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Slowed, But Not Stopped, by the Pandemic

PMT Renews Plans for Growth

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VOLUME 67 • NUMBER 3

Plastics Technology

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PT Tech Days

From Oct. 8 through mid-December 2020, *Plastics Technology* ran a series of live, interactive webinars on a wide range of topics pertaining to plastics processing. The series attracted in excess of 2500 registrants. Afraid you missed something? They are still available for viewing, for free, at: ***short.ptonline.com/TechDays20***

PT TechDays Interactive Webinar Series

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Meet Me in Chicago

In Rosemont, to be more specific. Join us September 21-23 for a first-of-its-kind, *in-person* event that brings under one roof our annual Molding and Extrusion 2021 Conferences, together with our Amerimold tradeshow.

Like many of you, I've had an occasion or two in the past year or so to reflect on new skills I've developed since the global pandemic put the kibosh on social gatherings. My list includes learning about various video conferencing platforms; how to use webcams, microphones and lights; how to make my at-home office look sort of like a production studio; and how to interview someone on camera and take notes at the same time.

Jim Callari
Editorial Director

Lots of new experiences to be sure, but I'm ready now to take a step back to the *old* normal. So, with that in mind, let me fill you in on an in-person event we at Gardner Business Media have planned for this fall: We're bringing three of our successful annual events together under one roof for a real-life gathering, giving injection molders, moldmakers, brand owners, OEMs, extrusion processors, and recyclers—and all of their suppliers—the opportunity to learn, network and perhaps even evaluate or buy machinery.

Amerimold 2021, Molding 2021, and Extrusion 2021 will be held September 21-23 at the Donald E. Stephens Convention Center in Rosemont, Ill. By then (knock wood), our country will have awakened from its slumber and been fortified to resist the nasty virus that has disrupted the U.S. and the rest of the world. While I've come to appreciate virtual events—we've had several of our own—I'm ready to go out and actually see stuff, say hello to old friends, meet new ones, and report on new technology. And what better place to do it than the Chicagoland area, the core of our industry.

amerimold 2021

Extrusion 2021

Molding 2021

Here's a little bit about our three events: Amerimold is an annual show presented by our sister publication, *MoldMaking Technology* magazine. It is intended for the entire injection molding supply chain: moldmakers, molders and their suppliers. The upcoming show will be unlike any Amerimold in the event's 20+ year history. Why? Because it will afford machine builders the first opportunity in months to bring equipment to a trade show and get face time with customers and prospects. I think there is a thirst for this, and I expect many machine builders will agree.

Molding 2021 (see p. 51) is an educational conference and exhibit where industry leaders discuss the latest developments in various molding processes, equipment, materials and management techniques, with special emphasis on adding value to your business. During 2½ days in Rosemont, attendees will have access to molding industry thought leaders, learning "Best Practices"—practically oriented talks on specifying or selecting equipment, organizing production, or addressing processing issues, as well as expert know-how on problem solving and troubleshooting. Afternoon sessions will consist of three concurrent breakout sessions that focus on key technology and end-market areas. Molding 2021 will also launch our first Top Shops Parts Competition, in which attendees will judge innovative examples of injection molded applications.

At our Extrusion 2021 Conference and exhibit (see p. 49), attendees will be brought up to speed over 2½ days on technology developments and best practices impacting all types of extrusion operations. Each day will consist of a morning General Session of interest to all extrusion processors, as well as afternoon concurrent sessions that will drill down into specific processes: Film/Sheet, Compounding, and Pipe/Profile/Tubing. The afternoon before our conference (Sept. 20) there will be a half-day symposium organized by TAPPI on Film Processing and Coating in a Circular Economy.

Wait, there's still more: On the afternoons of Sept. 21 and 22, we will also introduce our first-ever Recycling Conference. Intended for molders and extrusion processors—as well as the recyclers who supply them—our editorial team is putting the finishing touches on this program as I write this.

So be on the lookout for more details on this event, including registration and hotel information. And meet me in Chicago.

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Shintech North America Plans Even More PVC Capacity

Shintech North America is investing $1.3 billion to further expand its PVC manufacturing and packaging facilities in Plaquemine, La. This newly announced expansion is expected to boost capacity there by 1.3-billion lb/yr of monomer and 838-million lb/yr of PVC by the end of 2023.

Shintech Louisiana is already scheduled to start up a new 640-million lb/yr PVC plant (and a monomer plant of similar size) by June, which is expected to help reverse the current tight supply situation. This marks the first completley new U.S. PVC production line in several years, unlike incremental capacity brought on through debottlenecks of existing production lines.

Meanwhile, Formosa is scheduled to start up a new 300 million lb/yr PVC production line in Baton Rouge, La., in the second quarter of 2022.

Eastman to Build World-Scale Plastic-to-Plastic Molecular Recycling Facility

Eastman has announced that it is investing approximately $250 million over the next two years to build one of the world's largest plastic-to-plastic molecular recycling facility in Kingsport, Tenn. The planned facility will utilize the methanolysis polyester renewal process, first developed by Kodak 30 years ago to recycle polyester photographic film.

Polyester-based waste from PET bottles, packaging, carpets and textiles will be converted into high-performance materials across Eastman's Specialty Plastics Division's product portfolio, including Tritan Renew copolyester for durable products in electronics and medical devices, and Cristal Renew copolyester for the cosmetics market.

The company will source this feedstock waste from all over the country. It is already getting carpet from California and purchasing polyester from multiple sources.

Expected to be mechanically complete by year-end 2022, the facility will contribute to the company achieving its ambitious sustainability commitments for addressing the plastic waste crisis, which includes recycling more than 500 million lb/yr of plastic by 2030 via this method.

Caprolactone Resins Make PLA, PHA More Flexible, Biodegradable

Capa brand caprolactone thermoplastics from Ingevity, North Charleston, S.C., have been shown to increase the flexibility of PLA and PHA bioplastics. Ingevity acquired the Capa caprolactone division of Sweden's Perstorp Holding AB in the spring of 2019. Capa products include innovative copolymers that can be used to make new bioplastic compounds.

Capa thermoplastics are high-molecular-weight, low-melting-point aliphatic polyesters that come in powder or pellet form and have been shown to function as performance enhancers in other plastics. In particular, the material has been demonstrated to boost the flexibility of end-use products formulated with PLA and/or PHA, and to address the challenges of these materials such as brittleness, temperature sensitivity and ensuring full biodegradability.

Capa reportedly offers biopolymers like PLA over 500% more stretch before breaking and over 300% increased impact resistance. Capa products reportedly are process-stable in a wide range of conditions, fully compostable and food compliant. They add grease and moisture resistance and are tough and durable yet soft to the touch. They boast 100% biodegradability in 40 days.

Blow Molding: Simulation on 'Virtual Twin' Machine Speeds Upgrade on Plant Floor

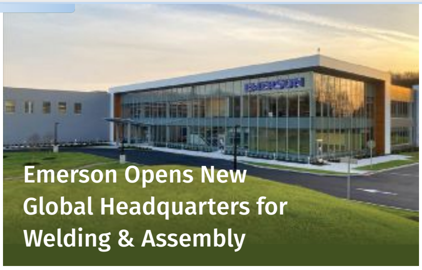
Commissioning complex blow molding applications and production systems often takes several days or even weeks and involves considerable downtime if an existing machine is being repurposed for a new task. But today's virtual development and testing environments can speed the process considerably. In one recent case, Kautex in Germany was able to reduce on-site commissioning of a new control program to a single day.

The goal of the control update was to optimize cycle time on the post-processing station (IntelliGate module) of a Kautex KBB400D double-station, all-electric, continuous-extrusion machine for jerry cans at a customer in Spain. The new control program was developed at Kautex headquarters

and tested (simulated) there on a virtual IntelliGate module before a Kautex service technician implemented the control change at the customer's site.

The technician received support from a virtually linked Kautex programmer. It was thus possible to implement the change and final adjustments in a single day—half the time originally calculated.

Says Kautex project manager Dirk Hiller, "Digital twinning of our machines means that we are now in a better position to adapt the control of the production system to changing conditions and production requirements more quickly."



Emerson Opens New Global Headquarters for Welding & Assembly

Emerson has opened up its new Branson global headquarters for welding and assembly technologies in Brookfield, Conn. It is located on a 13-acre site less than 2 miles from Branson's former Danbury, Conn., headquarters. This 146,000-ft^2 facility reportedly will offer unprecedented levels of customer support, including:

- A 16,000-ft^2 engineering lab for R&D, customer application development and materials testing.
- Advanced additive-manufacturing equipment for rapid-response prototyping and production tooling.
- A 48,000-ft^2 manufacturing space for CNC machining, assembly and customer application runoffs
- Collaborative workspaces to develop customer solutions.
- Dedicated training workspace for seminars, classes, technical support services, etc.

Emerson plans to host seminars and events to introduce clients to the capabilities of the new facility as soon as COVID-19 safety protocols permit.

Braskem Expanding into the 3D Printing Market

Last year, Braskem announced the expansion of its product portfolio to include polyolefin-based filament, powder and pellets for the additive manufacturing market. The company says polypropylene is well suited to additive manufacturing based on its recyclability, impact strength, chemical resistance, dimensional stability, durable living-hinge capabilities and lower density than other 3D printing polymers such as PLA. Braskem invested in a new dedicated additive manufacturing lab as part of an expansion of its Innovation & Technology (I&T) Center in Pittsburgh.

Braskem has developed two grades of PP filament for fused filament fabrication (FFF). They were made available May 2020 through a distribution partnership with M. Holland Co. Also released last May was the first-generation PP powder for Selective Laser Sintering (SLS) developed by Braskem and Advanced Laser Materials (ALM), an EOS company. It is being sold by ALM.

That same month saw the launch of Braskem's first PP for Titan Robotics' Atlas pellet extrusion system. "We saw the market struggle to try to convert traditional reactor-grade PP into a functional filament," says Jason Vagnozzi, Braskem's additive manufacturing leader for North America.

"Existing PP filaments on the market would warp and have issues with bed adhesion, so we developed a custom formulation specifically designed for 3D printing to overcome those issues, and saw amazing results." Braskem is seeing a lot of traction in aerospace, industrial and automotive applications, Vagnozzi adds.

Braskem's plans for 2021 including adding fiber reinforcements to PP for 3D printing. The company is also experimenting with incorporating 5-15% PCR PP in PP filament.

How Teel Plastics Battles the Coronavirus

As the coronavirus pandemic continues to challenge the world, Teel Plastics has risen to the occasion to quickly become one of the nation's largest suppliers of swab sticks for COVID-19 testing. Since March 2020, the custom profile and tubing manufacturer, based in Baraboo, Wis., has produced more than 500 million swab sticks for U.S. customers.

Thanks to a recent contract from the U.S. Dept. of Defense, Teel will boost production in 2021 by 66 million extruded and 50 million injected molded swab sticks each month. The company recently installed two Davis-Standard extrusion lines to support the increased capacity. In addition, Teel has been selected to manufacture profiles for a proprietary respirator device used to treat patients in critical care for COVID. These profiles will also be produced on D-S lines, including a new custom line.

"Before the pandemic began, we were the only U.S. company to make diagnostic swabs needed for coronavirus testing," says Christian Herrild, Teel's director of growth strategies. "This required us to react quickly to support the surge in test kits. Our development style, product repeatability, and ability to navigate highly regulated markets have been key to our response. Our dedicated employees have done what is necessary to meet very tight timelines, including taking on additional shifts. Our large manufacturing and engineering teams, chemists and analytical lab are definitely a differentiator for us."

Herrild continues, "We needed to boost production capacity and Davis-Standard responded to our extrusion needs in record time. They provided us with a demo line almost immediately and two additional lines within 10 weeks from order to delivery. It is also convenient to have one point of contact for pre-and post-engineering service and support."

Teel has more than 30 D-S extrusion lines, some dating back to the 1980s. The newly installed profile lines have controls, screws and other components customized for Teel's swab-stick process.

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Carbios Produces First Clear Bottles from Recycled Textile Waste

French biotech company Carbios has produced the first clear bottles from enzymatically recycled textile waste. This latest milestone confirms Carbios' capacity to recycle textile waste and opens up access to an additional waste stream. Around 85% of all discarded textiles in the U.S. are dumped into landfills or burned; and globally, just 12% of the material used for clothing ends up being recycled.

Martin Stephan, deputy CEO at Carbios, says, "Bottle-to-fiber is the typical process that is used today but we have demonstrated the first fiber-to-bottle process, which is much more difficult. Carbios is the first and only company in the world using the biological technology for the end of life for plastics."

Earlier this year, Carbios announced the start of construction of an industrial demonstration plant in France for enzymatic recycling of PET plastic. The first phase of operations is scheduled to launch in the second quarter.

The company's path to commercialization is supported by international cosmetic and beverage brands L'Oreal, Nestlé Waters, PepsiCo and Suntory Beverage and Food Europe, as well as multinational manufacturer Michelin and Novozymes, the world's largest enzyme producer.

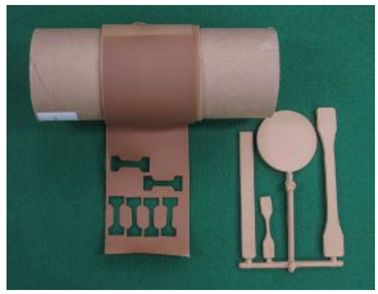
Ineos Styrolution Partners with Polystyvert to Advance PS Recycling

Ineos Styrolution and Canadian clean technology startup Polystyvert are collaborating to convert post-consumer polystyrene into new, high-quality, PS resin. Ineos Polystyvert will use a patented dissolution method of advanced recycling that takes plastic waste in solid form and dissolves it in a solvent. Once dissolved, the process can mechanically and chemically separate contaminants and additives, before finally separating the original polymer from the solvent. The end product is a cleaned polymer that may be used again as "new" resin.

Polystyvert's in-depth purification technology reportedly can treat all types of feedstock, from industrial waste to post-consumer streams. The technology reportedly can eliminate a wide range of hard-to-remove contaminants such as pigments and brominated flame retardants. Recycled PS pellets reportedly can be produced at a competitive price and can be used to manufacture even food-grade products.

Arkema and Polymer Engineering Develop PVDF/Rubber Blending Technology

The capability to blend high-performance PVDF with various types of rubber has been achieved jointly by Arkema and Canada's Polymer Engineering Company (PEC), a 36-yr-old privately owned consulting company. The combination of Kynar Flex PVDF thermoplastic fluoropolymer with thermoset rubber materials allows melt processing through chemical compatibilization, followed by vulcanization.



Kynar Flex PVDF fluoropolymers have been shown to impart to rubbers resistance to chemicals, swelling, UV and high heat, as well as high contact angle and good release properties. Rubbers can contribute impact strength, flexibility, strain recovery, electrical resistance, softness and compressibility. The final combination of properties can be tailored by the selection of the base fluoropolymer and the rubber or combinations of rubbers.

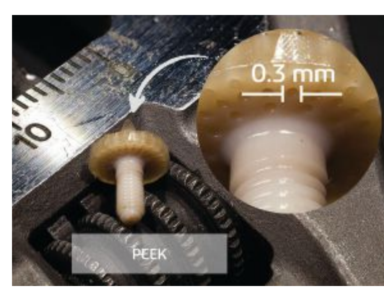
Arkema and PEC can provide manufacturing guidance for processors interested in blending PVDF and rubber for applications such as tubing, hose, gaskets, O-rings, films, linings, wire insulation, cable jacketing and molded structural parts. These blends of Kynar Flex PVDF and rubber can be extruded into profiles and injection or compression molded at temperatures similar to polyolefin thermoplastics. Due to the lower melting point associated with PVDF vs. other fluoropolymers, these blends are said to be easily processed on standard equipment with minimal or no additional investment.

According to PEC president Marek Gnatowski, industries such as fuel and chemicals are challenged by changes in regulations and performance requirements. Materials of construction that were previously considered reliable for long-term service may be considered no longer suitable. "The ability to blend rubber with a high-performance fluoropolymer allows the system designer to keep the friendly properties of rubber without early cracking or swelling failures in service," he says.

3D Printing News in Micromolding & PIM

In the past two years, Addifab of Denmark has introduced to the U.S. its Freeform Injection Molding (FIM) technology, which uses additive manufacturing to build injection mold-cavity inserts from UV-hardened liquid polymers. Those inserts are used to injection mold complex shapes that would otherwise not be moldable; the cavity inserts are dissolved in an aqueous bath, leaving the molded part.

Most recently, Addifab, which has an office in Palo Alto, Calif., debuted a new machine capable of printing mold inserts for micromolding. The AddLine Micro upgrade allows the company's printing machine to reduce resolution from 50 μm down to 10 m. The nominal feature resolution now achievable is smaller than a white blood cell, the company claims.



Meanwhile, researchers from Addifab and Germany's Fraunhofer Institute recently showed that FIM could be used to make cavity inserts for ceramic-powder injection molding (PIM). The researchers molded an 18-mm bone screw from an alumina ceramic feedstock in an FIM polymer cavity. A Boy 35 vertical press molded the part with a tool temperature of 94 F and a maximum injection pressure of 13,780 psi. The researchers noted that in a normal PIM tool, larger draft angles, a high degree of rounding and larger gates often must be designed into the cavity to ease demolding. The dissolvable FIM mold obviates those requirements.

Addifab also announced a collaboration with Mitsubishi Chemical Advanced Materials, which has begun offering FIM as a service from three locations in Mesa, Ariz., Belgium and Japan. The company offers engineering resins such as PC, nylon 66, PPA, PEI, PPS and PEEK.

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Take the Guesswork Out of Determining Screw, Barrel Wear

New technology from Glycon takes real-time measurements of screw and barrel wear and provides data to guide processors on the right time to swap out these components.

By Jim Callari
Editorial Director

Screw and barrel wear wreak havoc on every process, slashing throughput rates while generating additional scrap before shutting the line down altogether. But the what and when of such wear are somewhat mysterious; ascertaining the extent of wear—or whether it exists in the first place—often leads to head scratching and guesswork.

Over the past year, injection molding machine builders have tried to shed light on this vexing problem (see Keeping Up with Technology, February 2021). And now, Glycon Corp. is introducing technology to measure screw and barrel wear at the source—inside the plasticating unit. Glycon is in the first stage of rolling this technology out to the market, focusing on extrusion and blow molding, explains company founder and CEO Jeff Kuhman.

Kuhman notes that Glycon has actually been developing technology to measure wear since 1986, when, as Great Lakes Feedscrews, it was granted its first patent to measure screw wear. The company, which supplies a wide range of screws, barrels and other machine components, refined the technology to include measuring barrel wear, and was granted additional patents in 2006, 2007, 2008 and 2019. It has tested the technology both at its lab in Tecumseh, Mich., which houses a 2.5-in. extruder with 24:1 L/D, and in the field at an undisclosed sheet processor in the Midwest, which runs a 6-in., 32:1 extruder.

"Much has been written over the years on the causes and effects of wear in a plasticating extruder, and most plastics processors recognize the symptoms of wear, usually from a reduction in melting rate," Kuhman states. "At that point, most machine operators try to compensate by making adjustments to the screw speed or temperature settings. The problem is, each of these adjustments constitutes a departure from optimum conditions and will eventually result in lower productivity and higher scrap rates."

Technician installs proximity-detection sensor (inset) into SmartPort on barrel to measure the wear on both the OD of the feedscrew and the ID of the barrel.

Wear and production data are transmitted to an Electronic Measurement and Tracking portal at Glycon for all of a processor's production machines.

The new Glycon system seeks to avoid all that. Called EMT (for Electronic Measurement and Tracking), the system consists of Glycon's Flite-Scan eddy-current sensors that are installed at one or more locations in what Glycon calls a SmartBarrel. These barrels are furnished with a SmartPort, which Kuhman describes as an aperture through the wall of the barrel, together with a barrel-measuring plug configured for insertion in the aperture, a threaded retainer to hold the measuring plug in place, and a second set of threads to secure the electronic sensing unit for measuring the distance from the ID of the barrel to the surface of the feedscrew flight land, or the "gap."

When ordering a new barrel, adding the SmartPort will cost a few hundred dollars extra, Kuhman says. At the outset, wear measurements will be performed periodically at the processor's plant by Glycon field technicians utilizing a Flite-Scan sensor. Over the years, Glycon has worked with several suppliers of eddy-current sensors in search of the most robust design, finally settling on sensors developed jointly with Micro-Epsilon in Germany.

"Wear data obtained will allow engineers to determine the relationship of screw/barrel wear to key performance data."

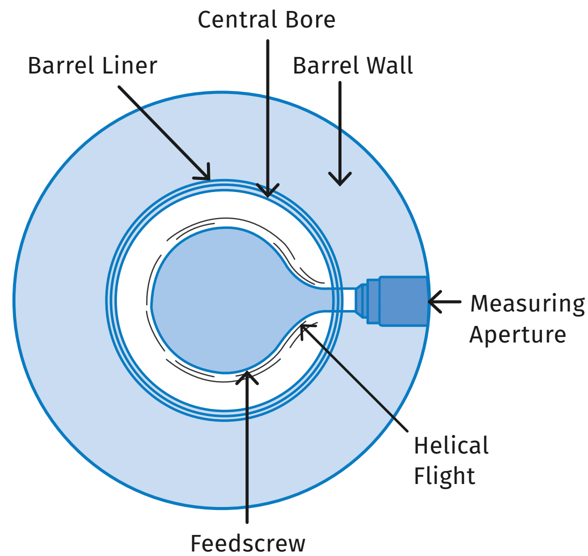
Kuhman explains, "We worked with a couple of other suppliers of sensors over the years and ran into problems related to high temperatures within the plasticating unit, which affected the accuracy of the sensors. Initially, processing temperatures above 300-350 F would result in inconsistent readings of the critical gap between the flight OD and the barrel ID. The initial sensors were fragile, and were susceptible to damage from abrasive fillers, metal-to-metal contact, and tramp materials in post-consumer reclaim. The Micro-Epsilon sensors are more robust and can provide accurate readings at operating conditions up to 600 F." Processors who prefer to take their own measurements can purchase the sensors directly from Glycon.

To take a measurement, technicians remove the barrel plug from the SmartPort. The proximity-detecting sensor is then installed in the SmartPort and secured by the retainer. The machine can be at or near operating temperature when the measuring process takes place. Ideally, material should be purged or nearly purged to facilitate removal of the plug and installation of the sensor. The screw is then rotated at minimal speed and the distance between the screw OD and barrel ID is measured, recorded and averaged, recognizing precession, or the orbital rotation of the screw inside the barrel. The rotation of the screw can be observed on the screen of the recording device.

The barrel plug, which is installed in the new barrel during the manufacturing process, is finish-honed with the barrel to ensure that the plug will match the barrel ID When the barrel plug is removed during the measuring process, it is installed in a "measuring fixture." The sensor is then installed in the opposite end of the fixture and used to measure the wear on the barrel plug. While the sensor is installed in the measuring port, the average reading will provide the wear on the screw, while the minimum reading indicates the wear on the barrel. The barrel wear can then be confirmed by the measurement of the barrel plug in the fixture.

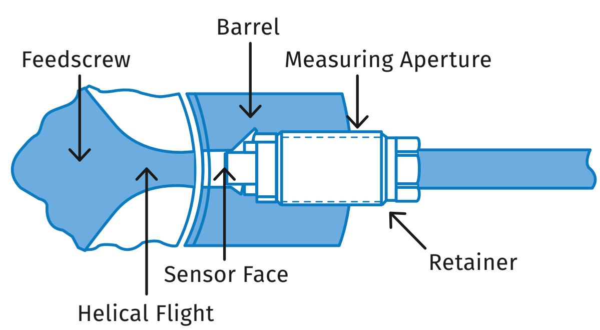
Whether done by Glycon's technician or by the processor's own personnel, data is transmitted to a customer's EMT portal

Cross-Section of Barrel & Feedscrew with Measuring Aperture



Cross-section of Glycon SmartBarrel with feedscrew installed and measuring aperture called SmartPort. To take readings, technicians insert an eddy-current sensor in the port after removing a barrel plug.

How the Sensor Measures Distance to the Flight Land



Cross-section of eddy-current measuring sensor installed and secured by a retainer in the SmartPort. The machine can be at or near operating temperature when the measurement is done.

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at Glycon, where it will be maintained on each of the customer's production machines, showing the date of installation, initial measurements, hours run, type of material being processed, approximate pounds of material processed, instrument readings and the total amount of wear.

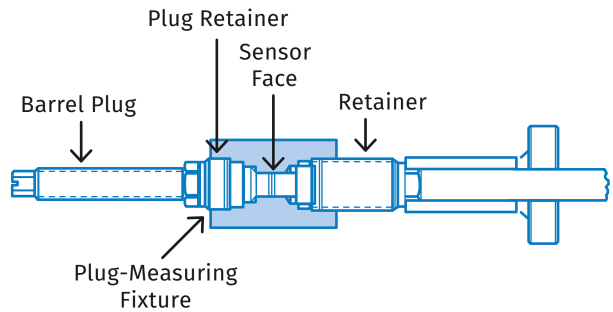
Kuhman says the objective of the EMT system is not only to analyze the data to determine the optimum time to replace or repair worn screws or barrels to optimize productivity, but also to relate the wear to:

- Materials of screw/barrel construction.
- Screw/barrel alignment.
- Polymers being processed.
- Impact of abrasive fillers.
- Performance related to wear, including production rates, cycle times, energy consumption, melting rates, head pressures and melt temperatures.

"Wear data obtained will allow engineers to determine the relationship of screw/barrel wear to key performance data," Kuhman says. "When this data is compared with the rate of wear or wear over time, it will allow processors to determine their most cost-effective time to rebuild or replace parts. Additionally, it will allow the screw and barrel supplier to recommend metallurgical solutions that could provide better wear resistance and longer life in their replacement parts."

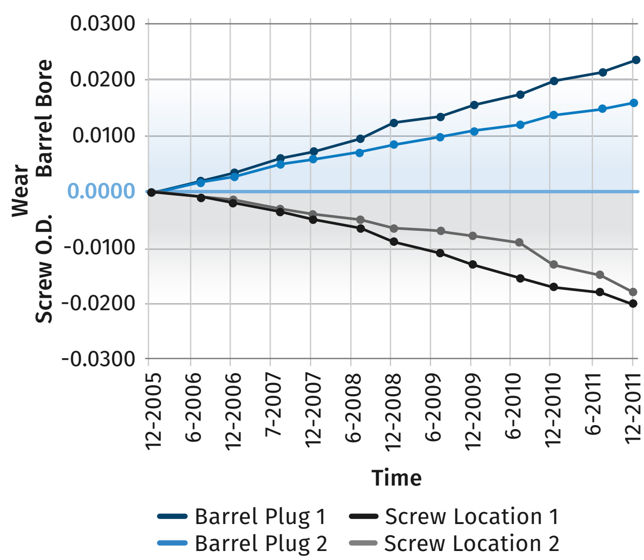
He continues, "The advantages of the Glycon EMT system are that it provides precise measurement of the wear on the OD of the feedscrew and the ID of the barrel and its simplicity and cost-effectiveness. It allows maintenance personnel to plan measuring intervals and to schedule changeouts at convenient times based upon wear-rate data rather than 'running to failure' and having to run inefficiently or not at all."

Barrel Plug Measured by Sensor in Fixture



The barrel plug is installed in the measuring fixture; the sensor installed in the fixture on the opposite side, and the reading indicates barrel wear.

Screw & Barrel Wear at Sheet Processor



Glycon technicians measured screw and barrel wear every six months at a sheet processor running LDPE with 80% regrind. The wear of both components resulted in a loss of output from about 2000 lb/hr to roughly 1750 lb/hr.

At the same time, drawing on a NASCAR analogy—recalling a race in which worn tires cost the driver a victory, Kuhman recognizes the reluctance of most processors to make "pitstops" to interrupt production by tearing down the machine to take measurements of the screw and barrel.

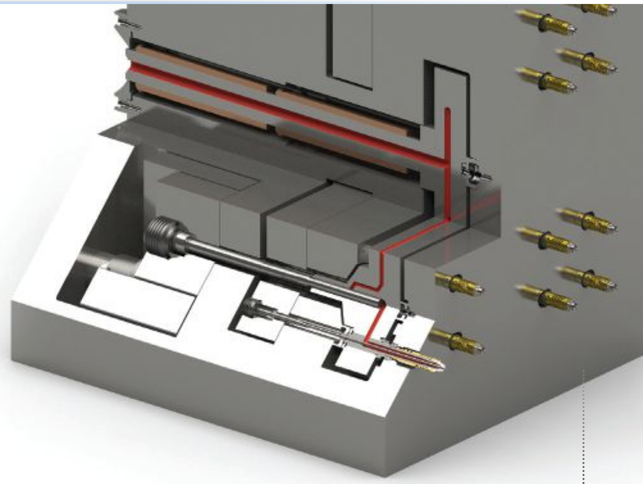
Notes Kuhman, "And who can blame them? Sometimes on larger machines, taking a machine out of production, removing the screw, cleaning and measuring both the screw and barrel, then reassembling the machine can take two or three days. Glycon can now reduce that process to less than 1 hour and eliminate removing the screw and cleaning the barrel, while maintaining the machine at or near operating temperatures."

Says Kuhman, "As nearly as we can tell, Glycon was the first company to have the foresight to envision the practicality of predictive analytics based on precise electronic measurement in plasticating machines—at least as far as foreseeing the value of being able to measure screw and barrel wear on an extruder or injection molding machine without having to shut down the line and disassemble the machine."

He adds, "With this capability, we have developed the technology to then calculate the rate of wear and predict future wear, and with this data determine the most cost-effective time to replace these components."

Precisely Managed Melt Delivery Moved into the Mold

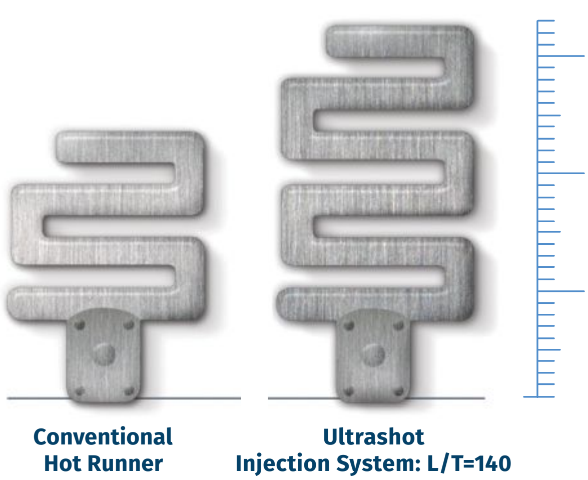
Husky says its new UltraShot injection system miniaturizes the shooting-pot concept of a traditional two-stage injection system—putting it within the hot runner—to create proximity to the gate that all but eliminates pressure drop.



Husky's UltraShot moves plasticated resin as close as possible to the gate so that resin can be held under lower pressures and temperatures prior to injection through adjacent valve gates, preserving the material's properties.

By Tony Deligio
Senior Editor

The new UltraShot technology from Husky is described as a completely standalone technology that is independent of the mold and the machine. UltraShot incorporates a series of small injection plungers in close proximity to one or a group of hot-runner valve-gate nozzles. According to Sheldon Alexander, business support manager for hot runners and controllers, this technology simplifies the role of the molding machine's injection unit, limiting it to melting and metering resin and then handing off to the UltraShot, which builds pressure as close to the gate as possible and injects with more precision, higher pressure and greater repeatability.



By better controlling injection pressure and moving it closer to the gate, Husky's UltraShot injection system achieves greater L/T flow ratios for shear- and temperature-sensitive resins.

UltraShot adapts the concept of two-stage injection, which splits the functions of the injection unit—melting/metering resin and injecting it into the mold—into two steps. In conventional two-stage injection, melted resin is metered into a plunger or shooting pot, which then injects material into the mold.

"What we've done," Alexander says, "is take the shooting-pot idea, miniaturize it, and put it into UltraShot system." UltraShot effectively replaces the injection unit from the standpoint of delivering melt into the cavities. "The injection unit is simply a way to melt and meter the resin and hand it off to us," Alexander explains, adding that there are no special requirements from machine, like a high-performance injection unit. "We actually take control of the injection unit and turn it essentially into an extruder," Alexander says.

Among multiple advantages, Alexander says one of the biggest is the overall impact on pressure. In a standard press, a molder might set the pressure to 35,000 psi in front of screw, but once the melt travels through the nozzle, sprue, manifold and hot runner, pressure loss can be up to 50%.

With the UltraShot moving the prepared resin as close as possible to the gate, the resin can be held under lower pressure and temperature prior to injection, preserving the material's properties. "That gives you more control and better melt quality," Alexander says. "You get control as close as possible to the gate." By doing so, any issues with melt compressibility and shear generation are minimized, if not completely eliminated, according to Husky.

WHERE ULTRASHOT SHINES

Alexander notes that two areas where the UltraShot really shines are in molding resins that are shear and temperature sensitive and in molding small parts below 10 g that require precision injection control.

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Another possible use would be in a family mold where the individual parts are very different in geometry and filling pattern. "Since we're essentially using mini injection units, you can add as many as you like," Alexander says. For a 16-cavity family mold with four different parts, UltraShot would provide four individual internal injection units with independent control.

In another example, Alexander says one of the UltraShot systems Husky currently has in the field is for a medical catheter—a two-component device composed of a long tube made from a harder material, with a soft tip at the end. Normally, such an application would be created in a multi-step process where a tube is extruded and cut; the tip is injection molded; and then the two are joined together. With the UltraShot, Husky was able to combine those steps into one machine, merging molding and assembly into one work cell.

MAKING MEDICAL LESS RISK AVERSE

The catheter application is a particularly apt example of UltraShot's potential, according to Alexander. Typically, in the medical field, new applications are ramped up slowly. A new device might be initially molded from a four-cavity prototype mold, moving up to eight, 12, 16 cavities or more, as it gains market acceptance. As molders boost cavitation, they often struggle to maintain quality.

"As companies increase cavitation, balance decreases and part quality, dimensional stability, and repeatability degrade," Alexander says. Because of this limitation, he adds, medical molders often are not running at optimal cavitation, from a business perspective. At a certain level of market demand, a 32-cavity mold might make the most sense, Alexander explains, but the best parts can only run on eight-cavity tools, so a molder might have to use multiple eight-cavity molds.

"With UltraShot technology, whatever quality results you get from a four-cavity mold," states Alexander, "we can scale up in multiples of four and give the customer confidence that the quality will be on same as they ramp up to 16, 32 or more cavities."

DESIGNING FOR THE PART, NOT THE PROCESS

He says Husky is most excited about the design freedom UltraShot can bring to molders, shifting away from today's dynamic where the process dictates the part. "We're at a point in the industry where part designers are more concerned with whether or not a part can be molded rather than the best design for the functionality of the part." UltraShot, says Alexander, frees the designer from this limitation.

"We can mold parts that were considered unmoldable," Alexander says. "Whether it's from an L/T standpoint, part complexity, heat-sensitive resins, shear-sensitive resins, or from a cavitation standpoint." PT

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New Technology Combines 3D Printing with Injection Molding

This new concept 3D prints a metallic endoskeleton and then injection molds a special polymer around that skeleton.

By Heather Caliendo
Senior Editor

A company in Brisbane, Australia, has developed a manufacturing technology that combines 3D printing with injection molding. Cobalt Extreme produces technology for engineering and manufacturing innovative artificial-lift equipment for oil production.

The company's performance materials laboratory has developed a material concept called Synthetic Metal (worldwide patents pending), which was originally developed for extreme environments in deep oil wells. This technology has potential to open up applications in new markets.

Cobalt Extreme's technology builds a metallic endoskeleton via 3D printing, and then injection molds high-performance polybutadienes (blue) and then a special TPU blend for the outer skin around that skeleton.

David Nommensen, director of Cobalt Extreme, says the biggest advantage of Synthetic Metal is its processability, by injection molding a unique polymer in and around a metal endoskeleton. "The injection molded polymer in and around the metal endoskeleton is not conductive and becomes an insulator, in addition to other benefits of the injection molded material, such as abrasion resistance, resilient deformability, cost, impact resistance, corrosion and chemical resistance, color, service temperature and low weight," he says.

The company's Synthetic Metal and Arpmax polymer technology combines the electronic characteristics of metal with the engineering properties of polymers. "A metal endoskeleton adds mechanical strength to a polymer (think reinforced concrete)," Nommensen says. "Imagine a human body without a skeleton."

> ***"Synthetic Metal offers new and unique material characteristics, which have yet to be fully explored."***

APPLICATIONS

An example of an application for Synthetic Metal is electrolytic-protection corrosion control in oil wells. Nommensen explains that a sucker rod is a magnet for corrosion in the presence of water and chemicals like H_2S, CO_2, and O_2. Cobalt Extreme created the Cobalt Synthetic Metal sucker-rod guide anodes to combat this.

The process is unique in combining plastic molding with 3D metal printing of the anode matrix to align with the very specific shape of the company's existing sucker-rod guide designs. Nommensen says the design of the metal 3D printed anode matrix is in two halves that are snapped onto the rod prior to injection molding of the spiral rod guide. The hydrodynamic design takes into account anode thickness, strength, openness and consistent surface contact to ensure that the function of the original centralizer is not compromised and that sufficient surface contact is made to create the required electrical circuit to be effective in preventing corrosion.

Nommensen says the current alternatives for managing corrosion in oil and gas wells are either epoxy coatings, thermal-spray metal coatings or injecting a liquid chemical corrosion

Synthetic Metal concept is used to create sucker rods for the oil and gas industry.

inhibitor. Installation of Synthetic Metal anodes reverses the galvanic action, and the corrosion then reacts on the anode rather than the tubing and the rods.

The Synthetic Metal anode is contained within an injection molded Arpmax proprietary polymer, designed as an alternative to PEEK for controlled cathodic protection of the metal sucker rod. For other than oil-well applications, the plastic can be a specially blended TPU, silicone, or other resins.

"The Synthetic Metal innovation is to utilize advanced additive manufacturing technologies to combine proven anode metallurgy with Arpmax polymer technology to create a polymer with the electrical/ thermal/conductivity and the structural strength of metal," he said.

Currently, Cobalt Extreme works with ProX DMP 320 direct-metal printing (laser sintering) technology from 3D Systems and injection molding equipment, sourcing unique metal alloys and organic polymer materials suited to individual product characteristics.

Other potential applications of Synthetic Metal in conjunction with the Arpmax range of polymers include electronics, marine, aerospace, sports, medical and military. "Synthetic Metal technology also has significant non-oil-field applications looking for a polymer with the electrical, thermal conductivity and structural strength of metal," Nommensen states. "Synthetic Metal offers new and unique material characteristics, which have yet to be fully explored." PT

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MATERIALS

PART 5

Tracing the History of Polymeric Materials

Creation of an invention like phenolic can be traced through a long chain of events and contributors. Here's the full story.

A review of the history of technological developments shows that breakthroughs do not happen in a vacuum. Different contributors take small steps, which are then advanced by others; and when an invention like phenolic comes together in its final form, its creation can be traced through a long chain of events. It is also true that multiple people often have the same idea, and the person that history remembers is often the one that first receives formal recognition for putting the last piece of the puzzle in place, rendering the development both technologically feasible and economically viable.

By Mike Sepe

Before Leo Baekeland in the U.S. had even started on his investigation into what would become phenolic chemistry, Arthur Smith obtained a British patent in 1899, the first one to be issued in the endeavor to produce a useful phenolic. However, it required several days to harden at a temperature of 90-100 C and distorted in the process. At the same time that Baekeland was working on refining the reaction between phenol and formaldehyde, a German chemist, Carl Heinrich Meyer, produced an acid-catalyzed reaction between phenol and formaldehyde, but its use was limited to lacquer and adhesives.

An Austrian chemist named Adolf Luft had been working on the same problem. But the compound that Luft came up with used camphor as the solvent and was very brittle. A British electrical engineer, James Swinburne, worked for three years to find a solvent that would correct this shortcoming and finally came up with caustic soda as the solution. He arrived at the British patent office just a little too late to become the historical figure remembered for the creation of phenolic. In fact, Baekeland preceded him by one day.

The moldability of phenolic gave birth to the discipline of plastic design.

Although rivals and potential adversaries, Baekeland and Swinburne ended up working together after Baekeland initially threatened patent litigation when Swinburne set up a plant in the U.S. In fact, Baekeland managed to maintain a dominant position in the market through a combination of patent litigation threats, the granting of permission for the use of his patents to Swinburne and others during World War I, and ultimately buying up many of his competitors in the late 1920s just as his patents were about to expire.

In the late 1890s, a mischievous cat spilled some formaldehyde that wound up in its milk, a chain of events that lead to the discovery of casein.

The route that Baekeland and Swinburne took to the process of manufacturing phenolics was a reflection of the difficulty in controlling a condensation polymerization reaction. Condensation polymerizations typically produce unwanted by-products that can hinder the desired reaction and must be removed or suppressed. The problem of managing this aspect of the chemical reaction was dramatically illustrated by the experience of the German chemist Adolf von Baeyer. Baeyer is primarily remembered for his synthesis of indigo, and he won the Nobel Prize in chemistry in 1905. He also was also a protégé of August Kekulé, the famous chemist mentioned in last month's column, whose assistant mentored Baekeland through his doctorate. Baeyer is credited with being the first person to investigate the chemical reaction between phenol and formaldehyde in 1872. The violent chemical reaction produced a resinous tarlike solid that Baeyer discarded after he was unable to analyze its composition.

That could have been the end of the road for formaldehyde-based polymers, had it not been for another accidental discovery made by Bavarian chemist Adolf Spitteler 25 years later. A cat that resided in Spitteler's lab knocked over a bottle containing an aqueous solution of formaldehyde, spilling the contents into a saucer of milk. Spitteler observed that the milk quickly curdled into a hard compound that appeared to have properties similar to those of celluloid. The chemical reaction that produced this material involved the crosslinking of a mixture of proteins known as casein by the form-


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Buttons were an early application for a crosslinked polymer named casein, discovered by accident in the 1890s when milk and formaldehyde mixed.

aldehyde and the polymer became known as casein. The discovery that formaldehyde rendered casein insoluble in water had actually been made four years earlier in 1893 by a French chemist, Alfred Trillat. But the historical credit goes to Spitteler and a non-chemist collaborator, Wilhelm Krische.

Krische was searching for a material that he could use to make washable white writing boards. He had already tried using casein, and while it worked initially, the casein softened the first time the whiteboard was wiped clean with water. The crosslinked material solved this problem and the market was so significant that Spitteler and Krische founded a company to make casein and related products. Trillat had tried to convince a French company to manufacture the product that had come from his research, but he was not able to generate the needed interest. The German company's success, coupled with the realization that casein could easily be fabricated into a wide variety of shapes, prompted the belated founding of a competing French operation.

The commercial product was named Galalith ("milk stone" in Greek). The material was displayed at the Paris Universal Exhibition in 1900 and was patented in 1906. There is no historical information indicating that the German and French companies litigated for the rights. They both produced the material to meet a growing market, primarily in the fashion industry to make buttons, buckles and jewelry, although casein found its way into a lot of products that also used celluloid, such as combs and knife handles. It was even used to make electrical insulators before the advent of phenolic.

For all of its success, and the fact that it preceded phenolic by over a decade, casein was still a material in the same vein as rubber and celluloid, a modification of a naturally occurring material and not a true synthetic product. However, it was much easier to produce than phenolic because the proteins, consisting of alpha, beta and kappa-casein, are already polymers with molecular weights in the range of 20,000 to 25,000 g/mole. Phenol has a molecular weight of only 94, requiring the formation of a prepolymer prior to crosslinking.

As a side note, those who have been in the plastics industry for more than 15 years remember a time when General Electric had a plastic materials division. When asked about the history of GE Plastics, even most of us old timers will point to the advent of polycarbonate in the mid-1950s. The story of that development was told in a commercial that ran a lot on Sunday morning news shows in the 1990s and showed a cat walking through a lab in the middle of the night. The cat knocks over a bottle and in the morning a scientist, presumably Dan Fox, comes into the lab to find a clear glob of material that he then subjects to boiling water, flame, and a hammer, all of which fail to affect the integrity of the material.

While it is true that polycarbonate was one of those accidental discoveries, there was no cat. The brilliant marketers at GE had borrowed the story of Spitteler's cat for their commercial. But polycarbonate was not the first product made by the GE Plastics division. Rather, it was phenolic. Remember, GE's core competency was in the electrical industry, where phenolic first made its mark. GE began advancing phenolic chemistry in the late 1920s after Baekeland's patents expired and sold a material under the trade name Genal until the early 1980s.

The success of the casein-formaldehyde chemistry took place before Baekeland had his breakthrough with phenolic. But it was this success that reignited interest in Baeyer's early experiments. And while several chemists were working on this new chemistry simultaneously, it was Baekeland who worked out the system that controlled the considerable explosive force associated with the generation of the by-products from the condensation reaction involved in producing the material. Earlier experimenters had attempted to control the reaction by lowering the temperature to slow things down, and for a time Baekeland followed the same strategy. His breakthrough came when he tried the opposite approach, raising the temperature and controlling the resulting faster reaction by running it in a pressurized vessel, called the Bakelizer.

The complexity of the phenolic polymerization contributed to Baekeland's decision to go into the production side of the business rather than make his money by granting licenses. The process was just too complicated for manufacturers without a chemistry background. The Bakelizer was something that would never pass an OSHA inspection. It included an agitator that required electric power. But the nascent electric grid had not reached Baekeland's area at that point. So, he acquired a steam engine and supplied the steam to the engine using a coal-fired boiler set up in a corner of the laboratory. The steam was then piped across to a garage where the resin manufacturing was done. A fire consumed most of the garage in March of 1909, leading Baekeland to relocate to a chemical works in Perth Amboy, N.J., where a major formaldehyde manufacturer was located.

The first fully synthetic polymer made its mark in electrical insulators, but over the course of the next 30 years it extended its influence into a wide variety of markets that included appliances, office equipment, communications, automotive, aircraft and weaponry, as well as the more trivial areas of bathroom fixtures and pen barrels. The moldability of phenolic gave birth to the discipline of plastic design. And it fostered other chemistries based on crosslinking with formaldehyde, including urea and melamine. These materials were more easily colored and had better resistance to a long-term effect of electrical current known as tracking.

The first synthetic polymers were thermosets, and they dominated the plastics industry for decades, a far cry from the landscape of our industry today. But the incursion of thermoplastics was already starting and would change things profoundly beginning in the 1930s. We will turn our attention to that part of the story next.

ABOUT THE AUTHOR: Mike Sepe is an independent, global materials and processing consultant whose company, Michael P. Sepe, LLC, is based in Sedona, Ariz. He has more than 45 years of experience in the plastics industry and assists clients with material selection, designing for manufacturability, process optimization, troubleshooting, and failure analysis. Contact: *(928) 203-0408 • mike@thematerialanalyst.com*.

INJECTION MOLDING

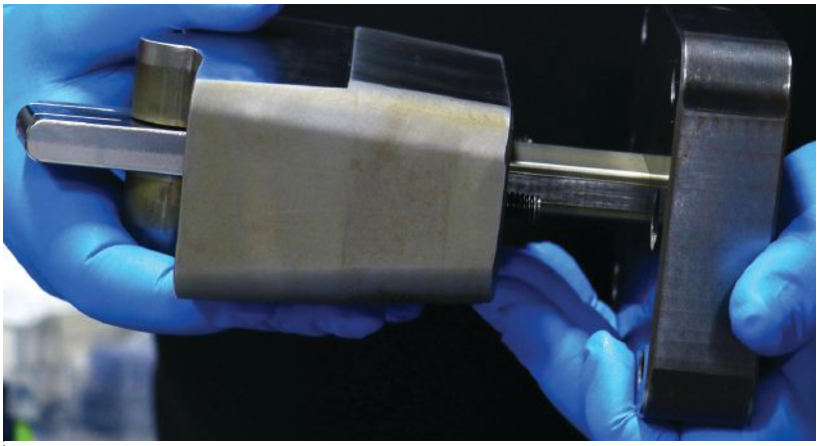
Three Key Decisions for an Optimal Ejection System

When determining the best ejection option for a tool, molders must consider the ejector's surface area, location and style.

Injection molders want plastic parts to eject easily, consistently, quickly. Parts getting stuck causes damage and can break mold components, resulting in longer cycle times, manufacturing delays and increased costs. An experienced moldmaker knows how to manage the complexities of your mold design with the necessary ejection strategy, improving your part quality and saving you time and money over the life of your mold.

By Paul Thal

For the optimal ejection system, your primary considerations should include ejection surface area, location and type. Let's delve into these separately.



Primarily used to form undercuts, lifters can provide ejection functionality in conjunction with other ejection systems.

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EJECTION AREA—SMALLER FEATURES, BIGGER PROBLEMS

Proper ejection is based on part size and geometry. Applying an insufficient ejection surface area results in component breakage, part deformities and slower cycles. Instead, you want to steer towards larger ejection surface areas.

Smaller ejection features on the plastic part require smaller ejection components. These smaller components can introduce both installation difficulties and wear and breakage risks during use because of their fragility. These factors ultimately increase costs for both the tool build and long-term maintenance. Best practice tells us to avoid using knockouts (KOs) under 3/64-in. diam. Thin walls in plastic parts require custom-made thin-wall ejector sleeves. Molders should know that these types of sleeves are not only expensive to manufacture but they will also not last as long as a standard sleeve.

EJECTOR LOCATION—FLATTER IS BETTER

The ideal surface for ejection is a flat one allowing the use of KO pins ground to the proper height. In the case where a feature does not provide a flat surface, the ejector component can conform to the part geometry. In some cases, severe contours could actually require part-design alterations. Keep in mind that recessed flats promote proper ejection because they provide a surface parallel to the parting line, making the plastic part easier to knock out.

Insufficient ejectors cause plastic part imperfections and ejector breakage, so molders should err on the side of more ejectors than might be required. However, that principle must be weighed against the fact that too many ejectors ultimately increase wear and cost of the mold. In addition, ejectors placed too closely together will result in thin-wall conditions in the steel mold. ►


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An adept moldmaker optimizes the number of ejectors while maintaining proper steel conditions. You want your moldmaker to balance the layout of the ejector locations to uniformly lift the part.

EJECTION TYPE—PROS AND CONS

In an ideal world, your moldmaker would use only KO pins in your plastic injection mold. However, most injection molded parts are just not that simple. Common ejector options include pins, blades, sleeves, bars, stripper plates and lifters—and each option brings its own tradeoffs. Different ejection options will leave different sizes and shapes of marks on the part and require different levels of maintenance.

Ejector blades have more surface area than pins and can therefore wear down more quickly.

Ejector pins offer the simplest and most cost-effective ejection system. As the default ejection system, they leave solid circular ejection marks on the part. The injection molding process subjects ejector pins to a great deal of pressure during ejection, so larger pin diameters present a safer option.

When ejector pins cannot fit within the allowable ejection area, blade ejectors offer a good alternative. These flat, rectangular pins can eject on thin part regions. Blades have more surface area than pins, so they can wear down more quickly. Because of their high wear, blade ejectors can be integrated into the mold as inserts for easier replacement.

Ejection sleeves distribute force evenly across small, circular features. The mark left on the part at the end of ejection mirrors the shape of the sleeve. Maintenance for sleeves involves checking the fit of the outside of the core pin to the inside of the sleeve. Checking this reduces the risk of plastic flashing into the ejection system.

Ejector bars offer a good option for ejection on lengths of flat surface. Ejector bars utilize multiple pins topped by a flat bar that evenly distributes their force. Unlike the preceding ejection systems, these tend to be larger and can utilize multiple pins beneath the bar. Because of their bigger size and high customization, ejector bars are typically high-cost and high-maintenance as the mold gets more wear.

Stripper systems eject a part on its perimeter. Maintenance involves ensuring that the stripper plate or block sits flush with the rest of the mold. At the part level, the need for mold maintenance can be evaluated by checking for flash on parts at the parting line of the stripper plate or bar.

Used primarily to form undercuts, lifters also provide ejection functionality in conjunction with other ejection systems. Unlike vertical ejection systems, lifters angle in the core plate. This allows the lifter to clear the undercut for ejection to take place.

The injection mold designer should follow the preferred order of ejection types. KO pins are reliable, inexpensive to purchase, easy to install, easy to maintain and easy to modify. Sleeves increase the expense to purchase and install. KO blades require extra cost for the pocket and fitting. Strippers offer the most expensive of the ejection options since they are a completely custom component driven by the part geometry.

A robust ejection strategy will improve the quality of the parts, optimize the immediate and long-term costs related to the mold, and increase the time the mold spends making parts, while the wrong ejection system can decrease uptime and curtail the life of your mold. PT

ABOUT THE AUTHOR: Paul Thal is a third-generation moldmaker and now has nearly 40 years of moldmaking experience. A Rutgers graduate with a degree in computer science, he started work at Thal Precision Industries, Clark, N.J., in 1993, after one year as an applications engineer at Cimquest. Contact: *732-381-6106*; *pthal@thalprecision.com*; *thalprecision.com*.

Dave Frecka

A Passion for Speed and Quality; a Career Marked with Success

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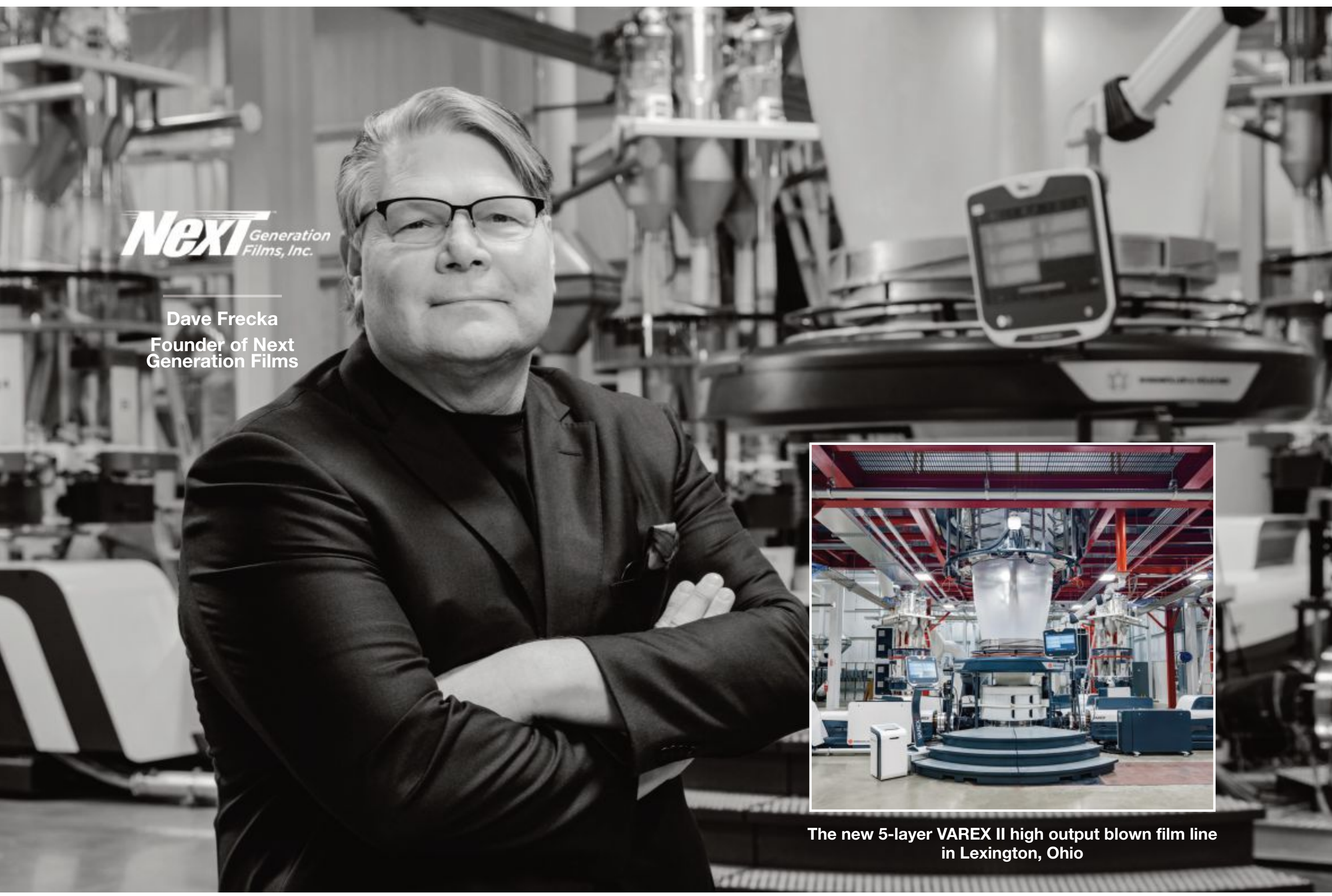

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Follow These Tips to Get Profile Die Design Just Right

Calculating polymer flow is fairly straightforward when designing a die for a simple round profile, but as the shapes get more complicated these calculations can get extremely challenging. Here's what you need to consider.

By Jim Frankland

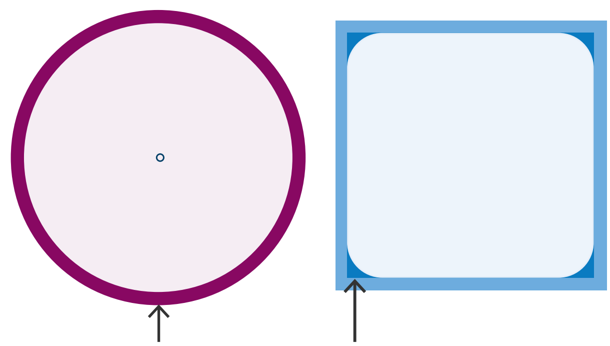
I have found that a lot of experienced extrusion operators—especially those with limited background in polymer rheology—tend to think the material "slides" through the die to form its final shape. In fact, the polymer should adhere firmly to the die walls with virtually no slip. That effect has a considerable influence on the die design, and it's important to understand this when troubleshooting die performance.

Once the polymer exits the extruder and enters the die it sticks quite firmly to the die walls and is sheared in the die openings as pressure from the screw or melt pump forces it through the die. When it slides or slips it's called melt fracture and the surface appearance is rough. Calculating polymer flow is not all that difficult when designing a die for a simple round profile, but as the shapes get more complicated these calculations can get extremely challenging. Just moving to a simple rectangle makes things more complex.

A circular profile tends to just get a little smaller than the die cross-section (neglecting polymer swell) because of the polymer adhering to the wall—but the shape does not change. On the other hand, with a simple rectangular profile the square corners will not fill out because the additional surface area in the corners causes a reduction in flow. This tends to round the corners. The shear stress in the polymer shape is always zero in its exact center of flow, which may or may not be the center of the part (except in the simplest shapes like a circle). The maximum shear stress occurs at the die wall, and shear stress increases proportionally with the distance from the center point of flow. That variation in shear stress alone develops a slight difference in viscosity due to the changing shear. The more complex the profile, the more complex the effects. Naturally balancing the shear rate throughout the profile cross-section can help by mini-

FIG 1

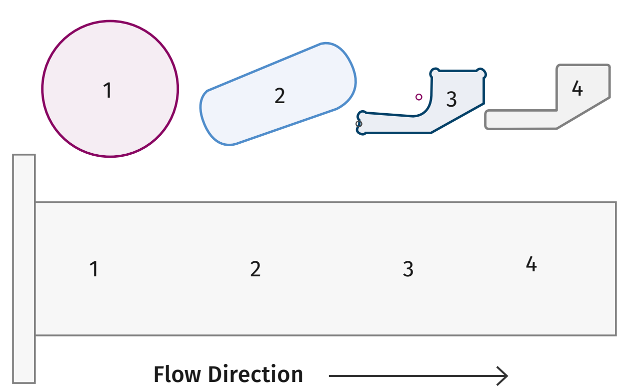
Rectangular Profile Dies More Complex to Design



A circular profile tends to just get a little smaller than the die cross section (neglecting polymer swell) because of the polymer adhering to the wall—but the shape does not change. But with a simple rectangular profile the square corners won't fill out because the additional surface area in the corners causes a reduction in flow. This tends to round the corners.

FIG 2

Build Relief in Die Corners to Develop Square-Cornered Profiles



The sections labeled 1 to 4 show how the shape of the die channel would change from extruder exit on the left to die exit on the right (with continuous transitions in between). Relief in the corners is needed to develop relatively square corners.

mizing viscosity variation, but in many cases the shape must also be controlled by pressure-drop adjustments.

Thus, as the die becomes more complicated, the variations in flow become more complex and the die internals often do not look that much like the final part. Note the rounded corners in the relatively simple square profile in Fig. 1. For that profile, the die had to be designed with additional space for polymer to flow into all the corners as the part moves through the die.

Each surface of the die also needs to be uniformly heated so that the viscosity along the walls provides for the same pressure drop to match the other legs, so that the profile stays "square" exiting the die. Any unbalanced heating of the die can distort the shape by varying the viscosity near the die wall. This occurs even in simple dies such as one in Fig. 1, but it becomes much more pronounced in more complex profile dies where the shape is more irregular (see Fig. 2).

Any unbalanced heating of the die can distort the shape by varying the viscosity near the die wall.

With a little more complicated (but still relatively simple) profile these differences can be seen. The sections labeled 1-4 show what the shape of the die would be from the extruder exit to the die exit. Between each section there are continuous transitions. Relief in the corners of the die is necessary to develop relatively square corners, both inside and out. The size of relief will vary with the polymer viscosity and the pressure drop in the leg.

Fortunately, there are now a number of very good simulation programs to assist in die design, saving hundreds of hours in calculating all the variables in a complex profile. But the important point is that the internal die design is not likely to mimic the final profile shape, except very near the exit, and there is no sliding/shaping like with a liquid in a shaped orifice.

Even though you may not design your own dies, having a basic understanding of die flow will help when problems arise with existing tooling. First, look for obvious changes in melt temperature and die-heating uniformity. Surprisingly, even changes in output can affect the shape of the profile if everything else seems correct. A change in output affects melt viscosity due to a change in melt temperature, and that can affect the balance of flow in various legs of a complex profile.

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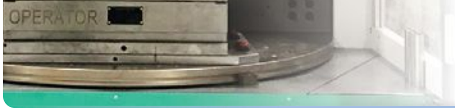
Plastic Molding Technology Inc. • El Paso, Texas

By Tony Deligio
Senior Editor

PMT's 60,000-ft² facility in El Paso, Texas, employs 100 and runs 24/7.

Custom Molder Catches Up With Its Plans for Growth

No one's 2020 plans survived the pandemic unscathed, including those of Plastic Molding Technology Inc. But this injection molder's vision of how it would continue to thrive as it approaches its fifth decade was simply deferred, not denied.



On Feb. 5, 2020, Plastic Molding Technology Inc. (PMT) announced plans to lease the unoccupied 39,000 ft² of its building in El Paso, Texas. To be completed by the fourth quarter of last year, the move would give the 47-yr-old custom injection molder nearly 100,000 ft² of total space, with room to add more value-added operations and cleanroom molding.

That expansion was part of the company's revised strategic plan, initiated back in 2019. As we know now, events were already in motion that would render moot the best laid plans of every company and individual in 2020. Just two days before PMT's press release about its expansion, the U.S. declared a public health emergency in response to the coronavirus, some three days after the World Health Organization (WHO) declared a global health emergency.

"We never did shut down. We ran 24/7 even if it meant running with a skeleton crew."

"We actually had a reasonably good January and February; March was kind of telling; and then came April," PMT CEO Charles A. Sholtis recalls. As customer shutdowns began last spring, Sholtis says PMT saw a 45% drop in sales, month over month, last April.

Ultimately, PMT did not proceed with the expansion it announced at the beginning of February, first pausing and then canceling the move. That call ultimately benefited its building neighbors, who were no longer in a position to move amidst the pandemic.

Despite the coronavirus, PMT pivoted to a new plan, and in February 2021, one year after it announced the now abandoned expansion, it took delivery of two new all-electric 110-ton Maruka Toyo injection molding machines. Those machines will occupy a new 1400-ft² white room, which is to be completed by March. That space will eventually be a class 100,000 cleanroom that can house five machines, as the company seeks to complete its ISO 13485 certification for medical-device production by July. Those weren't the only investments the company made last year, adding five new injection molding machines—four 200-ton and one 300-tonner—with accompanying robotics.

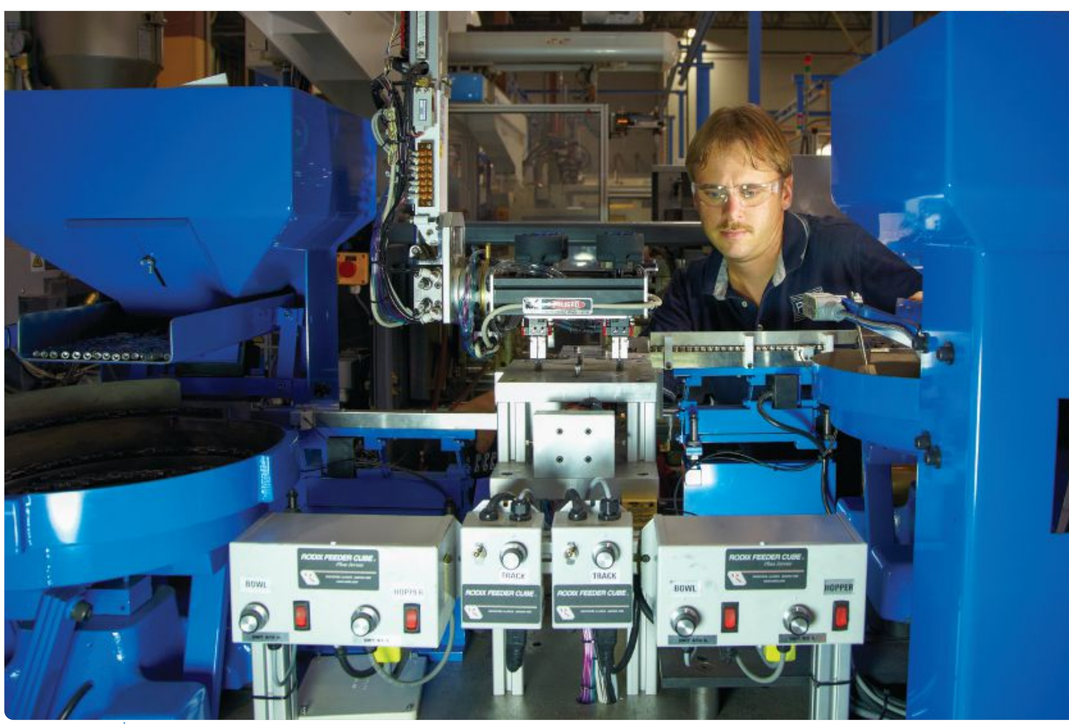
A RETURN TO ITS ROOTS

Founded in 1973 as Prototype Molding Co. by Sholtis' father, Charles E. Sholtis, in Bridgeport, Conn., with one Arburg C4B press in a 19th century mill building, PMT began life with a lot of medical molding business. After opening a satellite facility in 2001 in El Paso, PMT completely shifted operations to Texas in 2004, trading medical customers for ones in automotive, business equipment and industrial goods, as it took on more work with NAFTA-propelled maquiladoras.

"We did medical in New England," Sholtis says, "but when we relocated the plant in 2004, we lost a lot of that business because it was regional."

In pre-pandemic times, PMT laid out in its strategic plan an intent to return to medical, with a boost from BIO El Paso-Juarez, a nonprofit created in part to accelerate the formation, expansion/retention and attraction of biomedical enterprises in the region. PMT received a training grant from the nonprofit to support its bid for ISO 13485 certification, including auditor training.

"We focused on technical auto markets," Sholtis says, "so we're getting back to our roots, but this time we're embracing it in a more straightforward fashion, building out a white room and eventually going to a full cleanroom."



Complex automated insert molding is a core competency at PMT.

Once completed, the class 100,000 cleanroom will include a new material drying and conveying system, placed outside the room, delivering resin in a closed system to the presses, with space for

PMT has 62 injection molding machines at its facility in El Paso, ranging in size from 45 to 500 tons.

assembly and packing. Each machine will feature automation and run "basically lights-out tied in to IQMS Real Time," Sholtis says.

PMT was bullish about medical prior to COVID-19, but since the pandemic laid bare the shortcomings of OEMs' far-flung global supply chains, the company is feeling even more optimistic about its prospects to win and keep new business. "I think we can see the writing on the wall," Sholtis says. "The strategy for a lot of pharmaceutical companies and healthcare companies is they want to reshore."

ON THE FRONTIER

Located on the frontier between offshore and onshore, just 10 minutes from the Ysleta Port of Entry on the border with Mexico, PMT has a unique perspective on the flow of manufacturing work to and from the U.S. and overseas.

Training, including ongoing Paulson Training and RJG Master Molder courses, is key to PMT's retention of employees.

Nowhere is this more evident than in the fact that PMT's value-added offerings not only include typical services like pad printing, hot stamping, welding, assembly, and packaging, but what it calls "supply-chain value added." That means offering services like local daily deliveries to customer production lines, vendor-managed inventory, stocking agreements, global sourcing for components, and Mexican assembly options.

Sholtis says the anecdotal talk of work coming back to the U.S. is more than idle chatter. "I'm seeing a surge in cost studies, requests for quotes, everything from straight injection molding to small subassemblies, whether we use automation to make the subassembly here or we use direct labor in Texas."

OPERATING IN A PANDEMIC

"The number one thing coming into the pandemic was take care of our team members, be safe."

The coronavirus pandemic never forced PMT to cease production, fulfilling a commitment to customers. "We never did shut down," Sholtis says. "We ran 24/7 even if it meant running with a skeleton crew." This was achieved by focusing on protecting its people, Sholtis explained, as PMT worked to procure PPE and look at countermeasures and resources to keep its workers safe and working. "It all paid off in the long run because we were able to stay open. We had a few close calls with respect to COVID and the factory, but as it turns out, the factory is one of the safest places to work during COVID."

Immediately prior to joining PMT in 1986, Sholtis served as a U.S. Navy officer for three years, and to this day he emphasizes tactics and strategy in business planning. "One of the things I've always been a proponent of is: stop, make your assessment, and then put together an action plan going forward." In the very fluid early days of the pandemic, PMT's management team identified and evaluated its business options, laying out what steps would need to be taken on a daily, weekly and monthly basis. "We just set up a clear line of communication with our supply base, our employee team, and our customers," Sholtis says. "One of the biggest factors was being able to peer through the fog of war to see where things were going."

The challenge of navigating that fog made PMT's weekly management meeting, now held virtually, a must-attend. "I

think it's vital that we at least show up," Sholtis says. "It's non-negotiable." These get-togethers addressed many normal to-do-list items—onboarding a new employee, locating a raw material that's in short supply, air shipping a tool—as well as how *not* normal the situation was. "We'd also check into everybody's health," Sholtis says. "We'd talk up overall health and the psychological aspects of this new paradigm—working remotely and working under some stress with respect to the pandemic. I think it's important that leaders take that into account."

Sholtis said these discussions might have led to team members being encouraged to take mental health days, but there were zero lost work days in 2020, despite everything. That was a result of a renewed focus on safety in 2019. "The number one thing coming into the pandemic was take care of our team members, be safe," Sholtis says. "We've got to take care of ourselves, because if we don't, we're not going to have a business."

One year after canceling one expansion plan, in the midst of implementing a different expansion plan, Sholtis sees the pandemic as a teachable moment with a silver lining of optimism as the world and the country moves past it. "We have a lot of lessons learned from it, that's for sure," he says. "It's an exciting time to be a manufacturer. I think plastics is going to play an even greater role with the reshoring. We may be beaten and battered after the pandemic wave of recession last year, but we are back on track and we are unbroken."

In February, PMT took delivery of two new all-electric Toyo machines for its Class 100,000 cleanroom. Pictured here are PMT President Charles A. Sholtis (r) and John Getlein, chief maintenance engineer.

Expanding Profile Extrusion Capacity? Might Be Time to '*Go Dual*'

Demand for building products is thriving, and profile extrusion houses are looking to expand capacity. The choice they—and possibly you—face is to simply add more single-profile lines or run two strands. Here's what you need to consider.

By Ernie Preiato
Conair

While many industries have suffered during the coronavirus pandemic, some parts of the building-products industry have thrived. It's clear that some consumers, stuck mostly at home, caught the DIY bug and took on "wish list" projects to help create more comfortable and enjoyable surroundings. One result has been increased demand for many types of profile extrusions, including everything from wood-plastic composite (WPC) decking and window profiles, to plastic lumber, PVC fencing products, siding, fascia and decorative trim items.

Upstream on the supply chain, plastic and WPC processors have welcomed the added demand for these extruded-profile building products. But for any extrusion processor, added demand raises questions about how to scale up production capacity cost-effectively. Recently, a number of extrusion processors have answered those questions by deciding to "go dual"—that is, to convert single-profile production lines into "dual-profile" lines to capture unused extruder capacity, or to scale up by installing new and larger, dual-profile lines instead of additional single lines.

Processors that require larger production increases should compare the benefits of adding multiple single-profile lines with those of adopting larger-capacity, dual-profile lines.

Is that approach right for your operation? Start by asking yourself these questions:

1. **Should I add new lines?** If you are already running productive extrusion lines, the simplest way to expand production dramatically might be to add identical new lines. Depending on availability of space in your facility, you can simply install more of the same, based on exactly the same production model you currently use. So there's not much risk to making it work—you don't have to push the edges of technology. What's more, your personnel will already know exactly what to do. However, this approach is typically more expensive than the other alternatives.

2. **Can I get more production out of what I already have?** Maybe. If you are running your extruders at less than full capacity, it may be possible to increase production by speeding up the line. If you turn up your extruder rpm and can manage the increased output without compromising profile quality, it may be possible to increase line output by 10% to 20%.

Pulling more out of an existing extrusion line can certainly be a cost-effective approach, but it requires a willingness to risk some level of process redefinition, redevelopment, and experimentation to get the added throughput you're seeking. And it's not a sure thing, because there are a lot of variables: Increasing extruder speed increases shear, which can introduce process instability, profile

Calibration tables hold profile-specific tooling that can pull vacuum that helps hold and stabilize the shape of hot profiles exiting the extruder. Vacuum pumps are located in the base of the table.

stress, or dimensional problems. While existing tooling may work, you may find that you'll need to lengthen or modify dies and downstream tooling. And you'll need to adjust speeds, cooling capacity and other settings on your downstream equipment. So, while it's sometimes possible to get more out of equipment you already have, the potential upside is limited to approximately 20%.

3. Can I convert single lines to dual-profile lines? Or build new dual lines from scratch? Yes to both. Converting a single-profile line to a dual-profile line can be a wise investment if you have a single-line extruder with unused capacity of at least 50%. If you can sell that much additional output in the foreseeable future, then the payback numbers for converting to dual-line downstream equipment should be favorable. Dual-line conversion becomes an even more favorable option if you want to utilize excess extruder capacity but have limited facility space, or if you've already tried to speed up a single-profile line but have been unable to stabilize the output at the higher production rate.

Consider this example: A processor has an extruder with a rated output of 1500 lb/hr, but has been unable to stabilize output at more than 1000 lb/hr on a single downstream line.

In many cases, it is possible to successfully convert that extrusion line to dual-profile production, utilizing full extruder capacity to drive two profiles that run at about 75% of the original single-line speed, totaling a production boost of 50%. And, because the dual extrusions are running at slower line speeds than the original single extrusion, process stability issues are far less likely to occur.

Processors that require larger production increases should compare the benefits of adding multiple single-profile lines with those of adopting larger-capacity dual-profile lines. For example, with the soaring popularity of maintenance-free WPC decking, some decking manufacturers have shifted their primary production from single lines running about 1500 lb/hr—or 700+ ft of 5.5 in. wide × 1 in. thick decking/hr—to larger dual lines running 3000 to 3300 lb/hr—or nearly 1600 ft of decking/hr.

Of course, packing twice the production capacity into a limited amount of space takes a lot of planning. Upstream, there's the need to increase capacity for material handling and preparation. If you are extruding WPC, there is also a need for increased drying and pelletizing capacity. Because of the high moisture content of wood flour, hot-air drying is typically used to dry the compounded pellet. And, in certain applications, a second dehumidifying drying step may be required prior to extrusion. Then there's the need for a larger extruder. Downstream, there's the need to duplicate everything—from tooling to cooling, measurement, haul-off, and cutting/material handling.

Committing to dual-profile lines represents a major commitment of skill and resources. Compared with the single lines you're used to running, it does take greater patience and effort to get these larger, higher-capacity lines stabilized and running smoothly, because you're pushing the boundaries of the technology harder. But from a numbers standpoint, dual-line production can be a very wise investment (see sidebar).

TO GO DUAL, WORK FROM WHAT YOU KNOW

The key to success in switching from single-profile to dual-profile extrusion lines is to work from what you already know. Essentially, the idea is to create an identical second profile out of the extruder, and duplicate—as closely as possible—the tooling and process conditions already proven successful on the single-profile line.

Dual cleated pullers manage separate line speeds to maintain proper quality for each profile.

Dual-sided spray tanks provide high-intensity evaporative spray cooling for larger profile extrusions or for profiles made of wood-plastic composites or other materials that have high cooling requirements.

The first challenge in successful dual-line production is in creating the dual melt stream at the extruder outlet. This involves development and installation of a "Y block," a tool that splits the molten material into two equal streams. This output then flows through two identical die heads, providing two parallel profiles for downstream processing.

The second challenge is in stabilizing increased extruder output. Obviously, if you're going to utilize excess capacity by extruding a second profile, the extruder is going to be running faster than it did before. And there will be a need to redefine and rework your process until extruder output is stabilized and dual profiles are successfully produced. Note that line speed, not extruder speed, is the key variable in profile quality. So long as the dual-profile output is running at or below 100% of the single-line speed, the profiles should be able to process through essentially the same downstream tooling and equipment with quality as good as the single-line profile product.

LOOKING DOWNSTREAM

Downstream from the extrusion die, dual-profile equipment is essentially similar to single-line equipment, but duplicated and arranged in parallel. (For purposes of comparison, dual-profile equipment is typically of the same length and requires the same clearances as single-line equipment, but is about 50% wider.)

Many building-product extrusions—WPC decking, WPC or PVC

How Single and Dual Lines Compare

Processors requiring additional extrusion production capacity face difficult choices about how best to expand. Below are "rules of thumb" for two common expansion scenarios and a visual comparison.

- **Example 1:** Installation of two new single-profile lines vs. one dual-profile line of the same throughput.

Line Size	Single-Profile Line	Dual-Profile Line
Production capacity	1x	2x
Line speed	1x	1x × 2 profiles
Equipment space with access aisle	1x	1.25x
Capital equipment cost	2x	1.5 to 1.75x
Process-development time	1x	2-3x

This example assumes a dual line with twice the extruder capacity and throughput, with dual profiles running through two sets of tooling, followed by a dual-line spray tank, measurement system, puller/haul-off, and unloading system. Dual-line equipment is assumed to be identical to single-line equipment in length and clearances, but wider. For simplicity, access aisles are each assumed to be 8 ft. wide.

- **Example 2:** Converting a single-line with 50% unused extruder capacity to dual-profile output.

Line Size	Single Line	Dual Line (Downstream Conversion)
Production capacity	1x	1.5x
Speed	1x	0.75x × 2 profiles
Equipment space with access aisle	1x	1.25x
Capital equipment cost	—	40-50% of the cost of new dual line
Process-development time	1x	1.25-2x

window profiles, PVC fencing and the like—emerge from the extruder and are drawn "dry" through a series of sizing dies on a calibration table. The dies are equipped with internal water cooling so that they maintain an even temperature relative to the hot profiles, and may trickle drips of water to gently lubricate the profiles as they slide through. To help thin or complex profiles retain their shapes, some of these dies may draw a vacuum.

The profiles next enter a dual spray-cooling tank. Compared with immersion-style cooling, spray cooling is significantly more efficient. While immersion cooling tanks can allow for the development of an insulating "strata" of warmed water around a hot profile, spray tanks utilize more-efficient evaporative cooling to dissipate more heat more quickly. Spray cooling is a must for WPC extrusions like decking, since the heat index for their wood-flour component is much higher than that of typical polymer components in the composite mix. Tanks must also supply a much higher flow of cooling water for WPC profiles—up to three times more than is needed by ordinary plastic profiles. Spray cooling is also typical for large or complex vinyl extrusions used in window frames and fencing.

The overall speed of the process is fine-tuned using a dual-line cleated puller, with speeds slaved to the master extrusion control. Though both of the cleated puller lines share a common equipment housing, the speed of each is controlled independently. So, each can fine-tune or "trim" process speeds by small increments based on the line speed and continuous feedback from the extrusion process controller. This is important because although dual extrusion lines are designed to perform identically, small variations in flow through the Y-block and the extruder head are common, necessitating these fine adjustments. (Speed adjustments greater than 10% must be handled by adjusting the extruder rpm.)

Following the puller, the profiles next proceed to a dual-line saw table. Once again, the speed of each line—and the length of each profile—is managed by dual, independent measurement systems that drive dual saws. Profiles are cut to finished lengths and then pushed onto a dual dump table, which accumulates and then unloads cut lengths into stacks for pickup and packaging.

> ***Extrusion processors considering production expansions owe it to themselves to consider a variety of alternatives.***

Extrusion processors considering production expansions owe it to themselves to consider a variety of alternatives. While installing new single production lines of capacity identical to existing lines is often simplest in terms of effort, it is typically the most costly in terms of capital and facility space costs. Adopting, or converting to, dual-profile production lines requires significant upfront planning and additional startup and process-development time, but can be significantly less costly in terms of capital and facility space, while scaling up the overall production capacity of your business. PT

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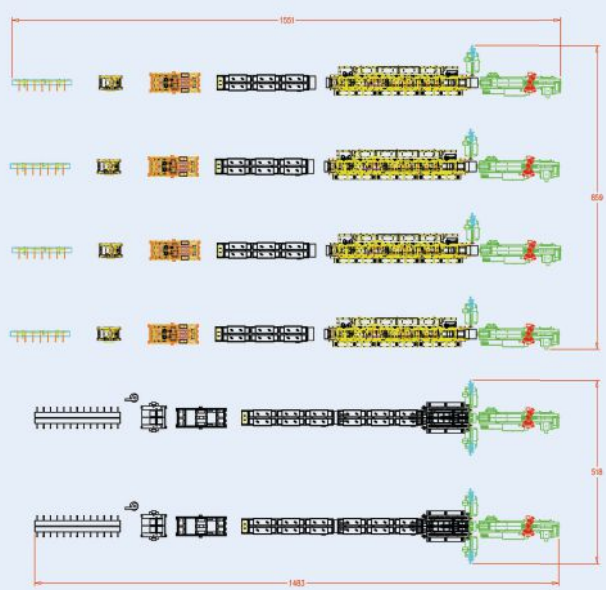
- **Example 3:** Production space requirements for single-profile and dual-profile production.

The accompanying illustration compares floorspace requirements for installation of four single coextrusion lines (top) vs. two dual coextrusion lines. Lines are typical of those used to make fence and deck profiles that are capped with PVC or color-stabilized WPC materials. Each line includes:

- Coextruder and die heads
- Calibration table with tooling
- Cooling tanks
- Haul-off/puller
- Cutoff saw
- Drop-off table

The four single lines and access aisles require 9252 ft^2/line, while the two dual lines require 5334 ft^2/line for twice the profile output.



Take These Steps to Optimize Your MFR Data

Make your life easier by paying close attention to the procedural steps detailed in the test standards.

The author demonstrates a Procedure B MVR test.

By Harry Yohn
Tinius Olsen

If you use an extrusion plastometer (melt indexer) to test the melt-flow rate (MFR) of resins, you can make your life a whole lot easier by paying close attention to the procedural steps detailed in the test standards, in order to ensure accuracy, efficiency and smooth operation. This is true whether you are conducting occasional tests or running extensive automated testing in a lab setting. Many say they meet a published test standard, but in reality they are not following the test standard exactly as written.

The melt-flow test is a measure of the mass of material that is extruded through a standardized orifice in a die under standardized temperature and load conditions; the results are expressed as g/10 min. It is a common test used in the plastics industry. Values obtained from the test are useful to processors for material selection and processing machine setup. The test is described and defined in ASTM D1238 (*Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer*) and ISO 1133 (*Determination of the melt mass-flow rate and melt volume-flow rate of thermoplastics*). The standards are similar but there are equipment and procedural differences that may produce differing results.

Procedure A is simply a collection of the mass of material that flows out versus time.

Here, we focus on the ASTM D1238 procedure. Both standards describe a manual cut-and-weigh type test, known as Procedure A and a more automated test, known as Procedure B.

It is important to remember that standards can change over time, based on real-world input from the many members of various industry associations like ASTM. In fact, the ASTM standard for melt flow was recently revised. That is why it is important to stay involved in the industry and to always be sure you are working with the latest version of any standard. An updated version of the D1238 was released in 2020. It can be downloaded from *www.astm.org* for a small fee. It is good practice to review the latest version of the standard before testing, regardless of whether you are a new user or an experienced testing veteran.

The melt indexer is basically a furnace that contains a heated metal cylinder with a bore drilled through it. The bore has specified dimensions and finish. At the bottom of the bore is a removable die with an orifice. The dimensions of the die are also specified. Material is heated in the furnace and driven through the orifice by a piston (plunger). A mass is applied to the piston which, along with gravity, forces the material to extrude. The temperature is controlled to within ±0.2° C at 10 mm above the die and ±1% of the setpoint 75 mm above the die.

The mass applied to the piston is material dependent and may vary, depending on required test conditions. Most modern machines are equipped with a built-in timer and are provided with the necessary tools to conduct a test. Optional accessories include a displacement-measuring device, necessary for Procedure B testing. These accessories can help automate the test and reduce variability from operator to operator.

The goal of the test is to allow the piston to develop a steady-state flow and get to the test start point within the window of time allowed by the standard. Before a test measurement can be made, the material is loaded in the bore of the cylinder in the furnace and then subjected to a preheat period in order to melt the material thoroughly and allow any trapped air to escape. Data is collected at a specified starting height over a defined stroke of piston travel.

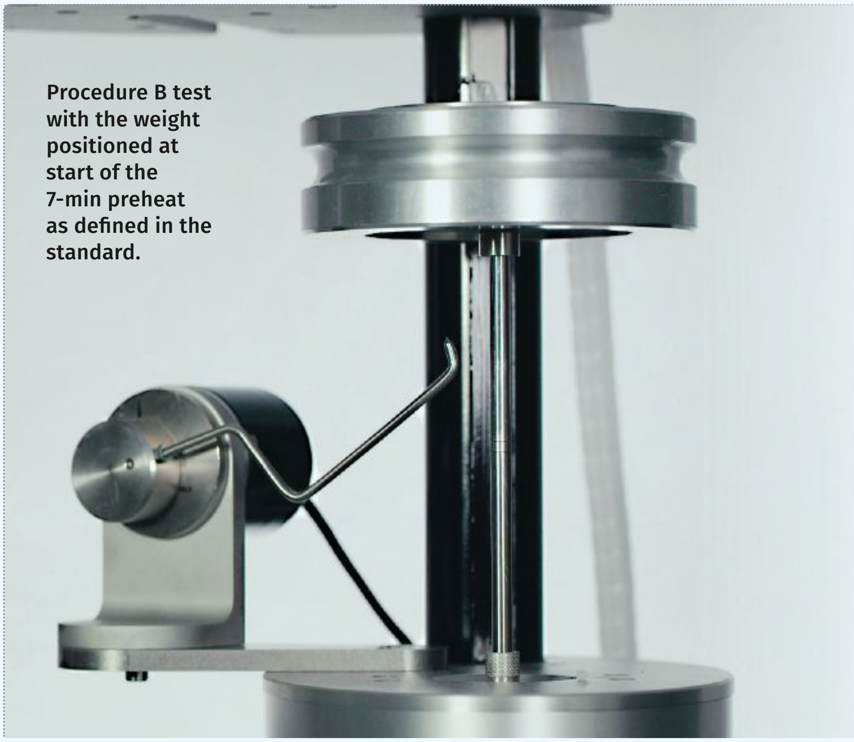
The preheat period begins after the material is charged and the piston is reinserted into the bore, and it ends when the piston foot reaches a specified height in relation to the top of the die. At that point, the operator begins the actual test. How the test is conducted depends on whether Procedure A or Procedure B is being used.

THE TEST SETUP

Regardless of which procedure is used, the operator plays a key role. The machine must be set up properly and kept clean, and adjustments and settings need to be made to the machine and test procedure based on the expected flow rate of the material. The first decision an operator needs to make is which procedure to use. Procedure A is simply a collection of the mass of material that flows out versus time. To prevent thermal degradation of the material under test, the actual test time is only a fraction of the 10 min reported, usually only 60 sec. However, the actual test time varies with the expected flow rate. High-flow materials are collected in less time, while fractional melts require more time to collect a useable sample. The mass collected is then multiplied by the appropriate number necessary to convert to the final reported value in g/10 min.

Procedure B employs encoder technology to precisely measure piston position and travel. Since the volume of the bore is specified, the volumetric flow rate of material (MVR) is determined in cm^3/10 min. The MVR is converted to MFR by multiplying the MVR by the material's melt density. The melt density (g/cm^3) is defined as the density of the material when it is in its molten state. If you are testing virgin polyethylene or polypropylene, you can use a generic value for melt density given in ASTM D1238. For all other materials, you will have to determine the melt density using a combination of Procedure A and B. Melt-density values change with processing and additives.

While there is no consensus on which procedure is best, Procedure A is typically most useful for organizations that test infrequently, use a wide range of materials, use different additives in their materials, or use regrind/recycled material. You can use Procedure A on materials that have flow rates under 50 g/10 min. Procedure B is best suited for labs that test the same material repeatedly and for higher flow materials. It reduces the amount of operator involvement but does not eliminate it.



Procedure B test with the weight positioned at start of the 7-min preheat as defined in the standard.

The next decision an operator must make is how much material to charge in the machine. The charge weight will vary based on the expected flow rate of the material. Some guidance on charging weight can be obtained from ASTM D1238. In reality, it will take some experimentation to determine the proper charge weight that will result in the piston being in the proper position at the end of the preheat period.

Again, the goal is to obtain a steady flow rate by the time the capture period starts. The amount of material charged in the cylinder will be less if the material has a low melt flow rate. It is important

QUESTIONS ABOUT TESTING?

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that the right amount be charged so that purging can be avoided, if possible. (Technically, purging of excess material is allowed, but not in the last 2 min of the preheat period.) Experience has shown that the force applied while purging will vary from operator to operator, and it can affect results for some materials. Purging can be avoided if the proper charge weight is used.

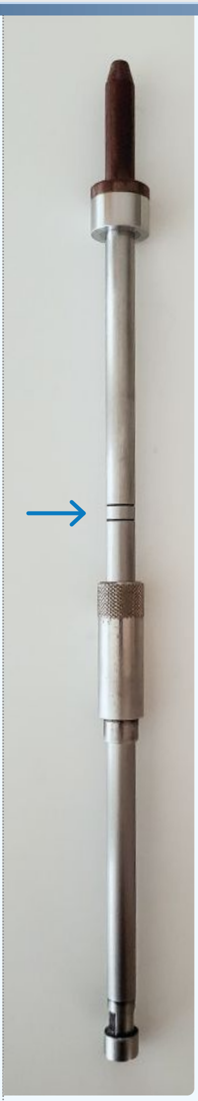
Conversely, higher flow materials will require more material.

THE PREHEAT PERIOD

Both procedures require a preheat period. The purpose of the preheat period is to allow the material to melt completely and to allow trapped air to escape. The preheat period begins after the piston is re-inserted into the cylinder after charging the sample, and it ends when the first capture, or test measurement, begins. Since the mid 1990s, ASTM D1238 has required a preheat time of 7 min ±30 sec (i.e., 390-450 sec).

The operator must then decide when to place the test load onto the piston. If the weight is applied too soon, all the material may flow from the cylinder before the end of the preheat, resulting in no material being left to test. Either the application of additional weights to the piston to complete the test load must be delayed or the load needs to be supported. This can be done using the machine, if equipped with a weight support, or the weights may be supported with a removable block. In cases where high-flow material is being tested, it will be necessary to delay application of the test load until the preheat time expires.

Additionally, the orifice in the die may need to be mechanically plugged to prevent any flow during the preheat period. In some cases, a small load may need to be applied to keep the piston from being forced out of the top of the bore due to material expansion while heating.



The arrow pointed at center of scribe lines designates ASTM D1238 start point.

THE TEST MEASUREMENT

Experience has shown that taking measurements when the piston is at different heights within the bore will result in differing test results. That is why a start height is designated in the standard. The test starts when the leading edge of the piston (bottom of the piston foot) reaches a point in the bore where it is 46 mm (1.811 in.) above the top of the die. The ASTM D1238 piston rod has two scribe lines engraved on the shaft. The center of the scribe lines indicates when the bottom of the piston foot is 46 mm (1.811 in.) above the top of the die. During a Procedure A test, the operator must observe the position of scribe lines in relation to the guide collar. When the bottom scribe line disappears into the guide collar, it's allowable, according to the standard, to make the first cut, ending the preheat period and starting the test. Just make sure to make the cut before the top line disappears.

When the start point is reached, the operator must make a clean cut of the material along the bottom of the die as the material exits the orifice, while simultaneously starting a timer. The material extruded during the preheat period is discarded. The length of time of a capture varies with the expected flow rate. Guidance can be obtained from ASTM D1238. A typical time interval for the test is 60 sec. At the end of the capture period, a final cut is made. The amount of material extruded out of the die during that 60-sec time period is then weighed and multiplied by 10 to report the flow rate in g/10 min.

The cutting technique should result in a clean cut of the extrudate, avoiding strings or material sticking to the underside of the furnace, if possible. It should be done at precise intervals, corresponding as closely as possible to signals from the timer. It is an acquired skill and may seem awkward at first. Automatic cutters can be used, but they may not work with all materials. The ASTM method requires a single cut be made for the test result.

For Procedure B tests, the operator must decide on the travel distance for the test. D1238 allows for either 6.35 mm (0.25 in.) or 25.4 mm (1 in.) of travel. Lower flow rates, generally under 10 g/10 min, use the shorter distance. The amount of material charged is the same as in Procedure A. The beauty of Procedure B is that if the machine is set up properly, a result is generated without further involvement of the operator, as a properly calibrated machine will know where the bottom of the piston foot is in relation to the top of the die.

The piston displacement on many modern melt-flow indexers can divide up the 6.35- and 25.4-mm travels into discrete measurements, if desired. It is important that the test result be reported as an average value of the captures taken over the 6.35 or 25.4 mm of travel, not as individual values. If the test material is subject to air bubbles, this technique can be useful to eliminate captures spoiled by the trapped air.

CLEANING UP

After a test is completed, the remaining material must be purged from the bore and the equipment needs to be cleaned. The importance of cleaning the machine properly cannot be over-emphasized. Some materials are easily cleaned from the machine while others present challenges. After the remaining material is purged from the bore, the piston rod and the die are removed from the bore and wiped down with a cotton cleaning rag. Both items should be cleaned down to bare metal.

The orifice in the die is cleaned with an orifice cleaning tool. Copper gauze or industrial abrasive pads work well to prevent residue from building up and causing the components to become out of dimensional tolerance. It is good practice to wipe with a cotton rag as a final cleaning step. The worst of the residue can be cleaned from the bore with cotton cleaning patches. Brass brushes may be used to remove stubborn residue. When paired with a cordless drill, the brass brush is highly effective. The bore should have a mirror finish, without any smudges or scratches. Using solvents or other chemicals to clean melt-indexer components should be avoided, because residue can remain on the surface and affect the results of subsequent tests. After cleaning, the die and piston should be reinserted to make sure they are at temperature prior to the next test.

The importance of cleaning the machine properly cannot be over-emphasized.

How you run your test depends on how your machine is equipped. Most melt indexers are available with optional features and accessories to perform additional testing procedures not covered in this article. Some materials require special treatment, like drying, before testing. Some melt testing applications call for more sophisticated data collection and storage, so most plastometers are designed to work with external testing software programs. Such software typically can store an unlimited amount of test settings and test results for easy recall, and there are usually more elaborate capabilities for generating test reports and SPC control charts. Contact your machine manufacturer for setup and maintenance instructions.

Finally, the accuracy of the results of any test relies heavily on how well a melt-index machine is maintained and cared for. Again, it is extremely important that the machine components that contact test material are cleaned thoroughly after each test. No residue should be allowed to accumulate on the piston, piston foot, die or the cylinder. These components should be visually inspected periodically for damage and wear and replaced if necessary. The machine should be calibrated on a regular basis by a certified metrologist, who will check it for temperature, physical dimensions, and distance- and time-measurement accuracy. PT

ABOUT THE AUTHOR: Harry Yohn has been a product applications specialist for Tinius Olsen in Horsham, Pa., since 1996 and has nearly 32 years of experience in mechanical and physical testing of plastics. In 1990, he joined ASTM International Committee D20 on Plastics, where he is now a vice-chair as well as Subcommittee Chairman for the Thermal Properties group, D20.30. Yohn has been honored with several ASTM Service Awards, including the ASTM International Award of Merit from Committee D20 on Plastics. He has also served as a U.S. Delegate to ISO TC61 Technical Committee on Plastics. Contact: *(215) 675-7100 X106*; *harry.yohn@tiniusolsen.com*; *tiniusolsen.com*

Keeping Up With Technology

PRODUCT FOCUS **Additives**

ADDITIVES

Polymeric Flow Aid for PLA

Boston-based CAI Performance Additives is now marketing what is said to be a unique flow improver for use with biodegradable PLA and other biobased polyester resins. Flow Improver ST-PA210 has been shown to increase melt-flow index, enhance dispersion and improve compatibility. Produced by China's Starbetter Chemical Materials, for which CAI Additives is the sole distributor in North America, this flow agent is based on a unique polymeric chemistry, unlike common wax or "oily" lubricants, and has been shown to be highly compatible with PLA, according to CAI Additives CEO Richard Marshall.

"It is dosed at low loadings but is highly functional without the brute-force lubricity seen in the traditional lubricants. So, it is effective with minimal adverse effects, such as loss of mechanical properties, along with no risk of waxy residues," Marshall says. Flowability of PLA with dosage of 1-2% of ST-PA210 has been shown to increase dramatically, according to Marshall.

The new additive is being targeted to both unfilled and filled PLA. CAI sells the additive in solid powder form to compounders and processors, who can add it at the extruder throat. Typical end-use applications include single-use cups, spoons, forks, coatings on coffee cups, transparent cold cups, deli containers and clamshell salad boxes.

ADDITIVES

Textural, Frosted Matte Masterbatch for PET

A special-effects masterbatch that provides a textural and frosted matte finish for all sorts of PET applications has been developed by Ampacet Corp. An extension of the company's popular Modern Mattes line of special-effects masterbatches, the new Whispers Collection reportedly provides a tactile, textural feel in combination with a visual matte effect. This effect is provided without the added expense of a secondary process or mold change.

Colors currently available include Blue Breeze, Calmed Coral, Golden Glimmer, Lucid Lilac, Muted Mauve and Soft Celadon. This collection of colors can be customized.

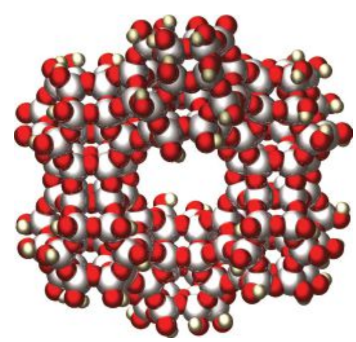
ADDITIVES

Zeolite Acid Scavengers Show Broad Use in Film, Packaging, Molded Parts

Newly available from Canada's Endex International, a supplier of blowing agents for plastics, are two natural zeolites (aluminum silicates) that act as acid scavengers, odor suppressors, molecular extenders and catalysts. They reportedly show promise in several thermoplastic film, packaging and molded parts.

Alterin 110 (28-30 micron) and 111 (10 micron) zeolite products sold in powder or masterbatch form were developed jointly by Endex and consulting firm Stabilization Technologies LLC, Charlotte, N.C., according to Joe Webster, president of Stabilization Technologies and a well-known technical expert in plastics additives. In polyolefin agricultural films, they have been shown to provide 30-40% greater moisture barrier than synthetic zeolites, and at a lower cost, while having significantly higher compounding durability than synthetics for plastics. According to Webster, approved plastics applications include:

- Ethylene scavenging in PE film packaging for extended use of fruits and vegetables. These products are sold as masterbatch to converters of polyolefin films for zipper-type or standard bags for packaging and shipping fruits and vegetables. Ethylene scavenging extends the lifetimes of fruits and vegetables.
- Masterbatch carriers for liquids and botanicals for slow release in injection molded inserts, bottles and films for retention of flavor and odor in polyolefin packaging. Also, to control and mediate insect vectors in bags for storage of grains and rice.
- Odor suppressants in a broad range of packaging, including medical, from extruded and thermoformed film to injection and blow molded rigid packaging, and from polyolefins and PET to nylons and ABS.



- Organo-mineral pigment filler (OMPF) in plastics to complement or replace other fillers. OMPF allows for use of dyes (including cationic and infrared types) that can be integrated into the zeolite to increase the dyes' limited heat and light stability in molded plastics, films and fibers. OMPF is applicable to polyolefins, nylon, PET, PBT, PC, HIPS and ABS.
- Synergist to enhance LOI in flame-retardant intumescent polyolefin compounds.

Alterin zeolites reportedly also reduce VOC emissions in plastics, and significantly reduce solvent odors, odors from certain fillers, and odors from degradation products in recycled plastics.


Nordson
BKG® Pelletizing
Technology

INJECTION MOLDING

Molding Straighter Medical Tubes: New Hot-Runner Technology Battles Core Shift

The high flow ratio (L/t) of blood tubes, which requires resin to travel a great distance relative to the tubes' thin wall, makes the application inherently challenging. That difficulty is further exacerbated by the slender cores used to form the inside of the tubes, which are prone to be shifted by the melt upon injection.

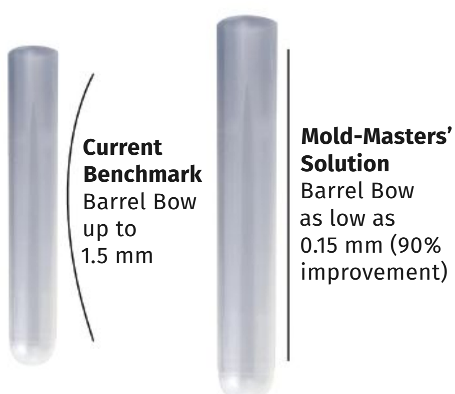
To prevent this core movement, molders often add hold time and hold pressure to correct for any shift, lengthening the cycle. Despite these efforts, the tubes often maintain a bow, which might be imperceptible to the human eye, but whose non-concentricity affects downstream operations, including labeling machines.

The seeming insurmountability of these hurdles led molders and their customers to accept a barrel bow or "banana" curve of 0.5 to 1.5 mm in the end product. Seeing a possibility to apply technology to improve the outcome, Mold-Masters set out to mold a better barrel and succeeded, cutting barrel bow to as little as 0.15 mm—a 70% to 90% reduction.

In addition to lightweighting the tube, reducing cycle time, and lowering scrap, the molding advance created tubes that rolled concentrically in the labeler, increased final-stage throughput and minimized machine downtime, according to Mold-Masters.

A Mold-Masters source says that all hot-runner valve-gate systems are affected by how and where the melt stream strikes the nozzle's pin. Using the analogy of a tree and the sun for the pin and the melt, this source says there will always be shade opposite the sun on one side of the tree. This applies equally to the valve pin and melt: There is always a "shadow" on the side opposite to where melt entered.

To overcome core shift or bending from the uneven distribution of melt, molders normally apply greater hold time and hold pressure to "push things back where they should be," says Thomas Bechtel, global sales dir. for packaging and medical. "Now they run a process that's optimized for cycle time, not hold time." Mold-Masters' patent-pending solution is to feed gates from multiple sides of the part, creating multiple "valve-pin shadows" that equalize each other. This creates symmetrical cavity fill, minimizing banana bow without extending cycle time. The company says cycle-time reductions of up to 2 sec are possible.



INJECTION MOLDING

Remote Service Added to Machine Line

Instead of a service technician identifying and fixing machine problems on-site, Boy Machines' new Smart Remote Service can establish a connection with the press remotely. While in the past the service technician's laptop was required as an access point to gain remote access to the control, this is now achieved via remote access integrated in the control. If there is no internet connection available at the machine's location, a router can be used to access the internet via a smartphone's hotspot. With this, the technician can perform software updates, debugging and maintenance as if directly on-site. The new online Smart Remote Service (SRS) tool can be used together with the interface package for all Procan Alpha 4 controls.

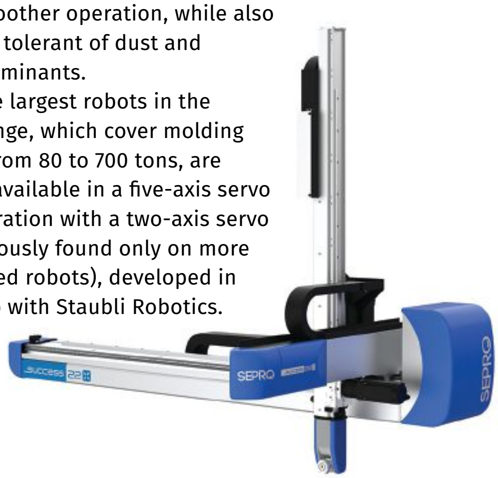
INJECTION MOLDING

Affordable Five-Axis Robots

At K 2019, Sepro showcased a prototype of a new, general-purpose, modestly priced, five-axis Cartesian robot in its best-selling series—the Success 22X with 22-lb payload capacity. It is now commercial, and Sepro has completed a redesign of the full line. In addition to aesthetic changes, the updated Success robots have an extended standard demolding stroke and, for the first time, a long-demolding (LD) configuration is available, which adds 200 mm to the stroke. In certain applications, this allows a relatively smaller robot to serve a higher-tonnage machine than previously possible.

In some models, the horizontal stroke has been lengthened, and a telescoping vertical arm is also available to extend that movement by as much as 200 mm. Sepro has returned to using cam-follower bearings for linear motions on the new Success robots. Patented by Sepro to handle large robots' heavy payloads and long strokes, they are now standard on all Sepro's Cartesian robots. Compared with linear bearings, this technology evens out weight distribution for smoother operation, while also being more tolerant of dust and other contaminants.

The three largest robots in the Success Range, which cover molding machines from 80 to 700 tons, are optionally available in a five-axis servo "X" configuration with a two-axis servo wrist (previously found only on more sophisticated robots), developed in partnership with Staubli Robotics.



EXTRUSION

Energy-Saving Twin-Screw Extruders

Italy's Bausano (U.S. sales offices in Houston and Oswego, Ill.) has introduced its next generation counter-rotating twin-screw extruder lines to the U.S. and Canadian markets. Both the MD Plus and MD Nextmover series are aimed at PVC pipe, profiles and wood-plastic composites, among other applications.

The MD Nextmover line features an all-new Digital Extruder Control 4.0 system with a multi-touch, panoramic screen. MD Nextmover also includes a new Smart Energy System for contactless cylinder heating. By using an alternating electromagnetic field, the new system reportedly delivers a significant reduction in wear and tear while delivering energy savings of up to 35%.

Both twin-screw lines also feature special multi-stage thrust bearings, which are designed to triple the dynamic load and enable the extruders to handle high-volume production. For smaller lines, Bausano has developed Multidrive 2x2, which features a single pair of motors to reduce overall dimensions while optimizing gearbox operation.

BLOW MOLDING

Screen Changers for Extrusion Blow Molders

A prominent supplier of extruders and extrusion heads for blow molding machines is now offering its own line of screen changers, too. According to Elijah Harris, marketing coordinator for W. Müller USA, "We began offering our own screen changers because a lot of our retrofit business involves vertically mounted extruders, for which there is no mass-market screen-changer solution available." Harris adds that demand for screen changers is growing in step with increased use of post-consumer recycled (PCR) plastics, which are susceptible to contamination. "Our biggest customer, which fulfills huge projects for a major consumer-products company that require 100% PCR, uses screen changers on almost every machine."

Harris cautions, "If you are only using virgin material, you don't need a screen changer. But if a processor only has capability to use virgin materials, chances are they won't be in business much longer."

W. Müller offers five models of screen changers for vertical or horizontal extruders from 25 to 120 mm diam. with throughput capacities from 55-88 lb/hr to 572-880 lb/hr. They have a piston with two screen positions, open for replacing a dirty screen, and closed to return it to operation. The extruder cannot operate while the screen is in the open position. The piston can be driven manually, using a power tool, or with servo-electric or hydraulic power (via connection to the molding machine's hydraulic system).

There is also a safety gate that can turn off the extruder, if needed, and connections for two burst discs, one melt-temperature sensor and two melt-pressure sensors. Harris notes that these sensors can give a machine operator "a lot of information about the effectiveness and health of their extruders."

The screen changers are retrofittable on existing extruders. Harris notes that their short flow length provides low residence times and "vastly improved color-change times relative to existing offerings."

BLOW MOLDING

'Highly Efficient' Purging Agent for Blow Molding Polyolefins

A purging agent designed to make resin or color changeovers in blow molding machines more efficient has been developed by Techmer PM. Purging agent PFM117632 is said to reduce purging time for HDPE dramatically. It can also can be used on PP lines.

Said Steve Smith, Techmer's rigid packaging manager, "We set out to develop an FDA-grade purge system specifically for extrusion blow molding equipment because those machines are notoriously difficult to clean out. This technology is a game changer, especially considering it only takes a couple of pounds of our masterbatch compared with other compounds on the market."

A major packaging blow molder has experimented extensively with this new concentrated product. Using a Bekum H-121 blow molding machine, the processor added just 2 lb of PFM117632 to the machine at a letdown ratio of just 5% while purging purple HDPE resin to a clean, natural color. It slashed its purging time to just 12 min. The company says it ran purging tests with six additional colors, and all had similar results. The product is designed for maximum processing temperatures of 500 F.

BLOW MOLDING

HDPE Boosts Performance of Blow Molded Bottles and Containers

A novel unimodal HDPE from ExxonMobil Chemical is said to represent a step-change in ESCR (Environmental Stress-Crack Resistance) without compromising stiffness, impact, top-load strength or processability of blow molded bottles and containers. Paxon HDPE SP5504 boasts a "paradigm shift" in the properties normally associated with currently available unimodal HDPE resins. Its superior ESCR performance makes it well suited to household and industrial chemical (HIC) bottles and containers for products like bleach, wipes, and agricultural chemicals.

Says Dr. James Stern, business-development manager for North America & EMEAF, "Until now, converters have often had to compromise to get the right ESCR performance of blow molded HDPE bottles and containers. But because there is no compromise in density or melt index, Paxon SP5504 enables converters to create cost-effective, innovative packaging solutions for HIC."

In cost-performance and processability, Paxon SP5504 reportedly fills the space between unimodal and bimodal HDPE grades. Says Stern, "It can be used as a drop-in solution for unimodal HDPE but with a better balance of properties. Or it can be used to replace bimodal HDPE grades in applications that have had to be over-engineered to obtain a desired balance of ESCR and stiffness." An added bonus of using Paxon SP5504 that is being further researched is that PCR content can be increased with minimal impact on its properties.

EXTRUSION

System Spots Surface Defects in Films

Optical Control Systems' External Film Surface Analyzer (FSA100EXT) is an optoelectronic laboratory inspection system for polymer films that can detect gels, holes, black specks, etc. The unit can be used with the supplier's own lab extrusion lines or with lab lines furnished by others. The FSA100EXT comes with a customized frame to accomodate an existing line.

The advanced V2 camera technology consists of a high-resolution dual-line CMOS camera and a user-specific, high-performance LED. This combination enables defect detection in transparent, opaque and colored films. In the FSA100 software, the measurement results are analyzed and defects classified according to customer specifications.

MATERIALS HANDLING

Enhanced Conveying Control

The SmartFLX conveying control from Conair has been enhanced with a more powerful PLC processor, faster and clearer communications, a Universal I/O panel structure, and an intelligent configurator that simplifies and reduces costs for system design and installation, system expansion, and remote diagnostics. With these improvements, Conair says many users will be able to adopt the SmartFLX system at a lower capital cost and with lower long-term operating costs than current FLX-128 systems.

Originally introduced in 2009, the FLX conveying control was developed as a flexible alternative to complex, large-scale control systems. Users could start small with a basic system of just eight loaders and two pumps (with one backup pump), and retain the flexibility to increase capacity and capability over time. The original FLX system provides such high-level functions as multi-source/multi-destination loading, ratio loading, reverse common-line conveying for regrind recovery and fill sensing. Over the years, the option to start small has remained, but the maximum capacity of the FLX system has expanded to the point that, when fully loaded, it can manage 40+ pumps, 128 receivers, and 256 controlled sources. In 2018, Conair offered users the option to add slow-speed, dense-phase Wave Conveying and Smart Services monitoring to the FLX system.

The new "smart" FLX conveying control system incorporates all of the FLX system capacity noted above, but does so with a new system architecture that reportedly is easier and more cost-effective to configure, install, manage and expand. A 10-in. color monitor displays the new SmartFLX user interface, developed through extensive user testing, and optimizes menu presentation and keystrokes associated with common user tasks. A context-sensitive Help system provides specific instructions for each screen presentation.

The new SmartFLX architecture separates communications into two channels. Control and diagnostic signaling for Conair equipment travels on a channel built to the lightning-fast, ultra-low-noise Powerlink standard. This new standard, developed to support crystal-clear data communications in noisy industrial environments, operates at a speed more than 6000 times faster than older communications protocols. All third-party equipment, as well as system reporting functions, are carried on the second data-communications channel, which operates using the proven Modbus communication protocol.

A key cost-saving feature of the SmartFLX architecture is "universal" system I/O panels. These enable any factory-configured SmartFLX system main panel (and remote or utility panel, when needed), to accept and operate any type of I/O—analog or digital, alarm or HMI, Wave Conveying valves or sensors, or pumps/receivers/loaders/ratio valves—in any available slots. This innovation means that the SmartFLX system can now support greater overall capacity—up to 40+ pumps, 256+ receivers and 500+ controlled sources and all available features—using just three I/O panel types. Operating the same features and equipment would have required purchase and configuration of up to eight different, dedicated types of I/O panels.

Also unique to the SmartFLX system is a software-based system configurator that simplifies everything from system design and ordering to installation, expansion, operations and maintenance/troubleshooting.

COOLING

Outdoor Chiller Boasts Wider Range of Operating Conditions

Thermal Care has introduced an outdoor packaged chiller designed with the flexibility to provide process cooling year-round, with a wider range of operating conditions than comparable models. Accuchiller KSE Series models are air-cooled outdoor units manufactured to work in the harshest weather environments. Units are factory tested and ready for easy installation; just run piping and power to the unit and it is set for operation.

Energy-saving variable-speed EC fans allow the chiller to withstand ambient conditions from 20 F to 125 F. As an added bonus, the process-fluid circuit allows for more flexibility with a setpoint temperature range from 20 F to 80 F.

KSE Series chillers come with an advanced outdoor PLC control system with ModBus TCP/IP & RTU and a 7-in. color touchscreen similar to the controllers used on Thermal Care's Accuchiller NQ Series portable chillers. This robust control system provides extensive diagnostic capabilities and a multitude of communication options, including OPC/UA. Screen layouts are improved to simplify finding data in an easy-to-follow format. Connecting to Thermal Care's optional Connex 4.0 system allows for integrated connectivity and secure remote access to all related connected equipment.

KSE Series chillers are available from 40 to 720 tons in a combined system. Units come with or without integrated pumping packages in either low- or high-pressure designs with an optional redundant standby pump. The high-pressure design allows it to support entire plantwide cooling systems.

TOOLING

Cycle-Counter Line Expands

Progressive Components' newest CounterView mold cycle counter is now available in both left- and right-hand orientations for mounting on either mold half and easier viewing while the mold is in the press. The new High Temp CounterView offers standard performance with the ability to function in hotter tools running at up to 375 F.

Progressive also introduced the new Retrofit Bracket, which insulates its CVe Monitor or CounterView for added heat protection. The bracket, which installs in an existing pocket without modification to the mold's cavity or core half, offers a maximum operating temperature of 410 F.

TOOLING

Self-Adjusting Precision Lifter

DME has redesigned its proprietary Accualign lifters, created to eject parts with undercuts. With older designs, any flaws in the original manufacture of the tool, or plate movement caused by thermal expansion during molding, could cause misalignment and put pressure on the lifter, ultimately leading it to bind or even break.

DME says its new multi-axis self-adjustment system compensates for misalignment. The 3D movement is accomplished by applying a carbide ball adapter that rides in a hardened shoe. This allows the rod and bar to self-adjust vertically to the correct non-binding position. DME says this design is complemented by a dovetail connection between the rod/bar and the ball adapter to adjust horizontally.

DRYING

Desktop App for Multiple-Dryer Control

The SmartView Desktop App from Dri-Air is a web-based application that connects a processor's dryers through each dryer's unique IP address. It allows control over multiple dryers—from just one screen—without any need to walk the plant floor.

Available with SmartTouch Industry 4.0 dryer controls, introduced early last year, the SmartView Desktop App permits control of all dryers from one central location, showing dryer status, dewpoint, hopper status and regeneration status. From this one screen, operators can start and stop dryers and set hopper temperatures on single- and dual-hopper portable dryers.

Prices Still Rising for Volume Resins

Global supply constraints on feedstocks and some resins, along with strong demand, are driving continued increases.

By Lilli Manolis Sherman
Senior Editor

Prices of PE and PP moved up in double-digits, while those of PS, PVC and PET were also on an upward trajectory, in the first six weeks of this year. The remainder of the first quarter was projected to continue on this track, owing to global constraints on feedstocks and some resins, coupled by continued strong demand in most cases. Those are the views of purchasing consultants from Resin Technology, Inc. (RTi), senior editors from *PetroChemWire* (*PCW*), and CEO Michael Greenberg of The Plastics Exchange.

Market Prices Effective Mid-February 2021

Resin Grade	¢/lb
POLYETHYLENE (railcar)	
LDPE, LINER	122-24
LLDPE BUTENE, FILM	105-107
NYMEX 'FINANCIAL' FUTURES	50
MARCH	57
HDPE, G-P INJECTION	127-129
HDPE, BLOW MOLDING	121-123
NYMEX 'FINANCIAL' FUTURES	56
MARCH	62
HDPE, HMW FILM	134-136
POLYPROPYLENE (railcar)	
G-P HOMOPOLYMER, INJECTION	95.5-97.5
NYMEX 'FINANCIAL' FUTURES	78
MARCH	90
IMPACT COPOLYMER	97.5-99.5
POLYSTYRENE (railcar)	
G-P CRYSTAL	114-116
HIPS	116-118
PVC RESIN (railcar)	
G-P HOMOPOLYMER	99-101
PIPE GRADE	98-100
PET (truckload)	
U.S. BOTTLE GRADE	57-60

PE PRICES UP AGAIN

Polyethylene prices rose 6¢/lb following the December 5¢ increase, and suppliers announced a 7¢ increase for February, according to Mike Burns, RTi's vp of PE markets, *PCW* senior editor David Barry, and The Plastic Exchange's Greenberg. Said Burns, "Prices are now 30¢/lb higher than they were in December 2019, without any significant cost increases to produce polyethylene."

These sources anticipated that the past month's 7¢ increase had strong potential of being implemented, attributing the increases to tight inventories that have resulted from both planned and unplanned shutdowns and strong domestic and export demand, particularly from Latin America and Mexico. Supply is especially tight for HPDE and LDPE, due to the outage of Braskem Idesa's large Mexican plant, explained Barry. While the plant was back up and running at 15% of capacity, it was unlikely to make a difference in the supply shortage until April.

Meanwhile, prices of spot PE were at prime material levels. Burns predicted that demand will be strong through the first quarter and perhaps into the second quarter, while supply will remain tight, and he did not expect much price relief till the second half of the year. *PCW*'s Barry noted that some processors who had bought heavily during December and January were positioned to cut back on orders last month and perhaps into this one. Spot availability was limited in the domestic resale market, and most offers were being quoted with the 7¢/lb February increase and a rollback provision.

Going into the second week of February, Greenberg characterized spot resin trading as hyperactive. "Processors, many on supply allocation, have flocked to the spot market as they scramble to procure material. This has resulted in very high volumes of resin changing hands through our trading desk, and buyers' resilience continued to astonish even as prices spiraled ever upward." He noted that spot gains so far this year were 11¢ to 19¢/lb, depending on scarcity of the grade.

Polyethylene Price Trends

	JAN	FEB
HDPE Injection	▲ 6¢/lb	▲
HDPE Blow Molding	▲ 6¢/lb	▲
HDPE HMW	▲ 6¢/lb	▲
LDPE	▲ 6¢/lb	▲
LLDPE Butene	▲ 6¢/lb	▲

PP PRICES CLIMB FARTHER

Polypropylene prices moved up 12¢/lb in January, in step with propylene monomer, which settled at 60.5¢/lb. Yet another double-digit increase was expected for the monomer last month, along with a 6¢/lb margin increase sought by PP suppliers, according to

Scott Newell, RTi's vp of PP markets and *PCW*'s Barry. Newell expected that suppliers would succeed with the margin increase. Barry also reported that LyondellBasell issued a 6¢/lb hike for March, in addition to any change in monomer price.

Newell, Barry and Greenberg all noted that these increases are primarily feedstock driven. Newell ventured that the monomer tightness would continue, as inventories had yet to be rebuilt following several outages in the last half of 2020. Despite very strong current PP demand, all three sources expected demand destruction to follow, though it has not occurred to the degree originally thought. "We're seeing increasing imports of propylene, PP pellets and finished goods like BOPP film," Newell said. "Imported PP is priced better than domestic resin, even with the higher freight costs." Barry noted that the spread between U.S. and Asian market pricing was approaching 40¢/lb.

Greenberg reported that PP spot prices were up 17¢/lb in January and gained another 10¢/lb in the first week of February. "Though the price stings, demand has remained good, and it has been easy to find homes for the slightly improved flow of spot offerings. We are undoubtedly seeing demand destruction too, but to date it has been overshadowed by the high level of inelastic demand chasing limited resin supplies."

Polypropylene Price Trends

Homopolymer	
JAN	FEB
▲ 12¢/lb	▲

Copolymer	
JAN	FEB
▲ 12¢/lb	▲

PS PRICES RISE

Polystyrene prices moved up 5¢/lb in January, following the December 6¢ hike, driven this time by increased costs of benzene, ethylene and styrene monomer, according to both *PCW*'S Barry and Robin Chesshier, RTi's vp of PE, PS and nylon 6 markets. Moreover, suppliers were looking to implement a 2¢/lb price hike in February, based on higher ethylene costs. January ethylene contracts settled 6.5¢ higher at 37.75¢/lb. Barry reported that the implied styrene cost based on a 30/70 ratio of spot ethylene/benzene by the end of the first week of February was at 33.8¢/lb, 2.7¢/lb above the previous four weeks.

Chesshier said current market dynamics did not justify the February increase, noting that spot benzene prices were dropping and that the higher domestic prices were the result of tightness, particularly in Asia, due to planned and unplanned plant shutdowns. "Domestic demand is down 3%, as are supplier inventories, but PS export sales are up 70%—a very unusual occurrence. So, North American processors are paying higher prices while suppliers export material at lower prices." Similarly, Barry noted that a global styrene shortage has resulted in domestic suppliers exporting monomer at a profit, while tightening domestic availability. Both sources noted tighter domestic PS supplies and ventured that prices in March and early April had potential to rise farther, depending on benzene supplies and cost and PS export demand. "We're not out of the woods in terms of further price increases through the first two quarters," summed up Chesshier.

Polystyrene Price Trends

GPPS	
JAN	FEB
▲ 5¢/lb	▲

HIPS	
JAN	FEB
▲ 5¢/lb	▲

PVC PRICES UP

PVC resins prices rose 4¢/lb in January and suppliers issued a 3¢/lb hike for February that was likely to be implemented at least partially, according to RTi's Kallman and *PCW* senior editor Donna Todd. Kallman characterized demand as strong, noting that housing starts are up and home renovation business continues to be strong, facilitating demand for products such as PVC flooring.

According to Kallman, March could prove tougher in terms of supply tightness, since plant maintenance shutdowns are scheduled. Todd reported that all four domestic PVC suppliers were building inventory ahead of their upcoming plant turnarounds. "Lack of product has kept export PVC prices above domestic prices. Looking at rising ethylene costs, tight resin availability and high export prices, some converters believe that producers will announce another PVC price increase for March."

Still, Kallman noted that export prices were going down 3-4¢/lb. "This was an early indication going into February that supply tightness was loosening up a bit. There is no doubt that this upward pricing is really about supply/demand imbalance, not feedstock prices."

PVC Price Trends

Pipe	
JAN	FEB
▲ 4¢/lb	▲

Gen. Purpose	
JAN	FEB
▲ 4¢/lb	▲

PET PRICES HIGHER

PET prices for spot railcars and truckloads started February steady from late January in the high-50¢/lb range, delivered to the U.S. Midwest and South. That was up from 50-55¢/lb in early January, according to *PCW* senior editor Xavier Cronin. Monthly contract business tied to PET feedstock indexes for February delivery stood between 52¢ and 56¢/lb delivered. Offgrade PET availability was limited due to the high availability of on-spec resin from domestic sources and imports.

Cronin ventured that PET prices would hit 60¢/lb by mid-February and would be higher than that in March, given robust demand for PET bottles, containers, packaging and strapping. "Demand typically falls during winter months, but has not done so this year due to COVID-related demand for all kinds of plastics."

PET Price Trends

Bottle Grade	
JAN	FEB
▲ 3-5¢/lb	▲

Processors Extend 2020 Expansion into New Year

Survey data report quickening expansion in plastics, notably in custom processing.

By Michael Guckes
Chief Economist/Director of Analytics

The Gardner Business Index (GBI) for plastics processing registered 57.5 in January, pointing to a quickening expansion in industry activity. (Index values above 50 indicate expansion; the larger the value, the faster the expansion.) The latest reading was supported by higher readings for supplier deliveries, production, and new orders. Employment and backlog activity both showed quickening expansion during the month, while export activity was unchanged. January's results mark the first time since January 2019 that all six index components registered flat or expanding activity.

Data provided by custom processors also indicated an expansion in overall business activity. However, all of January's improvement resulted from the meteoric rise in the supplier delivery measure, which is now 11 points above its previous all-time cyclical peak of 65.4. The latest reading overshadows the fact that all other measures of business activity expanded during the month, a feat that has not happened since Q1 2018.

If recent months' data (based on surveys of *Plastics Technology* subscribers) can serve as a strategic guide for manufacturing managers in 2021, the message it seems to convey is that processors will have to quickly find ingenious ways to mitigate their supply-chain issues or else potentially miss out on the growing wave of new-orders activity. PT

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

Gardner Business Index: Plastics Processing

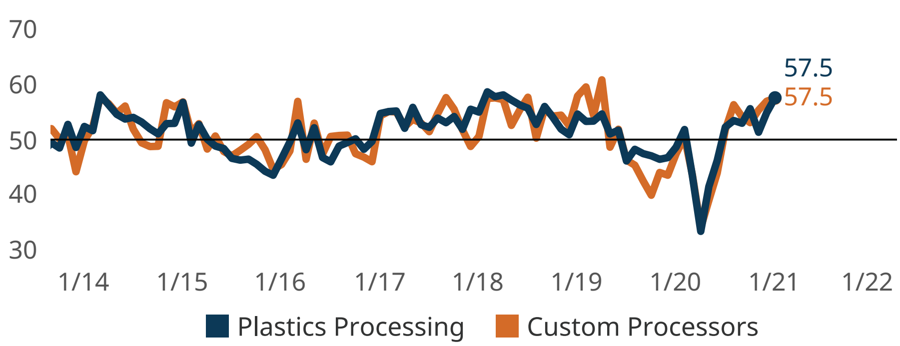


FIG 1

The GBI for plastics processing rose modestly in the first month of 2021, thanks to higher supplier deliveries, new orders and production. Five of the Processing Index's six components expanded in January.

Supply Chain Problems Persist into New Year

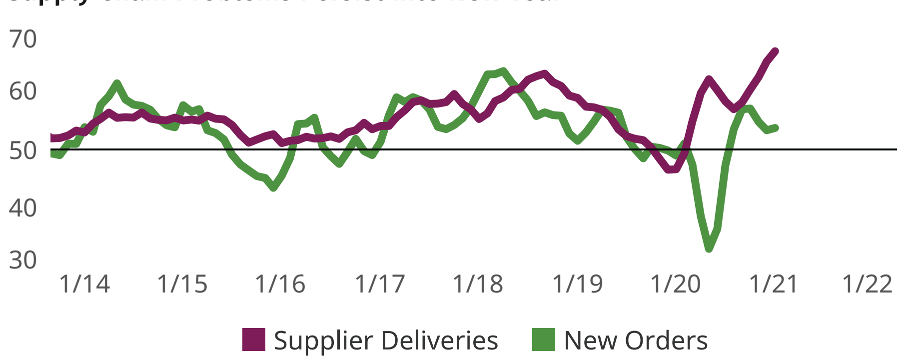


FIG 2

January's exceptionally high supplier-delivery reading points to greater industry problems than merely coping with the seasonal fluctuation in shipping-services demand. The combination of supply challenges and rising orders could create missed opportunities for processors early in 2021.

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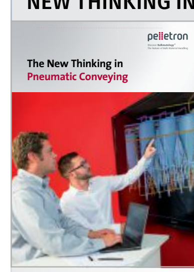

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ANT PACKAGING — BANGALOW, AUSTRALIA

ERP System Helps Bottle Molder Adjust to Pandemic

CyFrame ERP helps Ant Packaging boost production of hand-sanitizer bottles by 4.3 million.

By Jim Callari
Editorial Director

Australia's first carbon neutral, solar-powered injection molder dramatically boosted production to respond to need for hand-sanitizer bottles, assisted by CyFrame's recently installed ERP system.

Australia's Ant Packaging (***antpackaging.com.au***) thrived during the 2020 pandemic in no small part because CyFrame's ERP system helped it produce and deliver an extra 4.3 million hand-sanitizer bottles in just three months, up 67% from normal volumes.

John Ant, owner and cofounder, says CyFrame gave him and his team the ability to plan and create viable schedules six to eight weeks ahead, but shipping dates were an ongoing challenge in the face of rotating and extended COVID-19 lockdowns.

Fortunately, the CyFrame ERP let Ant Packaging plan so far ahead that they could accurately predict where they'd be at any given time. "The CyFrame data allowed us to give clients at least a month's notice if we expected delays; and because we were so transparent and kept them informed, customers understood we were doing our best for them under the circumstances," Ant says. "Customers loved the fact we knew if we'd be late, and if so, by how much."

A self-taught programmer who built his company's first ERP system, Ant Packaging's John Ant says the CyFrame system he installed in 2018 paid for itself in 18 months and boosted profits 85%.

CyFrame's ERP system, implemented in mid-2018, paid for itself in 18 months. That payback was 50% faster than forecast, thanks to an 85% increase in profits through planning and production efficiencies, fewer rejects, less material waste and lower material costs.

Because Ant had replaced the in-house ERP system he designed and built himself in the mid-1990s with CyFrame, Ant Packaging was able to support sales increases of 28% to 67% from pre-pandemic levels without scheduling and paying for overtime, hiring new employees or investing in new machines.

Ant Packaging has always had to be extremely agile and organized to schedule a wide range of custom orders and access the materials needed to support the just-in-time delivery customers demand. That was more crucial than ever during the pandemic, as the CyFrame system seamlessly managed operations end to end, from confirming and processing orders to material resource planning and ultimately, invoicing.

"The CyFrame ERP keeps us on track from start to finish and flags redundancies, so were not getting double-billed for any of the goods and services we've purchased," Ant says. "On top of that, the system's automated invoicing really closes the loop by making sure we get paid for every job we do."

The CyFrame ERP tracks historical production data and learns which machines will run a specific SKU the most effectively. It takes both quality and speed into account, as well as the potential regrind and material waste if it's run on a different machine. Material waste is down 2% to 5% due to improved production planning, and better coordination of mold and color changes to ensure they're not scheduled simultaneously on multiple machines, resulting in too few operators for the tasks at hand.

"The operators are more comfortable because they know they're where they need to be, thanks to schedules and routines that avoid conflicts," Ant says.

Online orders placed through Ant's website now account for 18% of business, up from about 15% before CyFrame streamlined and enhanced the user experience. CyFrame's online ordering seamlessly replaces the three standalone software systems that had supported Ant's online orders. Orders are confirmed by the ERP system, which also fully automates the creation of accurate, timely invoices based on order and shipping information. Pre-CyFrame, customers occasionally had to ask Ant to correct the price on an invoice or even issue an invoice for the SKUs they received, as Ant employees had to rely on their semi-automated accounting system to produce invoices.

"We probably didn't bill for up to 5% of the work we did and we only knew if a client owed us money when and if they told us," Ant admits.

"As much as I enjoyed programming and maintaining the in-house ERP, I'm appreciating the extra time I have to devote to customers and managing the company," Ant says. "Our results prove CyFrame was the right choice for us. Logical and intuitive, CyFrame really identified and addressed issues we didn't even know we had and made us more agile, more profitable and more responsive than we'd ever been."

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