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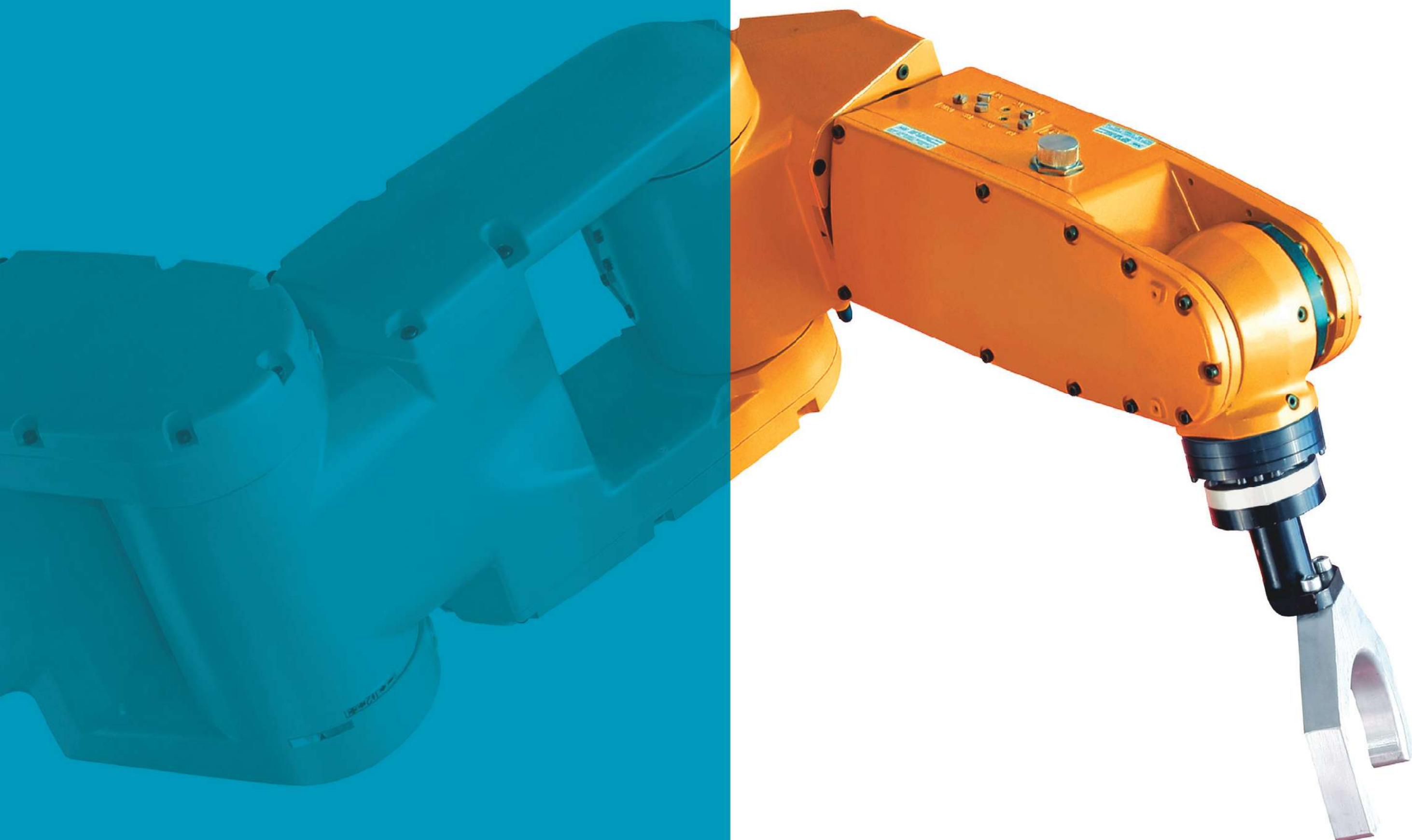

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Plastics Technology

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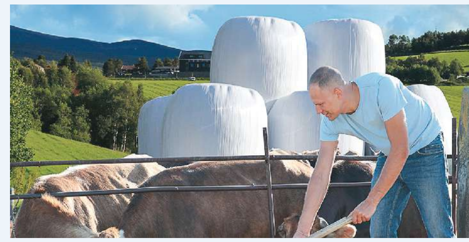
Workforce Development Panel at Molding 2018

A broad cross-section of the injection molding industry came together at Molding 2018 to discuss the challenge of workforce development in a lively panel. Rao Neelam, plant manager at Comar; Jason Holbrook, sales manager KraussMaffei; John Berg, director of marketing, Sussex IM; Michael Engler, president, AMA Plastics; and Alex Beaumont, director of business development, Beaumont Technologies, led the discussion, moderated by *Plastics Technology* editors Matt Naitove and Tony Deligio.

bit.ly/2qoH95S

BLOG: Polyethylene Film in Focus

Editorial Director Jim Callari continues a deep dive into the materials, markets and technologies that are driving polyethylene film extrusion, most recently tackling agricultural and meat and poultry films. If you're active in these markets, or would like to be, check out the series (links to all the posts are within the article).



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BLOG: Raise the Equipment IQ Of Your Shopfloor

Industry 4.0 is officially a buzzword, but that doesn't mean it's not an important trend to keep on top of. Senior Editor Tony Deligio cuts through the marketing hype ahead of Industry 4.0 at NPE2018 to lay out the difference between "smart" and "dumb" equipment.
bit.ly/2qoEZD7

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World of Extrusion Coming Together in September

The Extrusion 2018 Conference—the fourth annual *Plastics Technology* event devoted to all things extrusion—is coming to Cleveland.

Are you involved in extrusion, as either a business owner, plant manager, production or engineering manager, or perhaps even a newcomer to the industry? Then mark off Tuesday through Thursday, Sept. 18-20, on your calendar. The Extrusion 2018 Conference is coming to Ohio on those dates, specifically the Huntington Convention Center in downtown Cleveland, right across the street from the event's host hotel, the Marriott.

Jim Callari
Editorial Director

It's the fourth annual extrusion conference from *Plastics Technology* magazine. The first three were in Charlotte, N.C.; attendance climbed every year and reached nearly 500 in 2017.

The conference is distinctive in that it intends to bring together the entire extrusion community—the "world of extrusion," if you will—under one roof. No matter what is coming out of your die—film, sheet, tubing, pellets, etc.—there will be plenty there for you to learn. And the networking opportunities—with more than 70 speakers and at least that many exhibitors—are unprecedented.

The program will kick off the afternoon of Sept. 18 with a session of presentations on General Extrusion topics that apply to all types of extrusion processes. These will include talks on resins, additives, blending, drying, conveying, foaming, reclaim, controls, filtration, training, simulation, screw design and so on.

The mornings of Sept. 19-20 are similarly organized. During the afternoons of those days, however, we'll be offering concurrent breakout sessions that do a deeper dive into your particular extrusion process. We have four of these concurrent sessions planned: Cast/Blown Film, Sheet, Pipe/Profile/Tubing, and Compounding.

The Extrusion 2018 Conference focuses on new developments, best practices, troubleshooting, and processing tips and techniques— modeled after what we present every month in print and online.

Like the prior three extrusion conferences, the focus of Extrusion 2018 will be on new developments, best practices, troubleshooting, and processing tips and techniques—modeled after those we present every month in print and online—because we know you don't want to travel to Cleveland to hear sales pitches from suppliers.

While the program will be packed with technical presentations from the cream of the crop in the extrusion industry, there will be plenty of networking and mingling opportunities during breaks, receptions, and luncheons. And we'll have a tabletop exhibit area packed with more than 70 suppliers of the goods and services you rely on every day to run your business.

Your time and money are precious. But if you are involved in extrusion of any type, The Extrusion 2018 Conference is the place to be. Best to block off these dates on your calendar now and be on the lookout for more details from us—in print, on our website (*extrusionconference.com*), and via email.

Interested in speaking? Email me at *jcallari@ptonline.com*.

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@jimcallari

Thermoplastic Overmolded with Foamed & Solid LSR at NPE2018

At NPE 2018 this month, Negri Bossi North America, New Castle, Del., is displaying an example of the Canbio sT servo-hydraulic toggle line (180 to 500 metric tons), recently introduced to North America. These "highly modular" machines have the Tactus controller with 21.5-in. touchscreen and energy-consumption monitor. Particularly notable is the unit on display, a 180-m.t., two-shot model with a third auxiliary injector for molding a ping pong paddle with three materials (or four, depending on how you're counting).

The rigid core of the paddle is PBT, molded on the main horizontal injector. The smaller vertical injector molds a TPU soft-touch handle. The mold is directly fed liquid silicone by an "Easy-Balance LSR" unit from Guzzini Engineering (*guzziniengineering.com*). This unit overmolds two different ball-control faces on the paddle in two densities—the firmer face in solid LSR and the "spongier" side in microcellular foamed LSR. Parts are handled by a six-axis robot from sister company Sytrama.

302-328-8020 • negribossi.com

Snapple Replicates its Iconic Bottle in Plastic—and Keeps the "Pop"

When Dr Pepper Snapple Group (DPS), Plano, Texas, decided it was time to convert its Snapple juice and tea bottle from glass to lightweight, unbreakable plastic, it faced at least two challenges. One was to replicate that iconic bottle shape exactly in stretch-blow molded PET that would have to withstand hot filling and the stresses resulting when it cools and a vacuum forms inside. Second was to create the first PET bottle with a metal lug cap in order to retain the satisfying "pop" that consumers experience when cracking open a vacuum-sealed bottle.

To address those challenges, DPS collaborated with a firm it had partnered with before, R&D/Leverage of Lees Summit, Mo., an injection and blow moldmaker and package designer and engineer. According to Patrick George, senior director of packaging engineering for DPS, "We decided that success would mean that when the bottles were put side by side, we couldn't tell the difference between glass and plastic." R&D/Leverage was able to accomplish the "look" that DPS wanted: From the overall shape to the embossed "S" logo, the PET bottle matches the appearance of the familiar glass bottle, but at only 1/15th the weight.

Just as essential was getting the vacuum in the cooled bottle after hot filling just right. The challenge lay in generating enough vacuum for the metal lid to safely seal the bottle and provide the "pop," but not so much that it deformed the PET bottle. Accomplishing all this "was a technical struggle," says Duncan Hardy, director of sales for R&D/Leverage. One result was a robust, 50-g preform that would give a sturdy, glass-like feel to the resulting bottle. R&D/Leverage is exhibiting at NPE2018 in Orlando this month in Booth S32079. They will have examples of the Snapple bottle on hand.

816-525-0353 • rdleverage.com

Nissei Opens First U.S. Plant to Build Injection Machines

Nissei Plastic Industrial Co. of Japan started up operations in March at its first assembly plant in the U.S. for injection molding machines. The plant is operated by a new subsidiary called Nissei Plastic Machinery America Inc., in San Antonio, Texas. The new facility occupies 392,700 ft² and includes an assembly floor,

warehouse, showroom, technical center, and office space. The San Antonio plant will initially build large servo-hydraulic presses from 560 to 1300 tons. Those machines will be sold here by Nissei America Inc., Anaheim, Calif.

714-693-3000 • nisseiamerica.com

'Flake-to-Preform' Direct Recycling of PET Soft-Drink Bottles

Suntory Holdings Ltd., Tokyo, has developed what it calls FtoP direct recycle technology for converting soft-drink PET bottle flake to new soft-drink bottle preforms. This work is part of a joint effort with Kyoei Industry Co., Ltd. in Japan, Sipa SpA of Italy, and Erema Group GmbH of Austria. Preforms using this technology will be manufactured at Kyoei Industry and are scheduled to launch in soft-drink bottles starting this summer.

This new technology creates flake by pulverizing and washing recovered PET bottles. The flake is treated at high temperature and low pressure for a fixed period; and, after being melted and filtered, can be injection molded directly into preforms, Suntory states.

To form preforms of uniform quality, it is important to feed the melted flake into the molding machine at a constant pressure, the company says. In comparison with previous methods, which require many intermediate processes such as crystallization and drying, it is reported that an estimated 25% reduction in CO_2 emissions may be possible.

Super-Lightweight PET Bottle For Quick Refreshment

Krones AG in Germany (U.S. office in Franklin, Wis.) has developed a droplet-shaped 200-ml PET bottle for still water that weighs only 4.4 g. It has a 26/22 neck finish, typical for water bottles, and can be closed with a standard screw cap. The bottle can be stabilized for storage and transportation with nitrogen pressurization after filling.


Krones 200-ml PET water bottle.

This bottle debuted at last fall's Drinktec exhibition in Germany. At the same show, competing German PET bottle machinery maker KHS (U.S. office in Waukesha, Wis.) introduced what was billed as the world's lightest 500-ml PET water bottle, dubbed Factor 100, which weighs 5 g.

414-409-4000 • krones.com; 262-797-7200 • khs.com


KHS Factor 100 bottle.

Chemical Recycling Converts PET Waste to Virgin-Grade Material

Novel technology is said to convert PET waste back into base chemicals that can be repolymerized into virgin-grade material for use in food packaging. Consumer-goods company Unilever, start-up company Ioniqa, and Thailand-based Indorama Ventures, the largest global producer of PET, are working together to pioneer this chemical recycling technology.

Ioniqa, a recent spin-off from Eindhoven University of Technology in The Netherlands, has developed a proprietary technology that reportedly makes it possible to convert any PET waste—including colored packages—back into transparent virgin-grade material. The technology has passed its pilot stage and is now moving toward testing at an industrial scale.

Ioniqa's new technology takes PET waste that is not easily recycled, like colored bottles, and uses a patented magnetic catalyst to break it down to its chemical building blocks, while separating out colorants and other contaminants. The recovered chemicals are converted back into PET that is reportedly equal to virgin quality at Indorama's facility.

If proven successful at industrial scale, in the future it may be possible to convert all PET back into high quality, food-grade packaging. The three partnering companies believe that this fully circular solution could lead to an industry transformation, since the new technology can be repeated indefinitely.

Unilever, based in the UK and The Netherlands, committed last year to requiring all its plastic packaging to be reusable, recyclable or compostable by 2025. Chief R&D officer David Blanchard says Unilever is proud to support another sustainable packaging innovation. "This innovation is particularly exciting because it could unlock one of the major barriers today–making all forms of recycled PET suitable for food packaging. Making the PET stream fully circular would be a major milestone towards this ambition."

Topas Merges with Polyplastic

Japan's Polyplastics Co., Ltd. has merged its affiliate Topas Advanced Polymers, Florence, Ky., into Polyplastics USA, Inc., Farmington, Mich. The merger adds Topas cyclic olefin copolymer (COC) resins to Polyplastics USA's portfolio of acetal, PBT, and PPS engineering polymers. Polyplastics, which aims to build a stronger market presence in the Americas, has retained the majority of Topas's personnel to ensure continuity for the growing number of COC customers in packaging, healthcare, and other industries.

248-479-8928 • polyplastics.com; 859-746-6447 • topas.com

Novatec Expanding in Pennsylvania

Baltimore-based auxiliary-equipment builder Novatec is moving its two-year-old operation in Pennsylvania to a new facility that's more than 2.5 times as large. By July 1, the company expects to occupy an 80,000 ft^2 facility in Glen Mills, Pa., where it will make conveying pumps, receivers and loaders, conveying valves, and electrical panels. Novatec expects to increase its workforce in Pennsylvania by 50%. Novatec says it outgrew its 30,000 ft^2 building in Brookhaven, Pa.

800-237-8379 • novatec.com

'Floating' PP Coffee Pods Facilitate Recycling

At NPE2018 this month, Kiefel GmbH (U.S. office in Portsmouth, N.H.) is showing new patent-pending thermoforming tooling—developed in conjunction with sister company Bosch Sprang and a thermoformer—for producing PP coffee pods with a material density lower than 1 g/cc, allowing them to be recycled in float/sink water-separation systems.

The new tooling system can be adapted to most tilting-bed thermoforming machines, the companies say. Consequently, it does not require any special machine adaptions. The proprietary technology is based on several unique and innovative multi-functional elements in the tool that reportedly enable and control specific mechanical properties of the coffee pods.

Kiefel displays the technology at its booth on its KTR 6.1 Speed pressure-forming machine. The firm says the KTR 6.1 Speed sets new standards in power, forming area and speed. The machine is suited to a wide range of materials, among them RPET, PP, PS, PLA and PE, including foamed materials.

603-929-3900 • kiefel.com

BASF Boosts Polyarylsulfone Capacity

BASF (U.S. office in Florham Park, N.J.) has significantly expanded capacity for its high-temperature-resistant Ultrason polyarylsulfone with the recent startup of a new production line in Korea. The new line boosts global Ultrason capacity by 13.3 million lb to 53 million lb/yr. Ultrason production in Korea first started in 2014. The company also produces Ultrason in Germany. Both locations are designed to produce the entire Ultrason product range, which includes polyethersulfone (Ultrason E), polysulfone (Ultrason S), and polyphenylsulfone (Ultrason P). Among the latest innovations is optimized Ultrason Dimension, a highly filled polyethersulfone notable for its extraordinary dimensional stability and excellent flow properties.
800-431-2360 • basf.com

ExxonMobil Explores PP Expansion On Gulf Coast

Detailed engineering work on a potential U.S. Gulf Coast production facility to expand PP capacity by up to 900 million lb/yr is underway by ExxonMobil Chemical Co., Irving, Texas. The new facility would be able to produce advanced PP grades for use in high-performance automotive, appliances and packaging.

A final decision on this project is expected before year's end. Startup could be as early as 2021.
832-624-8372 • exxonmobilchemical.com

U.S. Military Researchers Use Recycled PET For 3D Printing

The U.S. Army Research Laboratory (ARL) and the U.S. Marine Corps are exploring ways to use recycled plastics for 3D printing parts that soldiers may need on the battlefield, according to a report from ARL. ARL researcher Dr. Nicole Zander and collaborator Marine Capt. Anthony Molnar generated 3D printing filament using 100% recycled PET from bottles without any chemical modifications or additives. Work is also underway to generate filament from other recycled plastics and reinforced filaments.

The filament was produced on a Thermo Scientific Process 11 co-rotating twin-screw extruder. The Process 11 is said to be the smallest scalable twin-screw extruder (11 mm), matching all the process variables of full-scale compounding extruders, yet physically small enough to fit on a tabletop. "The Army really thought out of the box on this application, turning a troublesome waste product into a valuable resource. This is a strong statement on sustainability," says Steve Post, business development manager at Thermo Fisher Scientific, Madison, Wis. (***thermoscientific.com***). Post envisions these machines being suitable for municipalities as they look for "value ad" in their waste stream, providing schools with resources for their 3D-printing/additive-manufacturing labs.

ARL's Zander said recycled PET (RPET) was shown to be a viable new feedstock, with mechanical properties of printed parts comparable to parts made from commercial filament. In addition to small parts for evaluation, several larger, long-lead-time military parts were also printed with the filament. For example, a custom fixture was made for mechanical testing of a 3D-printed radio bracket. Brackets made from recycled PET failed at a load similar to that of brackets printed with commercial ABS filament.

"In terms of mechanical properties, most polymers used in fused-filament fabrication have bulk strengths between 30 and 100 MPa. Recycled PET has an average strength of 70 MPa, and thus may be a suitable 3D printing feedstock," she said.

Zander and Molnar are building a mobile recycling facility to enable soldiers to be able to repurpose plastics into feedstocks for 3D printing.

DowDupont to Expand Specialty Products For Packaging & Transportation

A series of investments totaling about $100 million over the next two years by DowDupont, Midland, Mich., is aimed at expanding manufacturing capacity and facility modernization at the Sabine River Works plant in in Orange County, Texas. The plant is to incrementally expand production capacity of specialty materials produced at this site, including Surlyn, Fusabond, Nucrel and Vamac product lines. The company is also evaluating longer-term plans to build a new facility.

The investments will support growth of the Packaging & Specialty Plastics (P&SP) business in the Materials Science division (to be named Dow), as well as the Transportation & Advanced Polymers (T&AP) business of the Specialty Products division (to be named DuPont), The added capacity is expected to come online in several phases starting in 2020 and will enable both divisions to meet growing demand for Surlyn ionomers used in applications like high-end cosmetics packaging; Fusabond ethylene copolymers with anhydride functionality used as coupling agents for applications such as PE/wood composites; Nucrel acid copolymers used as tie layers; and Vamac ethylene acrylic elastomer terpolymers used in high-temperature automotive engine and transmission seals.
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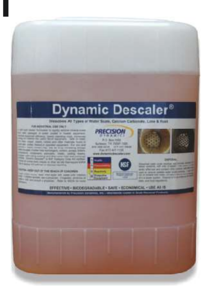

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'Digital Manufacturing' Evolves from Prototyping to 'On-Demand' Short Runs

Protolabs has built a business on speed. Today its "digital manufacturing" model is accelerating from rapid prototypes and first-run production parts to "on-demand" short-run manufacturing.

By Matt Naitove
Executive Editor

It was just a year ago that Protolabs announced that it was upgrading its capabilities for short-run, "on-demand" manufacturing in addition to its well-known rapid injection molding prototyping services. Says Rob Bodor, v.p. and general manager for the Americas, "With a name that suggests 'prototyping' and 'laboratory,' it's a challenge to convince people that you're also a production molding and contract-manufacturing house."

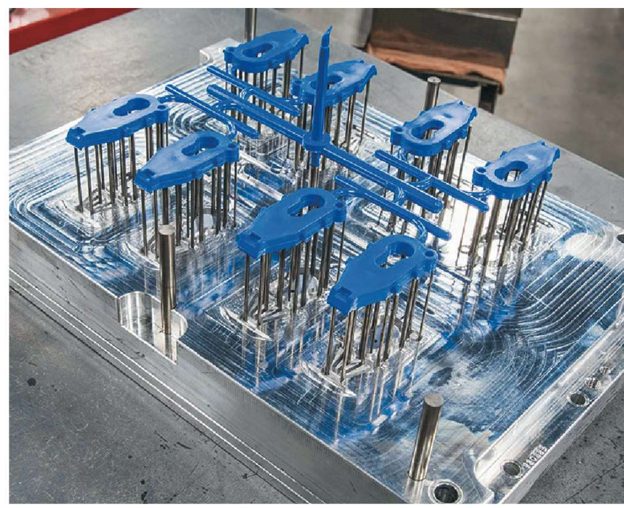
Apparently, Protolabs has met that challenge successfully: According to Bodor, one-demand injection molding of thermoplastics and silicone rubber outpaced its prototyping business for the first time. "Our CNC machining business has become huge, too."

Bodor points out that this evolution in the company's business model was not as abrupt as it might seem. Protolabs had offered short-run manufacturing for some time, but did not actively promote it until last year. Supporting this short-run service, the company outfitted its first metrology lab for enhanced inspection reporting on production parts. This lab has a range of standard inspection equipment, as well as 3D laser scanners that provide an automated 360° look at parts within minutes. "This is what customers had been asking us for," says CEO Vicki Holt.

> *"With on-demand manufacturing, in two weeks from receiving an order, we're ready to ship parts."*

With this enhanced metrology capability, Protolabs now offers a full suite of inspection reports, including conventional first-article inspection (FAI) and PPAP reports required in industries like automotive and aerospace. Also new are digital inspection reports based on laser-scan data, which provide a direct comparison to the original CAD data, including a colored "heat map" to identify dimensional variances.

Other new services related to on-demand manufacturing include guaranteed lifetime maintenance of the mold and customer ownership of the tool.



Protolabs' new push into "on-demand" short-run manufacturing is outpacing its original prototyping business.

ADDING FACILITIES & TECHNOLOGIES

As Bodor points out, Protolabs has been reshaping itself steadily over the last few years. In the last five years alone, he notes, the firm has expanded its range of services from two to 10—including new processes within injection molding and CNC machining, along with five different additive manufacturing (3D printing) technologies, and most recently, sheet-metal fabricating. Also, the company (***protolabs.com***) is exploring the potential of offering not just parts but sub-assemblies and perhaps complete products.

Headquartered in Maple Plain, Minn., the company now has seven production facilities in the U.S., five in Europe, and one in Japan. It has a moldmaking plant in the Minneapolis area that builds 800 to 1000 molds a month and operates two dozen injection presses for sampling and tryout. Protolabs has 110 injection presses in the Twin Cities region available for short-run molding of anywhere from a handful to 10,000 or more parts, and close

to 200 globally, with 33 to more than 500 tons clamp capacity. It has more than 2000 employees worldwide and served more than 37,000 customers last year.

Late last year, Protolabs acquired Rapid Manufacturing Group in Nashua, N.H., a specialist in quick-turn sheet-metal fabrication and CNC machining with a 140,000-ft² plant and 300 employees. And just two months ago, the firm bought a new 152,000-ft² plant in Brooklyn Park, Minn., which will be used primarily for CNC machining and will enable an expansion of injection molding capacity at the Plymouth, Minn., location.

Protolabs uses its proprietary software to design and build aluminum molds with up to eight cavities so quickly that it can supply molded parts in 15 days or less from receiving an order—even in just one day, on special order.

Over the past year, Protolabs has purchased 25 injection machines and more than 75 CNC mills for its U.S. facilities, and another six injection presses and CNC machines for its plant in Telford, UK.

As Bodor explains it, all this activity reflects the company's three-pronged strategy for business expansion:

"We're about lowering the cost of tooling and taking out design risk, supply-chain risk, and the cost of stored inventory."

- Grow revenue by expanding the customer base and deeper penetration with existing customers.
- Enhance capabilities by expanding services.
- Increase the scale of operations.

The expanding range of services offered by Protolabs starts at the front end of product development. "We don't do product design, but we do perform design-for-manufacturability (DFM) analysis," says Bodor, "analyzing factors like cosmetics, mating surfaces, undercuts."

Then comes rapid prototyping, the original core of Protolabs' business. The company uses CNC machining to cut injection molds capable of producing fully functional, production-quality prototypes using the same material as the intended production part. Most molds are aluminum, unless use of higher-temperature resins requires a steel tool. Injection molded parts ship in 15 days or less—orders can be expedited to as little as one day. 3D-printed parts also ship in as little as one day in some cases.

For rapid prototyping, Protolabs also has an 80,000-ft² plant in Cary, N.C., that Bodor says is "the largest contract 3D-printing operation in the U.S." It operates more than 100 3D printers utilizing five different processes for thermoset, thermoplastic, and metal printing: sterelithography (SLA), Polyjet printing, selective laser sintering (SLS), the new Multi Jet Fusion (MJF) process from HP Inc., and direct metal laser sintering (DMLS).

Beyond prototyping, Protolabs offers short-run production capability for injection molded, CNC machined, 3D printed, or sheet-metal parts. This service is aimed at customers who need bridge tooling while they ramp up to high-volume production, who've encountered supply-chain disruptions, who have uncertain demand for a new product, or variable and unpredictable demand for existing products. It also makes it more economical for customers to enter markets with low-volume, tailored products.

Rob Bodor, Protolabs v.p. and general manager of the Americas, sees a natural evolution of quick-turn manufacturing from prototyping to on-demand short-run production.

Above all, it meets the need for speed. "Traditional high-volume manufacturing works well where products don't change much over their life cycle," explains Bodor. "But today's OEMs deal with shorter life cycles, mass customization, SKU proliferation, and shorter windows of opportunity to launch new products."

That's the sweet spot for Protolabs' "on-demand" service. "In two weeks from receiving an order, we're ready to ship parts," says Bodor. "Our injection molds start at $1495, versus $30,000 for a relatively simple conventional tool. We don't do 96 cavities—eight is our maximum. And aluminum tools can be quite durable. We have functioning aluminum molds that are 18 years old. And we will replace a mold at no cost if it wears out during the life of a project." ►

Protolabs has a 77,000-ft² plant devoted to five different 3D printing technologies using thermoset, thermoplastic, and metal materials. Its newest technology, shown here, is HP's Multi Jet Fusion, which is said to be 10 times faster than other 3D-printing processes and to produce parts with properties closer to those of injection molding.

"On demand" means Protolabs has no minimum order volume and no maximum. "We have done runs into the millions of parts," notes Bodor. "In fact, we run millions of injection molded parts a month—three million a month in the Twin Cities area alone. We have many customers for whom we do all their production." These are suppliers of products required in limited volumes--special surgical devices, aerospace products, and other industrial, consumer, and electronic equipment.

Protolabs' short-run manufacturing has somewhat different goals from those of high-volume molders. "We're not so concerned with shaving every second off cycle time," says Bodor. "We're more about lowering the cost of tooling and taking out design risk, supply-chain risk, and the cost of stored inventory."

DIGITAL MANUFACTURING

What makes everything possible in Protolabs' ecosystem is its commitment to "digital manufacturing" as an end-to-end operating philosophy. "We focus on software for automating and digitizing the front end of manufacturing from the CAD file to the first part—increasing the speed and reducing the cost of making that first part." Protolabs, he notes, was started in 1999 by a software developer. It currently employs more than 125 software developers and has "reinvented the wheel" in many respects—creating its own systems for mold simulation and CAM for machining molds.

Protolabs' digital processes produce injection molding quotes in 3-4 hr and 2000-3000 quotes a day.

The digital process starts with the Request for quote (RFQ). When a customer sends in its requirements, Protolabs responds with an online quote within three or four hours (if the quote is for 3D printing, it's instant). The quote includes a 3D rendering of the virtually manufactured product showing potential deviations from the CAD model, based on the company's home-grown mold simulation. Interactive screens allow the customer to adjust parameters such as critical tolerances, and see those changes reflected instantly in the project pricing. Protolabs produces 3000-4000 digital quotes in a typical day.

From the CAD file (Protolabs accepts all major formats), the next steps are to precalculate all the steps to manufacturing—virtually making the product, as Bodor puts it. Protolabs uses its custom software to determine how to orient the part in the mold, where the parting line should be, the overall size of the mold, the need for any inserts or cams, and design of the ejector system, followed by choice of end mills to use in machining, tool paths, and 3D geometry development. "It's an integrated digital manufacturing process, not something you can buy commercially," says Bodor, noting that the company's software runs on large parallel-computing clusters.

"With these capabilities," Bodor says, "medical-device customers, for example, can ask us to produce eight to 10 competing designs, build 10 molds simultaneously, and mold hundreds of each part variety—all in a few weeks. We can do a whole production run in less time than an average molder takes to set up a new mold and get its first good parts."

3D printing is the epitome of digital manufacturing, since the process goes directly from digital file to physical part. The potential for 3D printing to go beyond prototyping to short-run production is still being explored. Last year, Protolabs became one of the first few firms to adopt HP's Multi Jet Fusion process (see Sept.'17 Close-Up). Protolabs has three MJF machines.

At *Plastics Technology*'s Molding 2018 Conference in February, Jeff Schipper, Protolabs' director of special operations, said this MJF technology is especially promising because it uses production-grade thermoplastic materials, delivers durable parts with properties closer to those of injection molded parts than with other 3D processes, and can print parts incorporating multiple colors and durometers. Although HP is eagerly promoting MJF as an alternative to injection molding for runs of 10,000 or even 100,000 parts, Protolabs is taking a wait-and-see position on that potential. "We haven't seen cannibalization of injection molding by 3D printing yet," says Schipper.

Materials Innovations for Film, Molding & Automotive

Highlights of the SPE Polyolefins Conference included a 'game-changing' LLDPE family, and new stabilizers and other additives for film extrusion and all types of molding.

By Lilli Manolis Sherman, *Senior Editor*

A variety of new developments in materials, additives, and processing were dominant themes at SPE's International Polyolefins 2018 conference, held in Houston in late February. There were over 700 attendees at what's said to be the world's largest polymer conference dedicated to polyolefins. There were 67 technical papers, five keynote plenary talks that addressed major industry trends, and 64 exhibitors.

Among the highlights is a unique family of LLDPE that can rival mLLDPE in flexible films, three new polyolefin stabilization systems, a new halogen-free flame retardant for a range of polyolefin formulations, advances in clarifying blow molded bottles, and new mineral fillers for demanding automotive TPO components.

The world's largest polymer conference dedicated to polyolefins featured 67 technical papers and five keynote plenary talks addressing major industry trends.

'GAME-CHANGING' LLDPE FOR FILM

Austria's Borealis Group (U.S. office in Port Murray, N.J.) unveiled a new family of high-performance LLDPE resins that offer performance similar to metallocene LLDPE (mLLDPE) in the flexible film arena—but with some advantages (***borealisgroup.com***). Produced with the company's proprietary Borstar bimodal technology—two-reactor systems using two comonomers and a new "smart" catalyst—the new Anteo family is a new generation of high-purity and transparent Borstar Bimodal Terpolymers (BBT). Until now, Borstar technology did not deliver highly transparent sealing materials, according to Maurits van Tol, senior v.p. of innovation & technology.

Tested and confirmed by over 100 customers, Borealis's new Anteo LLDPE offers wide-ranging benefits for packaging films.

Tested and confirmed by more than 100 customers, the overall performance of Anteo is said to exceed that of existing mLLDPE sealants, making Anteo a better option for a sealing material and for other flexible films where a boost in mechanical performance is needed. Anteo's attributes are said to include:

- Easy processability at lower extruder pressure—over 15% less than with conventional mLLDPE sealants.
- Improved sealing integrity and sealing speeds when used in laminated/non-laminated film, resulting in lower energy consumption and less material waste.
- Wider sealing window, lower seal-initiation temperature, and better hot-tack performance.
- Strong optics for enhanced shelf appeal.
- A step change in puncture resistance.

The Anteo family reportedly opens a range of opportunities in packaging—including frozen foods, pet foods, detergents, and personal-care products. Applications include laminates, stand-up pouches, heavy-duty shipping sacks, and stretch hoods.

Borealis's new Anteo LLDPE is said to outperform existing mLLDPE sealant products.

NEW STABILIZATION SYSTEMS

A newly patented family of blended antioxidant products with a new mode of pH-control technology for PP was discussed by Addivant, Danbury, Conn. (*addivant.com*). Warren Ebenezer, research manager for polymer applications, said the company now has powder-free NDB (No Dust Blend) additive packages with and without calcium stearate. All have full FDA compliance and are said to provide processors with unparalleled control over color and melt-flow rate. "Our new pH-control technology is being investigated throughout the polymer arena and is showing promise in many additional areas such as PE, engineering polymers and elastomers. We believe that this concept will reset the baseline performance demanded by polymer compounders."

Dover Chemical, Dover, Ohio (*doverchem.com*) presented the latest findings on its new class of liquid polymeric phosphite antioxidants—used primarily as process stabilizers in polyolefins. A proprietary, high-molecular-weight liquid phosphite, Doverphos LGP-11, has been shown to be an excellent replacement for workhorse phosphite TNPP, particularly for polyolefin packaging, where purity is an issue. LGP-11 contains no alkyphenols, has low migration, and displays excellent color performance, compatibility, and hydrolytic stability, Dover says.

In addition to providing melt-process stability, initial color and color hold, reduction of gels during film processing, and maintenance of mechanical and physical properties during long-term heat aging, LGP-11's unique chemistry and high MW are said to provide additional benefits during and after processing and post processing. These include excellent gas-fade performance during NOx exposure and heat aging, typically contributed by hindered phenolic antioxidants.

Dover researchers have found such color issues can be solved with blends of LGP-11 and Vitamin E—the latter replacing the hindered phenolic antioxidant at much lower levels in LLDPE. LGP-11 was shown to improve initial color, protecting the Vitamin E from over-oxidation and resulting in little color increase upon aging.

Songwon's new developmental UV stabilizer systems are specifically designed for rotomolding.

Gamma irradiation sterilization performance is also improved as has been shown in PP containers for medical devices, bottles and syringes. Because it does not contain alkyl-phenols, LGP-11 does not decompose as do other phosphites, and does not discolor under gamma-radiation sterilization.

Improvements in melt fracture reportedly are also achieved with LGP-11, which has been found to act synergistically with fluoropolymer-based process aids (PPAs). LGP-11 has been shown to reduce the time it takes the PPA to coat the die, allows the extruder to operate at higher speeds before producing melt fracture, and allows lower PPA use levels.

Songwon International Americas, Friendswood, Texas (*songwonind.com*), reported on two developmental UV stabilizer systems specifically designed for rotomolding. Exp UV 0117 for water and chemical tanks and Exp UV 0217 for bulk containers are synergistic blends of HALS (hindered amine light stabilizer) and a UVA (UV absorber). They reportedly cover a broad range of UV requirements (UV-8 and UV-16 rating) and offer excellent performance in unpigmented LLDPE. Low color after rotomolding and low volatility, good extraction resistance, and contribution to long-term thermal stability are also claimed. The company aims to commercialize these new stabilizers by midyear.

Solvay Technology Solutions, formerly Cytec (U.S. office in Saddle Brook, N.J.), introduced a novel UV stabilizer system that boasts outstanding color stability, gloss retention, and low odor, with extremely low contribution of VOCs, and excellent performance in carbon-fiber-reinforced and long-glass-fiber reinforced polyolefins. It targets automotive interior and exterior applications (***solvay.com***).

Solvay's novel UV stabilizer system boasts excellent performance in interior and exterior automotive applications and in highly filled polyolefins.

OTHER NOVEL POLYOLEFIN ADDITIVES

A newly developed nitrogen-phosphorus flame retardant primarily for polyolefins was discussed by Japan's Adeka, represented here by Amfine Chemical Corp., Hopkinsville, Ky. (***amfinechemical.com***). ADK Stab FP-2200S is a white powder with a thermal decomposition temperature above 500 F (260 C). It boasts low heat release and very low smoke release and smoke density, along with very low CO and CO_2 emissions. There are no corrosive gases released, and it forms a homogeneous char layer with closed cell structure.

> ***"Our new pH control technology is being investigated throughout the polymer arena and showing promise in PP, PE, engineering polymers and elastomers."***

Recommended for PP, PE, EVA and other polyolefin compounds, it typically can be used at significantly lower loadings than ATH or MgH, as well as ammonium polyphosphates. It has been shown to result in reduced density of the final compound compared with inorganic and halogen-based flame-retardants.

Milliken Chemical, Spartanburg, S.C. (***millikenchemical.com***), presented its latest advance in clarified PP for blow molding. When the company launched its fourth-generation Millad NX8000E clarifier seven years ago for extrusion blow molding, it found that it could not replicate good results in industrial settings, according to Zach Adams, North American sales manager for plastics additives.

He noted that the clarifier improved the appearance of blow molded bottles significantly compared with traditional clarification. However, Milliken found only moderate improvements when running double-station, fast-output shuttle machines.

While trials are ongoing, Adams discussed how Milliken has been able to overcome these limitations via the synergy between NX8000E clarifier and optimized rheology. In one study, optimizing rheology enables NX 8000E to perform under industrial settings at 376 F (191 C). In yet another case study, optimized rheology vs. standard architecture enabled the clarifier to offer superior visual appearance at a parison temperature of 417 F (214 C).

Adams noted that Milliken has conducted 13 different industrial trials in Europe, with the next one slated in North America. "We have been able to replicate see-through clarity and gloss," adding that all trials used FDA-approved PP grades made with Z-N catalyst and there were no changes in processability of these resins.

Two new high-performance developmental mineral fillers for PP and TPO were discussed by Maz Bolourchi, senior manager for polymer applications at Imerys Performance Additives North America, San Jose, Calif. Both are targeted for automotive applications like under-hood components that require high reinforcement and good CLTE.

EXP-ND127 is a proprietary acicular (needle-shaped) fiber hybrid in the Wollastonite family. In TPO formulations, it enhances stiffness and flow as well as lightweighting. It is recommended for both interior and underhood components. E7542 is a highly delaminated, high-aspect-ratio mica that provides maximum stiffness and CLTE in TPOs, suiting it to underhood components. "The higher the aspect ratio, the better the distribution," noted Bolourchi. He added that both minerals fit in well with the trend in automotive TPO impact requirements for demanding applications to move from -22 to -40 F (-30 to -40 C). PT

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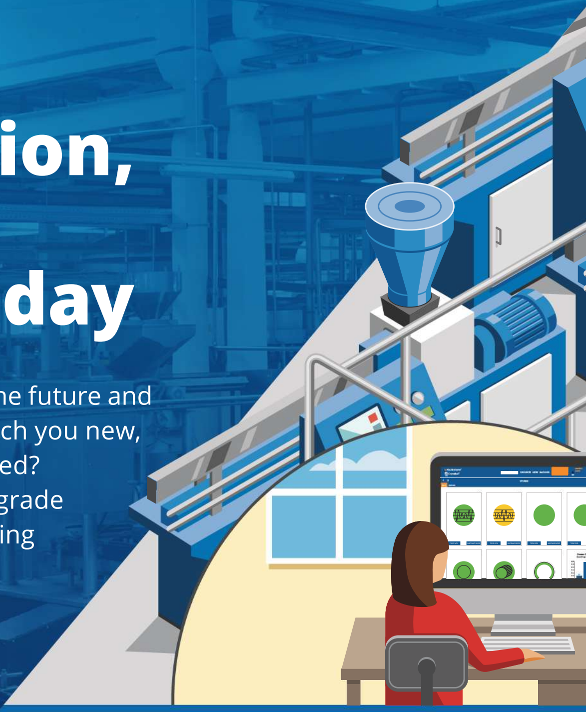

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P&G Explores the Frontiers of Injection Mold-Temperature Control

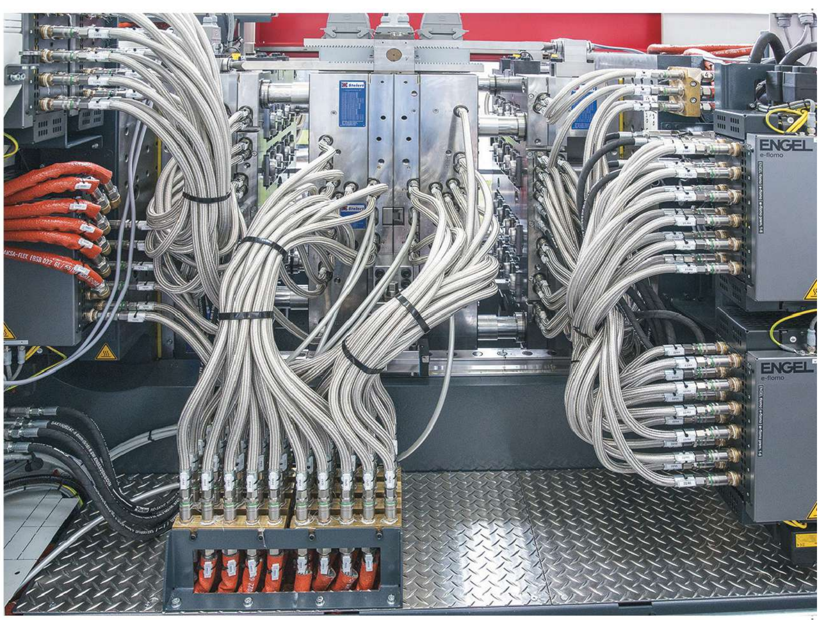
Sharing in development of leading-edge technology for monitoring and control of flow and temperature in each individual mold circuit has given P&G's German operations lower investment costs, decreased energy consumption, and increased product quality.

By Matt Naitove
Executive Editor

In the era of "smart machines" and "smart processes," a number of companies are focusing on one of the last frontiers for getting a firm grip on the injection molding process—mold-temperature control. Two of those companies are Engel Austria (*engelglobal.com*) and Procter & Gamble (P&G) in Marktheidenfeld, Germany, which has collaborated with Engel since 2007 and became a test customer and development partner in mold-temperature control in 2013. P&G thus has been one of the first to benefit from the new trend to providing both greater visibility of what's happening in individual cooling channels inside the mold and direct closed-loop control of cooling at the individual circuit level.

The potential benefits of this trend for injection molders worldwide is enormous. "In injection molding, around 25% of all scrap parts are a result of temperature-control errors," says Klaus Tänzler, temperature-control product manager at Engel. "This is precisely why Engel's development team is working intensively on this topic."

That is also why P&G takes mold-temperature control so seriously. As a healthcare company, P&G has "grayroom" production; all processes are validated, and quality takes top priority in all production areas. Any innovation that enables more consistent processes is generally of great interest to P&G.



Two-face stack mold for electric-toothbrush charger runs 16 + 16 cavities with 56 heating/cooling channels that are dynamically controlled by Engel's e-flomo to maintain constant in/out ΔT in all individual circuits. This cell uses three TCUs (instead of 10 previously) and nine e-flomos mounted on the mold.

OPENING UP THE 'BLACK BOX'

"Temperature control was a black box for us," says Andreas Franz, process engineer at P&G's Marktheidenfeld production plant. For a long time, only the supply temperature was known. To get any more detail on how temperature was distributed over the individual heating/cooling channels during molding, the only option was thermography (an infrared image of the mold or part), a complex process that does not give more than a snapshot (see March '11 feature for details).

As part of a reassessment of mold cooling by several industry firms, Engel (U.S. office in York, Pa.) introduced a step forward at K 2010. Its flomo electronic water manifold system replaced the maintenance-intensive cooling-water distributors with a device using vortex flow sensors that have no moving parts. It can individually monitor and document all cooling and temperature-control circuits.

The next-generation e-flomo, which emerged at Fakuma 2014 and NPE2015 goes another step further by actively adjusting valves to control flow rate or temperature difference (ΔT) in all individual circuits.

Three years ago, P&G's Molding Technology division in Marktheidenfeld started to analyze and optimize its injection mold-temperature control. "Our goal was transparency and with it, increased process reliability," says Christian Rieb, equipment engineer at P&G.

As a safety-related component, the ASA housing of the toothbrush charger places the highest demands on dimensional stability, which requires consistent mold-temperature control.

POM profile rings and tube sections for replacement toothbrush heads, molded in 64 and 32 cavities, respectively. The finger cores for the tube sections require especially careful temperature control to avoid warpage. Addition of e-flomo units permitted cutting seven TCUs down to five and eliminating two pressure boosters.

The Marktheidenfeld plant focuses on oral hygiene and produces Oral B electric toothbrushes. The molding shop has 100 injection machines from 50 to 500 metric tons.

One successful application of Engel's e-flomo was a mold for the housing of the chargers for the hand pieces of electric toothbrushes. This was the first to be investigated by the newly established Temperature Control Project Group at P&G.

The oval base of the ASA housing has a thin dome at top center that holds the hand piece in place when charging. For stabilization, there are small webs on the inside. The fully assembled housing contains all the electronics, including connecting cable, which is embedded in a potting compound. The complex 3D structure of the housing places high demands on precision and process consistency during molding. "Even the tiniest dimensional deviations or incompletely filled areas cause the potting compound to leak out," explains Andreas Spitznagel, who manages the Process Technology Group for P&G in Marktheidenfeld. "In the past, we frequently experienced warpage due to uneven temperature control. But what exactly was causing the fault was difficult to determine because there was simply too little information."

Standing in front of an Engel victory 300 tiebarless press, l. to r.: Andreas Spitznagel, Carmen Stollberger, Christian Rieb from P&G; Klaus Tänzler from Engel Austria; Andreas Franz from P&G; Falk Boost from Engel Germany; Johannes Baunach and Mario Aulbach from P&G.

This mold, with 56 heating/cooling channels, presents a particular challenge and was well suited to test new temperature-control technology. It's a stack mold with a total of 32 cavities in two parting lines. Since the melt is routed through the first parting line to the second, a lot of heat is generated in the center mold plate. Before installing e-flomo, 10 temperature-control units (TCUs) were used—eight small ones on the operator side and two large ones on the rear side of the machine.

In collaboration with Engel, a new production cell was planned and the mold design was optimized for the use of e-flomo. All 56 connections are now arranged on one side of the mold, which speeds mold setup, shortens the piping, and makes it easier to inspect. Now nine e-flomo units are mounted near the mold on the edge of the platens of a tiebarless Engel e-victory 300 press. Each e-flomo supplies several mold circuits.

From dirt, deposits and air bubbles in the mold channels to fluctuations in pump supply pressure, many different factors can disrupt mold-temperature control. If such a condition occurs in the new system, e-flomo detects the irregularity and automatically adjusts the valves to compensate. All 56 circuits are adjusted at the same time. “Reproducibility has increased enormously,” reports P&G’s Franz. “The blindfolds have gone and we have a genuinely transparent process now.”

Improved reliability opens up massive potential savings, not least because of increased confidence in the mold-temperature control. The new production cell uses just three TCUs instead of the 10 previously.

“Temperature control was a black box for us. The blindfolds have gone and we have a genuinely transparent process now.”

Each mold plate now has its own TCU, and all three units fit under the clamp of the machine, saving space.

The initial temperature of all three TCUs is currently set to 55 C (131 F). Initially, three-quarters of the 200 l/min flow rate available on each TCU was used, as in the past, but P&G found it could cut the flow rate to 40 l/min during the course of system validation—a startling 73% reduction. “This is significantly less than we expected, says Rieb. “At the start of the project, it was not clear to us that we could save so much in addition to the increased transparency and reliability.” Fewer TCUs, and lower flow rates mean lower investment costs, more compact cell layout, and—above all—significant savings in energy consumption.

Similar success was experienced in a second production cell where temperature-control overhead was reduced while also increasing product consistency. Another Engel tiebarless victory 300 machine molds two parts for replacement toothbrush heads. Profile rings of POM (acetal) are produced in a 64-cavity mold, and tube sections of POM are produced in 32 cavities. The flow temperature is 90 C (194 F) in each case. Again, high dimensional accuracy is essential to ensure the functional capability of the toothbrushes. “Temperature control of the long finger cores forming the tube sections is critical, above all," says Carmen Stollberger, process engineer in the Temperature Control Technology Team. "If the cores are too hot, distortion can occur. In general, the circuits close to the cavity have a greater influence on the product quality than those farther inside the mold."

Before optimization, this cell was operated with seven TCUs plus two pressure boosters. Now, with e-flomo, there are only five TCUs, without any pressure boosters. "If everything is functioning optimally and is well monitored, you can venture closer to the limits without needing a safety buffer," comments Stollberger. Theoretically, even fewer TCUs could be sufficient for this application, but the project team divided the mold into five temperature-control zones, some of which are set to different supply temperatures.

CHECK THE PROCESS, NOT THE PRODUCTS

P&G is training process engineers from other plants to use the new system. "Our goal is to successively retrofit the legacy systems," says Rieb.

After its success with e-flomo, P&G is taking the next step and using Engel's iQ flow control software to integrate mold-temperature control into the machine controller. This software was introduced at K 2016 and is seeing its launch in North America at NPE2015 this month. The software networks the TCU, e-flomo, and injection machine to create a single unit, and it controls the TCU pump-motor speed on demand, thus further boosting energy efficiency. Integration also improves clarity: Engel's CC300 injection machine controller displays the actual values for all temperature-control circuits in a complete overview. Changes or errors can be detected at a glance.

"We are working on the assumption that we will no longer test the parts in the future, but just the processes."

A key element of this system is the new e-temp TCU with variable-speed pump, created for Engel by HB-Therm in Switzerland. The first set of e-temp units is being commissioned in production by P&G.

For the connection between e-temp and the CC300, Engel relies on the OPC-UA communication protocol that is becoming increasingly popular in plastics for networking injection machines, sensors, and peripherals, and is an important component of the Engel's emerging Industry 4.0 platform, which it calls inject 4.0. This platform is designed to help clients pave the way to the "smart factory" with continuously self-optimizing processes aided by smart systems such as iQ flow control.

"We are working on the assumption that we will no longer test the parts in the future, but just the processes," says P&G's Spitznagel. "This is our goal: Stable processes that we can rely on 100%." PT

MATERIALS

PART 5

A Processor's Most Important Job

Using a mold temperature above a polymer's Tg ensures a degree of crystallinity high enough to provide for dimensional stability, even if the part must be used at elevated temperatures. But POM is an exception. Why?

By Mike Sepe

Three commonly used semi-crystalline polymers, polyethylene, polypropylene, and acetal—more commonly referred to these days as polyoxymethylene (POM)—have glass-transition temperatures below room temperature. This means they continue to crystallize even when they have cooled to room temperature. Processors who have had to mold parts in these materials to close tolerances have experienced this continued crystallization as a prolonged period over which the molded part continues to shrink.

Most of the time a molded part will cool to room temperature and become dimensionally stable within 30-90 min, depending upon the polymer, the wall thickness of the part, and the dimension being measured. But in these three materials, dimensional changes can continue for 24-48 hr. This continued shrinkage is physical evidence that crystallization is continuing.

Fortunately, most parts reach stable dimensions within this extended time. However, if the mechanical properties of the polymer are measured, a progressive change in strength, modulus and impact resistance will be observed that can continue for weeks. One of my clients reported that when they shipped parts fabricated in POM on a just-in-time basis, they would get complaints that the parts did not "feel stiff enough." They did not receive these complaints on parts that had been in the warehouse for several weeks before being shipped. This behavior is particularly troublesome in POM because of the need for dimensional precision and stable properties in functional parts such as gears. The problem becomes magnified if the part must operate at an elevated temperature, since this will promote even more post-mold shrinkage.

Previously we discussed a principle that employing a mold temperature above the glass-transition temperature (T_g) of the polymer ensures a degree of crystallinity high enough to provide ►

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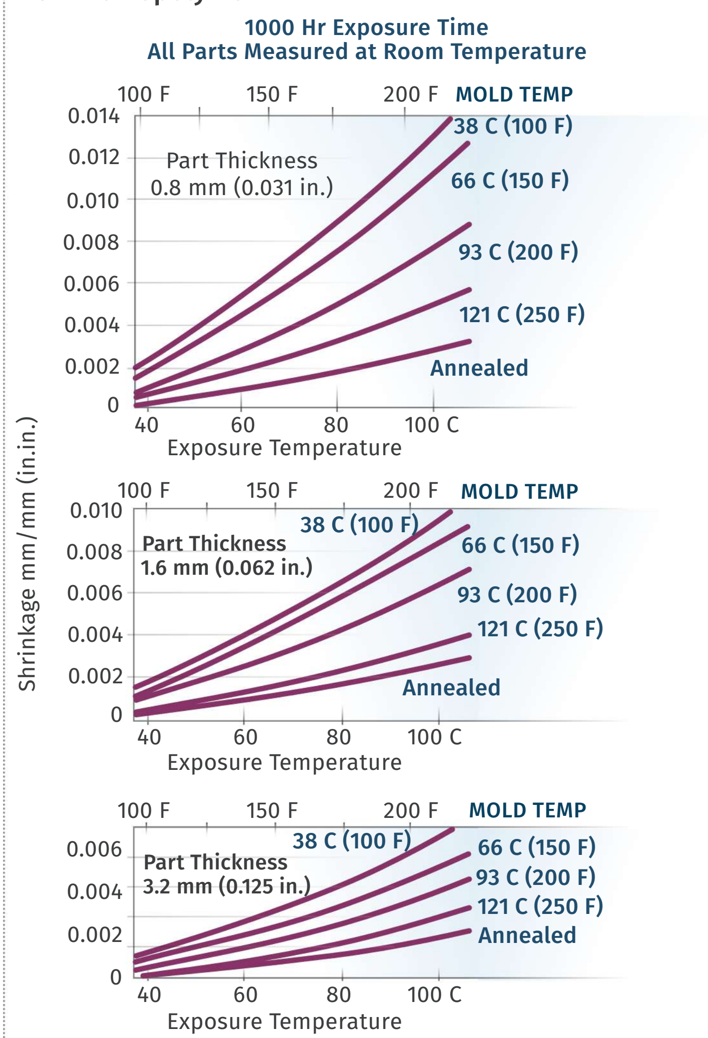
FIG 1 **Long-Term Dimensional Stability of POM Homopolymer**



With POM, there is a complex relationship between mold temperature, part wall thickness, and post-mold dimensional changes at various application temperatures. These three graphs plot the relationship between the application temperature and subsequent post-mold shrinkage that may occur as a function of the mold temperature used when the parts were produced. (Source: DuPont)

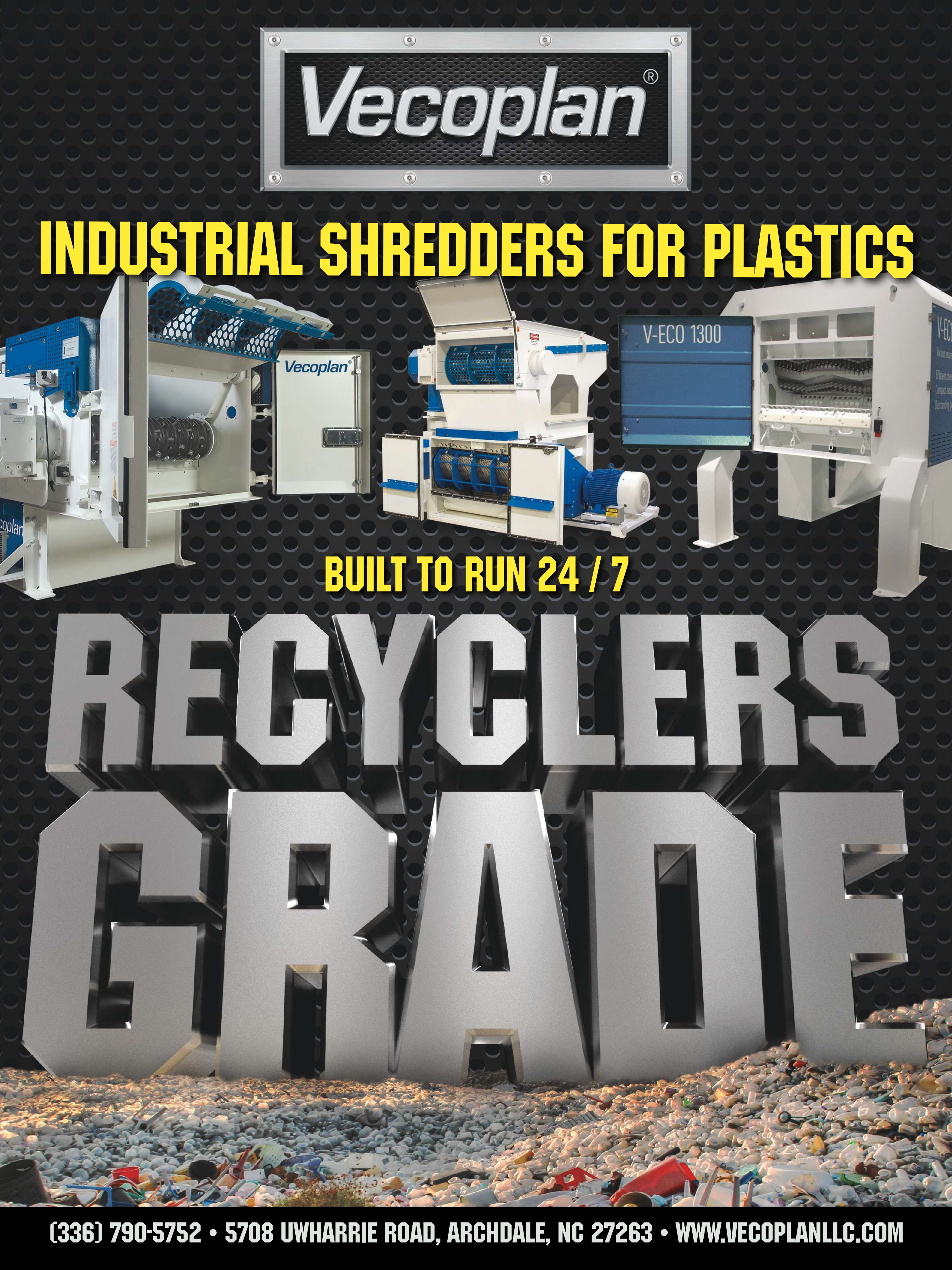

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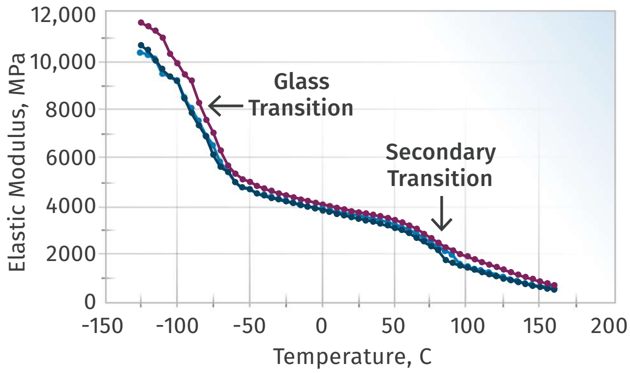
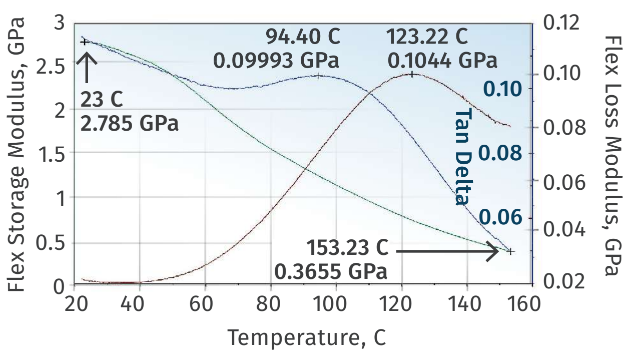
FIG 2 Plots of Elastic Modulus for POM Copolymers



Plots of elastic modulus vs. temperature for three different samples of POM. The scans begin at -125 C (-193 F) so that the glass transition can be observed.

FIG 3 Plot of Viscoelastic Properties for POM Highlighting Secondary Transition



An expanded view of the secondary transition shown in Fig. 2, plotting a more complete set of viscoelastic properties to highlight the area of importance

for dimensional stability, even if the part must be used at elevated temperatures. But this rule appears to break down when it comes to POM. The T_g of POM is near -80 C (-121 F). Therefore, running even chilled water through a mold should be sufficient to ensure adequate crystallinity. But the suppliers of these materials recommend use of relatively high mold temperatures: 80-85 C (176-185 F) for copolymers and 90-95 C (194-203 F) for homopolymers. The design and processing guides from the resin suppliers have treated this subject in great detail to quantify the complex relationship between mold temperature, part wall thickness, and post-mold dimensional changes at various application temperatures.

Figure 1 shows such a review for POM homopolymer provided by DuPont, which invented the material in 1960. The three graphs plot the relationship between the application temperature and subsequent post-mold shrinkage that may occur as a function of the mold temperature used when the parts were produced. This relationship is shown for three different wall thicknesses; 0.8 mm (1/32 in.), 1.6 mm (1/16 in.), and 3.2 mm (1/8 in.).

The thickest wall provides the greatest degree of dimensional stability. At this thickness, if the parts are never exposed to conditions above room temperature, then the subsequent dimensional change is 0.001 in./in. if the part is molded at 38 C (100 F). As the mold temperature increases, this post-mold change drops essentially to zero when the mold temperature reaches 121 C (250 F). However, if the part is exposed to elevated temperatures, the dimensional change due to post-mold shrinkage increases significantly. For the part molded at 38 C, exposure to an application environment of 100 C results in a dimensional change of 0.007 in./in. Even at a mold temperature of 121 C the change will be 0.002 in./in. But it is apparent that the higher mold temperature minimizes dimensional changes that may occur due to solid-state crystallization.

As the nominal wall becomes thinner, this effect is magnified. By the time we reach the thinnest wall of 0.8 mm, the dimensional change for a part molded at 38 C and then exposed to 100 C has doubled to 0.014 in./in., while the 3.2-mm-thick part using a mold temperature of 121 C reduces this change to 0.004 in./in. This is due to the faster cooling rate of the thin wall. Plastics are relatively poor conductors of heat. In the thicker wall, the core sections are farther from the molding surface and are insulated by the frozen layer that forms. This reduces the cooling rate and increases the degree of crystallization that can occur.

It is quite clear from these data that a mold temperature far above the glass-transition temperature is needed to establish a stable crystalline structure in this material. And yet very little is said about the fact that the behavior of POM does not follow this rule, nor is there any discussion about the reason for this departure from what is otherwise a reliable guideline for achieving optimal levels of crystallinity in semi-crystalline polymers. However, if we closely examine the temperature-dependent behavior of POM, we may find a clue as to the reason for this unusual behavior.

When one molder shipped POM parts on a just-in-time basis they would get complaints that the parts did not "feel stiff enough." But not on parts that had been in the warehouse for several weeks before shipping.

Figure 2 shows plots of elastic modulus vs. temperature for three different samples of POM. The scans begin at -125 C (-193 F) so that the glass transition can be observed. The large decline in modulus that concludes at approximately -70 C (-94 F) is due to the glass transition of the polymer. A close examination of these curves also shows a much smaller step transition in these samples that occurs near 80 C.

Figure 3 provides an expanded view of this transition, plotting a more complete set of viscoelastic properties to highlight the area of importance. In particular, the property known as the loss modulus, which exhibits a peak associated with important transitions, shows a maximum just below 95 C. The related tan delta peak occurs at 123 C (253 F). This places us squarely in the recommended range of mold temperatures for producing dimensionally stable POM parts.

The importance of paying attention to the advice from the material suppliers on this matter is not to be taken lightly and it can be easily demonstrated by simply measuring dimensions on a molded part, placing the parts in an oven at an elevated temperature that may be related to the application environment, and then re-measuring the dimensions after the parts have been removed from the oven and cooled back to room temperature. The more stable the structure in the polymer, the smaller the dimensional change of the molded part will be and the more likely it is to perform as expected. Large dimensional changes indicate that the molding process has failed to achieve the desired structure.

Some years ago, I worked with a client who was molding assemblies that involved two POM homopolymer parts that were in relative motion during operation. The mold temperature being used was 60 C (140 F) and the parts performed satisfactorily as molded. However, the end user knew that the parts might be exposed to application temperatures as high as 85 C (185 F). Therefore, they tested the assemblies by heating them to 85 C for eight hours. They then cooled them back to room temperature and re-tested the assemblies. After this treatment the parts did not move freely. This problem was solved by simply raising the mold temperature to 99 C (210 F), just as the molding guide instructed.

It is frequently assumed that the additional shrinkage will result in a part that is out of print on the small side. This may be the case if the shrinkage value that the tool was built to is incorrect. However, a very important part of achieving stable dimensions is ensuring a fully packed-out part. Raising the mold temperature also increases the time required for the gate to freeze, thus allowing for a longer pack and hold time that can provide the additional material to the cavity to offset the increased shrinkage brought about by achieving a higher degree of crystallinity.

In our next article we will look at some of the long-term effects of inadequately crystallized material. These effects reduce performance of a part in a way that may not be apparent until the part has been in service for a while. And the practice is unfortunately encouraged by some suppliers of these high-performance materials.

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INJECTION MOLDING

A Practical Approach to Calculating Residence Time

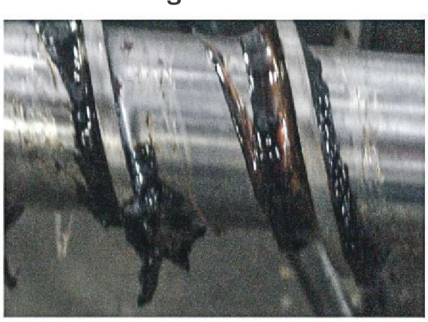
Toss the formulas. The best way to determine residence time is to conduct a simple experiment.

By John Bozzelli

During the introduction to my seminars, I often present this definition of injection molding developed by legendary consultant and Plastics Hall of Famer Glenn Beall: "Injection molding is a jungle of disconnected facts and fairy tales." The fairy-tale aspect is true for many residence-time calculations that are bantered about in our industry. Unfortunately, the cynic in me—when I shift to Crusty Sr. mode—looks at them with more than a little suspicion. They look good and follow reasonable logic, but yet do not cut it when you want good data. So, how do I find out the true residence time?

This is where the "Scientific" in Scientific Molding comes in. You do an experiment to get "Scientific" data—data that should verify a formula that appears to cover the bases. Most of the formulas used to calculate residence time are based on barrel capacity, percent of the barrel used, cycle time, etc. All logical, but if you spend some real time on and around an injection molding machine, especially when a screw is pulled, you notice there are issues that these formulas do not take into consideration.

FIG 1 Degraded Material At Base of Flights



Clear resin shows significant degradation as a result of getting hung up on a dead spot in the screw for too long.

Several were covered in an Extrusion Know-How column Jim Frankland wrote ("Dead Screw Talking") in July 2011. True, he deals with extrusion, but like it or not, extrusion people have more savvy on the matter of screw design then most of us molders. For our purpose of finding residence time, it does not matter what type of screw you have, but we will base this on the typical general-purpose (GP) screw. Frankland calls GP screws "no-purpose" screws. While I agree, and I don't recommend using one, in reality such designs are the most common in molding. For a 20:1 length-to-diameter (L/D) GP screw, this means 10 flights of feed, five flights of transition or compression, and five flights of metering. A 20:1 L/D is my recommended minimum L/D for molding.

> ***Residence time at high temperatures causes polymer degradation.***

The concept is that the resin pellets enter through the feed throat and travel through the feed, transition and metering sections, passing from one flight to the next. But inspection of used screws reveals that there is more to the story. In particular, focus on the hangup or "dead space" at the base of the flights, both the front and the back sides.

Figures 1 and 2 provide examples. Figure 1 shows significant degradation of a clear resin. How did this material "hang up" or remain too long in the dead spaces of the flights? Residence time at high temperatures causes polymer degradation. Figure 2 shows a red resin clinging to the screw flight. This red material "hung up" for over a month as this machine was switched to black and ran only black for the next month before the screw was pulled for cleaning.

At first, this molder insisted the plant *only* ran black, never any other color. The screw tells a different tale (as did the molder's manufacturing supervisor upon further reflection). Seems that they had a short run of red a month earlier. Bottom line: Screws have "dead spaces" where material can get trapped for significant periods of time. Hence the frequent "carbon showers" we all have tried in vain to purge out. Such trapped resin is seen nearly 90% of the time with injection molding screws when pulled for service,

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FIG 2 Red Material 'Hangup' On Flights

Though this molder had run only black for months, traces of red from a short prior run had clung to a dead spot on the screw flights.

especially those that have not been cleaned for months. So, what has this got to do with residence time?

It forces one to put a fudge factor into the equations that calculate residence time. How long does it take for the resin to move from one flight to another? It is anybody's guess, and that throws out the formulas or equations. What is left to find residence time?

As mentioned earlier, an experiment! One that will provide you with a more realistic residence time. With the machine running on cycle allow the existing resin to run until you can see the flights of the feed section. Carefully move the hopper off the feed throat. Please do not look down into the feed throat without goggles—better yet, use a highly polished metal mirror and a flashlight to watch until you can see a couple of flights are empty. The entire feed section does not have to be empty, just the flights visible as the screw turns.

As soon as these rear feed flights are empty, drop in a few different colored granules of the same resin followed by the normal original resin (move the hopper back). Immediately start counting shots, keeping track until the different color appears *and* purges out. That is, keep counting shots until the different color is gone and only the original resin color is in the parts. Now get the calculator and multiply the number of shots times the cycle time.

Bottom line: *measure* the residence, toss the formulas. Check it out for yourself. I'm pretty sure I will get some arguments about stopping as soon as you see the different color but give the purge-out time some thought. Also, take note on how the new color appears in the parts. It should be a pastel of the mixed colors. Any swirls, streaks, etc. and you have just proven you do not have melt uniformity. Then it will be time to consider problems with the GP screw design. PT

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EXTRUSION

Barrier Screws: Metering Section or Not?

A barrier screw without a metering section can reduce output and increase melt temperature.

By Jim Frankland

A balanced design is required to get the best performance from a barrier screw. Barrier screws typically have three or four distinct sections that have somewhat different function, with each section balanced in relation to the others.

First is the solids-feeding section, followed by a compression or melting section, and then a metering section. The metering section is meant to stabilize the output and develop pressure to overcome the resistance of the die and downstream apparatus. Sometimes a fourth section (for mixing) is included in the design.

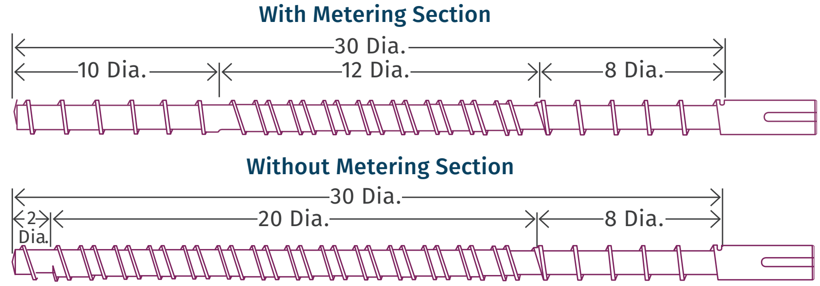
Some barrier-screw designs have little or no metering section. Instead, they are designed with a very long barrier section often followed by a mixer. That means the barrier section must assume the functions of the metering section as well. Using the barrier section to do this is inefficient if there is significant head pressure, particularly if processing a low-viscosity polymer. The barrier section is designed so that the melt passes over the barrier clearance and accumulates in a deep, narrow "melt channel." The deep, narrow channel is necessary to meet the volume requirement to carry most if not all the melt forward, and the narrow width minimizes additional shear heating of the already melted polymer.

However, deep, narrow channels do not develop much pressure. In the event of substantial head pressure, these channels will have a large portion of backward flow (or pressure flow) that subtracts from the forward or drag flow, thereby reducing the net output. Moreover, the pressure flow results in repeated shear heating of the backflowing polymer and an overall higher melt temperature. Of course, this won't be a problem if there is a very low head pressure and/or if the extruder is equipped with a melt pump. Under those conditions, the requirement for pressure development in the metering section is largely eliminated, but stability may still be affected.

The accompanying illustration compares two barrier-screw designs that have identical dimensions except for the length of the barrier section. In a computer simulation, the screw with the longer barrier section (no metering section) has 9-10% less output at 100 rpm and 3500 psi head pressure with a 5 MFI PP copolymer. The melt temperature is also higher; the backflow and the pressure stability exiting the screw has more variation because the discharge pressure from the solids and melt channels differ. The metering section provides a damping effect to stabilize any pressure variations coming from the barrier section. There can also be disadvantages in melting with too long a barrier section.

Any barrier-screw design—or any screw design for that matter—must be suited to the particular requirements of its application. One of those is the head pressure against which the screw will have to work. A barrier screw without any metering section compares well to one with a metering section at 500 psi head pressure, with the exception of stability. This will vary with melt temperature, polymer type and barrier screw design. I just did some extensive tests on a heavily-filled material and, when varying the head pressure with a valve, saw a drop in output of more than 15% at 3500 psi vs. a similar screw with an eight-turn metering section, which had only a 3-4% drop. If you use a melt pump, there is not much difference with or without metering, as the pressure is seldom above 1000 psi. But with this material, a melt pump was not an option.

Barrier Screws With & Without Metering Section



These barrier screws have identical dimensions except for the length of the barrier section. The design on the bottom has a screw with a longer barrier section (no metering section).

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

PART 1

Clamp Pressure and Cavity Land Area

What you need to know to prevent flashing and mold damage.

Bad things can happen when one tiebar is tighter than the others.

By Jim Fattori

You sample a brand-new two-plate, cold-runner mold and the part flashes. You know exactly how much peak injection pressure it took to fill the part. You divided that value by the projected area, which includes both the cavity and the runner areas, to determine the clamp force required to keep the parting line tightly closed. The math says you have enough—but you don't.

What's really puzzling is, you know that for this type of mold, there is a very large safety factor built in by taking the peak injection pressure and dividing it by the total projected area. It should take considerably less tonnage to keep the mold closed than the calculated value. There are pressure drops as the material passes through the restrictive machine nozzle tip, the sprue bushing, the runner, and the gates. You are actually using only a portion of the peak injection pressure to fill the cavity, which is where the majority of the projected area is trying to blow the mold open. Additionally, the pressure in the cavity continually decreases as the material flows from the gate toward the end of fill. And knowledgeable molders know it only takes about 3000 psi of plastic pressure at the end of fill to pack out a part. So why is it flashing?

Did you account for all the projected area? For a short period of time, the molten plastic within the cavity acts like hydraulic fluid inside a cylinder. It pushes in all directions—not just parallel with the centerline of the machine. If it's a cam-action mold, a portion of the injection pressure acting on the face of the cam is adding to the forces trying to blow the mold open, especially if the tip of the heel holding the cam in place is interlocked with the opposing side of the mold. Even if a hydraulic cylinder actuates the cam, if there is a heel keeping the cam in position when the mold is closed, a portion of the injection force requires additional clamping force.

This needs to be added to your original estimation of the tonnage required to prevent flashing. I take the projected area pushing against the cam face, multiply it by the sine of the angle of the locking heel, and multiply that by the peak injection pressure. I have seen many molds with very little parting-line projected area that had flashing issues due to a tremendous amount of projected area on the cam faces.

> ***It can take 10% or more of the available clamp force just to get the two mold halves to align.***

There are several potential processing and material-related reasons for a mold to flash, such as injection speed, barrel temperature, residence time, mold temperature, material viscosity and material additives, such as lubricants. But unless they are excessive, these are not always the primary suspects.

The focus of this column will be on the molding machine and the mold, as they relate to clamp pressure and mold flashing. Ideally, you want a mold to run in the smallest machine possible because the hourly rate of a molding machine is based on its clamp tonnage. Some molds, due to their physical dimensions or required shot size, cannot be installed in a smaller machine. But many molds can. The issue then becomes, will there be enough clamp tonnage to keep the mold closed and prevent flash from developing on the part, without having to process around it?

To begin with, a molding machine's hydraulic piston or toggle mechanism cannot generate any force against a mold without being constrained by the tiebars. Just like a threaded bolt, tiebars stretch

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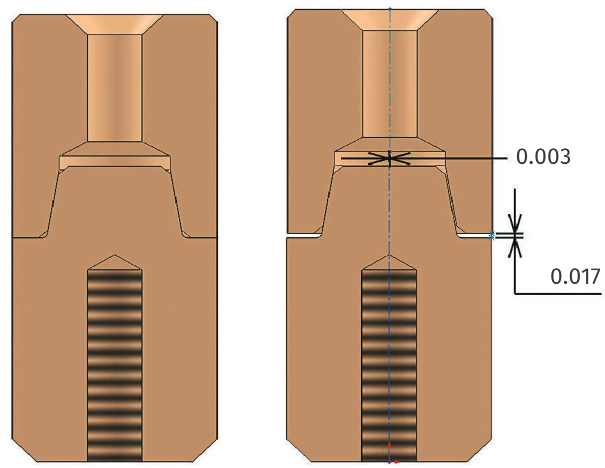
I once read that it can take 10% or more of the available clamp force just to get the two mold halves to align. A worn platen, worn tiebar bushings, improperly adjusted moving-platen support feet, a machine that's not level, and uneven tiebars can cause the mold halves not to be parallel, especially if the mold is heavy relative to the size of the machine. In severe cases, the moving platen can tilt on an angle large enough to cause leader pins to hit their bushings lightly when the molds close. So it makes sense that some amount of force is required just to align the mold halves.

Conical interlocks are notorious for thermal misalignment issues.

If the mold is fairly large and you are using different cooling temperatures on the injection and ejection sides (typically to prevent a part from sticking), some types of interlocks will try to prevent the mold from closing. The difference in thermal expansion of each mold half will cause the interlocks to be misaligned. When the mold closes, the clamp will try to re-align them—and that takes force. For the sake of example, say the interlocks are 24 in. apart and the temperature differential (ΔT) of one mold half vs. the other is 40° F:

$$24 \text{ in.} \times 40° \times 6.3 \times 10^{-6} \text{ (in./in.-°F)} = 0.006 \text{ in.}$$



Differential temperatures misalign interlocks and can prevent the parting line from closing.

Conical interlocks are notorious for thermal misalignment issues, especially if they are preloaded. Bar interlocks are even worse if they are installed in a direction that does not allow for thermal expansion and contraction.

Assuming the machine, process parameters and material aren't the cause of the flashing, the next thing to do is "blue off" the mold inside the press using Engineer's Blue. Engineer's Blue is a mixture of Prussian Blue pigment and an oily material, such as grease. It's nontoxic, highly pigmented and non-drying. Engineer's Blue is also known as Machinist's Blue, Scraping Blue, High Spot Blue, or (technically incorrectly), Prussian Blue, or simply Blue. But don't confuse Engineer's Blue with Layout Blue. Layout Blue is Prussian Blue mixed with methylated spirits to form a quick-drying stain, used when laying out and scribing lines on plates or parts to be machined.

Moldmakers almost always "blue off" a mold during the final assembly and "fitting" stages of mold construction, primarily to check the mold's shutoffs. They typically apply the blue with a paintbrush that has shortened bristles. I prefer to use a fine, closed-cell sponge—the type used to apply makeup. I apply a thin layer completely around the perimeter of the cavity, on the face of the sprue bushing, on top of the return pins, on any shutoff surfaces, on the sides of the interlocks (integral to the cavity or separate components), on the faces and heels of the cams, and especially in all four corners of the mold.

After the blue is applied, the mold is closed on the workbench or in a "spotting press"; pressure is applied, and then the mold is opened and inspected. Areas that had no contact with the opposing half of the mold will only have bluing on the side it was applied to. Areas that had full contact will have very little bluing on both halves, because it was "squished" out. And there will be spotty areas somewhere in between these two conditions. (Note: It's wise to wear latex gloves when applying blue to a mold. This stuff does not want to wash off. Mold cleaner, acetone and most other solvents will take it off—and leave your skin bone dry. There is a water-soluble Machinist's Blue, which is easy to wash off, but I don't think it works as well as the oil-based type.)

Differential temperatures can even cause interlocks to break.

When a mold is mounted in a molding machine, several additional variables come into play that may not show up on a workbench or in a spotting press. The first thing you want to do is quantify how much tonnage it takes to make the mold halves align. Secondly, you want to check for areas other than the perimeter of the cavity that may be hitting excessively hard and robbing you of the clamp force necessary to run in a smaller machine without flashing.

If your machine can be set at a very low clamp force, close the mold at only 5% of the maximum force. Open the mold and inspect the blue. If there's not a uniform impression around the perimeter of the cavity, increase the clamp force incrementally by 5% and repeat the process until it does. That's how much tonnage is required to straighten out the mold halves, and should be subtracted from the total clamp force when calculating the available tonnage to prevent flashing.

Some people suggest using a piece of paper around the perimeter of the part to perform this test. I prefer to use Engineer's Blue. Even though a sheet of paper is only 0.0035-in. thick, any amount of thickness can give you erroneous results. Other people like to use pressure-sensitive film to check all the areas of the mold. The big advantage of using this film is that it turns various colors based on the amount of force it is subjected to—quantifying the amount of force without the need for any special devices. The downside of using this film is that it is not easily applied to contoured surfaces, it's 0.0045 in. thick, and it's considerably more expensive than a tube of Engineer's Blue.

The nice thing about performing this alignment test is that it considers all the mold components that are preloaded. Some of these components are cam heels (wedges), angled cavity shutoffs, parting-line or cavity interlocks, support pillars, and coil or urethane springs on the parting line or between a set of mold plates. Except for the springs, it's almost impossible to calculate exactly how much resistive force preloaded components generate. As much as I am in favor of mold-filling simulations, I doubt any of them can account for these preload conditions.

As you progressively increase the clamp force, you will start to see some areas hitting harder than others. That's because they are protruding slightly higher than everything else. Whatever is hitting first becomes the primary bearing surface, which will be subjected to higher clamp force, and will reduce the amount of force around the perimeter or land area of the cavity. Looking at it another way: To close a mold completely, anything that is protruding or is preloaded has to compress, bend, flex, twist or break, or it has to cause something else to do the same.

I have blued off literally hundreds of molds in my career, but never at low clamp pressures to see what was required just to get them aligned. So, I tested a half-dozen molds in machines ranging from 60 tons to 600 tons, and the results were incredibly informative. The lightest molds in the smallest machines took between 5% and 10% of the total clamp force to align the two halves. The heaviest molds in the largest machines took between 10% and 20% to align, and most of them hit at the top of the mold first because the moving platen was slightly tilted.

The real eye-opener for me was the medium-sized molds in medium-sized machines (100 to 300 tons). At 10% to 20% of clamp force, there was a wide variety of areas that blued off first: a sprue bushing, a return pin, an interlock, a corner of the mold base, a corner of a core insert, or the center of the mold (which had a preloaded support pillar). Amazingly, on the molds that had an area or two that hit hard, it took 30%, 40%, even 50% of the available clamp force to get the remaining areas to blue off. Just 0.002 in. or 0.003 in. in the wrong spot was enough to require a significant amount of clamp pressure to seal the perimeter of the cavity in order to avoid flashing.

An alignment test considers all the mold components that are preloaded.

They say that a molded part speaks to a plastics engineer. I can now say without hesitation that a blued-off mold under low clamp pressures speaks even louder.

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By Heather Caliendo,
Senior Editor

Images by Fred Joe Photography

Plastics-to-Oil Recycler Finds New Niche in Polystyrene

Agilyx is in an innovative area of recycling: extracting value from waste plastic streams. The company has expanded to develop the first full-circle chemical recycling of PS.

Because of the dip in the oil market a few years back, Agilyx pivoted to PS recycling, producing styrene monomer for reuse by resin makers.

A lot can happen in 14 years. Agilyx in Tigard, Ore., was founded to develop hydrocarbon recycling technologies that convert mixed plastics to high-quality crude oil (otherwise known as plastics-to-oil). Around 2008, the company's batch pyrolysis technology was commercialized, and by 2012, Agilyx synthetic crude oil became a U.S.-registered synthetic chemical. Agilyx went on to produce and sell more than 800,000 gal of oil from waste plastics.

> ***"We know how to take waste plastic to make high-quality crude oil, and we had a 'eureka' moment."***

However, when oil prices plunged, this impacted energy-dependent companies, including Agilyx, and the low oil prices forced the company to make a shift. As a result, it found a new opportunity: Agilyx expanded its technology platform by developing what's reportedly the first circular chemical-recycling system capable of converting waste polystyrene back into styrene monomer.

The company began testing different plastic streams on its pyrolysis unit that was previously used to produce the plastics-to-oil and eventually settled on PS. Joe Vaillancourt, CEO of Agilyx (*agilyx.com*), says PS is a distinct polymer with a high need for recycling, and that focusing specifically on the material is less complicated than working with lots of different plastics.

"We have a fantastic technology. We know how to take waste plastic to make high-quality crude oil, and we had a 'eureka' moment," says Brian Moe, v.p. of operations.

Polystyrene lately has developed a bad reputation in the public eye for being perceived as unrecyclable. Even though some PS is recycled, it's not on a large scale. This is where Agilyx saw the market need.

FINE-TUNING THE PROCESS

"You can't just turn a machine on and put waste plastic in and expect quality output," Vaillancourt says. "There is a significant amount of know-how and chemical testing that must take place."

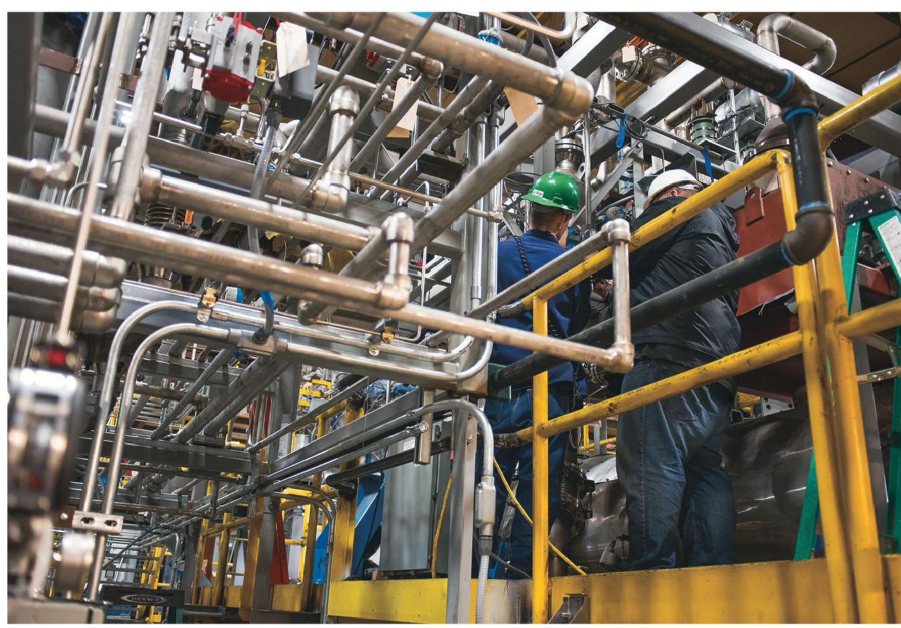
When the company decided to change courses, it retrofitted parts of the Tigard facility that was originally set up for mixed waste and the plastic-to-oil process to instead perform PS-to-styrene-monomer production. While the pyrolysis and front-end systems are the same for mixed-waste plastics and PS, the back-end cleaning trains are different. About 50 "tweaks and enhancements" were made to the company's equipment to be able to convert PS to styrene monomer. In 2016, the company had its first successful styrene run in Tigard.

GATHERING THE MATERIAL

Moe says that for the process to be truly effective, Agilyx needed to go upstream to manage the plastic feedstock itself. Particularly with PS, very few recycling programs allow the material into the recycle stream. "We found by us creating innovation around the supply chain, how we source and pre-process the material allows us to control the output of our product," Moe says.

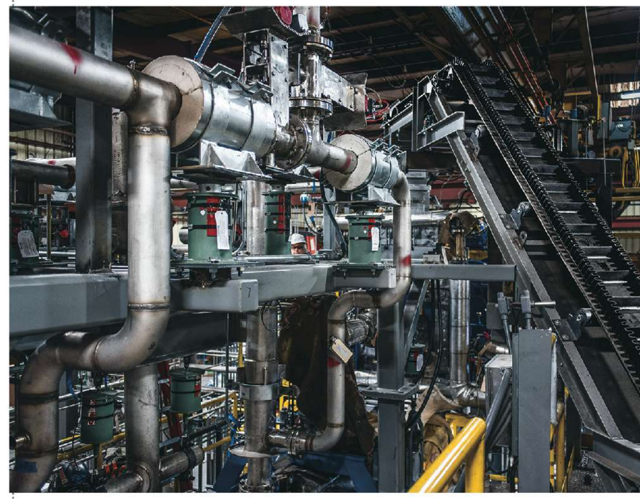
Agilyx can handle all types of foam PS materials, including cups and food containers that might still have residue left on them. The company reached out directly to businesses and the general consumer market to obtain the material. Outside of the Tigard plant is a drop-off bin where consumers can leave their waste polystyrene. Vaillancourt says Portland is the ideal community to launch such an initiative because there's plenty of community engagement and they've had around 100 people a day drop material off.

Agilyx worked with local supermarket chain Fred Meyer to launch a pilot program to recycle PS foam from seven of the Fred Meyer stores in the metropolitan Portland area. A company called B-Line, an urban delivery service, agreed to use its fleet of electric-assisted tricycles to collect PS from two of the downtown stores. This is considered an innovative collaboration in which a major store chain works with a "final mile" logistics company to deliver waste PS for recycling.



Agilyx retrofitted parts of the Tigard facility originally set up for mixed waste and the plastic-to-oil process to instead perform PS-to-styrene-monomer production.

Agilyx workers gather PS material that consumers and businesses bring to the facility.



As a result of proprietary technology, Agilyx believes its monomer made from recycled PS is as good as, if not better than, virgin styrene monomer.

"We have lots of people dropping off the material at our facility, and a lot of people have the desire to make sure it gets recycled," Moe says. "We also have partnerships. The good news is there are many people open to cooperate with us to make sure the material ends up in the right place."

Last year, Agilyx received a $50,000 grant from the Foam Recycling Coalition to purchase a densifier, allowing for more recycling of foam PS. Adding a densifier at the front end of the operation will allow for more efficient recycling and processing of the material.

HOW IT WORKS

Once Agilyx receives the material, the firm converts it to liquid styrene through pyrolysis. The liquid styrene is then sent to a styrene refiner, and the refined styrene is shipped to a resin manufacturer. AmSty in The Woodlands, Texas, and Ineos Styrolution, Aurora, Ill., produce PS materials using Agilyx's refined styrene.

"We have lots of people dropping off the material to our facility and a lot of people have the desire to make sure it gets recycled."

"With our product, there are no restrictions since we are creating monomer that's as good as virgin, or in some cases better than virgin. There's no downgrade in the product," Moe says.

Agilyx's plant, which opened in April 2018, became the world's first commercial-scale, closed-loop chemical recycling process for PS. It can recycle up to 10 tons/day of previously unrecoverable polystyrene waste and produce high-quality styrene monomer.

"Chemical recycling and innovative recycling solutions for PS will enable us to reuse collected post-consumer PS waste in our manufacturing processes to produce high-quality virgin PS. This represents a great opportunity to save valuable resources and avoid waste ending up in landfills," says Ricardo Cuetos, v.p. of standard products at Ineos Styrolution America.

HERE TO STAY

Prior to joining Agilyx, Vaillancourt's background included 15 years with Waste Management Inc., and then working with private equity in the energy and industrial sectors, including participating in the financing and commercialization of more than 15 environmental technology companies. He says Agilyx occupies an interesting position between the petrochemical and recycling industries, two areas that don't typically have a lot of crossover.

Agilyx believes its chemical recycling pathway is a true circular and sustainable solution for waste PS and serves as a foundation to pursue other discrete polymer recycling pathways.

"I've been in this industry for a long time—not just plastics recycling—and I think unfortunately there's a huge misunderstanding and lack of education about plastics and recycling," Vaillancourt says. "We use plastics in almost everything we do every day. As long as we work together to do the right thing, the material can be durable for a long time."

And while chemical recycling is still a new industry, he believes it has staying power. "Chemical recycling isn't a small boutique opportunity—it's massive," he says. "It can be as big as the U.S. oil industry, but the only real way it happens is for people to take a proactive participation approach. The recycling behavior is really the key: If people want us to clean up the world, they just have to participate." PT

QUESTIONS ABOUT RECYCLING?
Learn more at PTonline.com
Visit the Recycling Zone.

Getting Started with Medical Molding: First Consider the 'Four E's'

A typical ISO 8 molding cleanroom at Nypro.

Global medical molder Nypro provides first-hand guidance on what you need to get into the medical molding business.

By Stephen Costa,
Nypro, a Jabil Company

The competitive and regulatory demands on medical-device OEMs require them to work with injection molders that can bring the right environment, equipment, engineering materials, and employees to the manufacture of their designs. These "Four E's" encompass important evaluative criteria by which medical-device manufacturers identify and measure with whom they partner among molders and other plastics processors. The criteria under each are defined as follows:

> ***Most, but not all, Class II medical devices are molded or assembled in ISO Class 8 cleanrooms.***

- **Environment:** Includes cleanrooms and non-cleanrooms, and quality and regulatory requirements such as cGMP, ISO 13485, ISO 9001, and lot traceability.
- **Equipment:** Covers injection molding machinery, molds, robotics and assembly automation.
- **Engineering Materials:** Encompasses non-commodity plastics with challenging process requirements. Includes supply lot controls, USP Class VI, BSE/TSE and 10993 compliance.
- **Employees:** Includes highly-skilled people who work with technically advanced molds, equipment and processes supporting complex mold and assembly validations.

The Four E's represent more than evaluative criteria for medical molders. In many ways, they define higher standards for performance that set these molders apart and qualify them for the rigorous demands of medical-device manufacture.

ENVIRONMENT

Like the industry they serve, medical molders operate in a highly regulated, quality-intensive environment that often involves manufacturing products in cleanrooms that require special air-filtration systems. The decision to use a cleanroom depends on the level of air cleanliness—a function of airborne particle sizes and quantities—required during manufacturing.

To ensure air cleanliness, cleanrooms rely on HEPA filters installed in the ceiling, where air enters the room through the ceiling and sweeps down to the base of the walls to exhaust ducts near the floor. The air flow is laminar, top to bottom, and keeps particles from floating in the air, causing contamination.

There are different classifications of cleanrooms, each of which indicates the allowable size and amount of particulate matter in a cubic volume of air. A cleanroom's classification also determines the frequency of complete air changes. In a typical 25,000 ft^2 ISO 8 cleanroom, the entire room volume of air is changed more than 20 times/hr. Of course, HEPA filters need to be replaced and cleanrooms require periodic cleaning. Medical molders operate according to strictly documented procedures that describe these and other requirements.

For instance, employees must follow specific procedures for gowning. Donning is done from top to bottom, starting with a hair/beard net and followed by a coat, pants and shoe covers. A bench separates "clean" and "dirty" sides so that an employee's shoes won't contaminate the floor. Jewelry must be covered or removed completely. Hearing protection, safety glasses and gloves are also mandatory.

Most molding cleanrooms are certified to ISO 8 standards. Nypro's molding cleanrooms are all ISO 8 certified, while its cleanrooms for assembly are ISO 8 or ISO 7—a more-stringent standard. If cleanroom manufacturing is required for a project, the customer's quality specs will indicate the ISO level. In medical molding, it's especially critical to follow written documentation and procedures.

Medical molding machines must be closed-loop systems with precision injection and clamp movement.

When a medical-device designer is unsure whether a molded product requires cleanroom manufacturing, the U.S. Food and Drug Administration's (FDA) device classification can be helpful. For example, Class I medical devices may not require cleanroom molding because they carry the lowest level of risk and must comply with the lowest amount of regulatory control. Examples of these simple devices include elastic bandages, dental floss, floss boxes and toothbrushes.

Class II medical devices have medium complexity but pose a higher risk. Therefore, they carry more stringent regulatory controls to ensure they are safe and effective. Most, but not all, Class II medical devices are molded or assembled in ISO Class 8 cleanrooms. Among the medical parts molded in cleanrooms are asthma inhalers and auto-injector pens. Class II devices that do not require cleanroom manufacture include condoms and pregnancy testing kits.

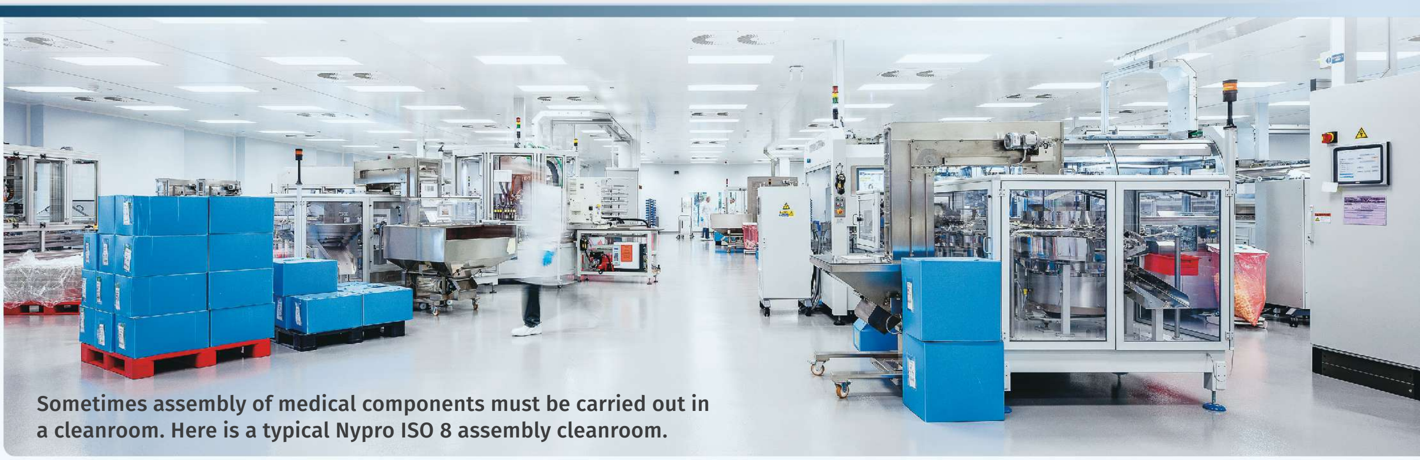
Class III medical devices are the most complex, carry the highest risk and, consequently, impose the most stringent regulatory controls. Examples include implantable pacemakers, continuous glucose monitors, and other implants, all of which are usually molded and assembled in cleanrooms to minimize the potential for contamination from airborne particulate.

Together, the costs and procedures required to maintain these highly regulated and quality-intensive environments can pose a major barrier to entry to medical molding and set the practice apart from conventional industrial molders. Establishing a quality-management system (QMS) to meet FDA requirements for 21 CFR 820 compliance, cGMPs, and ISO 13485 certification is expensive. It may also require hiring additional quality personnel.

Maintaining certifications and compliance can be challenging as well. There are regular audits by ISO registrars, continuous audits by customers, and periodic audits by the FDA. Quality documentation begins at incoming inspection when a certificate of analysis (COA) for materials is captured as part of the device history file (DHF). Batch records must be kept for several years and must provide complete traceability.

Medical molders also need statistical process-control (SPC) charting and the validated inspection of critical and process-sensitive dimensions. All molds and assembly automation must be validated and undergo a rigorous installation qualification, operational qualification, and performance qualification (IQ/OQ/

Highly skilled workers are an essential part of a successful medical-molding business. Here, a Nypro employee operates a complex assembly machine.



Sometimes assembly of medical components must be carried out in a cleanroom. Here is a typical Nypro ISO 8 assembly cleanroom.

PQ) process. Fully documented reports include first-article inspection (FAI) and process-capability results that require customer approval for production readiness.

EQUIPMENT

Not surprisingly, medical-molding equipment must undergo strict installation qualification procedures. Confirming the correct setup is essential for compliance, quality, safety and cost control. Most injection molding machines are housed entirely inside ISO 8 cleanrooms. Medical molders must also identify and document their equipment to support daily process audits.

Most of Nypro's presses are equipped with robots that automatically remove finished parts to ensure they remain clean and undamaged. The machine-mounted robots also provide mold protection by confirming part removal and preventing the mold from closing on parts.

Molding machines can be either electric or hydraulic. Electric molding machines use approximately 40-50% of the electricity of hydraulic equipment, which explains their favor for lowering manufacturing costs. However, hydraulic equipment is still a better fit for some larger-tonnage, thin-wall packaging applications.

Medical molders need controls to avoid cross-contamination between jobs, with rigorous line-clearance procedures and frequent process audits.

For both electric and hydraulic equipment, however, medical molding machines must be closed-loop systems with precision injection and clamp movement. Today, many medical devices incorporate small, intricate parts with complex, multi-functional geometries. This requires injection molds with complex actions or mold movements.

Molds used in medical molding can have as many as 128 cavities. They include hot- or cold-runner, single- or two-shot mold designs. Because mold validation is time-consuming and expensive, molds must be built to high quality standards that will achieve millions of cycles. For best results, they are made of high-quality steels such as 420 stainless steels, H13 or S7.

Some medical applications preclude the use of nickel-plated components. Other applications don't allow beryllium copper components that make direct contact with plastic parts. Microtiter plates used in blood diagnostics are a good example, as beryllium copper may interfere with the binding of antigens inside the plastic wells and affect diagnostic results. Another example is a molded surface that contacts blood flow or a drug, formed by a mold component that could transfer small particles of beryllium copper.

Material handling also poses extremely important considerations for medical molders. Contamination from using the wrong material is costly. It's an even bigger problem if the molder doesn't catch the mistake. Medical molders need controls to avoid cross-contamination between jobs, with rigorous line-clearance procedures and frequent process audits.

Typically, material handling is performed outside of the cleanroom. Material is vacuum transferred from the gaylord into a dryer, if required, and then vacuum transferred into the molding machine hopper.

Proper material handling also helps to prevent black-speck contamination. Often, black-speck allowance limits are specified on the plastic part quality plan and the customer's quality specifications. Most, but not all, medical products require 100% virgin material. Regrind is not allowed when there is risk of contamination or the loss of mechanical properties. Avoiding regrind can also minimize the presence of black specks.

ENGINEERING MATERIALS

Many medical molding applications use highly engineered materials to improve performance in medical devices. These materials may contain special additives like PTFE (a fluoropolymer) or silicone for a low coefficient of friction and low-glide-force performance.

Compared with commodity materials, engineering materials are harder to process and have narrower processing windows. Validation requires documenting the material melt-flow index (MFI) and ensuring that this value is within a specified range.

Nypro requires material certificates of analysis (COA) or conformance (COC) with each lot of material to indicate both melt-flow index and filler content. Certifications for each lot are reviewed at incoming inspection and before use. Lot numbers become part of the DHF and provide traceability for the material used in molded parts. Traceability resolution is available to the box level.

In engineering materials, additives such as oils and fillers are controlled by percentage. To ensure consistent processing and molded part performance, a medical molder must specify and document non-substitution agreements. Engineering materials must also comply with restrictions or regulations such as USP Class VI (U.S. Pharmacopeia biocompatibility), ISO 10993 biocompatibility, and BSE/TSE (bovine-free compliance).

When high-volume colored materials are used, medical molders like Nypro buy precolored or color-compounded materials. Low-volume colored materials are mixed at Nypro from color concentrates. Materials with fillers are always precompounded at the material supplier.

EMPLOYEES

Last but certainly not least, highly skilled employees are one of the "Four E's" that medical molders must have in order to succeed. Managers, engineers, technicians, inspectors and operators must know and understand current Good Manufacturing Practices (cGMP) for both medical molding and assembly, and work with care and diligence to ensure high levels of quality and compliance.

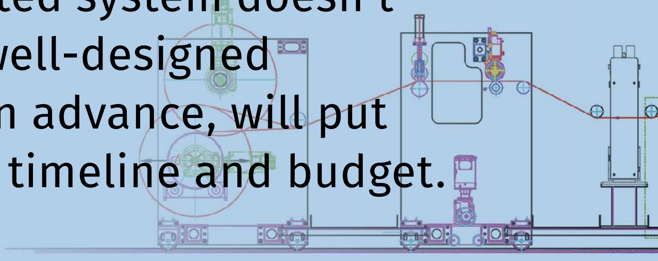
The complexity of medical molds and extensive validations demand high skill levels. Generally, the salaries of medical molding employees are higher than for conventional/industrial molders.

Molders looking to take on medical-device manufacturing must be cognizant of the intrinsic challenges and costs imposed by this industry. Without investing in the proper environment, equipment, engineering-material processing knowledge, and highly skilled employees, device manufacturers may find a particular molder ill equipped to meet their needs. These key fundamental elements of medical molding can make the difference between success and failure in medical-device manufacturing and being awarded new opportunities. PT

ABOUT THE AUTHOR: **Stephen Costa** is senior director of plastics engineering & technology for Nypro, a Jabil Company, based in Clinton, Mass. In this role, he oversees central quoting for plastic molded parts, assembly, molds, and assembly automation for its healthcare business. He also provides technical support to Nypro sites, and contributes to new technology development and adoption efforts related to plastics processing and equipment. Previously, Costa held several roles at Nypro, serving as global program director for Healthcare, director of engineering, senior program manager and senior tooling engineer. Costa's expertise includes single- and two-shot tooling, injection molding, automation, and program and engineering management. Contact: *(978) 365-9721*; *nypro.com*.

‘Follow the Plan’ When Installing and Commissioning Compounding Lines

A fully operational and documented system doesn’t happen by chance. An efficient, well-designed installation plan, prepared well in advance, will put you on the path to maintaining a timeline and budget.



By Bert Elliott, Bill Novak and Charlie Martin
Leistritz

When you are shopping for a line for compounding, devolatilization, reactive and direct extrusion, purchasing the correct equipment is only part of the equation. Not unlike an addition to your house, communication (by providing all relevant specifications) and selecting the right contractors will make all the difference in getting the project completed on time without (or at least with minimal) cost overruns. Local contractors are generally preferable.

You must be prepared to provide detailed specifications and engineering efforts up front to any companies, including machinery suppliers, that offer turnkey solutions. An organized engineering effort is required to provide an accurate turnkey system and installation proposal. A word to the wise: Don’t overly rely on third parties.

WHAT YOU WILL LEARN

1. **DOCUMENT:** Provide contractors all relevant specs.
2. **PREPARE:** Site preparation and coordination of multiple tasks are best not left to chance.
3. **INSTALL:** Establish available resources to help ensure successful project completion.
4. **START-UP:** Conduct a preliminary equipment evaluation prior to production.

PREPARATION PHASE

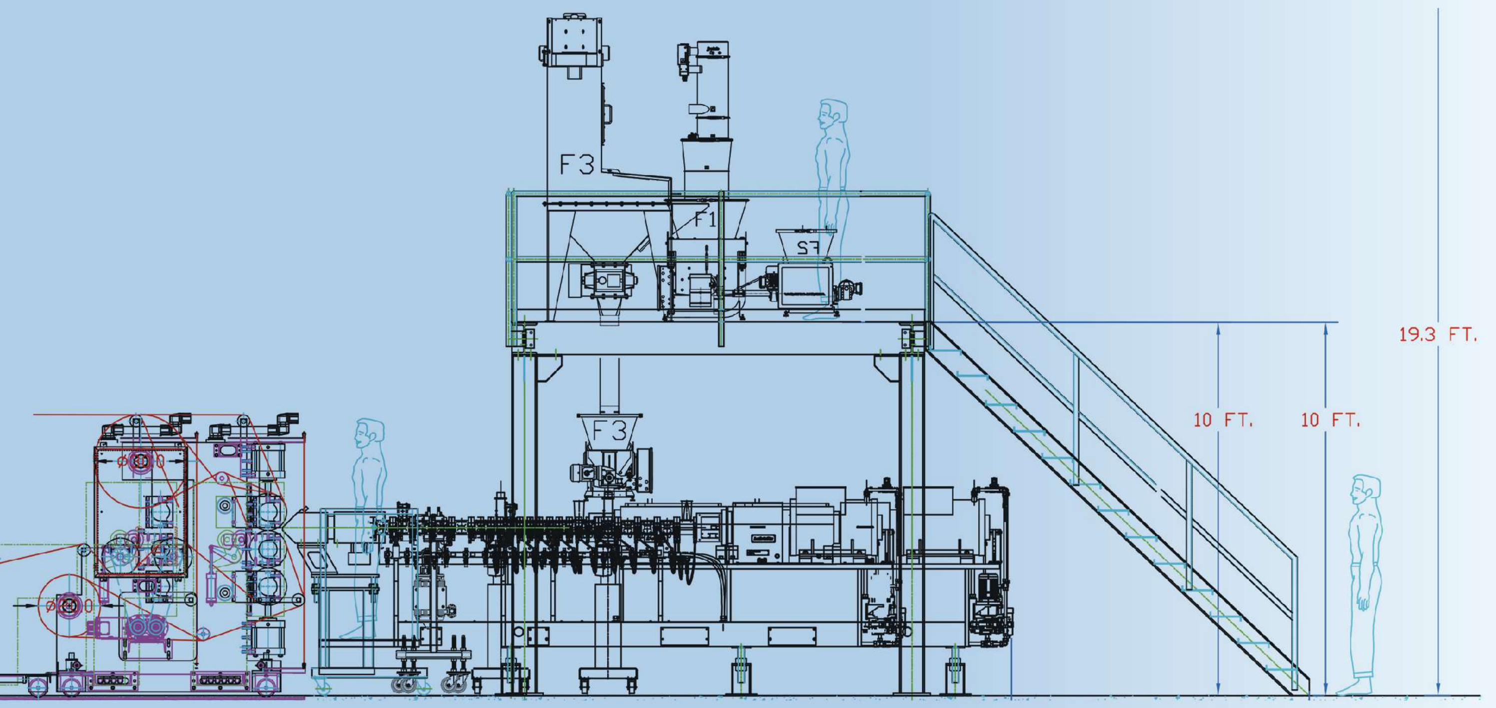
Site preparation and coordination of the many divergent tasks that are required to install and successfully commission equipment is best not left to chance. Even modest advanced planning will yield benefits far beyond the installation and startup phases of a new project.

Before starting, it is highly recommended that the technical and timeline aspects of a project be defined in a written specification. Request-for-quotation and bid documents need to be thoughtfully prepared to facilitate effective communication with vendors and contractors to obtain accurate information on both performance and timeline. Using local and experienced contractors that are familiar with plant personnel and local codes, where possible, generally helps the project’s overall efficiency.

The following checklists are intended to serve as a rough guideline for what’s needed:

Engineering Documentation:

- In-house and vendor drawings prepared in AutoCAD;
- Operating manuals for all equipment;
- P & ID drawing for entire system;
- General arrangement views of entire system, plan and elevation;
- Extruder assembly drawing, three views;
- Barrel/screw layout (to scale in AutoCAD), elevation view only;
- Standard utility requirements: electrical, water, compressed air;
- System utility requirements: dust control and any special HVAC requirements;
- Wiring diagrams for extruder, feeders, and other auxiliary equipment.



Contractor Documentation:
- Sub-vendor mechanical, electrical, and installation drawings;
- Floor loading drawing;
- System interconnecting cabling drawing;
  Conduit runs;
  Number of conductors;
  Wire type and gauge, etc.;
- System interconnecting piping drawing.

Additional Documentation:
- Detailed functional specification for PLC logic;
- System Input/output list;
- Source code for programming;
- Bid package preparation for third-party contractors;
- Spare-parts lists/pricing for all equipment supplied from bill of materials;
- Environmental permit applications, as required.

Factory Acceptance Test (FAT), including:
- Visual inspection and identification of system components;
- Review of control-panel layout;
- Documentation of model numbers, serial numbers, and pertinent specifications of all applicable components;
- Inspection of electrical devices and corresponding wiring;
- Confirmation of tagging and labeling;
- Heat-zone check-out;
- Identification/verification of product contact materials and surface finishes;
- Overview and demonstration of power-up procedure;
- Verification of temperatures, speeds and other indicated values;
- Complete system dry test;
- Generation, recording and compilation of FAT documentation.

Many responsible parties must contribute to ensure that a twin-screw system is operational on time and producing a quality product.

INSTALLATION PHASE

This is where you find out how prepared you really are. Adequate space, light and administrative assistance may not always be available, but establishing the resources that are available will help ensure a successful completion of a project. Careful planning and implementation are the keys to success, including:

Mechanical:

All workers must have adequate PPE (Personal Protection Equipment). Generally, this includes, as a minimum, safety shoes, safety glasses, a hard hat, and work gloves. Explosion-proof and hazardous materials require special handling and treatment.

Set up a "contractor area" and provide multiple copies of all the mechanical and electrical drawings. Require that all responsible parties have access to information as needed.

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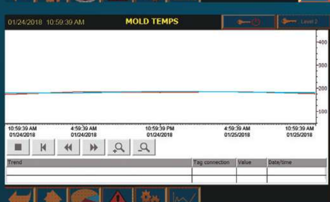

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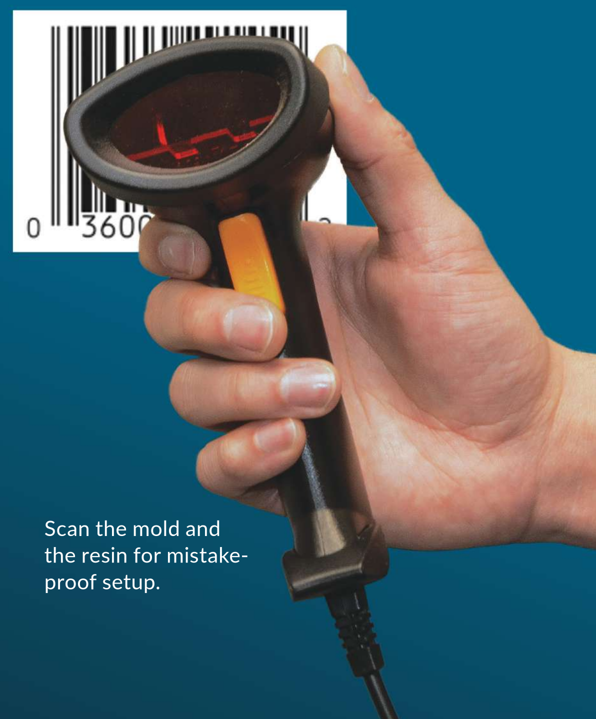

Scan the mold and the resin for mistake-proof setup.

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Create a physical "laydown area" in the plant. This area will be used to lay out the equipment as each skid is unpacked. Keep it separate from where the equipment will be installed, but not too far away. Open cardboard boxes so you can see what's inside. Keep the parts from each supplier together. Take pictures of incoming packages and parts.

Use the general-arrangement drawing to mark the floor with the rough outline in chalk of each major piece of equipment or component.

Carefully consider the order of installation. Generally, start with larger machines and work toward smaller pieces. Remember not to position something large, like the power panel, so that it blocks access to another part of the line. The twin-screw extruder is typically installed after the mezzanine and support structures.

Even modest advanced planning will yield benefits far beyond the installation and startup phases of a new project.

Rigging tip #1: Don't lift a machine any higher than is required, and move very slowly. (Professional riggers never want a lifted load to have any momentum.)

Rigging tip #2: Know the approximate weight of each item before attempting to lift it, and never lift a load over a person (web straps and chains can break).

Don't anchor any machinery to the concrete floor until everything is installed and it's confirmed that all the positions and alignments are correct (an exception may be necessary for some machinery because of its size and weight distribution).

Once you are satisfied that all the machinery is in the correct position, anchor the fixed machines to the floor.

Electrical:

Review the field wiring specification with the electrical contractor to ensure it follows the provided cabling- and conduit-run instructions. Make note of any exceptions and document each remedy for issues that develop.

Review each piece of equipment's wiring diagram with the contractor and confirm the availability of the various types of wire and cables required.

Make sure all power is "locked out/tagged out" while the electrical work is being done. Confirm the on-site procedures. There should be absolutely no way any part of the system can be energized.

Think through which machines are fixed and which are moveable. (Example: underwater-pelletizer cart moves on floor tracks.) Make sure flexible cables and appropriate connections are planned.

All interconnecting wires/cables should be marked according to the wiring diagram. Changes/corrections should be noted for the as-built configuration.

Do not apply power to the main panel or any other parts of the system until the appropriate technician is on-site and has inspected the installation.

In the installation phase, you should generally start with larger machines and work toward smaller pieces. Remember not to position something large, like the power panel, so that it blocks access to another part of the line. The twin-screw extruder—in this case a 180-mm machine—is typically installed after the mezzanine and support structures.

Once a system is installed, but before it is started up, conduct a preliminary evaluation of the equipment. This will include the technical documentation (SOP, FAT) as well as operating instructions. Time should be allotted for operator-related modifications to the system.

Make a note of the gearboxes that arrive from the factory filled with oil and establish which are sealed and will not require oil changes. (Synthetic oils are now being used and are good for the lifetime of many smaller gearboxes.)

Check to ensure all water-cooling tanks are filled. Sometimes it's best to start with plain city water. If no leaks are apparent, then change to the recommended water with corrosion inhibitors.

Safety Check:

A safety team or OSHA team must evaluate the installation for potential hazards and confirm that issues are being addressed systematically by the site's safety/health program.

Categorize concerns as they apply to the relevant regulations and suggest remedies as required. Categories may include:

- Walking and working surfaces;
- Fire safety;
- Hazardous-material storage/handling;
- Confined-space entry (vessels and crawl spaces);
- Machine guards;
- Lock out/tag out;
- Electrical (power tools/welding equipment).

Piping/Plumbing:

As part of preparation, the piping contractor provided a drawing (P&ID) showing all the pipe routings and sizes suited to the expected maximum flow rates. As installation progresses this document is modified accordingly.

Discuss with the contractor what material will be used for the various piping runs (black iron, galvanized, stainless steel, PVC, etc.).

Confirm the location of isolation ball valves. Branches of the system will need to be shut off for maintenance. To aid in troubleshooting, consider where pressure or temperature gauges are to be located. Mark all the final information on the P&ID.

As with the electrical contractor, where machines are on tracks or will be moved for maintenance, plan on flexible connections and make a note of any required quick disconnects.

If any of the piping will be carrying chilled water, those pipes should be insulated.

When finished, label all piping with its purpose and arrows showing the flow direction.

Filling and Checking Fluids:

Confirm that each gearbox in the system is filled with the correct grade of oil.

START-UP PHASE

Before any production, a preliminary evaluation of the equipment is conducted. This will include the technical documentation (SOP, FAT) as well as operating instructions. Time should be allotted for operator-related modifications to the system.

Installation Qualification:

The first thing the technician should do upon arriving on-site is to inspect the installation work.

- Visual inspection and identification of system components;
- Verification of all utility connections;
- Inspection of electrical devices and corresponding wiring;
- Heat-zone check-out;
- Overview and demonstration of power-up procedure.

The technicians should follow a start-up checklist. Beginning with the machine interlocks, the checklist will include:

- Verification of all safety devices and system interlocks;
- Verification of temperatures, speeds and other indicated values;
- Complete system dry test;
- Generation, recording, and compilation of IQ documentation;
- Mechanical items related to machinery operation.

It's best to check the functions of the most complicated componentry (PLC/HMI, Emergency Stop, AC variable-speed drives, heat zones, etc.) before simpler items such as single-speed motors and level switches. Some motors need to be tested uncoupled, while most peripheral-system motors are safe to test coupled. It is important to confirm that the motor rotation is correct prior to running the machinery under load.

Material will be required to put an initial load on the extruder. Have plastic on-site, so the technicians can put a load on the extruder when it's ready for an initial test. Run all the machines below 50% load at first, while checking for any abnormal sounds, vibration, fluid leaks, etc. When the technician is confident all is OK, then the system can be run up to higher rates.

Operational Qualification:
Training is the final step in starting up a new system. Once the system is working properly it's time to tackle operator training. It's very difficult to troubleshoot equipment issues while training people at the same time. Operator training is best handled independently after the system is up and running.

It's very difficult to troubleshoot equipment issues while training people at the same time.

- Review customer-generated SOPs;
- Review equipment and systems manual;
- Review FAT and IQ documentation where required;
- Equipment operation conformity check-out;
- Review the normal value on the gauges, indicators and the zone controllers in a manual/discrete operator interface;
- Confirm the initial calibrations and establish a method to collect the data that will be used to maintain an operating baseline;

- Review touchscreen/HMI operation:
  Access level (operator/engineer/administrator);
  Heat-up, interlock/bypass;
  Set up screen;
  Calibration screens;
  Interlocks and alarms;
  Startup checklist;
  Main screen;
  Data logging.

- Review the startup procedure:
  The main disconnect;
  Temperature settings and heat-soak times;
  Startup water-cooling systems and lube-oil pumps;
  Turn on downstream equipment;
  Fill the feeders;
  Start the main drive at low speed;
  Start the feeders at low rate;
  Monitor torque;
  Engage the pelletizing equipment;
  Ramp up extruder and feeders to appropriate rate;
  Increase the pelletizer speed to match rates.

- Turn on vacuum pump and/or open valve to the system. Review how to clear an upset condition and clean/maintain the vacuum pump.
- Monitor feed throat for feed limitations.
- Discuss various processing tips.
- Review the use of the special tools and preventive items to be noted daily, monthly, and annually.

The objective for the installation of any twin-screw extruder system is to plan well, provide an efficient, well-designed installation plan, and maintain a timeline and budget. The end-result is a fully operational and documented system.

This doesn't happen by chance. The initial specifications developed during the preparation phase of a project become a "living document." While this up-front work can be tedious and time consuming at the beginning, it ultimately minimizes miscommunications and saves time and money.

Turnkey isn't always turnkey. While the term may be flippantly used to describe the installation, in reality there are many responsible parties that must contribute to ensure that a twin-screw system is operational on time and producing a quality product. No matter what, it'll be a lot of effort.

ABOUT THE AUTHORS:
Bert Elliott has held various manufacturing and engineering positions with extruder OEMs since 1981 and has been Leistritz's engineering manager since 1993. He has been involved in over 1000 extruder installations, including many in the Far East. Contact: *(908) 685-2333*; *belliott@leistritz-extrusion.com*; *leistritz-extrusion.com*.

William L. Novak is the product-area manager for Leistritz Extrusion in Somerville, N.J. His responsibilities include business-development efforts to expand the use of twin-screw extrusion into new areas and applications, as well as regional responsibilities. Previously, he was Coperion's regional service manager. During his tenure at Coperion, Novak held several sales- and engineering-related positions and has more than 27 years of product-development experience. Contact: *wnovak@leistritz-extrusion.com*.

Charlie Martin is president and general manager of Leistrtiz. Martin has been in the extrusion industry for more than 25 years, is a member and former chair of the SPE Extrusion Div. and has given 100+ papers at various technical conferences on a range of extrusion topics around the world. Contact: *cmartin@leistritz-extrusion.com*.

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The Automotive Division of the Society of Plastics Engineers (SPE®) is announcing a "Call for Nominations" for its 48th-annual ***Automotive Innovation Awards Gala,*** the oldest and largest recognition event in the automotive and plastics industries. This year's Awards Gala will be held Wednesday, **November 7, 2018** at the Burton Manor in Livonia, Mich. Winning part nominations ***(due by September, 15, 2018)*** in 10 different categories, and the teams that developed them, will be honored with a **Most Innovative Use of Plastics** award. A **Grand Award** will be presented to the winning team from all category award winners. An application that has been in continuous use for 15 years or more, and has made a significant and lasting contribution to the application of plastics in automotive vehicles, ***(nominations due by May 31, 2018)*** will be honored with a **Hall of Fame** award.

SPONSORSHIP OPPORTUNITIES
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PART 1

Improving Molding Process Capability: Understanding the PVT Graph

Process capability is related to the variation in part dimensions from shot to shot. High values of process capability require the shrinkage of the material to be identical on each shot, which can be confirmed from the pressure-volume-temperature (PVT) graph.

By Suhas Kulkarni
Fimmtech

In part one of this two-part series we will be discussing how to improve the capability of a given molding process. In this installment, we'll cover Process Capability and the Pressure–Volume–Temperature (PVT) graph.

PRIMER ON PROCESS CAPABILITY

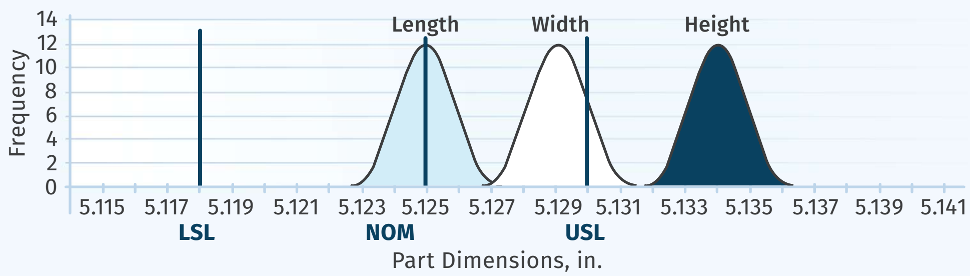
Variation is natural to all processes, and this variation can be measured in the output of the process. For example, one of the outputs of the processes of getting to work is the time it takes to get to work. We can say it takes us 20 minutes, but in reality, it is an average value of the times it has taken us to get to work over the past few days or weeks or years. The actual value on a certain day is therefore anywhere around the 20-minute average and may be, for example, somewhere between 17 and 23 minutes.

There is always a spread of the values from which an average is calculated. In injection molding, if a dimension is measured and reported as an average of 2.175 in., then there will be a spread around the 2.175 in. with a natural variation of, for example, ±0.002 in. The distribution shows one peak and two tails and appears to be fairly normal. In this article we will deal with only normal distributions.

Consider the case of a box that needs to be molded with the length, width and height all with a nominal value of 5.125 in. The allowable tolerances are set at ± 0.006 in. The Lower Specification Limit (LSL) is therefore 5.119 in., and the Upper Specification Limit (USL) is 5.131 in.

A mold trial is undertaken, 30 parts are molded, and the three dimensions of the length, width and height are measured on all 30 parts. The average length measures 5.125 in., the average width measures 5.130 in., and the height averages 5.135 in. Each of the dimensions has a spread of 0.004 in. for the 30 parts measured. As can be seen from the Fig. 1, the length of the part is within specifications for all the 30 parts, the width of the part is acceptable for some of the 30 parts and the height of the parts is out of specification for all the parts. In each case, the total spread of the variation is 0.004 in. and the total available tolerance is 0.012 in.

FIG 1 Average and Inherent Dimensions of a Part



Here, part length is within specifications for all 30 parts, while part width is acceptable for some, and the part height is out of specification for all. In each case, the total spread of the variation is 0.004 in and the total available tolerance is 0.012 in.

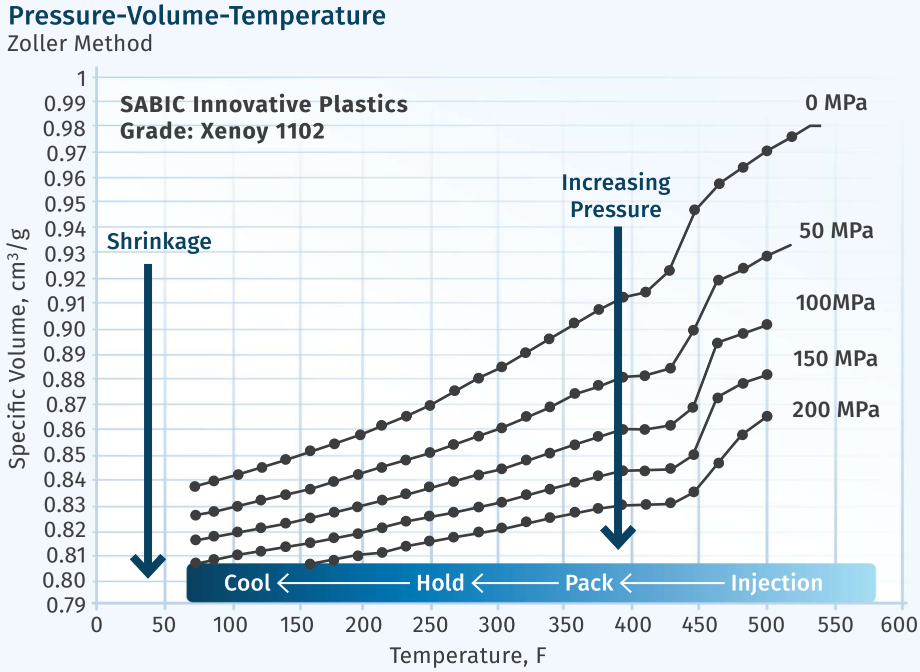
There are four terms that are defined based on the spread, the tolerances and the possibility of molding acceptable parts. These are process-capability indices called Pp, Ppk, Cp and Cpk. Pp and Ppk are related to confined smaller sample sizes, such as the one above of 30 parts when an initial trial was performed. These are anecdotal and related to the particular run or experiment. Cp and Cpk are related to the long-term predictive performance of the process.

Pp and Cp are the ability of the process to produce acceptable parts if the average of the parts was centered at nominal. If the variation of 30 parts is less than the available tolerance, and if the average of the 30 parts for all the three dimensions was equal to the nominal value on the drawing, then all the 30 parts would be acceptable for the length, width and the height of the part. In all the above cases, the variation in the 30 samples is 0.004 in. compared with the available tolerance of 0.012 in. In such a case, the calculated Pp value is high for all the dimensions. A Pp value of 1.33 or more is preferred.

Ppk and Cpk are the ability of the process to produce acceptable parts with the current status of the mold and process. In case of the height of the part, the average is at 5.135 and all the parts are out of specification. In such a case, the Ppk is very low, since although the spread is acceptable, the complete spread is outside of the specification limits and no part is acceptable. A Ppk value of 1.33 or more is preferred. In such cases, a variation-reduction action is not required but process centering will need to be done. Process centering can be achieved by adjusting mold steel dimensions and/or the product specification. The premise here is that a robust process was developed using the techniques of Scientific Molding and Design of Experiments (DOE).

Most books on process control and quality have more information on the topic, including the formulas. Chapter 13 of my book, ***Robust Process Development and Scientific Molding***, also carries this information.

FIG 2 Plastic Volume vs. Temperature



Shrinkage is the reduction in volume and is therefore reflected in the PVT diagram. Shrinkage determines the final dimensions of the part.

UNDERSTANDING THE PVT RELATIONSHIP

Figure 2 shows a typical PVT diagram. The X-axis represents the melt temperature and the Y-axis represents the specific volume of the material. (Specific volume is the ratio of volume to mass, or cm^3/g. It is the inverse of specific gravity, g/cm^3.) At 0 MPa of pressure, as the temperature of the plastic is increased, the specific volume increases. At any given temperature, if an external pressure is applied, the melt gets compressed and the specific volume decreases. Specific volume is directly proportional to temperature but is indirectly proportional to pressure.

In injection molding, a combination of these factors is involved as the melt is transformed into the product. The melt is collected as a shot in front of the screw. There is some compression of the melt because of the backpressure during the shot buildup process. The molten plastic is then injected with high pressure into a cold mold. During this process—and after the plastic is inside the mold—the melt is cooling. As the melt is being transformed into the final molded product, the pressure, volume and temperature of the melt are all continuously changing, and the final contour in the PVT graph is a combination of the curves in Fig. 2. Shrinkage is the reduction in volume and is therefore reflected in the PVT diagram. Shrinkage determines the final dimensions of the part.

Process capability is related to the variation in part dimension from shot to shot and therefore in the complete set of parts, such as in a production run. To achieve high values of process capability, the shrinkage of the material must be identical from shot to shot, which in turn mandates that the resultant PVT graph is repeated from shot to shot inside the mold.

In Part 2 we will discuss how each of the five pillars of molding play a role in process capability: part design, plastic material, mold design and moldmaking, molding machinery, and the molding process. PT

ABOUT THE AUTHOR: Suhas Kulkarni is the founder and president of Fimmtech, San Diego, an injection molding service-oriented firm focusing on Scientific Molding. Fimmtech has developed several custom tools that help molders develop robust processes, and its seminars have trained hundreds of individuals. Kulkarni is an author of the book, *Robust Process Development and Scientific Molding*, published by Hanser Publications. Contact: *(760) 525-9053*; *suhas@fimmtech.com*; *fimmtech.com*.

Keeping Up With Technology

PRODUCT FOCUS **Recycling**

Pretreatment Process for Food-Grade RPET Sheet

The PURe system from Italy's Bandera is a pretreatment process that purifies RPET flake for food-contact applications. It uses microwave generators to treat the flake for its cleaning process. PURe is a dual-reactor process that cycles between the reactors in a semi-continuous manner. Cycle times are approximately 30–45 min. The treated flake is then ready for processing into sheet through the HVTSE twin-screw process.

There are multiple system sizes available, from 1100 to over 4400 lb/hr. In North America, the technology is available through PTi/Processing Technologies International LLC, Aurora, Ill. It is being highlighted at NPE2018 this month.

630-585-5800 • ptiextruders.com

RECYCLING

Shredder/Granulator Combo

Avian (USA) Machinery LLC, Chicago, is introducing to the North American market at NPE2018 a large-diameter shredder and granulator combination size-reduction system called the Shred & Grind Combi. This machine is available in three different series encompassing seven models.

The company says the dual-purpose machine greatly reduces total equipment investment costs for a machine that's more compact and easier to maintain. The cost of wear parts is also largely reduced, while energy consumption is reportedly decreased by 30%.

Avian says the machine can be applied for processing a wide variety of HDPE and PVC pipe and fittings, large bulk materials, and thick-wall moldings or profiles.

630-687-9876 • aviangranulator.us

RECYCLING

Reactive System Raises RPET IV and Decontaminates

In the Next Generation Recyclingmaschinen GmbH (NGR) P:React processing system, an upstream extruder supplies devolatilized and filtered melt to a Liquid State Polycondensation (LSP) heated reactor. There, the melt is exposed to a strong vacuum at a very high surface-area-to-volume ratio. These conditions initiate the polycondensation process where IV increase and decontamination occur extremely rapidly. In many cases, the need for predrying can be avoided. Maximum IV increase and decontamination are typically achieved with a 25-min residence time, after which, the RPET will have reportedly near-virgin-like qualities.

The polymer melt pump at the LSP reactor outlet extracts the melt at constant volume and constant pressure. In addition, an inline viscometer gives feedback to the reactor control to ensure constant IV production. This combination of constant pressure, volume, and IV reportedly provides exceptional process stability, which can be direct coupled to nearly any downstream process such as sheet, fiber or film production.

Exibiting at NPE 2018, NGR (U.S. office in Norcross, Ga.) says that in film and sheet production with RPET, the high process stability of the P:React system has resulted in noticeably less process downtime, leading to higher production rates. In addition, NGR Connect gives operators a live digital connection to their recycling process. This is done by recording relevant operating parameters for the NGR system and making them accessible to the user on any device (tablet, smartphone, etc.). In conjunction with the P:React, NGR Connect monitors the decontamination performance based on sensor signals. Recipe management directly on the machine makes it possible to classify the PET input material and link to P:React production data. As a result, users have real-time process tracking.

678-720 9861 • ngr-usa.com

ADDITIVES

Compatibilizer & Chain Extender for Recycled PET

Two innovative technologies for driving increased use of recycled polyester in nylon alloys and enhancing the benefits of recycled PET are being launched at NPE2018 by Vertellus Holdings LLC, Indianapolis. These ZeMac products are patent-pending technologies with different chemistries, as noted by global commercial development director Ashok Adur. (He verified for an article in 2015 that the original ZeMac additives were alternating copolymers of ethylene and maleic anhydride.)

ZeMac Link NP is a novel compatibilizer for creating alloys of recycled PET and nylon that gives these alloys performance properties closer to those of virgin nylon, but with a significant cost advantage. Adur views these compatibilized nylon/polyester alloys as similar to nylon/PP alloys, which can deliver performance close to that of virgin nylon but at lower cost and with a sustainability advantage. Key target applications include fasteners, hand tools, furniture, string trimmers, and hubcaps.

ZeMac Extend P is a novel chain extender primarily for upgrading recycled PET. However, its chemistry appears very promising for use with any natural or synthetic polyester, including bioplastics like PLA, PHA, and Ecoflex from BASF. This technology also has potential for increasing melt strength to enable use of recycled PET in blow molding and extruded profiles and films.

973-440-4400 • vertellus.com

RECYCLING

Flexible Line for PP, PE Recycling

The GM105 Compac regeneration line from Italian supplier Gamma Meccanica S.p.A. (U.S. office in Greer, S.C.) is said to be flexible and suitable for recycling PP and PE in the form of pre-sized films, coils or loose products. Like all GM Compac lines, the GM105 extruder block and feeding system are assembled to provide greater stability and offer a more integrated and compact layout to the line. The electrical panel is mounted on the base, helping prevent errors during installation since it is not necessary to disconnect cables during transport and rewire them during assembly. The line is controlled by an electronic touchscreen panel whose position can be adjusted by the operator.

The line's components include a feeding system with cutter-compactor; single-screw extruder with double-degassing vents; filter; and a water-ring pelletizer. Production capacity range is 900-1500 lb/hr.

Its Ecotronic software for power control reportedly provides potential energy savings up to 40%. The Ecotronic platform also allows temperature control without injecting water into the material. An important feature is the feeding screw, which guarantees a constant flow of material to the extruder. As on all GM lines, it is possible to monitor and control the line remotely while it is running.

877-675-0775 • irecyclingsolutions.com

See what these exhibitors and many more are planning for NPE2018 at NPE.org!

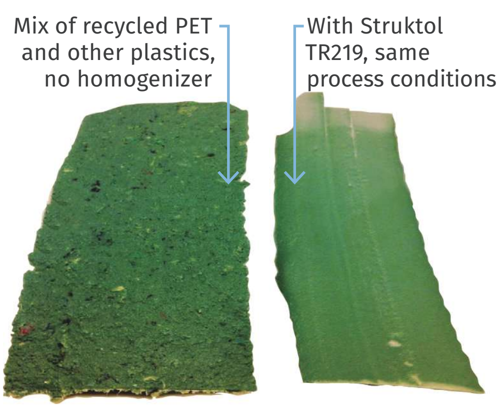
ADDITIVES

Additives for Recycled Plastics

Struktol Co. of America, Stow, Ohio, is showcasing its expanded line of additives for 100% recycled plastics and compounds with recycled content at NPE2018. These products are said to be useful in a broad range of resins from polyolefins to engineered plastics. For engineering plastics, there are products that combine a compatibilizer with lubricants to aid incorporation of mineral or glass fillers with improved mixing and flow properties and mold release.

Among the latest additions is Struktol TR229 for use in PC and PC/ABS blends, as well as nylon 6 and 66. It can be used in FDA-approved applications. Another product is Struktol TR 219 for nylon 6 and 66; it also has been found to be effective in PET and PBT.

Struktol RP 23 is a new multifunctional package for recycled PP that incorporates vis-breaking technology with lubricant and mold-release functionality. It boasts significant viscosity reduction at low loadings. Its lubricant base is said to boost processing



in compounding and extrusion, as well as increased mold flow and metal release.

Another new product, Struktol TR 251, combines surfactant and lubricant technology for enhanced functionality over other single-component lubricants in both polyolefins and engineered plastics. It is said to be very effective in improving mold flow of recycled compounds without significantly changing the melt flow rate.

Struktol TR 052 is a new compatibilizer and blending aid that helps incorporate regrind or recycled content in a wider range of polymers. It has been shown to significantly improve processability and performance of mixed recycled streams; effectively compatibilizing dissimilar polymers.

330-928-5188 • struktol.com

INJECTION MOLDING

New Mold Monitoring System Promises Speed & High Resolution

Comet Plastic Equipment, Riviera Beach, Fla., is introducing the PE-600 mold-monitoring system, described as the industry's first mold-protection device to use full-color, high-resolution digital image-processing technology. The PE-600 system's processing speed (0.012 sec)—60% faster than its predecessor—allows it to protect molds even in ultra-high-speed molding with sub-2-sec cycles. Image resolution has been more than doubled to 1920 × 1080 pixels. Comet President Tom Rajkovich says full-color digital processing reduces errors caused by outside light, reflections from the shiny mold surface, shadows on the mold, and residue, improving overall detection.

Above and beyond ejection-error detection, the PE-600 can also monitor the positions of the slide core, insert-loading errors, and broken pins. Automatic compensation for position—mold-opening stop position—is a standard feature, and for ejection errors, the user can pre-select the number of ejector strokes to be performed until the part is successfully ejected prior to stopping the machine and actuating an alarm.

Exhibited at NPE2018, the PE-600 features a 10.4-in. color LCD touchscreen. The entire unit weighs just 3 lb, allowing for hand-held operations, including entering settings while standing in front of the mold. The control features an automatic setup program allowing precise monitoring of selected areas of the mold. When a problem occurs, a database stores the inspection data and mold images for later review. Mold setup information and the inspection database, with images, can be stored on a USB flash drive for remote review on a PC.

Options include a second camera and wide-angle and zoom lenses. Comet notes that in a family mold, for instance, a standard lens can be focused on the larger parts, while a zoom lens focuses on the smaller or even micro-sized parts. For very large mold surfaces, either two cameras or a single camera with a wide-angle lens can be used. Optional LED and halogen lighting sets are available for high-intensity lighting, as is infrared lighting, which can reduce ambient lighting impact.

800-328-5088 • cometpe.com

INJECTION MOLDING

Negri Bossi Launches New All-Electric Generation at NPE2018

Continuing the trend toward revving up all-electric machines for high-speed packaging and medical markets, Negri Bossi North America, New Castle, Del., is introducing its fourth-generation all-electric machines, the Nova eT series, at NPE2018 this month in Orlando, Fla. The showpiece is a 180-metric-ton model molding four food-container lids with in-mold labeling (IML) in 3 sec, using a side-entry robot from sister company Sytrama (also with offices in New Castle).

Relatively few details were available at press time before the show. The Nova eT series ranges from 50 to 350 m.t. It has a new-generation Tactum touchscreen control that accepts multi-touch gestures such as swipe and scroll. Its Smart Flex 2 toggle clamp has a new geometry designed specifically for electric actuation. Multicolor injection options are available with additional, all-electric injection units. Negri Bossi claims energy savings of up to 80% compared with conventional hydraulic drives.

302-323-8020 • negribossi.com

INJECTION MOLDING

Engel Brings Economical Line of Chinese-Built Machines to the Americas

Engel Machinery (Changzhou) Co., Ltd. has been building a line of Wintec hydraulic and electric machines in China since 2014. At NPE2018, Engel (U.S. office in York, Pa.) is introducing these machines to the U.S., Canada, Mexico, and Brazil. These are attractively priced, general-purpose machines for standard applications—mainly high-volume, single-component molding. Machines are delivered preconfigured, which Engel says guarantees short delivery times and fast startup.

Designed and developed in Europe, Wintec machines are built in China to the same strict quality standards as at all Engel plants worldwide, emphasizes Peter Auinger, Wintec president Americas, who is responsible for sales and service in this hemisphere. Wintec has already set up a team of experienced service technicians in the Americas and established a spare-parts warehouse.

Wintec t-win series of servo-hydraulic two-platen presses (above right) from 500 to 1900 U.S. tons are currently used mainly in the automotive and white-goods sectors. Their clamps ride on linear guides and they have a KEBA C2 controller with tilting 15-in. touchscreen.

Wintec e-series all-electric toggles from 55 to 310 tons (above left) also have linear platen guides and KEBA C2 control. They also boast a swiveling injection unit, automatic mold-height adjustment, automatic clamp-force correction for mold heat-up, and clamp-force measurement at the center of the platen, rather than on one tiebar as on some competing machines.

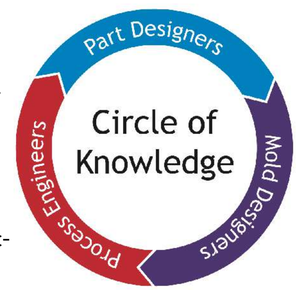
717-764-6818 • wintec-machines.com

INJECTION MOLDING

New Online Training for Mold & Part Designers & Process Engineers

Torsten Kruse, whose firm, Kruse Analysis, is known for injection molding simulation services, has started a new venture to train part and mold designers and senior process engineers. Kruse Training provides an interactive, online training platform called "The Circle of Knowledge"—the "circle" referring to the productive flow of information between part and mold designers and process engineers.

This subscription-based program offers various levels of certification for successful completion. The "virtual learning assistant system" combines animation, timelines, videos, interactive quizzes, and multimedia presentations. The program is divided into four levels of training from introductory to advanced, covering molding fundamentals, polymer materials, part and mold design, processing, special processes, the molding machine, and "art-to-part."



239-351-7428 • krusetraining.com

EXTRUSION

High-Speed Pre-Stretched Film Rewinder

Unitech SRL of Italy is presenting its T012 pre-stretched film rewinder at NPE2018. The T012 is a fully automatic, high-speed rewinder for stretch film. Its servo-drive technology allows it to run at high speed while keeping accurate control of the pre-stretch process. Pre-stretch ratio is variable and can be adjusted from the operating panel. Running at an average speed of 3500-4000 ft/min, it has a productivity of 400-500 lb/hr. The T012 rewinder can work with cast or blown film.

+39 0381 630 300 • unitechpackaging.com

COMPOUNDING

One-Step Color Masterbatch Production

At NPE2018, KraussMaffei Berstorff, Florence, Ky., is showing direct production of PE color masterbatches on a ZE 28 BluePower twin-screw extruder, using what it says is a unique liquid-color compounding process to produce masterbatches of any color in a single cycle, meaning no intermediate mono-concentrate production step.

The ZE 28 BluePower running in the booth has a 46:1 L/D and is equipped with a liquid- and solids-metering system so that color masterbatches can be produced using any type of starting material. Color masterbatches are usually based on mono-color concentrates, which are produced on single-screw extruders in a separate processing step, intermediately stored and then fed into the twin-screw extruder in a second step. With the liquid-color compounding technology, the intermediate mono-concentrate production step is no longer needed. Color masterbatches produced this way are said to offer "unparalleled cost-effectiveness and unique color precision." The firm's twin-screw extruders are self-cleaning, so changes from dark to bright colors can reportedly be made without any problems.

Recipes stored in the company's proprietary Process Control Advanced system are automatically set for the complete line at the simple push of a button on the control panel. The compounding line exhibited is furnished with an Econ underwater pelletizer.

The company says ZE 28 BluePower twin-screw extruder is suited to R&D applications as well as for small-batch production. All extruders in the ZE BluePower series feature an OD/ID ratio of 1.65, specific torque from 13.6 up to 16 Nm/cm^3, high drive power, and speeds rated at 900 to 1200 rpm. The 4D and 6D barrel sections can be combined with the extensive range of modular screw elements.

859-283-0200 • kraussmaffeigroup.us

EXTRUSION

Measurement Systems for Large Pipe & Other Extrusions

The Centerwave 6000 from Germany's Sikora (U.S. office in Peachtree City, Ga.) is a system for measuring the diameter, ovality, wall thickness and sagging of large pipe from 90 to 3200 mm during extrusion. The system, displayed at NPE2018, is based on millimeter-wave technology. It's available in a rotating version, offering the complete measurement of wall thickness at 360 points across the entire circumference of the pipe. Alternatively, Sikora offers a multi-axial system with static sensors. The Planowave 6000, also based on millimeter-wave technology, is used for thickness measurement of sheet.

Sikora is also displaying the Purity Scanner Advanced for online inspection and sorting of material. The combination of an X-ray camera with a flexible, optical camera system is said to be the only technology at present that reliably detects contamination on the surface as well as inside of pellets. Contaminated pellets are automatically sorted out. Depending on the type of contamination and application, optical high-speed cameras as well as X-ray, color and infrared cameras are used.

For smaller material throughputs and for applications where sampling analysis or incoming goods inspection are sufficient, Sikora is displaying the Purity Concept Systems. These analysis devices can be equipped with X-ray technology, optical cameras or infrared sensors to detect contamination in pellets, flakes, films/tapes and crosshead parts.

770-486-1233 • sikora-usa.com

THERMOFORMING

Food Trays Formed From Crystallized PLA

At NPE2018 this month, OMG of Italy is thermoforming crystallized PLA (CPLA) food trays that are said to withstand surface temperatures up to 250 F and are microwave friendly. The 100% compostable CPLA extruded sheet is provided by Advanced Extrusion Inc. (AEI), Rogers, Minn.

The energy-efficient electric OMG thermoformer produces finished parts by way of precision steel-rule-die trimming on a heavy-duty, four-post, servo-driven trim press. Parts such as food trays, lids, containers, cups and clamshells are loaded into an auto–stacking-counting station, an integral part of the OMG thermoforming system. Parts are then mechanically discharged onto a final packing station.

To further demonstrate the versatility of its machinery and tooling, OMG is also forming AEI's CPET, which can withstand temperatures of -20 F to 375 F. This is done using the same tooling as for the CPLA tray. Both materials incorporate a unique nucleating agent to promote accelerated crystallization during the thermoforming process.

+39 011 9947156 • omgitaly.com

BLOW MOLDING

U.S. Debut of Versatile Injection Stretch-Blow Machine

At NPE2018, Kiefel Technologies (U.S. office in Portsmouth, N.H.) is showing for the first time in the U.S. the Blowliner single-stage ISBM machine from its daughter company Mould & Matic Solutions. Major advantages of this machine are said to be its compactness and its versatility. It can process PET, PP, and HDPE; it can also be upgraded to multilayer barrier applications at any time. It also provides the flexibility to mold containers from 10 ml to 5 L on the same machine.

In this linear machine layout, the preform injection molding unit is based on a servo-hydraulic Engel press with a vertical clamp. Preforms can be molded in eight to 64 cavities using a hot-runner tool with valve gates. The blowing station accepts one to four rows of preforms in 10 to 150 mm diam. Each row of cavities has its own pre-blow and main blow valve so that the pressures can be set individually. The stretch-blow unit has servomotor drives for exact repeatability, precision, and energy efficiency. The integrated linear robot has a vacuum gripper to unload finished bottles and place them on a conveyor or into boxes.

The machine at the show is a Blowliner M (Medium), which permits cycle times of 10 sec. The smaller Blowliner S (Small) can achieve 8 sec. At NPE, the machine will make 250-ml PET pill bottles weighing 30 g in a two-row tool with 12 cavities. Maximum throughput of the "M" model is 286 lb/hr of PET.

603-929-3900 • kiefeltech.com

MATERIALS HANDLING

Dust Collector Stands Alone

A new stand-alone dust collector from Flexicon Corp., Bethlehem, Pa., removes airborne dust from upstream processes and discharges it into containers positioned below the collection hopper, protecting operators and improving plant hygiene. The housing is equipped with a 6-in.-diam. side inlet port, dual-filter cartridges, 2-hp fan, 2.5-ft^3 collection hopper with flanged slide-gate valve, and automated controls.

At timed intervals, an automatic reverse-pulse filter-cleaning system releases short blasts of compressed plant air inside the filters, causing dust buildup on the outer filter surfaces to fall into the hopper. Because the filters are blasted alternately at timed intervals with adjustable force, operation of the dust-collection system is both continuous and efficient.

An indicator light on the control panel notifies the operator when the receiving hopper is full. The system's stainless-steel housing and support structure, together with NEMA 4X water-resistant controls and washdown-duty fan motor, allow rapid cleaning or sanitizing of the entire unit between product runs.

610-814-2400 • flexicon.com

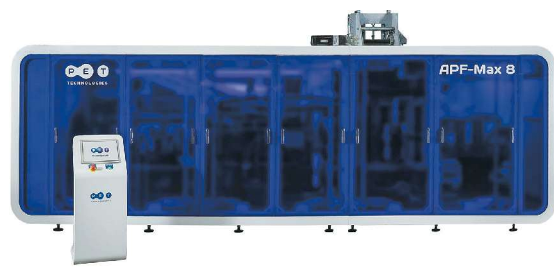
BLOW MOLDING

New Series of Flexible, High-Speed PET Stretch-Blow Molders

PET Technologies GmbH has brought to market its fourth generation of PET reheat stretch-blow molding machines, called APF-Max, with output range 6000-14,000 bottles/hr for bottles of 0.2–3.0 L. The product range consists of three basic models: APF-Max 4, APF-Max 6, APF-Max 8. The machines are all-electric with B&R PLC control. The company is based in Austria and manufactures machines in Ukraine.

NPE2018 THE PLASTICS SHOW

APF-Max series has 4, 6, or 8 cavities. A machine originally purchased for 7000 bph can later be modified for up to 14,000 bph by installing extra ovens and mold cavities. Mold cavities can be added or removed individually. The company says 15 min are enough to change the blow mold and start to produce another bottle format. All 108 collets in the oven can be replaced in 15 min. And customers report that only 2 hr are needed for change-over to another preform neck standard.



APF-Max is equipped with a special short-wave near-infrared (NIR) heating system. Although not a common heating method for PET blow molding machines, the company says it makes preform heating more efficient and consumes less power. The oven itself is said to be significantly shorter than on other machines, making for a more compact footprint.

PET Technologies makes other reheat machines for hot-fillable containers and products up to 4.5 gal size. It also builds filling, labeling, and packing machinery and PET container molds for its own machines and for those from Sidel, Krones, SIPA, KHS, and others.

917-809-4742 • pet-eu.com

BLOW MOLDING

Injection-Blow Molder Gets a Speed Boost

At Chinaplas last month, Jomar Corp., Egg Harbor Township, N.J., introduced the TechnoDrive 65 injection-blow molding machine. It's a faster version of the company's Model 65, with 52-ton preform clamp. It has a dry-cycle time of only 1.8 sec, a full second faster than the Model 65. According to Jomar, what makes this possible is a closed-loop hydraulic-cylinder system on the clamp, which provides so much tighter control of position and speed that the clamp can move much faster without the "slamming" that might otherwise occur. In fact, the clamp stops at mold touch, then completes closing and pressure buildup. The result is fast closing while prolonging the life of molds and reducing jarring of cylinder seals, one of the main causes of oil leaks.

The closed-loop clamping system is adapted from Jomar's new IntelliDrive models of 72 to 175 tons, which use hydraulic pumps with servo and variable-frequency drives on the injection and clamp, respectively. For the 50-hp drive of the TechnoDrive 65, servo and VFD pumps are not cost-effective, according to Jomar.

Both IntelliDrive and TechnoDrive presses use a radial piston motor on the plasticating screw, which has superior durability and 11% greater efficiency, the company says. Both types of machines also have remote-access capabilities that allow Jomar's service department to connect with the machine via the internet.

609-646-8000 • jomarcorp.com

MATERIALS HANDLING

Bulk-Bag Unloader Keeps Spout Taut

The Model 820 Bulk Bag Unloader from Acrison Inc., Moonachie, N.J., features a patented bag-spout clamping mechanism for unrestricted access to the bag's discharge spout. The clamping mechanism keeps the spout taut during the bag emptying process, and is quickly and easily attached via a simple, manually operated clamshell clamp.

An optional bag-spout closure valve that is pneumatically operated closes off the bag's discharge spout, allowing it to be retied for removal of a partially empty bag. The Model 820 is also available with a dust collection system that also assists in deflating an empty bag, as well as bag-lifting racks that automatically maintain upward lift on the bag and bag liner to facilitate product discharge.

201-440-8300 • acrison.com

MATERIALS

Easy-Clearing Universal Purging Compound

A new universal purging compound that reportedly completely removes carbonized material from the screw, barrel and nozzle of an injection molding machine is being launched in North America at NPE2018 by machinery supplier Md Plastics, Columbiana, Ohio. Manufactured by the U.K.'s Aquapurge, Barrel Blitz Universal (BBU) is made from a stable, easy-clearing polymer and Aquapurge's proprietary Scrubber Concentrate.

This mechanical purging compound is effective from 320 F to 698 F, so it's suitable for higher-temperature materials. It is said to be easily cleaned out by any material, including clear ones, and is supplied as a free-flowing powder. BBU boasts fast, smooth color changes by removing all trace of the previous job from the barrel. According to Md Plastics, one molder switched from a black part to a white part within six shots by feeding just 6 kg (13.23 lb) of BBU through the hopper.

In addition, difficult material changes such as running PE before PC, which can lead to milky moldings, are reportedly solved when using BBU. Recent formulation changes have simplified the process for removing a high-temperature material like nylon before molding a lower-temperature material such as a TPE.

330-482-5100 • mdplastics.com

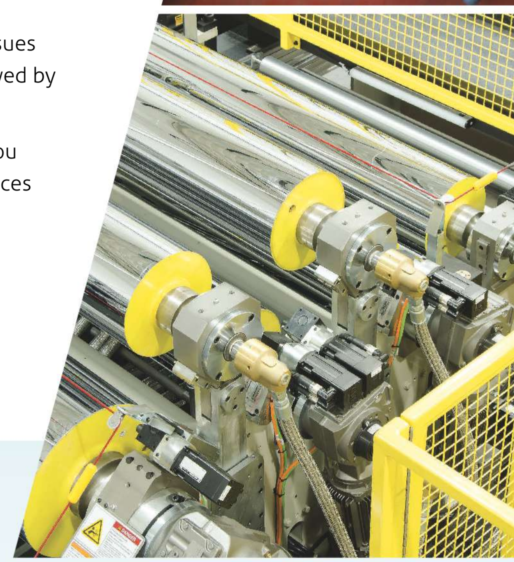
MATERIALS

New Source of PES Resins

A distributor of high-performance engineering thermoplastics, Conventus Polymers LLC, Parsippany, N.J., is highlighting the latest addition to its product line at NPE2018: Paryls PES (polyethersulfone) from China's UJU New Materials Co. Ltd.

Conventus has been an exclusive distributor of UJU's Paryls polysulfone (PSU) and polyphenylsulfone (PPSU) products since 2013. Conventus now also offers three Paryls PES grades with varying viscosities. PES provides high heat resistance (Tg of 225 C/437 F), combined with excellent dimensional stability, creep resistance, chemical resistance, and electrical properties.

973-343-7669 • conventuspolymers.com



Inset photos courtesy of (from top to bottom): Windmoeller & Hoelscher Corp.; Processing Technologies International LLC.; Gardner Business Media, Inc.

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Contact Ryan Delahanty | +1 630-345-3465 | ryand@gardnerweb.com

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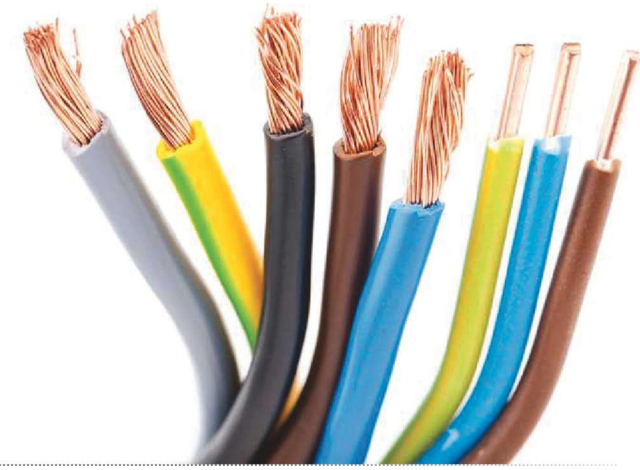
MATERIALS

Low-Smoke, Zero-Halogen CPE Wire & Cable Compounds



SACO AEI Polymers, Sheboygan, Wis., a global producer of cross-linked PE (XLPE) compounds and low-smoke, zero-halogen additives, is exhibiting its wire and cable compound technologies, as well as several new, patent-pending low-smoke, zero-halogen technologies at NPE2018.

Pexidan moisture-cure XLPE is said to offer outstanding long-term performance with superior strength, toughness and resistance to heat, chemicals, abrasion and creep. It boasts easy processing by most techniques.

Thermodan Advanced Low Smoke Zero Halogen and CPE-based sheathing compounds are said to provide an excellent balance of properties, suiting them for demanding applications. Performance characteristics include excellent chemical resistance, flexibility, low-temperature resistance, and inherent flame retardancy.

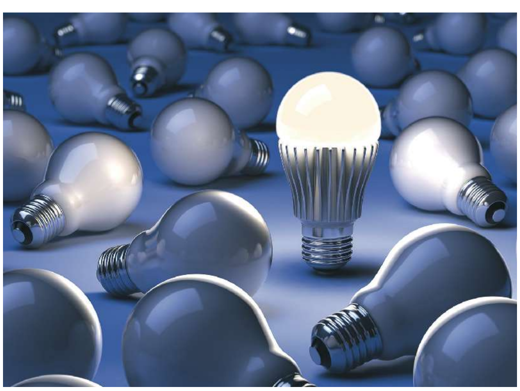
844-722-6234 • sacoaei.com

MATERIALS

Thermally Conductive Nylon 6 Compounds

To meet increasing demand for thermally conductive thermoplastics in industries such as automotive, E/E, and lighting, Pittsburgh-based Lanxess has developed four new compounds in its Durethan TC (thermally conductive) nylon 6 portfolio.

High reflectivity and flame retardancy, along with excellent thermal conductivity and tracking resistance, are claimed for a developmental nylon 6 compound. Its thermal conductivity is direction-dependent due to the mineral filler particles and equals 2.5 W/m-K in the direction of melt flow (Nanoflash method.) This halogen-free flame-retardant compound achieves UL 94V-0. Despite the significant concentration of thermally conductive particles, the compound reportedly can be processed as easily as nylon 6 with high glass-fiber content and exhibits a low level of tool abrasion. It's targeted to heat sinks and support profiles for LED lights, LED cooling fins for automotive headlamps, and battery-system housings and cell holders.



Alternatives to compounds filled with boron nitride or aluminum oxide are two new easy-flowing nylon 6 compounds filled with a special thermally conductive mineral that comprises 65% and 75% of the compound's weight, respectively. Durethan BTC65H3.0EF and BTC75H3.0EF have thermal conductivity of 1.3 and 1.7 W/m-K, respectively, in the direction of flow. Their thermal conductivity is also almost entirely isotropic, meaning they dissipate heat nearly equally in all directions. Both compounds reportedly offer an excellent price-performance ratio. They are said to offer heat dissipation as good as that of aluminum oxide systems and to have better mechanical properties than boron nitride-filled nylon 6.

Excellent flame retardancy in accordance with DIN EN 45545 is claimed for new, easy-flowing, halogen-free Durethan DPBM65XFM30. This glass-fiber and mineral-filled compound is designed for moderate thermal conductivity. One of its strengths is excellent flame retardancy. It achieves UL 94V-0 and also meets the highest classification of Hazard Level 3 in tests pursuant to the German DIN EN 45545 standard for fire protection on railway vehicles in specific applications such as chokes, voltage transformers, windings, contactors, and switches. Other applications include medium-voltage insulating parts, solenoid valves, and high-current circuit breakers.

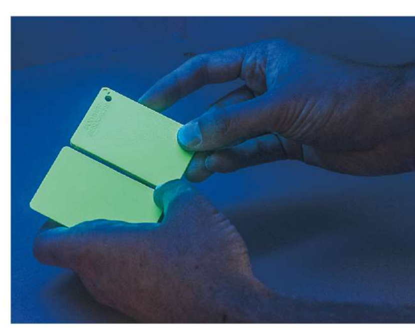
412-809-1000 • lanxess.com

MATERIALS

Specialty Alloys For Electrical & Weatherable Products

A new expedited service—Express Services, for color matching or rush orders, and additional stocking programs for shorter delivery times, as well as the addition of multiple warehouse locations—is being featured NPE2018 by Polymer Resources Ltd., Farmington, Conn. The company is also highlighting its custom engineering resin compounds. Among its newest additions:

- A PC/PBT for natural and all-color listing in the electrical market. This impact-modified alloy has high UL ratings of 94V-0, 5VA and F1, suitable for housings, connectors and other electrical components.



- PC/ASA blends that are both impact modified and have strong weatherable performance. The company has invested in weathering data for lawn & garden and outdoor recreational and industrial equipment.

800-243-5176 • prlresins.com

ADDITIVES

Conductive Carbon Black For Automotive

A new specialty conductive carbon black is being launched at NPE2018 by Orion Engineered Carbons, Kingwood, Texas. Said to be suited to thermoplastic automotive parts that require conductivity for trouble-free painting, XPB 633 Beads are also said to be suitable for electronic packaging and for blown films for a range of packaging uses.

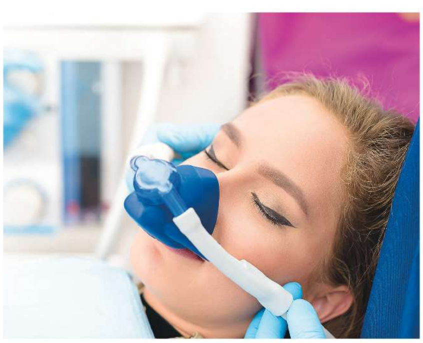
Excellent dispersion is claimed for XPB 633 Beads, which reportedly also improve melt flow and mechanical properties, compared with the company's previous grade.

832-445-3300 • orioncarbons.com

MATERIALS

Medical TPEs Launched at NPE

Elastocon TPE Technologies, Springfield, Ill., is unveiling its latest compounds for medical applications at NPE2018. Having recently passed USP Class VI testing for respirators and other medical applications, two new grades—Elastocon 8028N and 8068N—can be injection molded, extruded or overmolded. These reportedly odorless grades are formulated to provide high flow, flexibility (28A and 68A Shore hardness), excellent cold-weather stability, UV stability, good surface finish, and resistance to chorine and most sanitizers as well as many cleaning products.



These new grades offer designers and manufacturers of medical, industrial and consumer products, and particularly respirators, a full complement of design flexibility. These new grades are the latest additions to the extensive Elastocon 8000 Series TPEs. The firm also can develop custom grades for specialized applications.

888-644-8732 • elastocon.com

ADDITIVES

Variegated Effects Colorants For Polyolefin Consumer Goods

A new line of colorants for polyolefins from Teknor Apex Co., Pawtucket, R.I., allows injection and blow molders to impart variegated colors that add shelf appeal to consumer goods or have practical functions for products used indoors and outdoors. The company is showcasing the new CampTek concentrates at NPE2018.

These colorants can be used to enhance the appeal of products such as containers, lunch boxes, coolers, or can yield a "camouflage" look for products like kayaks or fishing-tackle boxes. CampTek concentrates contain proprietary formulations that yield mottled, swirled, streaked, or other variegated effects in products molded on standard equipment, requiring only an adjustment to process parameters. This is key, as improvements in screw design and mixing on modern processing equipment no longer make it possible to easily achieve such effects.

401-725-8000 • teknorapex.com

INJECTION MOLDING

New Source of Moldflow Training

RJG Inc., Traverse City, Mich., now offers online and in-plant training courses in Autodesk Moldflow simulation. Attendees learn to create digital prototypes, run analyses and interpret results. The course covers fill, pack, cooling and warpage analyses, evaluating an injection molded part for manufacturability, interpreting CAD geometry for runners and cooling lines, and learning how to evaluate simulation results to make sure they are reliable.

Individual courses cover Autodesk Moldflow Adviser, Autodesk Moldflow Insight Fundamentals, Moldflow Insight Advanced Flow, and Moldflow Insight Advanced Cool and Warp.

To deliver these courses, RJG hired an expert in the field. Ana Maria Marin has over 20 years of experience in plastics, specializing in simulation. She worked as an instructor at Autodesk Moldflow and is an Autodesk Authorized Trainer and RJG Qualified Trainer. Bilingual in English and Spanish, she has provided instruction to more than 1300 corporate customers.

The first classes began last month and more classes will be added in Gibsonville, N.C., in November.

231-947-3111 • rjginc.com

EXTRUSION

Next-Generation Coating and Layer-Thickness Measurement

Sensory Analytics, Greensboro, N.C., says its SpecMetrix systems allow measurement precision down to sub-micron levels on products that have not previously been measurable using older in-line gauging technology. The optical interference (ROI) technology designed into all SpecMetrix In-line systems is reportedly built to withstand the rigors of manufacturing. The system's broad wavelength range reportedly can accurately monitor wet or dry coating or film layer thickness as low as 0.25 micron across a web, performing more than 150 measurements/sec.

SpecMetrix systems can measure single or double layers simultaneously and individually, helping film processors identify underlying problems with a particular layer in the film stack. SpecMetrix measurement capabilities range from sub-micron barrier layers to thicker base films. These systems are available in fixed probe, traversing or OEM configurations for ease of integration onto new or existing plant coating lines.

336-315-6090 • specmetrix.com

INJECTION MOLDING

New Alternative to Band Heaters For Small Injection Barrels

APSX LLC in Blue Ash, Ohio, is a manufacturer of aftermarket automotive electronics that designed and built its own desktop (7.5-ton) plunger injection machine to mold the plastic parts it needs (see March '17 Close-Up). This experience gave the firm a first-hand appreciation of the limitations of standard band heaters, which are susceptible to damage, burnout, and frequent replacement. They also lose a substantial portion of heat to the ambient air.

In response, the two engineers who founded the company created their own barrel heater for their machine and any other of similar size. The new design encases four straight cartridge heaters in a 6061 aluminum housing. The heaters, surrounded by heat-transfer compound, are arranged parallel to the axis of the injection barrel and are spaced evenly around the circumference at 90° intervals.

Through extensive testing on the APSX-PIM desktop injection machine, the company claims that the new heater design improves heat retention and has greater durability and longevity than heater bands. What's more, there is no need for internal thermocouples. The cost of the new heater is said to be comparable to that of a regular band heater with internal thermocouple.

The new heater is sized for the 2.5-in.-diam. barrel of the APSX-PIM machine, but it can also be used on other machines with the same barrel size. APSX says that if there is sufficient interest, the firm could produce similar heaters for different barrel sizes.

513-716-5992 • apsx.com

Mixed Bag for Commodity Resin Prices

Following price increases for most resins except PP, a flat-to-downward trajectory emerged.

By Lilli Manolis Sherman
Senior Editor

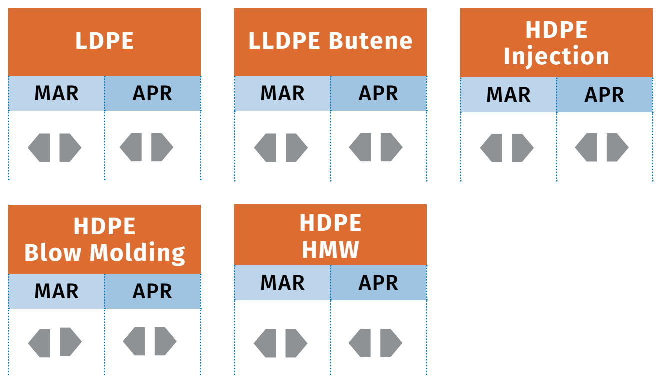
While PS, PVC and PET prices moved up in March, a reversal of those increases was expected by this month. Driving prices back down was a combination of falling feedstock costs and improved monomer and polymer availability. Meanwhile, PE prices remained flat despite a March increase that was delayed until April but did not appear to have teeth. If anything, there was potential for continued flat or even lower prices going into May. The exception was PP, with a double-digit drop going into April. Falling feedstock prices, a drop in export demand, and some improvement in material availability were among the drivers, though a margin-expansion price hike was looming for May.

These are the views of purchasing consultants from Resin Technology, Inc. (RTi), Fort Worth, Texas (***rtiglobal.com***), CEO Michael Greenberg of the Plastics Exchange in Chicago (***theplasticsexchange.com***), and Houston-based *PetroChemWire* (*PCW*, ***petrochemwire.com***).

Market Prices Effective Mid-April 2018

Resin Grade	¢/lb
POLYETHYLENE (railcar)	
LDPE, LINER	101-103
LLDPE BUTENE, FILM	87-89
NYMEX 'FINANCIAL' FUTURES	48
MAY	48
HDPE, G-P INJECTION	103-105
HDPE, BLOW MOLDING	93-95
NYMEX 'FINANCIAL' FUTURES	50
MAY	50
HDPE, HMW FILM	110-112
POLYPROPYLENE (railcar)	
G-P HOMOPOLYMER, INJECTION	77-79
NYMEX 'FINANCIAL' FUTURES	57
MAY	57
IMPACT COPOLYMER	79-81
POLYSTYRENE (railcar)	
G-P CRYSTAL	115-117
HIPS	121-123
PVC RESIN (railcar)	
G-P HOMOPOLYMER	85-87
PIPE GRADE	84-86
PET (TRUCKLOAD)	
U.S. BOTTLE-GRADE	72

Polyethylene Price Trends



PE PRICES FLAT TO LOWER

Polyethylene prices were flat in March and were expected to remain so in April, with potential even for some downward movement this month, according to Mike Burns, RTi's v.p. of client services for PE. Burns, *PCW*, and The Plastic Exchange's Greenberg all wagered that suppliers might aim to push through the 3¢/lb March increase in April, but they doubted such a move would succeed.

"Producers will take another shot in April, but processors feel the top of the PE market might already be in place," reported Greenberg. *PCW* noted that pricing momentum appeared lost amid soft domestic demand. Both sources characterized spot PE prices as flat to lower, with weakened buying activity on both the domestic and international fronts. Greenberg reported particular weakness and decline of as much as 4¢/lb for LDPE and LLDPE injection grade as more material has become available

Said Burns, "Global PE prices were much lower heading into April, as there's a lot of supply available. Also, China is not importing any resin right now, which has been clogging things up." Burns emphasized that North American PE prices must remain no more than 7-10¢/lb above the global price level to retain export demand. He noted that off-grade PE prices are back down to pre-Hurricane Harvey levels, while spot ethylene monomer prices in March were near a 10-year low.

Burns expected "a lot of pricing discussions" at NPE2018 this month in Orlando, Fla. "Processors are now paying 14¢/lb more, than they expected in late 2017 when doing their budgets. They thought prices would drop by 3¢ this year and instead, prices went up 11¢/lb." Still, he foresaw downward pressure going into this month but did not expect a major decline—say, on the order of 3¢/lb.

PP PRICES DROP

Polypropylene prices dropped another 6¢/lb in March, in lock step with propylene monomer contracts, following the 6¢/lb drop in February. While late-settling April monomer contracts were expected to be flat to down by 1-2¢, several PP suppliers had issued price increases of 3-5¢/lb for April 1. Industry sources were doubtful about full, if any, implementation of such increases.

RTi's v.p. of PP markets, Scott Newell, noted that the proposed April hike is an attempted margin increase. He expected PP prices in April would be close to flat—plus or minus at most 1-2¢/lb. He expected similarly stable pricing in May, barring any major unplanned occurrence. He noted that PP suppliers claimed supply tightness and being sold out, though plant utilization rates were under 80% of capacity for the first two months of the year. Newell expected an increase in production rates and in demand between March and May, thereby returning at least to normal levels.

There were some contrary indicators, however. *PCW* reported that PP spot prices were steady, though availability of prime material was limited because of low operating rates in the first quarter. The Plastics Exchange's Greenberg reported that spot market demand was off as buyers anticipated further price decreases, even though suppliers with very little inventory feel otherwise. Regarding the announced price increase for April, he noted, "It has been a while since a margin-enhancing increase has held, but fundamentals are currently leaning toward some level of success."

Polypropylene Price Trends

Homopolymer	
MAR	APR
▼ 6¢/lb	◀▶

Copolymer	
MAR	APR
▼ 6¢/lb	◀▶

PS PRICES UP, THEN DOWN

Polystyrene prices generally moved up 4¢/lb in March, as suppliers forced through an increase. The move was attributed to tight styrene monomer supplies due to unplanned outages. However, both *PCW* and Mark Kallman, RTi's v.p. of client services for engineering resins, PS and PVC, were projecting a short life for that increase.

Kallman expected a falloff of at least 1-2¢/lb in PS prices in April, with the rest the March 4¢ increase slipping away by early May.

PCW reported that overall spot PS availability was adequate, as the first-quarter monomer outages appeared to be having minimal impact on PS operations. "The U.S. styrene supply situation was loosening up significantly," *PCW* reported. Kallman noted that benzene contract prices for April dropped 7¢/gal to $2.99/gal, while March ethylene contracts were expected to drop for a second consecutive month by another 1-1.5¢/lb. Another month of declines was considered likely for both chemicals. Kallman expected PS prices to remain flat in May.

Polystyrene Price Trends

GPPS	
MAR	APR
▲ 4¢/lb	▼

HIPS	
MAR	APR
▲ 4¢/lb	▼

PVC PRICES UP, THEN FLAT

PVC prices appeared to have moved up 2¢/lb in March, following implementation of the February 3¢/lb price hike. *PCW* reported that while suppliers were still aiming to pursue in April the remaining 2¢ of their March 4¢ hike, it appeared that neither this nor an attempt by two suppliers for a new April increase would be implemented. RTi's Kallman also ventured that the 2¢/lb already gained would come off in April due to improved PVC capacity following planned maintenance turnarounds.

Kallman also cited lower ethylene contract prices, a softening in export demand with lower prices abroad, and a delay in the construction season due to weather conditions. He predicted stable prices for May, barring sharp demand spikes. *PCW* indicated that suppliers would aim to hold onto their total of 5¢ in price hikes as long as possible. "Their hope is to repeat last year's feat of stable pricing for six months. The consensus in the market is that their success will be determined in large part by what happens in the ethylene market, as continued weakness in ethylene pricing will undoubtedly put pressure on PVC prices."

PVC Price Trends

Pipe	
MAR	APR
▲ 2¢/lb	▼

Gen. Purpose	
MAR	APR
▲ 2¢/lb	▼

PET PRICES FLAT-TO-DOWN

PCW reported that domestic bottle-grade PET resin started April at 72-74¢/lb truckload and railcar delivered Midwest, up 1¢/lb from March. However, prices were expected to be flat or to drop 1-2¢/lb during April, driven by falling feedstock costs and a steady supply from domestic production and imports. Meanwhile, imported PET with an IV of 78 or higher was at 69¢/lb delivered duty-paid (DDP) to the West Coast, and 72¢/lb DDP to the East Coast, no change from March 1.

Anti-dumping duties were slated to be imposed on U.S. PET imports from South Korea, Indonesia, Taiwan, Brazil and Pakistan in late April. This was expected to produce an overall drop in imports starting in May and through the summer as those five countries accounted for about 42% of all U.S. PET imports in 2017. PT

PET Price Trends

Bottle Grade	
MAR	APR
▲ 0-2¢/lb	▲ 1¢/lb

Plastics Processing Closes Best Quarter in Recorded History

March comes in at 57.7. Index for the first-quarter of 2018 reaches 57.1

By Michael Guckes
Chief Economist

Hitting 57.7 in March, the Gardner Business Index (GBI): Plastics Processing index hiked the overall first-quarter index to 57.1, its best quarter in recorded history. The index is based on responses to a monthly survey from subscribers to *Plastics Technology* magazine.

New-orders growth was slightly slower than production growth for the first time since the fourth quarter of 2017. Supplier deliveries expanded strongly in March, which should support faster production growth in future months. March's index reading was driven higher by production, supplier deliveries, and new orders. Backlog, employment, and exports all pulled the Plastics Processing Index, which is calculated as an average, lower during the month. All components of the index—except for exports—experienced growth during the month.

Among only custom processors, March represented the second-best reading in the history of the index. The index was higher only once before, in early 2014. Growth among custom processors has continually accelerated over the last five months. In March, custom processors reported that supplier deliveries expanded very sharply, while growth in new orders and production increased, but at a slower rate than reported in February.

Michael Guckes is the chief economist for Gardner Intelligence, a division of Gardner Business Media, Cincinnati. He has performed economic analysis, modeling, and forecasting work for nearly 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*.

GBI: All Processors vs. Custom Processors

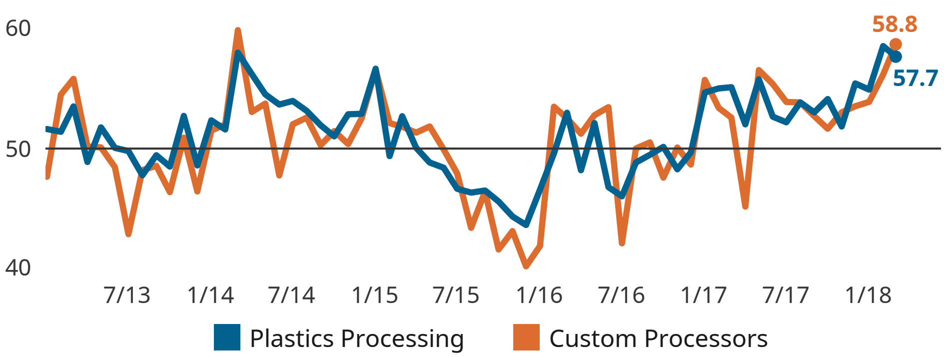


FIG 1

March results indicate that the Plastics Processing Index just concluded its best quarterly performance in history. New orders, production and supplier delivery activity all experienced significant growth during the quarter.

GBI Plastics Processing: Production & Supplier Deliveries

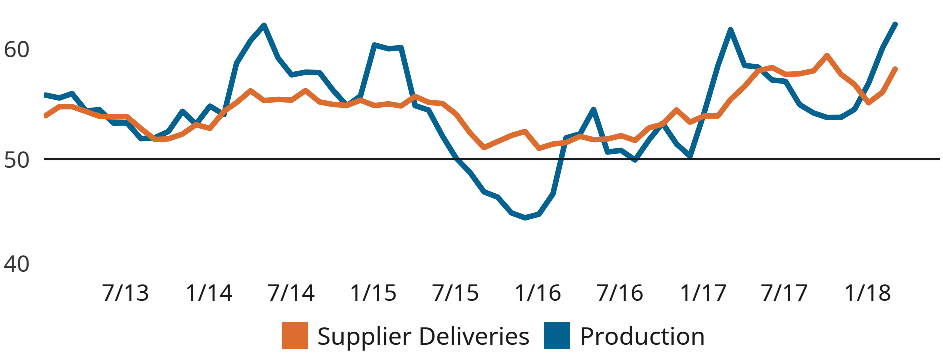


FIG 2

Suppliers to plastics processors increased their shipments during the first quarter of 2018, which helped support strong production readings. Despite increased activity by suppliers and processors, backlogs grew at an increasing rate throughout the first quarter of the year.

Construction to Continue Healthy Growth in 2018

Housing market data in seventh year of improvement

By Michael Guckes
Chief Economist

At nine-years' old, the current economic expansion in America has lasted longer than most other economic expansions—and probably longer than most economists have expected. For many business leaders, knowing that the economy is due to for a pull-back may be reason to hedge against expanding business and taking on new risks. In some end-markets this may be prudent, but of all markets, data from housing indicates that there is very little chance of a slowdown even in the event of a short-lived recession.

According to U.S. demographic and housing data through January 2018, the industry continues to make solid gains for the seventh straight year. The fundamentals supporting this growth give Gardner Intelligence confidence that this market remains substantially underserved; that is, even in the event of an economic slowdown at some point in the next few years, odds are that the housing market will be a source of strength, rather than a weakness for the economy.

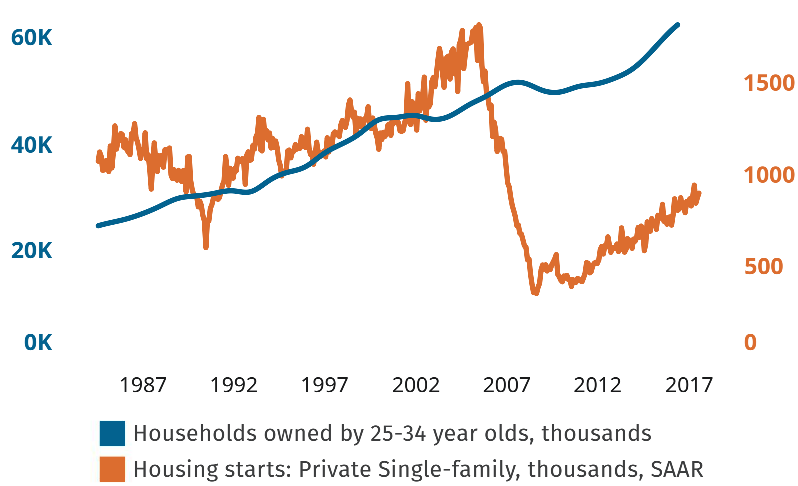
Between the great recession and 2016, demographic data indicated a decline in homeownership rates among those between the ages of 25 and 39. At the same time, the number of households created in this same age range has increased every year since mid-2010 and is now 20% higher than at the peak of the 2007 housing boom. This combination of lower ownership rates and high household formation has created a foundation for additional housing that will be especially sharp in light of rising wages and low unemployment, which may move more families into the category of homeowner.

Strong demographic trends and good home affordability will produce substantial tail-winds in the housing markets.

Housing starts have progressively improved every year since 2009; however, even the latest annualized housing construction rate of 900,000 homes is more than 20% *below* the average home starts rate between 1985 and 2001 of greater than 1.1 million homes. Low housing-start levels in recent years also come at a time when housing affordability is better now than at any time prior to 2008. Housing affordability, which hit a multi-decade high in 2012, has fallen since, yet is still significantly better than at any time between 1985 and 2007. Looking forward, should the Federal Reserve raise interest rates, as is expected to happen several times in 2018, this will increase mortgage interest rates, increasing the cost of home ownership, hurting the housing affordability index.

Despite the increased chances of a slowing economy at some point in the future, strong demographic trends and good home affordability will produce substantial tail-winds in the housing markets. Manufacturers and fabricators looking to diversify and grow should keep watch for opportunities for their companies to grow in this market.

New Home Sales Under $300K To Help Drive Packaging Demand



The number of young adult (25-43 yr old) households has grown 20% in the current economic cycle, while housing starts are still below their long-term creation level. This combination of events, combined with strong home affordability, will act as a basis for continued housing market expansion in 2018 and beyond.

ABOUT THE AUTHOR: Michael Guckes is the chief economist for Gardner Business Intelligence, a division of Gardner Business Media (Cincinnati, OH US). He has performed economic analysis, modeling and forecasting work for nearly 20 years among a wide range of industries. Michael received his BA in political science and economics from Kenyon College and his MBA from The Ohio State University. *mguckes@gardnerweb.com*

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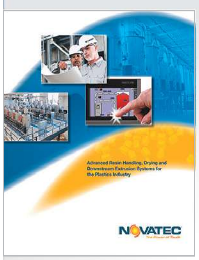

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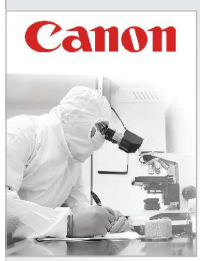

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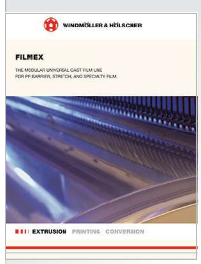

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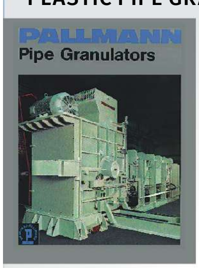

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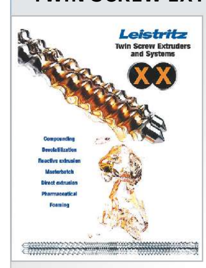

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PSI MOLDED PLASTICS — WOLFEBORO, N.H.

Newly Merged Molder Beefs Up EMI-RFI Shielding Operations

PSI Molded Plastics' mechanized copper-paint line can handle large parts.

By Lilli Manolis Sherman
Senior Editor

A significant expansion of its in-house electromagnetic interference (EMI) and radio-frequency interference (RFI) shielding capabilities enables PSI Molded Plastics to reduce overall product cost for customers who find it advantageous to keep the entire process—from molding to finishing—under one roof. The new 9000 ft² paint facility was completed by GI Plastek in Wolfeboro, N.H., prior to its merger with its two sister injection molding companies—Precision Southeast Inc., and Plastics Solutions—into PSI Molded Plastics, all owned by publicly traded business-development company Gladstone Investment Corp.

Rick Collopy, v.p. of sales & marketing, says the new painting and RFI shielding line is 50% larger than the firm's previous line. "It has resulted in both a 40% increase in capacity and has increased capability with the addition of more booths," explains Collopy. The $1-million investment has enabled the company to apply shielding to parts as large as up to 4 × 5 ft on a mechanized production paint line.

Spray-on shielding reduces the number of parts used on instruments, eliminating the cost of a box within a box and associated attachment parts.

PSI (*psimp.com*) applies a copper shielding emulsion onto plastic molded parts to eliminate EMI-RFI penetration that could disrupt sensitive components and circuits in electronic equipment and potentially throw off instrument calibration. The shielding is also used to eliminate emissions from healthcare instruments that could interfere with other patient-care equipment and affect patient safety. Collopy notes that the paint operation is used primarily for shielding of electronics of large laboratory and healthcare equipment. He estimates that the medical/healthcare/diagnostic equipment segment is about 25% of this injection molder's business.

Copper-emulsion spray painting holds advantages over other forms of EMI/RFI shielding.

The expanded paint operation runs two shifts a day, five days a week, increasing throughput potential. The line has four drafted booths for priming, painting, coating and texturing operations, along with an in-line convection oven. PSI can spray EMI and RFI shielding onto most substrates.

Collopy notes that copper-emulsion spray painting holds advantages over other forms of EMI/RFI shielding for plastics, particularly for shielding larger diagnostic and healthcare equipment. Conductive spray-on material is a far more cost-effective option than large, heavy sheet-metal liners or enclosures. Spray-on shielding reduces the number of parts used on instruments, eliminating the cost of a box within a box and associated attachment parts. This in turn reduces overall product cost.

The PSI Molded Plastics merger, which includes manufacturing facilities in Wolfeboro, N.H.; South Bend, Ind.; and Myrtle Beach and Marion, S.C., has expanded the company's presence into a variety of markets, including automotive, healthcare and diagnostics, appliances, materials handling, filtration, sports & leisure, industrial, and lawn & garden. PSI's injection molding capabilities include gas assist, structural foam, and overmolding, along with in-house tooling.

In addition to supporting customers' injection molded component requirements—from large parts to small, and from low to high volumes, the new organization also offers post-mold finishing, painting and decorating, and assembly capabilities, as well as automotive certifications.

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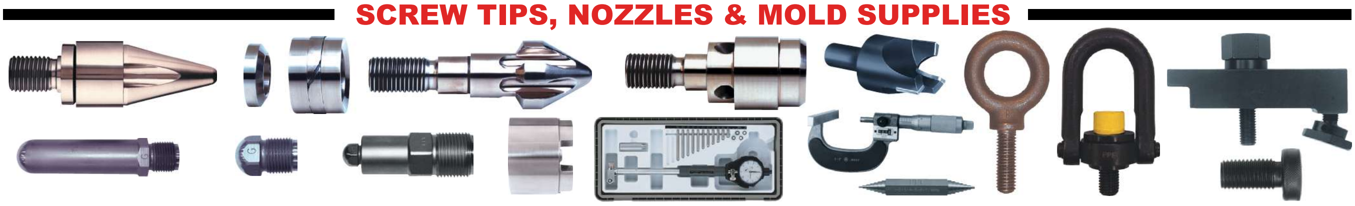

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