, the most basic line might be used to make pellets with a color concentrate on a simple mixing system in which five or six ingredients are mixed, taken to a single feeder and fed into an extruder. Compounded material then goes through a pelletizer to create the end product. A business with five or six of these lines can easily duplicate them without having a lot of engineering support in-house.

A more complex operation, with all compounding performed at the extruder instead of in a mixing room, requires multiple loss-in-weight feeders — up to eight or nine depending on the number of products requiring material. A compounding line of that size will require a mezzanine over the extruder and the appropriate material handling system to fill an array of feeders. Even operations with in-house engineering support might opt to choose an experienced vendor to assist in building such a complex system.

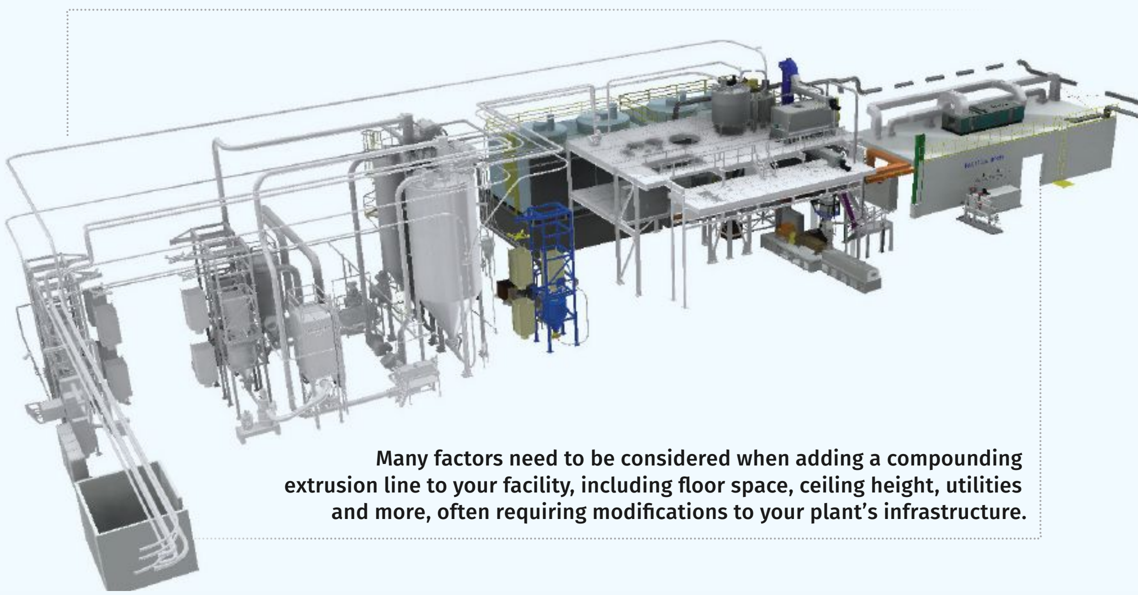
CHOOSING AN EXTRUDER

The extruder is of course the heart of your compounding line — and choosing the right screw size depends on the size of your production runs, the amount of material you're making and the price of raw materials.

General guidelines:

- An extruder with 27-mm screws is an ideal machine for lab use.
- The most common extruders for compounding run from 33 mm to 53 mm.
- Large-scale pelletizing applications (hundreds of thousands of pounds per year) might require a 73-mm extruder or occasionally a 103-mm extruder.

Because there is always some waste material at startup, the smaller the extruder the less initial waste. That's important when handling the costlier materials. Smaller extruders are also easier and faster to clean during job changeovers.



Many factors need to be considered when adding a compounding extrusion line to your facility, including floor space, ceiling height, utilities and more, often requiring modifications to your plant's infrastructure.

FINDING SPACE

- **Ceilings:** The size of your compounding extruder line determines the space required to locate it. The key factor here is head height over the line. Standard ceilings can accommodate lines featuring 33- to 53-mm extruders. But 73 mm and larger, which require bigger material handling equipment, will require more ceiling height.

- **Utilities:** Power and water requirements for compounding lines with extruders of 33- through 53-mm are relatively low and can often be accommodated with the existing infrastructure. The utility requirements for large extruders often require modifications to a facility's infrastructure. For instance, a 73-mm extruder can have a 600-hp motor, requiring more power than what is available. Bringing in a new transformer is a significant additional expense. That added expense might lead to an operation sticking with a 53-mm extruder.

PLANNING AND EXECUTING THE INSTALLATION

The number of players involved in planning the design and installation of a compounding extrusion line is another critical factor for a successful operation.

With enough in-house engineering experience, an operation might choose to buy components — the extruder, pelletizer(s) and material handling equipment — individually from different vendors. But making components from different vendors work together seamlessly can be a challenge.

The fewer players involved means less chance of having to troubleshoot complex equipment communication failures among disparate brands.

CHOOSING A VENDOR

While you are planning to introduce a compounding extrusion line into your operation, you'll want to carefully consider a vendor which has the necessary expertise to not only sell you a system but help you get the most out of it over time.

The ideal vendor can demonstrate expertise with components throughout the compounding extrusion line — from the extruder itself to the feeders, pelletizers, controllers and more.

A qualified supplier should be positioned to lend its know-how on how to optimize your new compounding line, including the advantages of water baths, slides and underwater pelletizing.

Side feeders, vacuum stuffers and other equipment can be used for better compounding quality, efficiency and safety.

Questions to ask your vendor:

- **Lab resources:** Can you run preproduction material tests to screen for processing performance and inform equipment decisions?
- **Pelletizing:** Do you understand the advantages of underwater pelletizing, water slides or a water bath with a rotary cutter?
- **Feeders:** Can you advise on the benefits of volumetric versus loss-in-weight options?
- **Changeovers:** Do you provide quick-change capabilities for replacing screws?

FEEDER KNOW-HOW

It's worth noting that as soon as a second feeder is added to a compounding line, formulation consistency — and potential deviations — becomes a critical issue. For instance, if you're selling pellet comprising 50% calcium carbonate and 50% polyolefin, a second feeder of the wrong type could introduce a variation that could veer off to as much as 40% of one and 60% of the other.

Additional considerations regarding feeders include:

- Most compounding lines will use loss-in-weight feeders.
- Powder cannot typically be fed through a pellet feeder.
- Some powder feeders can feed pellets if the screw and/or tube is changed. While you don't want to pay extra for the agitation capability that powder requires, the pellets of some materials stick together and therefore require that additional agitation.

MAINTAINING BARRELS AND SCREWS

The primary wear items on extruders are the barrels and screws. Improper alignment will shorten their lifespan because they are rubbing together — and making metal scrap instead of parts.

Wellness checks are an ideal way to ensure your barrels and screws function properly and enjoy long life. Even compounders who have extensive experience will call in external experts to assess the health of their equipment, as alignment and wear assessment require the utmost accuracy.

Questions to ask your vendor:

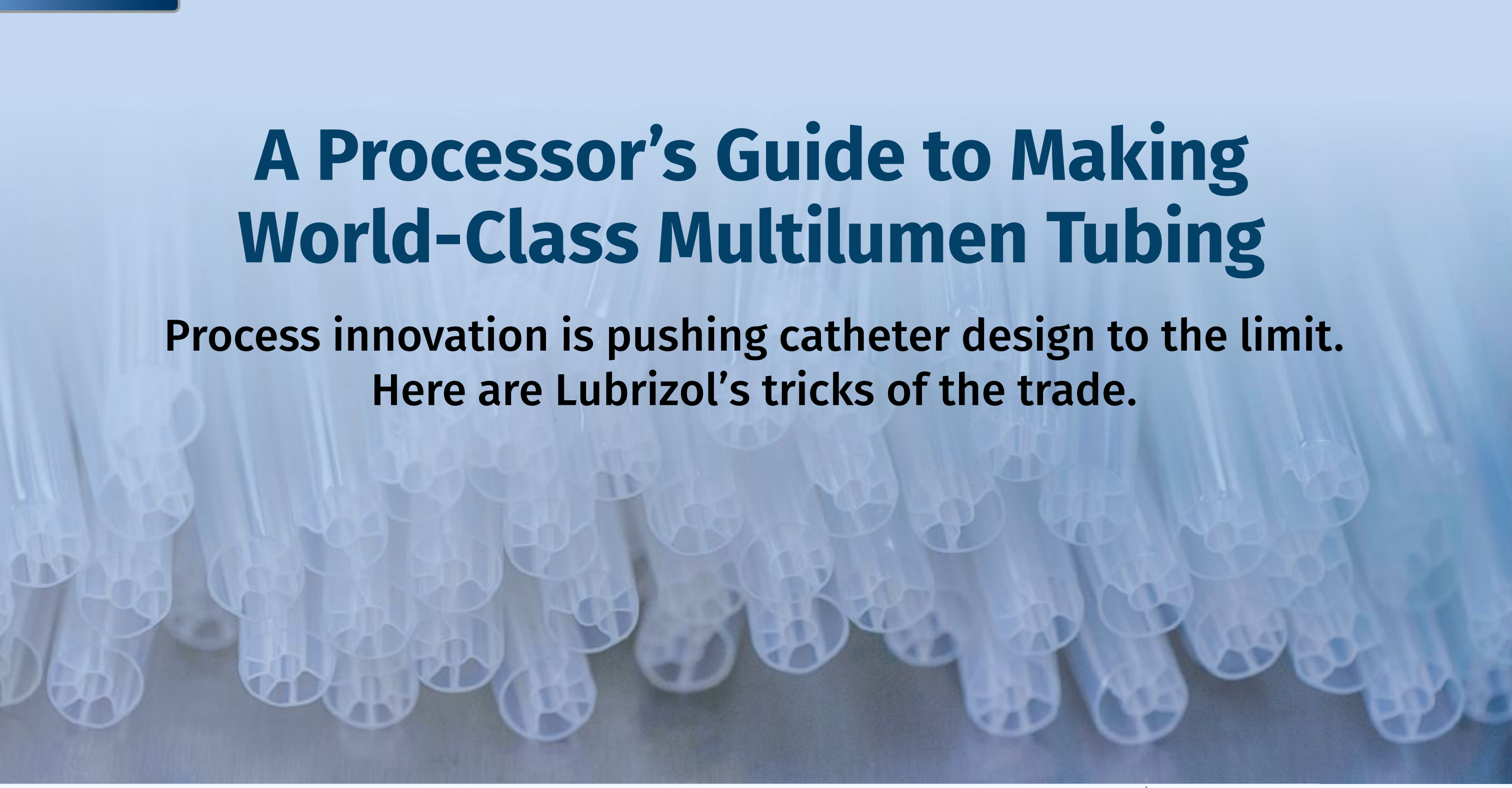
- Do you have the expertise and personnel to keep equipment running and support any level of in-house competency with compounding extrusion lines?
- Do you include a built-in maintenance schedule to alert operators when it's time to perform critical tasks such as changing gearbox oil or torquing the heaters?
- Do you provide services for monitoring and maintenance with laser-alignment tools and wear-assessment tools?

All considered, there are tremendous benefits to installing a compounding extrusion line in your operation. Choosing the right vendor with the proper range of expertise in all the equipment required is the first step toward successful compounding operations. PT

ABOUT THE AUTHOR: Al Bailey is one of ENTEK's sales engineers. In this role, he assists with mechanical and electrical quoting for turnkey projects, interviews contractors and prepares detailed schedules for entire projects from the engineering phase through equipment and plant build, installations, startup and training. A 1992 graduate of Eastern Washington University with a degree in mechanical engineering technology, Bailey has worked at ENTEK since 1995, when he joined the company as a controls engineer. Contact: 541-619-4985; *abailey@entek.com; entek.com*.

A Processor's Guide to Making World-Class Multilumen Tubing

Process innovation is pushing catheter design to the limit. Here are Lubrizol's tricks of the trade.



Multilumen medical tubes here featuring intricate internal channels designed to support complex catheter functions such as steering, fluid delivery and real-time sensing in minimally invasive procedures. Source (all images): Lubrizol

By Oliver Vasquez
Lubrizol

When it comes to medical device tubing, the difference between an ordinary extrusion and a truly exceptional one often comes down to a complex, high-stakes process: multilumen extrusion. This highly specialized manufacturing method is responsible for the intricate, multichannel tubing found in many of today's most advanced medical devices — everything from steerable guide catheters to neurovascular implants.

But why do so many OEMs avoid taking on multilumen extrusion in-house? And what makes certain extruders uniquely equipped to handle the job? The answer lies in a combination of material science, advanced tooling and decades of hard-earned process knowledge — making multilumen extrusion an art form just as much as it is a science.

Without a firm grasp of material behavior, flow dynamics and die design, achieving consistent multilumen extrusion is nearly impossible.

WHY OEMS AVOID IT

Even the biggest names in the medical device industry tend to avoid multilumen extrusion in-house because of its extreme complexity. Complexity alone isn't the problem; it's the razor-thin tolerances and unforgiving material behavior that make it so hard to master. Many companies have dabbled in multilumen extrusion, only to realize that the level of control required to scale it successfully is beyond what their existing processes can handle.

Multilumen tubing presents a formidable challenge after all. Engineers want increasingly smaller tubing, more lumens and thinner walls — often thinner than a human hair. Holding tolerances that tight, across multiple lumens, while working with materials that can behave unpredictably, is a daunting task to say the least.

Flow balancing adds another layer of difficulty. With single-lumen tubing, the material flows smoothly through one continuous channel, but with multiple lumens, every internal pathway must be precisely balanced to prevent distortions, blockages or collapse. Each lumen essentially has its own personality — some take in more material, some resist it and keeping them all in harmony requires meticulous process control. If the material distribution isn't perfectly controlled, one lumen might collapse, another might expand too much and suddenly you're looking at an unusable extrusion.

Without a firm grasp of material behavior, flow dynamics and die design, achieving consistent multilumen extrusion is nearly impossible. A single-lumen design enables a polymer to move without much resistance, but in multilumen tubing, each internal channel changes the way material flows and solidifies.

WHAT MATERIALS WORK BEST?

Polyurethanes and nylons demand precise handling, but their unmatched strength, flexibility and ability to meet medical safety standards make them the best materials for multilumen tubing. Some of the toughest materials to work with in multilumen extrusion are specialized polyurethanes and nylons because they flow unpredictably, degrade under shear and require precise heating to avoid defects.

These materials require an exacting balance of heat, pressure and flow to prevent issues such as premature solidification, die swell inconsistencies or collapse. The complexity of extruding them is then compounded by their narrow processing windows, meaning even minor deviations in temperature, shear rate or residence time can lead to defects like molecular degradation, voids or dimensional instability.

A technician closely monitors an automated bonding system during catheter assembly, ensuring precision alignment and secure connections at micron-level accuracy.

Two views of a precision multilumen extrusion line in action, showcasing the extrusion die (inset) and downstream puller mechanism guiding ultrathin medical tubing during production.

WHAT ARE TOOLING CONSIDERATIONS?

Of course, mastering multilumen extrusion is not merely a matter of material selection — it is equally contingent on advanced tooling and meticulous process optimization. Appreciate for a moment how industry veterans stress that the most successful extrusion setups rely on proprietary tooling designs developed through years of trial, iteration and empirical refinement, rather than being derived from conventional design principles such as those easily found in textbooks.

These specialized tool designs ultimately regulate the polymer flow path at a microscopic level to mitigate shear-induced degradation, reduce polymer crystallization at die exits and ensure dimensional precision down to the micron scale.

Consistency in multilumen extrusion demands that every component of the process — from extrusion die geometry to vacuum calibration — plays a role in keeping lumens stable. Getting a smooth, even melt without excessive heat or strain comes down to the extruder screw design. Processors typically use barrier screws, variable pitch configurations and mixing elements to prevent gel formation and keep viscosity under control.

Die geometry is another critical factor — custom-designed multilumen dies incorporate precision-engineered distribution manifolds to ensure even polymer flow, thereby reducing differential cooling rates which could lead to lumen warping. ►

HOW SHOULD TUBING BE COOLED?

For even quality and reliable performance, advanced cooling is just as important as other process controls. That's why processors trust vacuum sizing tanks, precision water baths and air-knife cooling to lock in quality. But this alone isn't enough — thin-walled structures are extremely sensitive, and if the puller speed doesn't sync perfectly with the extrusion rate, things can go wrong fast. Pull too slowly and the tubing thickens or deforms. Pull too quickly and you risk stretching the material too thin, leading to weak spots, oval lumens or complete collapse.

QUALITY CONTROL

When it comes to multilumen tubing, high-resolution laser micrometry helps manufacturers achieve ultraprecise measurements. These systems continuously measure outer diameter and concentricity, typically exceeding 90% accuracy and, in some cases, even reaching 97% thanks to submicron tracking of lumen geometry.

It's all about catching problems before they start, including gel formation. Gels are a major challenge wherein tiny, transparent imperfections in the polymer matrix form when polymer chains don't fully melt, when crosslinked residue builds up or when material stagnates in the tooling. A minor imperfection in everyday products may be overlooked, but in medical devices it can cause materials to fail, functions to falter or pathways to clog.

Processors prevent gels by first filtering the polymer through ultrafine mesh screens, removing any unmelted particles before they can reach the die. However, too much filtering can degrade the polymers or affect mechanical properties.

If you want good melting, mixing and flow, you also need a great extruder screw that does more than just move material. It must be precisely engineered with compression zones, barrier flight elements and mixing sections to ensure the polymer is fully homogenized. If the

Steering Interventions in New Directions

Steerable guide catheters are at the heart of modern structural heart procedures, helping doctors perform transcatheter mitral valve repair (TMVR) and left atrial appendage closure (LAAC) with precision. These devices carefully navigate the twists and turns of the vascular system, giving physicians the control they need to deliver implants or treatments without harming surrounding tissues.

For this kind of precise maneuvering, steerable guide catheters depend on highly accurate multilumen extrusions, often with nine or more lumens to accommodate:

- Pull wires for multidirectional steering and torque transmission
- Guide wire lumens to facilitate access and navigation through tortuous anatomy
- Fluid delivery channels for flushing, contrast injection or drug administration
- Electrical or sensor-integrated lumens for pressure monitoring or real-time feedback

These catheters must rotate in multiple directions while remaining flexible enough to maneuver, strong enough to hold their shape and be resistant to kinking. This requires ultrathin walls to enable more lumen space while still being tough enough to handle mechanical demands.

Deep investment in multilumen extrusion underscores just how intricate and specialized this field has become in medical manufacturing — one that few manufacturers can master at scale. For Lubrizol, the promise is not only in streamlining production but also expanding the potential for more complex and effective procedures that lead to better patient outcomes.

HAS COMPLEXITY HIT ITS LIMIT?

With multilumen extrusions continuously raising the bar in precision engineering, the industry is at a transformative crossroads. With advancements in extrusion, manufacturers are successfully producing intricate designs, such as 13-lumen tubes with walls thinner than two-thousandths of an inch, which challenge the limits of scalable production. The question now isn't whether we can push extrusion further — but how far we can take it.

A rising innovation in the field is hybrid construction — combining multilumen extrusion with laser-cut hypotubes to improve durability without sacrificing flexibility. The hypotubes provide a solid structure with excellent torque transfer while enabling flexibility. In addition, steel coils and braided reinforcements work together to keep these hybrid tubes both strong and pliable. Their unique combination of durability and flexibility makes them a trusted solution for structural heart interventions, neurovascular procedures and catheter-based therapies.

With automation and AI in the mix, quality control is also getting faster and sharper, enabling manufacturers to detect and fix tiny defects on the spot with micron-level accuracy. With the ability to capture thousands of frames per second, high-speed imaging keeps a constant watch on extrusions, flagging any defects in size, shape or material makeup. At the same time, continuous data feedback to a closed-loop control system catches defects before they spread through production and become costly mistakes.

An automated precision testing system grips and inspects a catheter tube segment, showcasing advanced quality control technology used to ensure dimensional accuracy, lumen integrity and structural performance in high-spec medical tubing.

screw design isn't right, material inconsistencies can clog the system, produce hot spots which degrade the polymer or affect lumen formation and stability in other ways.

Additionally, manufacturers rely on state-of-the-art defect detection systems to ensure every millimeter of tubing meets the highest standards. Inline optical inspection and infrared spectroscopy can catch the slightest imperfections to ensure that only flawless tubing moves forward in production.

The bottom line is that extruding multilumen polymers — especially the difficult ones — is all about balance. It takes a highly focused collection of technology, talent and oversight to avoid rolling the dice on production quality.

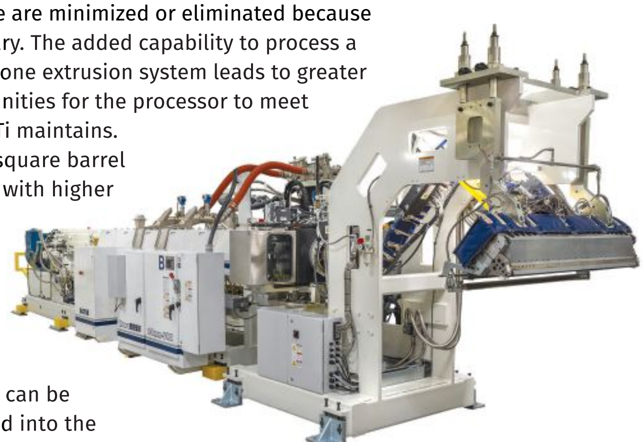
ABOUT THE AUTHOR: Oliver Vasquez is a senior process engineer for medical devices at Lubrizol. With more than 14 years of engineering experience, including eight years in the medical device industry, Vasquez specializes in polymer extrusion technologies for catheter-based devices. In his current role, he supports Lubrizol's Corona, California, facility by developing novel processing technologies for complex extrusions for device OEMs. He graduated with a bachelor's degree in mechanical engineering, with a focus on manufacturing, from the University of California, Riverside. Contact: *951-547-7400; oliver.vasquez@lubrizol.com; lubrizol.com/Health*.

Keeping Up With Technology

EXTRUSION

No-Dry Twin Screw Extruder Series Can Handle Multiple Resins

The MultiRESN twin-screw extruder from Processing Technologies (PTi) features improvements that have been implemented over time to meet industry demands and processing capabilities. The twin-screw extruder is said to be capable of processing a variety of virgin, postconsumer and postindustrial resins and flake, including PET, PLA, PP, PS, PE and other unique blends, without first changing screws or drying or crystallizing resin. PTi says the machine offers processors several significant advantages over other machines in the market. Among other things, its compact design (the machine's L/D ratio has been cut from 52 to 50:1) is said to reduce floor space requirements, while labor and energy usage are minimized or eliminated because predrying is unnecessary. The added capability to process a multitude of resins on one extrusion system leads to greater versatility and opportunities for the processor to meet consumer demands, PTi maintains.



A newly configured square barrel design heats up faster with higher heater-to-barrel mass density ratios versus that of round barrel counterparts, resulting in heat-up times reduced by as much as 30%. Material can be immediately introduced into the process without drying. Furthermore, the starve-fed system means blends, colors and quick changeovers can be accomplished on the fly and in as little as 20 minutes.

The series features many improvements over past designs, including:

- **Targeted Sizes:** Machine sizes coincide with processor needs. Model size capacities align with production targets.
- **Modular Components:** Fully welded modular barrel sections with liquid cooled cores (eliminating 350-plus hydraulic barrel cooling plugs) are engineered with specific metallurgies for extended component life. Additionally, the square barrel segments (two unique nonvented and vented) provide an incremental balanced process profile and cost-effective serviceability.
- **Heat Retention:** Oven-style barrel guards (integrated thermal guards) provide tool-free access and excellent heat retention.
- **Energy Efficiency:** Cast bronze and aluminum high-watt density heaters use targeted energy theory to maximize efficiency and overall machine performance.
- **High-Torque Rating:** Screw elements feature full-length, inner-splined bores for improved torque ratings.
- **Unique Screw Removal:** The drive end decouples from the downstream barrel section to permit screw removal out the back for reduced footprint requirements, and ease of service and inspection.
- **Stainless Steel:** High-vacuum circuits offer all stainless-steel construction to assure long component life and superior performance with toolless-access cleanout hatches.
- **Higher Outputs:** Overall machine design yields 15%-plus greater production outputs per horsepower, making it highly efficient.

DRYING

AI-Powered Drying Technology

Conair's ResinWorks with Optimizer is an AI-driven, multihopper drying platform that can monitor resin temperatures and adapt heat inputs to optimize resin drying while producing energy savings up to 40% over manual operation.

Introduced in March at PTXPO 2025, Rosemont, Illinois, the system relies on artificial intelligence (AI) to automatically and seamlessly adjust for operating rates, material conditions (incoming and in-process), and live data feedback from each hopper, Conair says. A hands-free operation that requires no operator involvement, the technology is billed as an energy saver: up to 40% in real-world testing. This is achieved because electrical and mechanical adjustments to power consumption are automatically made based on current drying conditions.

In real time, the system monitors and adjusts for variations in throughputs, materials, bulk densities, material temperatures, moisture content, drying time, airflow and dew point. In the case of ResinWorks with Optimizer, the manual damper handles, which regulate airflow to the hoppers, are omitted in favor of the AI-driven control logic. The Optimizer logic monitors overall airflow, first ensuring that only active hoppers are served. Then, it optimizes airflow through each active hopper based on changes in mass flow and temperature.

Once material at the bottom of the hopper achieves the proper temperature, the Optimizer logic holds it steady, while incrementally adjusting airflow through the rest of the hopper to match the actual processing rates, incoming material condition and material drying requirements.

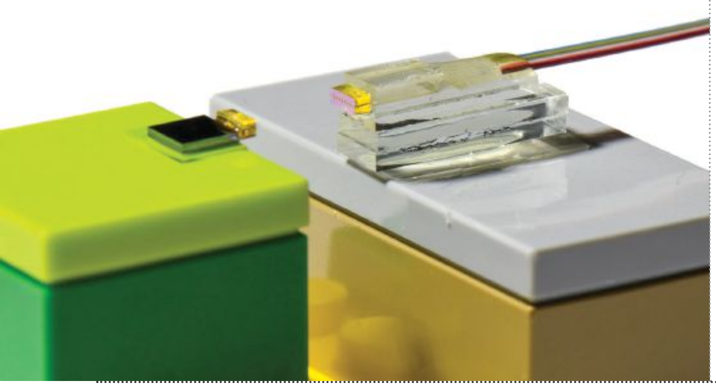
MATERIALS

SABIC Introduces New Grade of Extem RH Resin

Saudi Basic Industries Corp. (SABIC) has announced Extem RH1017UCL polyimide resin for optical applications. According to SABIC, the resin withstands 260°C reflow soldering and features enhanced properties supporting high-volume production of multilens arrays for optical connect assemblies and subassemblies.

"The optimization of network architecture to handle the explosion of data from AI, cloud, and social and digital media requires infrastructures that can boost transmission speed, bandwidth capacity and reliability," says Sergi Monros, vice president, SABIC Polymers, specialties business unit. "SABIC's specialty thermoplastics and dedicated design services can help the industry build these infrastructures at scale. Our materials enhance the performance, precision, cost-effectiveness and manufacturability of components ranging from connectors and optical interconnects to wire and cable," Monros says.

New Extem RH1017UCL resin is suitable for emerging technologies like onboard and co-packaged optical interconnects. Compared to fused silica and thermosets, this optically transparent material can deliver greater design freedom, support scaled-up production and reduce system costs by avoiding secondary operations. The new product surpasses other Extem grades with improved near-infrared (IR) light transmission, lower moisture uptake and easier processing.

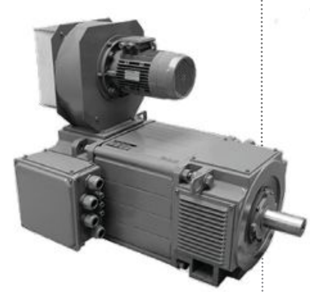


EXTRUSION

Extruder Drives, Motors Ease Switch from DC to AC

Integrated Control Technologies (ICT) is introducing two new products which are intended to facilitate the conversion from DC drives and motors to AC in extrusion. The products are also said to provide additional protective features for an extruder that previously required a control upgrade.

First, the Extruder Duty Motor from ICT has a laminated frame design similar to a DC motor frame and eases the physical difficulties normally associated with a retrofit. In addition, it comes with insulated bearings and an Aegis Bearing Protection Ring to resolve premature bearing failures, along with RTDs and thermostats built into the windings. ICT says it carries 100-500-hp motors as standard inventory, reducing the wait of 16 weeks for a custom motor with similar features.



Secondly, what ICT bills as an industry-first development is the Extruder Drive Guardian. The Extruder Drive Guardian is a Plastic Logic Drive (PLD), which is said to be new technology designed for extrusion which combines an AC drive with the logic control of a PLC to provide protective features for an extruder that would previously require a control upgrade.

In addition, it accurately measures the temperature of the new Extruder Duty Motor to anticipate motor problems before a catastrophic failure. It is built on the ABB ACS880 platform with custom firmware to provide a wide range of features which include scripted application configuration; alarms viewed on drive HMI; screen trending; a default display of screw speed, drive amps and pressure; screw-break prevention; high-pressure shutoff; low-pressure start prevention with bypass; motor temperature monitoring (with Extruder Duty Motor); vibration monitoring; and more.

The Extruder Drive Guardian is available from 50 to 500 hp and is the first in the series of plastic solution drives from Integrated Control Technologies.

MOLD MAINTENANCE

Microwelding, Cleaning and Descaling Innovations to Optimize Plastic Processes

PCS Company demonstrated some of its latest technologies at PTXPO 2025, March 18-20, in Rosemont, Illinois. Featured products include the Lase One microwelder, Rhinofeet mold base storage solutions, compact locking date stamps, metric straight round locks, Goodway descaling systems and liquids, a dry ice blaster and the TC56-12 temperature controller.

The company's Lase One microwelder is a spot plasma unit (0 to 300 joules) for complex assembly and repair microwelding for a range of applications, materials and configurations. Akin to the capabilities and weld quality of a pulsed YAG laser with the benefits of an electric solution, the programmable Lase One features independently adjustable welding power and weld time, with the weld time adjustable to the tenth of a millisecond with pulse duration of 0.1 to 10 ms.

Other benefits include no over-heating or deformations, as well as easy assembly and repair welds of very small to large parts. It can weld ferrous, nonferrous and precious materials, including gold, silver and more.

PCS' IB 10/15 L2P Dry Ice Blaster spontaneously cleans molds and dies for short-term applications. L2P stands for "liquid to pellet," which the company says means that it is the world's first dry ice blaster in which dry ice pellets are made from liquid CO_2, when necessary. Liquid CO_2 can be stored in gas cylinders for an extended period of time, thereby avoiding time-consuming dry ice logistics.

AUXILIARIES

Molding and Part Handling Solutions Advance Molding Capabilities

Two Globeius offerings include the Mouldpro mold splitter tables and molding part separator trials using Crizaf demo machines. Mouldpro mold splitting tables are designed for easily handling molding tools. The tables simplify maintenance tasks by opening and closing molds in seconds, enabling quick access to different parts. The tables also feature a wide range of customizable options to adapt for any type of mold.

According to the company, choosing the right injection molding part separator can be overwhelming. That's why Globeius is offering free separation trials to help molders find the best solution for their unique parts. Molders can send sample injection molding parts to Globeius and receive a video of the results.

Plastixs is offering a variety of new technologies to optimize moldmaking capabilities, including fluids, tools and monitors. The Paratherm heat transfer fluids are a range of specialized fluids for temperature control in molding, extrusion, press heating, line tracing and coating rolls, as well as a liquid cleaner for hot-oil units.

Barb-Tech hose assembly tools are versatile tools that can be used with any type of hose. Portable, efficient and easy to use, they can accommodate many types of fittings, including straight and elbow. Users can benefit from safe hose assembly in injection molding, robotics, automation, pneumatics and other industrial applications. The Model V is a hose-gripping system, while the Model PQD is available in two kits — the PQD-CM and the PQD-PM.

TOOLING

Mold Sensor Prevents Accidental Closure in Injection Molds

Burger & Brown Engineering's Global Thinswitch is specially engineered for use in injection molds with 3-mm and 4-mm rest buttons to verify ejector plate return. When tied to the machine control, the Global Thinswitch can help prevent mold crashes due to premature mold close, saving the user downtime and expensive mold repairs.

The Thinswitch helps prevent accidental closure in injection molds by verifying ejector plate return in injection molds with 3-mm and 4-mm rest buttons, and where occasional water or oil spray is present. The switch features a spring clip mounting option which makes it easy to remove from the mold without using tools, thereby preventing accidental wire damage in storage.

This model may be mounted directly to the mold using integral mounting holes or by using the spring clip. The bracket enables molders to slide the Thinswitch into place without disassembling the mold or using screws to hold the switch in place. Spacers placed under the switch accommodate different rest button heights.

Switch mounting is accomplished using integral mounting holes, or using the spring clip bracket which enables the sensor to slide into place from the edge of the mold base. Housing thickness is 3 mm, and each switch is shipped with a 1-mm thick spacer to accommodate 4-mm rest button thickness.

The operating point is adjustable between 0.2 and 1 mm above the top of the switch housing. Special mold base pocket machining is not required. A polyurethane dome and wire seal protect the internal switch mechanism from water or grease contamination, providing a longer switch life. The switch is compliant with CE directive IEC 60730-1, and suitable for use in environments up to 80°C. Switching action is SPST with gold-plated internal contacts for reliable operation.

Wire leads are 28-gauge stranded, 2-conductor shielded cable, 2 m long. Ends are stripped and tinned, ready for installation. According to the company, product testing has exceeded 14 million cycles without failure.

Prices for 4 of the 5 Commodity Resins Flat-to-Down

PET is the exception from this general trajectory, at least for now.

By Lilli Manolis Sherman
Contributing Editor

The trajectory of prices for four of the five commodity resins — polyethylene (PE), polypropylene (PP), polystyrene (PS) and polyvinyl chloride (PVC) — was trending flat-to-down for at least the early part of the second quarter. Contributing factors include sluggish demand as evident from lowered operating rates, lower feedstock costs and the 'anxiety-inducing' uncertainty of the impact of U.S. and retaliatory tariffs, which could affect prices of resins and finished goods, as well as demand and trade flows. The exception as noted below is polyethylene terephthalate (PET), in which the tariffs on aluminum are likely to result in higher PET feedstock costs, a reduction in competitively priced PET imports which have traditionally supported the domestic market, and a resultant domestic supply tightness.

These are the views of purchasing consultants from Resin Technology Inc. (RTi); David Barry, associate director for PE, PP and PS PetroChemWire (PCW); CEO Michael Greenberg of Resintel, the market intelligence service of The Plastics Exchange; Scott Newell, executive VP polyolefins at distributor/compounder Spartan Polymers; and Mike Burns of Plastic Resin Market Advisors.

Market Prices Effective Mid-April 2025

Resin Grade	¢/lb
POLYETHYLENE (railcar)	
LDPE, LINER	65-67
LLDPE BUTENE, FILM	62-64
HDPE, G-P INJECTION	62-64
HDPE, BLOW MOLDING	60-65
HDPE, HMW FILM	65-67
POLYPROPYLENE (railcar)	
G-P HOMOPOLYMER, INJECTION	56-58
IMPACT COPOLYMER	59-61
POLYSTYRENE (railcar)	
G-P CRYSTAL	97-99
HIPS	101-103
PVC RESIN (railcar)	
G-P HOMOPOLYMER	57-59
PIPE GRADE	58-60
PET (truckload)	
U.S. BOTTLE GRADE	59-61

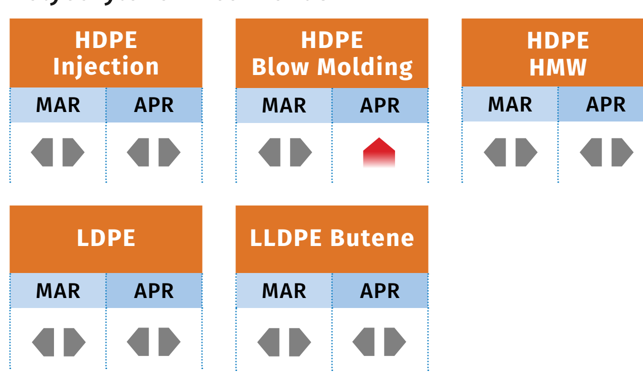
PE PRICES FLAT-TO-DOWN?

PE prices rolled over in both February and March, and were largely expected to remain that way, or possibly drop a bit, within the April-May time period. This despite suppliers' 5¢/lb price initiatives for each of those months, followed by new April price hikes, mostly in the 5¢/lb range, according to David Barry, PCW's associate director for PE, PP and PS; Resintel's Greenberg; Mike Burns of Plastic Resin Market Advisors; and Kevin Mekaru, RTi's senior business leader commodity plastics.

According to PCW's Barry, there is "too much negative sentiment" as indicated by traders and processors who had been aiming to reduce their inventories going into April, as they believed PE prices could well be lower in the second quarter. "Domestic demand has slowed as have exports," Barry says. "In the case of the latter, that includes flat demand in Asia and disinterest from European countries in buying U.S. resin at this juncture." Adds Burns of Plastic Resin Market Advisors: "The tariff outcome will be a leading economic indicator and influence processors' behavior."

Burns also notes that market fundamentals remain unchanged from 2024, and that suppliers will continue to rely on the exports market to manage the record production rates. The January price increase will most likely remain in place through the second

Polyethylene Price Trends



quarter, while nonmarket activity and competitive prices should be expected through midyear. Overall, he saw resin availability and prices remaining favorable for U.S. processors, due to flat demand and export challenges. RTi's Mekaru ventures that there was potential for processors to get a decrease of 2¢ to 3¢/lb before the end of second quarter due to slower demand, and the wrap-up of plant turnarounds that would further amplify suppliers' inventories, along with the impact of tariffs.

PCW's Barry at March's end reported PE spot prices as flat to lower as sluggish domestic and international demand weighed on the market. Suppliers were believed to be reducing operating rates in response to weaker demand. Resintel's Greenberg notes: "Domestic buyers mostly procured for near-term needs while resellers tapped the spot market to fill in supply gaps, and few were seeking resin for needs beyond April. Exports to Mexico were solid, Latin American sales were workable at lower levels, while our European sales were limited to Canadian-produced resin. Export logistics were strained as containers were in short order, and sellers scrambled to ship out material, causing some high demand destinations to roll bookings. Canadian PE producers continue to stage railcars in the U.S. in case the tariffs are implemented, and we have seen some processors in both the U.S. and Canada seeking alternative supplies."

PP PRICES DOWN FOR NOW

PP prices in March dropped 4¢/lb in step with propylene monomer contract settlements. Whether this downward momentum would continue into April-May was uncertain. More certain, however, was that PP suppliers' attempts at any nonmonomer (or margin) increase were very improbable within the first half of this year at least, according to PCW's Barry; Spartan Polymers' Scott Newell; Resintel's Michael Greenberg; and Paul Pavlov, RTi's VP of PP and PVC.

Polypropylene Price Trends

Homopolymer	
MAR	APR
▼ 5¢/lb	▼

Copolymer	
MAR	APR
▼ 5¢/lb	▼

"Whether this downward trend continues is very much dependent on monomer," PCW's Barry says. "Spot propylene prices were rising a bit, and monomer supply availability appeared to be pretty balanced going into April." At the same time, he and Spartan Polymers' Newell note that demand for the monomer, as well as the resin, was not great. PP plant operating rates continued to be well under 80%. In fact, suppliers were reported to be throttling back production in the face of sluggish demand. RTi's Pavlov ventures there would be further downward movement for April with stable prices for May.

These sources looked at overall demand for key sectors, including consumer goods, construction and automotive, and unfortunately did not see the typical seasonal uptick in demand going into the second quarter. "The tariffs uncertainty is bringing projections on demand into question," Newell says. "The industry sentiment is weak, with some orders cancelled or delayed and, by now, seasonal demand should have been stronger. There is an overall cautious behavior prevailing."

PCW's Barry reported spot prices as flat to 1¢/lb lower going into April, as lackluster demand and monomer volatility weighed on market sentiment. "Ongoing concern about pending tariffs and overall economic demand has kept resin buyers on the sidelines," Resintel's Greenberg says. "Many processors are working down on-hand resin supplies and finished goods while only buying new material as needed."

PS PRICES UP, THEN DOWN?

PS prices in March appeared to have moved up 2¢ to 3¢/lb as suppliers held firm on passing their 3¢ to 4¢/lb price hikes, but prices in the April-May time frame were likely to rollover and possibly drop, despite the seasonal demand uptick that typically takes place, according to PCW's Barry and RTi's Pavlov.

Polystyrene Price Trends

GPPS	
MAR	APR
▲ 2¢/lb	▼

HIPS	
MAR	APR
▲ 2¢/lb	▼

Projections for key feedstocks benzene and ethylene were for sharply lower pricing as PS resin demand remained lackluster. RTi's Pavlov ventures that processors would most likely get that 2¢ to 3¢/lb back before June. "There is no justification for an increase, barring a major disruption event, and suppliers were understood to be closely matching (low) operating rates to firm orders, resulting in limited spot resin availability," Barry reports. Going into April, the implied styrene cost based on a 30% ethylene/70% benzene spot formula was at 29.2¢/lb, down from 35.3¢/lb a month earlier.

PVC PRICES UP, THEN FLAT

PVC prices in March moved up 1¢/lb, following the February 2¢/lb increase, owing mainly to unplanned and planned shutdowns earlier in the year, according to RTi's Pavlov. His projected trajectory change for April-May anticipated that prices would most likely be flat with the potential for a decrease next month. He attributes this to sluggish demand, lower feedstock costs and a 10% increase in new capacity. Also of concern is the impact of tariffs on the PVC exports business.

PVC Price Trends

Pipe	
MAR	APR
▲ 1¢/lb	◀▶

Gen. Purpose	
MAR	APR
▲ 1¢/lb	◀▶

PET PRICES MOVING UP

PET prices in March increased by 1¢/lb and were generally expected to move up by 5¢/lb in April and perhaps more in May, according to RTi's Mekaru. He attributed this to a combination of an uptick in seasonal demand, higher feedstock formulation costs that were expected to rise as tariffs went into effect, and a potential increase in demand for PET due to tariffs on aluminum. Moreover, retaliatory tariffs were very likely to result in lowering the volume of PET imports, which have long been a major part of the market, and which in turn would tighten domestic PET resin supply.

PET Price Trends

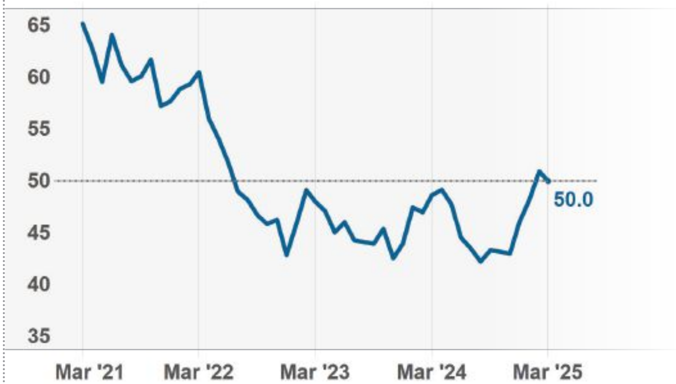
Bottle Grade	
MAR	APR
▲ 1¢/lb	▲

Find the latest plastics processing market research and reporting at **GardnerIntelligence.com**

Plastics Processing Activity Lands Flat at 50 in March

Latest reading is a slight regression from February but not enough to call it contraction.

FIG 1 Plastics Processing Index



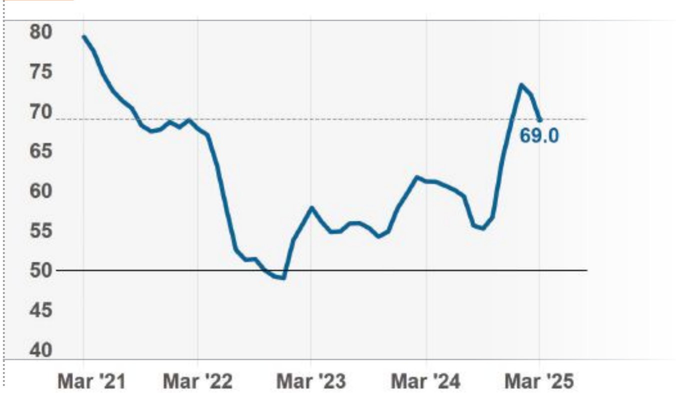
The GBI is an indicator of the current state of plastics processing. Over 50 is expansion. Under 50 is contraction.

FIG 2 Components Scorecard

	Change vs Month Ago	Change vs Year Ago
New Orders	▲	▲
Supplier Deliveries	▲	▲
Production	▲	▲
Employment	▼	▼
Exports	▲	▼
Backlog	▲	▲

Shade = distance from 50 (darker shades are further from 50)
Direction = change (Pointing up is better)

FIG 3 Future Business Index



Numbers in Perspective

Production pared back its gains based on the recently released March GBI: Plastics Processing Index, which declined from 56.2 to 52.2. However, the March reading remains above monthly figures recorded in 2024. On a three-month moving average basis, the production stood at 52.3 — marking its fifth consecutive monthly increase. Although there have been recent announcements regarding U.S. tariffs and trade policy, further developments are anticipated. Policy shifts have occurred frequently, making it difficult to keep pace. For instance, effective April 9, the U.S. imposed a 104% tariff on Chinese imports, following a universal 10% tariff on goods from several countries that took effect on April 5. Additionally, "reciprocal tariffs" were applied to dozens of countries starting April 9.

By Perc Pineda

As of this writing, President Trump has authorized a 90-day pause on certain tariffs and reduced reciprocal tariffs for some countries, following diplomatic outreach from more than 70 nations seeking to negotiate lower rates, according to the White House press secretary. Meanwhile, tariffs on Chinese imports were raised to 125%, effective immediately.

These shifts have heightened uncertainty for the plastics industry. While the U.S. aims to reshore manufacturing, near-term progress is unlikely. More likely is a rebalancing of tariffs through bilateral talks. Globalization enabled offshoring of U.S. manufacturing by opening access to lower cost labor markets. To offset tariff impacts and improve competitiveness, the U.S. should also consider policy tools like regulatory reform and full expensing of capital investments —measures that can support domestic manufacturing regardless of tariff outcomes.

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

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PLASTILENE — WASHINGTON COURT HOUSE, OHIO

Innovative Film Processor Adds Water-Blown Technology to Barrier Offerings

A market leader in technical films in Latin America, Plastilene enters U.S. barrier market with nine-layer technology, including an upside-down, water-quenched system.

Plastilene's investment in W&H's water-quenched Aquarex film extrusion line has enabled it to penetrate high-end barrier packaging markets for meat and poultry. Source: Plastilene

By Jim Callari
Editorial Director

One of Latin America's leading producers of flexible and rigid packaging products has established footing in the U.S. and is armed with innovative blown film technology that it contends will give it an edge in packaging of meat, poultry and other protein products.

Family-owned and run, Grupo Plastilene was founded in 1958 in Colombia by the father of Stefano Pacini, the company's current CEO. Today, Plastilene operates in 16 countries, has eight production plants and roughly 1,200 employees. It has a capacity of roughly 80,000 metric tons a year, and extrudes film and sheet up to nine layers for a wide range of markets that include food, personal care, agriculture, frozen food, fruits and vegetables, pet food, industrial and many others.

Plastilene is also vertically integrated. It compounds many of its own formulations; sister company Reciclene furnishes it with functional blends and postconsumer recycled resins called Cicloene.

As a second-generation owner, Pacini's vision was to grow Plastilene into a global entity. He says, "We have always been an innovative company. We develop a lot of our own formulations, technologies and compounds. We are leading the trend toward sustainability packaging by using PCR in films, and we've been carbon neutral since 2020. But when I got in charge of the company about 15 years ago, I wanted us to be a worldwide player. We have invested in technology and talent to achieve that goal."

To that end, roughly two years ago Plastilene opened its first U.S. production facility in Washington Court House, Ohio, a 70,000-square-foot facility where it mainly produces barrier films. The company has installed two nine-layer lines from Windmoeller & Hoelscher (W&H): a Varex II line, with a 400-mm die, and a nine-layer Aquarex line, with a 500-mm die. Aquarex is a water-quenched system in which the bubble is blown upside down. Pacini notes that Plastilene has one such line at its plant in Bogota, Colombia. Plastilene installed the Aquarex line in Ohio in 2023, making it the first such W&H line installed in the U.S.

Pacini says Plastilene worked with W&H to customize the nine-layer extruder Aquarex line for its specific needs. Pacini says Plastilene runs a variety of materials on the line, including polyethylene, polypropylene, nylon and ethylene vinyl alcohol. Primary applications for film are packaging for meat, poultry and other proteins. "Our competition is primarily cast films. But we believe our films provide better mechanical properties, transparency and optics than what is currently on the market," Pacini says.

Participating in the upper echelon of the barrier film market puts Plastilene up against some of the largest film processors in the world. But Pacini believes that Plastilene's ability to be nimble and customize products gives it an edge. "We believe in working closely with customers to develop specific products tailored to their applications. We encourage customers to come to us and tell us what they need so that we can develop a solution specific to that need."

This requires more in the way of changeovers than might be typical on the lines the size and complexity that Plastilene runs. Notes Pacini, "The larger companies may say no to a short run, because their business model is to turn the machine on and run it. Ours is to customize, so we say yes." Pacini says the Aquarex line is running at about 75% of capacity.

In the area of development, Plastilene worked with Collin Lab & Pilot Solutions on a one-of-kind R&D line that can be converted between a conventional blown film system and a water-quenched system that runs upside down.