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PUBLISHER	Jeff Sloan *jsloan@gardnerweb.com>*
ASSOCIATE PUBLISHER/ EDITORIAL DIRECTOR	Jim Callari *jcallari@ptonline.com*
EXECUTIVE EDITOR	Tony Deligio *tdeligio@ptonline.com*
ASSOCIATE EDITOR	Matthew Stonecash *mstonecash@ptonline.com*
MANAGING EDITOR	Angela Osborne *aosborne@gardnerweb.com*
CONTRIBUTING EDITORS	Matthew Naitove *mnaitove@ptonline.com* Lilli Manolis Sherman *lsherman@ptonline.com*
SENIOR CONTENT MANAGER	Sarah Barnett *sbarnett@gardnerweb.com*
ADVERTISING SALES	Lou Guarracino *loug@ptonline.com* Jackie Dalzell *jdalzell@ptonline.com* Dale Jackman *djackman@gardnerweb.com* Madeline Kline *madeline.kline@gardnerweb.com*
ART DIRECTOR	Sheri Kuchta Briggs *sbriggs@gardnerweb.com*
MARKETING MANAGER	Andrew Roe *aroe@gardnerweb.com*
AD PRODUCTION COORDINATOR	Patty Caldwell *pcaldwell@gardnerweb.com*

Subscription Inquiries: For questions or issues related to your subscription, please call 513-527-8800 or email subscribe@ptonline.com.

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GARDNER Business Media, Inc.
6915 Valley Avenue
Cincinnati, OH 45244-3029
Phone 513-527-8800
Fax 513-527-8801
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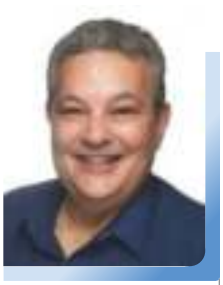
First Reflections of NPE2024

After a six-year hiatus, this year's show was a resounding success, with meaningful technologies on display that will help processors run their businesses more efficiently.



Jim Callari
Editorial Director

Over the next three or four months, we will get into the nitty-gritty of what was on display last month in Orlando, Florida, at NPE2024. For now, suffice to say that trends such as sustainability, recycling, energy efficiency, automation, smart machinery/artificial intelligence and more will be coming to a processing plant near you in the future.

By virtually every standard, NPE2024 was a success. After a six-year hiatus brought about by the cancellation of the 2021 show due to COVID-19, there was a palpable excitement on the show floor, with processors hustling from booth to booth looking for new technology to solve their problems. Early numbers from the Plastics Industry Association suggest the industry is getting younger. Of the more than 50,000 registrants, 63% said it was the first NPE they ever attended, with some 30% of attendees revealing they were under the age of 40.

Exhibiting at a trade show the size and scope of NPE is no inexpensive endeavor. In fact, quite a few exhibitors invested seven-figure sums to bring and operate machinery to the show. In injection and blow molding, it's not unusual to see machines running during a trade fair. This year's show also featured three Italian extrusion machinery suppliers running lines: Bandera and Macchi of the multilayer blown film variety, and a Colines of the cast/stretch film type. *Salute*. This is a testament, I think, of the potential for growth in the North American processing market.

Speaking of international matters, this year's show was also more global than ever. More than 15,000 registrants traveled from beyond the U.S. to attend, making the 2024 show the most international in NPE's history. Representatives from 133 countries — or 68.2% of nations worldwide — registered to attend the global plastics trade show. This represents a 9.9% increase of countries registered at NPE2018.

We will begin our in-depth coverage of new technology from the show floor next month. PT

In Memorium: Mike Sepe

The plastics industry lost a giant when Mike "The Material Analyst" Sepe passed away April 28 after an unexpected illness. He was 71.

A long-time member of SPE, Mike was an invaluable contributor to *Plastics Technology*, authoring a monthly column called "Materials Know-How," for more than 10 years. His final article for us is on page 14 of this issue.

Mike had a 50+ year career in injection molding and worked with processors around the world, helping them solve molding problems or determine why parts failed.

Although he attended Columbia University, where he studied chemistry and anthropology, Mike once told me that much of what he learned about polymer science was self taught, which I found astounding.

Mike started his career in this industry with Stelle Plastics in 1975, where he learned injection molding. After Stelle Plastics, he worked as the technical director of Dickten and Masch in Nashotah, Wisconsin, until 2006. In addition, he established the company's first analytical lab.

After leaving Dickten and Masch, Mike started his own independent consulting business, partnering with his wife, Audrey, who supported him as accountant and office manager.

Mike was a brilliant and prolific consultant, trainer, speaker and writer. He will be missed.

PET Cap and Closure Manufacturing System Launches

Origin Materials, Sacramento, California, which introduced a PET cap in 2023, has partnered with Brückner Group company PackSys Global, a Swiss-based maker of plastic closure slitting machines, on a PET cap and closure manufacturing system. After conducting successful tests of the system at the PackSys' KREA LAB technology center located in its Rüti, Switzerland, headquarters, the companies showcased the results at NPE2024.

PackSys is featuring its TEM-SF Plus slitting and folding machine and its capLAB+ inline unit for checking the tear-off force of the tamper-evident tape (TE tape) on closures. That system ran at Netstal's booth where it was integrated into an Intravis CapWatcher System and was presented together with a Netstal injection molding machine. Packsys and Origin representatives are split between the Brückner Group USA's and Netstal's booths. Packaging supplier Berry Global is also an onsite partner.

Caps are traditionally injection molded or compression molded from HDPE or PP, complicating end-of-life recycling for PET bottles. At this time, a spokesperson for Origin declined to say how the PET caps are initially produced but noted that any PET, including recycled or its own biobased PET, can be used in its production system. Origin also notes that PET offers better oxygen and carbon dioxide barrier than HDPE and PP.

ICIS Launches: Ask ICIS Generative AI Commodities Assistant

London-based global commodities intelligence provider ICIS is launching what is said to be the first-of-its-kind generative AI assistant, called Ask ICIS. This AI assistant is expected to enhance access to ICIS' well-recognized intelligence and insights for the energy and chemicals markets. As commodity markets become more complex and dynamic, the need for both highly accurate and up-to-the-minute information has never been more important. Underpinned by unparalleled chemical and energy market datasets and decades of editorial expertise, Ask ICIS essentially combines ICIS' vast market intelligence with the power of generative AI technology.

Currently in beta testing, Ask ICIS is available in multiple languages and supported with citations. Ask ICIS enables customers to delve deeper, supporting timely, confident strategic decision-making with comprehensive market intelligence. Sourced exclusively from ICIS' expert data and insight, Ask ICIS connects users to content tailored directly to their needs based on their role, region and priorities. Source citations are built into every response, allowing users to delve deeper and enabling more confident, timely, strategic decision-making. In addition, Ask ICIS also provides bespoke suggested prompts and follow-up questions to enable users to uncover additional insights and "unknown unknowns" to gain an unprecedented view and understanding of market events.

Uniloy Enhances Aftermarket Services, Renews Its Machinery Portfolio

Reflecting a business based largely on parts and service, Uniloy highlighted several new programs in these areas at NPE2024. But, behind the scenes, it has begun launching the first fruits of a wide-scale machinery development program.

Among new aftermarket services, Uniloy is spotlighting its new asset-management program, called Mold Maintenance R&R (Repair and Refurbish). Started last year with selected customers and now being rolled out to a larger audience, this program is aimed at customers that have tooling for several hundred cavities of the same bottle. It involves regular maintenance of tooling, some of which is stored at Uniloy for quick shipment to the customer when needed. "This way, customers can get refurbished tooling in 72 hours instead of the usual six to eight weeks," says Uniloy CEO Gary W. Riley Sr. "Also, there's a set charge for the service, eliminating delays for quoting each job."

In addition, Uniloy has increased its service staff almost tenfold over the last two years, through both new hires and certifying independent contractors after training at Uniloy University. The company has also invested millions of dollars in its Uniloy Genuine Parts business, increasing both quantities on hand and the range of part numbers by 30%. In the third quarter, the company will launch an online catalog and store, aimed initially at Uniloy's reciprocating-screw machines, though it will be expanded later to injection-blow and shuttle extrusion lines.

Also new is an interactive electronic machine manual with schematics, bills of materials, safety videos and more. It's available first for Uniloy's UR 100 reciprocating-screw machine.

Without revealing details, Riley hinted that Uniloy planned to announce a mold-making acquisition at the show, which was held last month in Orlando, Florida.

Coca-Cola's Redesign of Small PET Bottles Pushes Lightweighting Below Prior 'Floor'

For the first time in decades, The Coca-Cola Company has completely redesigned its small PET bottles (12, 16.9 and 20 oz.) for sparkling Minute Maid Refreshments and Minute Maid Aguas Frescas soft drinks. The new bottle design will also be extended to Coca-Cola brand carbonated drinks in 20-oz., 100% rPET bottles (excluding caps and labels). All three bottle sizes were trimmed by 2.5 g from 21 g to 18.5 g, an 11.9% weight reduction.

This initiative is expected to reduce the company's use of new PET by more than 30 million lbs in 2025, the equivalent of around 800 million bottles.

Says Alejandro Santamaria, Coca-Cola's senior director of Global Packaging Development and Innovation, "We've been working continuously to 'right-weight' our bottles, going incrementally from 27 g to 21 g over the last 10 years, but we'd reached the 'floor.' The older preforms we were using were not conducive to more lightweighting, so we needed to rethink the design completely and create new preform molds to get below 21 g.

"We used this opportunity to refresh and modernize our bottle designs, while incorporating learnings from past lightweighting initiatives — including how to maximize stretching during the blow molding process and how to design our bottles to minimize the number of weak points. We changed the preform shape (aspect ratio) and leveraged multiple breakthroughs in PET bottle designs through computer modeling.

"Once we landed on a preform that worked for all bottles, suppliers' existing preform equipment was retooled to produce the new 18.5-g preform design, then bottlers supported this sustainability progress by investing in new blow molds."

Program Provides Equipment Maintenance, Overhauls and Upgrades

Maguire's new MOU (Maintain, Overhaul, Upgrade) program is designed to revolutionize how existing customers engage with their equipment, offering a comprehensive suite of maintenance, overhaul and upgrade solutions.

Maguire says the MOU program consolidates its commitment to providing unparalleled customer benefits. It ensures that customers' equipment remains at peak performance levels throughout its life cycle. Highlights of the MOU Program include:

1. **Maintain — Focusing on Long-Term Value:** Under the Maintain tier, Maguire emphasizes the importance of proactive maintenance and service, particularly within the 5-year warranty period. Customers access a wealth of maintenance resources through the MOU Program, including part libraries, exploded views, calibration/maintenance checklists and accredited service.

2. **Overhaul — Built to Last Longer:** The Overhaul tier ensures that Maguire's equipment is built to last. With an effective overhaul, users can extend the life of their products by another 10 to 15 years. Maguire or local authorized distributors evaluate equipment, assess its condition and perform necessary repairs. Regardless of the condition, Maguire guarantees to restore the equipment to "as new" status, backed by a 1-year warranty.
3. **Upgrade — Adding New Features and Capabilities:** The Upgrade portion of the program enables existing users to adapt their equipment as applications evolve. Whether upgrading controllers to the latest generation touchscreen controls, enabling remote controls, adding additional materials to a process or updating hardware for high-temperature operating conditions, Maguire offers a broad range of upgrades for all equipment.

StackTeck Establishes iMFLUX Center of Excellence

High-volume injection mold tooling manufacturer StackTeck Systems Ltd., Brampton, Ontario, is now supporting the iMFLUX low-pressure injection molding process to help its customers meet the challenges of molding recycled materials. Following successfully using this patented technology to qualify a range of postconsumer recycled (PCR) resin grades, StackTeck said it received permission from Procter & Gamble, where the technology was patented, to use and share StackTeck's experience with molders that have iMFLUX-capable machines. In 2023, P&G changed its business strategy for iMFLUX going forward.

StackTeck notes that in its experience, iMFLUX has proven capable of handling large and sudden material property variations in real time. In a release, Jordan Robertson, VP business development and marketing at StackTeck, recounted watching iMFLUX's Automatic Viscosity Adjustment capability handle going from a polypropylene with a melt-flow index (MFI) of 40 to a 5 MFI polypropylene with no shorts or scrap parts. "Based on many years working with PCR resins for thinwall, PCR, horticultural products, the power of this technology was immediately evident," Robertson says.

The iMFLUX process utilizes a closed loop control system to manage injection pressure during every molding cycle based on real-time measurement of the molten plastic in front of the screw. Pressure measurements are taken at a frequency of 1,000 Hz, and the control system maintains a constant injection pressure, regardless of potential variations caused by material changes over time.

Technology Aims to Smarten Up Resin Conveying

At NPE2024, Novatec moves to rewrite the rules for material conveying with patent-pending smart-pump technology.

By Jim Callari
Editorial Director

At NPE2024, Novatec took the wraps off new technology that it says will give processors more power, flexibility and finesse to convey materials in their plant without the need to oversize the system.

Called The Infinity Conveying Pump Series, the patent-pending conveying technology comes on the heels of Novatec's reintroduction of the DryerGenie, which was also displayed at NPE2024. Both are efforts by the machine builder to tear down traditional belief on how these machines operate. In the case of drying, the DryerGenie enables processors to dry based on material condition, as opposed to the traditional method of drying based on time.

Concerning conveying, The Infinity Conveying Pump Series takes aim at the convention of suppliers to engineer plantwide vacuum conveying systems to accommodate the longest distance and the highest velocity the processor could ever need. Notes Novatec CEO Conrad Bessemer, "Both of our new systems are about using 'finesse' and moving past 50-year-old, etched-in-stone commandments for resin drying and conveying."

Bessemer maintains that most suppliers have historically designed conveying systems based on the worst-case scenario. This has meant "overpowering" the vacuum system to accommodate the longest possible conveying distance and/or the highest throughput. This approach, however, comes with consequences in cases where high speed and throughput are not required by the process, such as when machines or other auxiliaries are closer to the vacuum source.

Bessemer elaborates, "Those consequences include high velocities, which are damaging to destination equipment in terms of product wear, especially with the increasing use of abrasive materials. Another issue is the fracturing of material within the lines or deformation caused by excessive heat caused by that high velocity. In addition, because most vacuum conveying systems are designed for the 'worst case,' they have to use higher line sizes, this makes them tough to use with minor accessory add-ons such as feeders or some blenders in typical resin handling systems."

Over the years, suppliers have tried to address these issues with mechanical flow control systems to try to control that rate, but few have had the adaptability or ease of use to truly be practical in a typical plastics processing setting, Bessemer explains.

The Infinity Conveying Pump Series from Novatec offers a higher speed range, is quieter than conventional VFD drives and also has no belts or pulleys. Source (all images): Novatec

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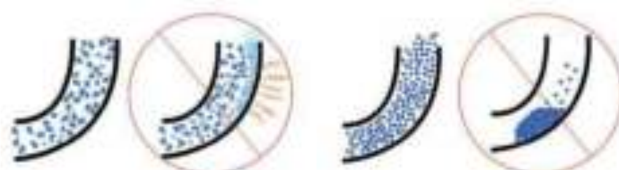
New smart resin-conveying pump can be ramped up to “ludicrous speed modes” of up to a theoretical 150% when necessary, such as to help clear such common issues as line plugging caused by verticals.

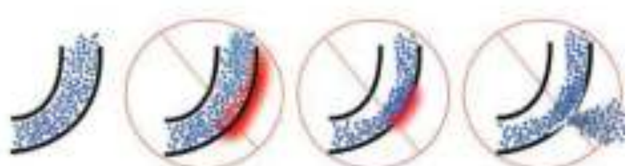
Conveying Heavy and Fragile Materials



Protects Fragile Material from Turning to Dust | Optimizes Heavy Material Flow to Prevent Blockages

New pump design can be finessed to automatically adjust for the pickup velocities and be intelligent enough to slow down at destination to avoid pellet fracturing and abrasion.

Intelligent Conveyance Adaptation



Balances Strong Starts with Gentle Conveyance | Mitigates Angel Hairs | Mitigates Elbow Wear | Mitigates Blown Walls

With its wide range of speed and velocity control, Novatec’s Infinity Conveying Pump Series can mitigate damage done to both material and conveying components such as elbows.

FINESSE PLUS POWER

But with the Infinity Conveying Pump Series, Novatec has endeavored to rewrite the rules by using novel technology commonplace elsewhere and updating/modifying it for plastics. At the heart of the resin conveying rethink is a totally new machinery concept for vacuum conveying pumps. Often isolated because of their noise, these pumps provide the raw power to carry resin from multiple sources to multiple end-use destinations throughout the factory.

But Bessemer says they’ve been traditionally engineered akin to the gas guzzlers of old — raw power sized for the worst possible case. Now, with using Novatec’s own IPM-SynRM motors — originally conceived to power electric vehicles efficiently — the company is able to achieve remarkable finesse in vacuum conveying pumps with speed ranges unheard of before to address the fundamental flaws of these juiced-up systems.

With the replacement of the fan-cooled induction motor, Novatec’s new pump can go down to incredibly low speeds (around 30%), which the company says conventional variable frequency drive (VFD) systems are unable to achieve. At the same time, they can be ramped up into what Bessemer refers to as “ludicrous speed modes” of up to a theoretical 150%, when necessary, such as to help clear such common issues as line plugging caused by verticals. “This dramatic boost in speed ranges achieved by this type of motor over conventional VFD drives gives this series incredible advantages in conveying while also saving about 15% on energy,” Bessemer maintains.

Sensors adjust the pump for changes in elevation, measure power use and detect flow anamolies.

As Bessemer explains, the ability to “finesse” enables the system to automatically adjust for the pickup velocities and slow down at destination to avoid pellet fracturing and abrasion. It’s all done electronically, not through expensive, hard-to-operate mechanical adjustments that Bessemer says are not practical in the plastics processing industry. The pump has no belts or pulleys, which cuts maintenance costs, and runs below the industry limit of 80 db (85 db requires ear protection) set by OSHA. At the show, the Smart Pump ran in the middle of Novatec’s booth at about 70 db.

The new pumps are rounded out by incorporating sensors that automatically alert to low lubrication levels and other service conditions pioneered by Novatec’s MachineSense group. Additionally, new sensors can adjust the pump automatically for changes in elevation in most areas, measure power use and detect anomalies in line flow. Everything is controlled by a modern state-of-the-art system that not only monitors the new pump systems but also the sensors and all the remote destination equipment, such as blenders, feeders, dryers and receivers.

Says Bessemer, “The realities of profit and loss in plastics processing is all about minimizing expensive resin losses and minimizing the time constraints in the process. These two new systems from Novatec — integrated moisture-controlled drying systems with the DryerGenie along with smart conveying with Infinity Conveying Pump Series — are prime illustrations of using modern technology to substantially change the design direction, efficiency, and economics of drying and conveying today.” PT

MATERIALS

PART 3

Let's Take a Journey Into the World of Molding Thermosets

Thermosets were the prevalent material in the early history of plastics, but were soon overtaken by thermoplastics in injection molding applications.

Editor's Note: *With great sadness I must inform readers that Mike Sepe passed away shortly after writing this article. Mike was an superb writer whose insights on polymers were unmatched. He has been a valued contributor to Plastics Technology for more than 10 years, as well as a friend. His passing is a tremendous blow to the industry.*

By Mike Sepe

Thermosets dominated the early history of plastics. This was foreshadowed by the emergence of the rubber industry in the mid-1800s, fueled by the development of vulcanization. Attempts to introduce early thermoplastics based on cellulose were met with fierce and sometimes questionable competitive strategies by the entrenched rubber industry.

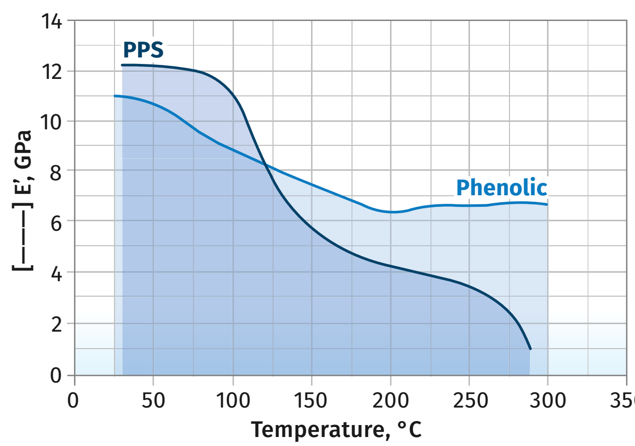
While some of the thermoplastic offerings did become commercial, the most successful early introductions were cross-linked materials, the most notable of these being the first truly synthetic polymer, phenolic. This was followed in the first half of the 20th century by the introduction of epoxies, unsaturated polyesters and silicones.

In parallel, many of the commodity thermoplastics were being developed in the 1920s and 1930s, including polyethylene, polystyrene, PVC and acrylic. The performance profiles of these early introductions were relatively unimpressive, particularly when it came to heat resistance, and the two classes of materials coexisted. But with the introduction of nylons, things began to change. Here was a material with a melting point of 260°C (500°F) that could replace some of the thermoset materials.

Thermoplastic polyesters soon followed, and by the 1950s and early 1960s the development of new thermoplastic polymers with higher performance profiles became an avalanche. By the mid-1970s, there was a general sentiment within the industry that sooner or later a thermoplastic could be developed that would replace any

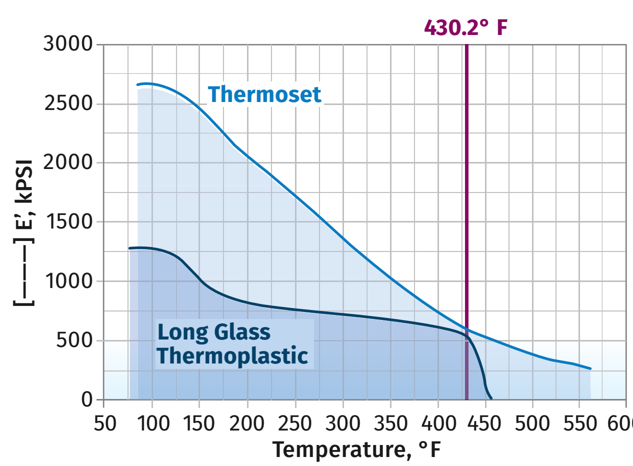
Scan for more expert advice in materials.

FIG 1 **DMA Comparison of Phenolic with 40% Glass-Filled PPS**



At room temperature, the PPS is superior. At the elevated temperatures at which the two materials are likely to be used, the phenolic outperforms the PPS and at a lower cost per pound.

FIG 2 **DMA Comparison of a Crosslinked Thermoset and a Thermoplastic Polyester with the Same HDT**



In comparing a thermoset polyester to a long glass fiber-reinforced thermoplastic polyester, the two materials have the same heat deflection temperature, but the full temperature map clearly shows the advantages of the crosslinked material.

thermoset. Polyimides represented the pinnacle of performance in crosslinked materials, but were closely matched with similar thermoplastic chemistries that included polyamide-imide, thermoplastic polyimides, polyetherimide and even higher heat variants.

The drive to seek these alternatives was due in large part to productivity concerns. While thermosets offered impressive properties, they were not readily converted into molded parts by the big up-and-coming processing method, injection molding. The traditional thermoset molding processes — compression molding and transfer molding — were slower, more manual processes. In addition, because of the low viscosity of the pre-gelled materials, the parts almost always required the secondary process of deflashing, much like aluminum and zinc die casting. Thermoplastic parts came out of the mold quickly and required little to no secondary finishing.

Injection molding of thermosets did start to become feasible in the late 1970s. I can remember at NPE1979 watching a Cincinnati Milacron injection molding machine producing phenolic parts. A sign prominently displayed at the machine warned attendees not to pick up the parts coming out of the tool, as they were ejected at temperatures of around 150ºC (302ºF). And, yes, they still had to be deflashed.

THERMOPLASTICS GAIN MOMENTUM

But there was another element that drew the industry toward the thermoplastic market. The material suppliers developing these materials represented an all-star lineup of the major chemical companies and included General Electric, Bayer Material Science, DuPont, Dow, Union Carbide and Celanese. These companies produced a wealth of information on part design, mold design, material properties and processing, and they did so in attractively packaged brochures and technical documents delivered by polished sales people and knowledgeable tech service personnel.

While thermosets offered impressive properties, they were not readily converted into molded parts by injection molding.

The thermoset manufacturers were outgunned when it came to resources. Many of the thermoset manufacturers had qualified experts who understood very well the parameters associated with good design and processing practices. But most of them worked behind the scenes developing formulations and customers rarely saw them. ►

To make matters worse, thermosets tried to compete with thermoplastics on the terrain of short-term data, with a focus on room-temperature properties. This was a losing proposition because properties like tensile strength and impact resistance are not generally strong points for thermosets. These materials offer advantages at elevated temperatures that are not addressed by short-term properties published on datasheets.

One of the prominent advertisements that one thermoset material supplier ran during the late 1970s and early 1980s demonstrated the large deflections that flexural bars molded in thermoplastics exhibited when compared with phenolic. I recall sitting through a presentation where the case being made on behalf of phenolic was a head-to-head comparison with unfilled ABS. The two materials exhibited comparable tensile and flexural strength at room temperature and, of course, the phenolic displayed a higher heat deflection temperature.

Unmentioned was the substantial advantage in toughness that the ABS possessed. This type of comparison of a rigid, filled thermoset with an unfilled and ductile thermoplastic like ABS or polycarbonate missed the point that these tough, unfilled materials were not the competition.

One of the conferences that reflected the vitality of the thermoset industry in the Midwest was an annual event held in Madison, Wisconsin, each October. In the 1970s and 1980s this conference drew more than 300 attendees every year to an event that included two days of presentations. Booths were hosted by processing equipment manufacturers and most of the major thermoset material suppliers located in Indiana, Illinois and Wisconsin. Some attendees came from as far away as Germany.

Injection molding of thermosets did start to become feasible in the late 1970s.

'NEW' APPROACH TO MATERIAL CHARACTERIZATION

In 1988, I gave my first presentation at this conference, providing data that compared the properties of thermoset materials with filled and reinforced semicrystalline materials and high-performance amorphous polymers using the relatively new tool of dynamic mechanical analysis (DMA). DMA had been developed as an analytical method in the 1960s, but much of the early equipment was custom built by individual researchers and little had been done to create test standards around the method. By the mid-to-late 1980s, instrument manufacturers had perfected forced oscillation devices that greatly enhanced the ability of the method to characterize material properties, and ASTM and ISO standards had been developed.

Figures 1 and 2 show typical comparisons that were made, focusing solely on a property that was readily understood, the modulus of the material as a function of temperature. Figure 1 compares the performance of a phenolic compound to a 40% glass fiber-reinforced PPS and shows that: while at room temperature, the PPS is superior; at the elevated temperatures (at which the two materials are likely to be used), the phenolic outperforms the PPS and at a lower cost per pound. Figure 2 compares a thermoset polyester to a long glass fiber-reinforced thermoplastic polyester. These two materials have the same heat deflection temperature, but the full temperature map clearly shows the advantages of the crosslinked material.

The response to this "new" approach to material comparisons was overwhelming, at least for the moment. But, ultimately, one individual pursued this line of thinking, Larry Nunnery. He was a newcomer to the thermoset side of the plastics industry, but Nunnery was no stranger to the world of polymers, having spent most of his career up to that point at GE Plastics. GE was a master at brand marketing, and Nunnery brought this tradition and know-how to a company he had just purchased, Bulk Molding Compound Corp. (BMC Corp.), in St. Charles, Illinois.

Like many thermoset resin manufacturers, BMC Corp was small when compared to the major thermoplastic resin juggernauts. For many years, it maintained a presence in the industry by catering to niche markets and always had a small booth at NPE because, at that time, the triennial show was held right down the road at McCormick Place in Chicago.

That all changed when Nunnery assumed ownership. He immediately understood the implications of the DMA data and how it could be leveraged into a competitive edge. We characterized some of his flagship materials at our lab along with some appropriate competitive thermoplastics, such as highly glass fiber-reinforced nylons, PBT and PET polyesters, PPS and sulfone polymers. The comparisons showed the superior performance of the crosslinked materials at elevated temperatures, and Nunnery and his people took it from there, running advertisements showing the graphs and highlighting the superior dimensional stability and resistance to warpage that the crosslinked materials exhibited.

This became a platform for a new type of presentation of thermoset materials to the industry that was unfamiliar to both the thermoplastic and the thermoset community.

ABOUT THE AUTHOR: Mike Sepe is an independent, global materials and processing consultant whose company, Michael P. Sepe LLC, is based in Sedona, Arizona. He has more than 45 years of experience in the plastics industry and assists clients with material selection, designing for manufacturability, process optimization, troubleshooting and failure analysis.

INJECTION MOLDING

Use These Seven Parameters to Unravel the Melt Temperature Mystery

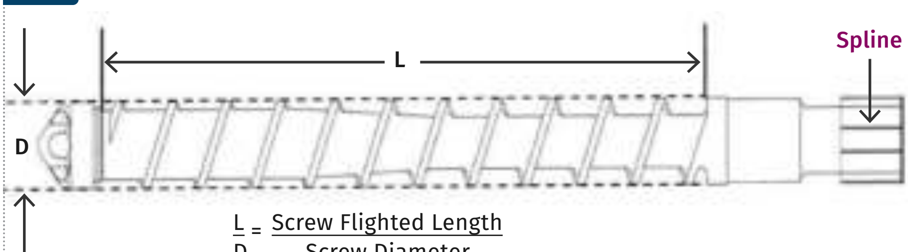
Despite its integral role in a stable process and consistent parts, true melt temperature in injection molding can be an enigma. Learning more about these seven parameters may help you solve the puzzle.

By Umberto Catignani

As an engineer, I am always struck at how some of the simplest questions in our field are the most difficult to answer. For example, if I were to approach a process engineer at a machine and ask, "What temperature are you running the plastic at on this machine" or, more specifically, "What is the actual melt temperature of the plastic as it leaves the machine nozzle tip orifice?"

Inevitably, I will receive various responses ranging from "I'm not sure" and "I don't know" to someone citing the recommended barrel temperature ranges from the material suppliers' processing guidelines. Alternatively, the process engineer might review the barrel temperature set points on the machine controller and make a guess or approximation.

FIG 1



$$\frac{L}{D} = \frac{\text{Screw Flighted Length}}{\text{Screw Diameter}}$$

Depiction and equation of the length to screw diameter ratio. Source (all images): Orbital Plastics Consulting

I do not fault the process engineer for any uncertainty because I'm actually asking a difficult and potentially "trick" thermodynamic question. When conducting a public or private injection molding training, a hypothetical question that I enjoy asking is: What is the actual plastic temperature for a process utilizing a flat barrel profile of 400°F, hydraulic back pressure of 50 psi, screw rotation speed of 75 rpm and a cycle time of 30 seconds? Is it above 400°F, at 400°F, below 400°F or could it be any of these?

Most responses are above 400°F, however, the correct answer is it could be any of them. The reason being is I have not given enough information to truly answer the question. Is the material amorphous or semicrystalline; what is the material residence time; what is the screw configuration; what is the machine-intensification ratio to convert the hydraulic pressure to plastic pressure? These are just a few unknowns that make it difficult to answer this question.

To truly answer these questions, one would need to conduct an air shot on machine cycle and measure it with either a needle nose pyrometer or an infrared device such as a camera. Using these two methods is not as repeatable or reproducible as we would desire because the procedure is not standardized. The measuring devices might not be calibrated; the emissivity of the object we are measuring with the infrared device is not precisely known; human error is possible; and typically it takes two individuals to conduct this measurement. With this in mind, to what degree of certainty can we determine if the measured temperature is reasonable, repeatable or reproducible?

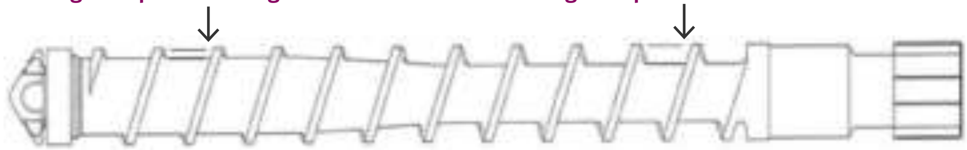
As mentioned in *PT*'s March 2024 article, "Understanding the Effect of Pressure Losses on Injection Molded Parts," we can simplify the injection molding process by focusing on what the plastic "experiences" as it travels through the machine and into the mold. This perspective can be referred to as "Injection Molding from the Plastic's Point of View" or Scientific Injection Molding. There are many parameters that can be adjusted, but it is important to acknowledge adjustments will affect one or more of the four primary plastic processing conditions, which are:

- Plastic Temperature
- Plastic Flow Rate
- Plastic Pressure
- Plastic Cooling Rate and Time

With a machine or cycle time change, there are seven parameters that have a large influence on the actual plastic temperature:

- Residence Time
- Plastic Flow Rate
- Screw Configuration
- Barrel and Nozzle Heats
- Screw Speed or RPM
- Back Pressure
- Feed Throat Condition

FIG 2



$$\text{Compression Ratio} = \frac{\text{Flight Depth Feed Zone}}{\text{Flight Depth Metering Zone}}$$

The compression ratio considers the flight depths of the metering and feed zones of the screw.

1. Residence Time

Residence time can be impacted by increasing or decreasing the amount of material the machine processes per hour or if the injection unit specifications have changed, which is common when moving molds among machines. The residence time is defined as the time a resin pellet is physically in the barrel and exposed to shearing or heating via conduction. Changing any time-related machine parameter — cooling time, packing time, holding time, mold open/close times, mold protection time, part ejection time and the addition or removal of a robot — will change the residence time.

There are other parameters or conditions that will affect the plastic temperature to a smaller degree but are still important, such as: the nozzle-tip orifice; the use of a general-purpose or a reverse-taper nozzle tip; changes in resin moisture content; lot-to-lot resin variations; the use of color concentrates; the letdown ratio of the color concentrate; the use of regrind (including the amount, its size and its moisture content); resin pellet size and shape; the use of a static or dynamic mixing section; the screw rotate delay time; and the screw dwell time, which is the time between the completion of plastication and the end of the cooling time.

2. Plastic Flow Rate

It is important to note that the plastic flow rate is one of the four primary plastic processing conditions, and if we were conducting a Design of Experiments (DOE), we would find that the plastic flow rate and plastic temperature have a strong correlation. As the plastic flow rate is increased, the amount of internal heat generation or shear heat is increased. This phenomena, called drag flow, is due to the friction between the tool steel and the flowing polymer chains. Due to friction, a velocity profile or flow speed differences are developed along the cross section of the plastic with the plastic flowing slower near the wall and faster toward the center of the flow front.

The velocity profile causes the polymer chains to orient in the direction of flow, and these flow speed differences generate friction or shear heat between one plane of chains flowing faster than another plane of chains. This phenomenon exists regardless of the temperature difference between the tool steel and the melt temperature. In fact, a velocity profile or flow speed difference is generated when water is flowing through a pipe; however, shear heating is not observed nor is the reduction in viscosity for a non-Newtonian medium such as plastic.

3. Screw Configuration

Screw configuration is quite complex, but for the purposes of this article, we will focus on the length-to-diameter ratio (L/D) and the compression ratio for a general-purpose screw without a mixing section. General-purpose screws are commonly used because they can process a large range of thermoplastics. However, there are numerous screw configurations and screws designed for specific materials or molding specific types of injection molded parts, such as thin-wall packaging and PET preforms.

Nonetheless, it would be cumbersome and time consuming for an injection molder to change screws and potentially the barrel based on a material change. If a molding facility is dedicated to molding thin-wall packaging or PET preforms, it is highly likely that specific screw designs are used, as they will optimize melt homogeneity, plastic temperature, plasticizing capacity and cycle time.

The L/D ratio is represented and mathematically defined in Figure 1. Here L/D is the screw flighted length — ignoring the screw's shank length and front-end components — divided by the screw diameter. For thermoplastics, the L/D ratio can range from 16:1 to 25:1, with 20:1 being the most common for general-purpose screws. Larger ratios increase plastic residence time, the amount of shear heat generated and ultimately the plastic temperature. A ratio of 25:1 is common for packaging applications or molding PET preforms where larger amounts of shear heat are needed to bring the resin to its melt or processing temperature.

The depiction and simplified equation for the compression ratio is defined as the flight depth in the feed zone divided by the flight depth in the metering zone (See Figure 2). For thermoplastics, the compression ratio can vary from 1.5:1 to 4.5:1 with most general-purpose screws ranging from 2.0 to 3.5:1. Larger compression ratios increase shear heat, melt temperatures and the potential for melt degradation.

Unfortunately, it is my experience that molders rarely know the L/D or compression ratios for their machine inventory, and I have yet to see the compression ratio and rarely seen the L/D ratio noted on the machine manufacturer's press specifications. This is a big unknown for most molders, and this lack of knowledge creates a large gap in understanding the plastic temperature and can potentially produce processing problems based solely on the screw configuration.

Problems I have observed over the years stemming from this knowledge gap include degraded material, marbelizing of the plastic, variations in color consistency and dimensional variations. Some of these issues were caused by not knowing a barrier screw design with a dynamic mixing section were being utilized.

It is possible to specify a specifc screw design when purchasing a new machine or simply ask what the L/D or compression ratio is during the quotation process for a general purpose configuration. In fact, some manufacturers will actually measure the screw flight depth and root diameters in multiple areas to serve as a comparison for when the screw is checked for wear in the future.

4. Barrel and Nozzle Heaters

These are placed around the circumference of the barrel and nozzle body. Via conduction, heat is transferred into the plastic to melt and soften the plastic. Changing the heater set points is one of the most efficient methods of changing the plastic temperature, especially in the front zone of the barrel where the flight depth is the most shallow and where the next shot of material resides. It is important to note that the thermocouples are measuring the steel temperature of the barrel and nozzle, and not the actual plastic temperature inside. This is why simply reviewing the barrel set points will not provide the actual plastic temperature.

The thermocouples are measuring the steel temperature of the barrel and nozzle and not the actual plastic temperature inside.

When replacing heaters, it is important to note the heater band material, the width of the heater band, the precise location of the heater band and the wattage rating. If a heater band is not replaced and located properly, this will change the amount of heat generated via conduction and ultimately the plastic temperature. I have personally witnessed the incorrect replacement of heater bands, unknowingly, resulting in several hours of troubleshooting to determine why the unchanged barrel set points resulted in a noticeable change in the process and plastic temperature.

It is possible to utilize a flat, forward or reverse temperature profile down the length of the barrel, depending on the shot size, material type, screw design and residence time. A "hump" profile can be used by increasing the compression or transition zone of the barrel by 30°F to 50°F, above the rear and front zones. In most conditions, it is ideal to set the front zone temperature to the desired plastic temperature.

5. Screw Rotation Speed or RPM — 6. Back Pressure

During the plastication phase, the screw rotation speed and back pressure are adjustable, and increasing these can generate larger amounts of shear heat, thereby increasing plastic temperature. Back pressure is the pressure resisting the screw moving backward during screw rotation. A minimum amount must be utilized to compress the plastic down the length of the barrel, remove any air bubbles that may have been plasticized into the melt and to consistently control the melt cushion. Because plastics are compressible, an increase in back pressure can cause the density of the shot to increase.

7. Feed Throat Set Point or Condition

The feed throat serves as an area to introduce the plastic pellets to the rotating screw and heated barrel. The feed throat must be cooled to prevent heat from building up in this area and ensure that plastic pellets do not start to melt or soften at or near the feed throat. If cooling is insufficient, plastic pellets may begin to stick to the screw or feed throat and result in the barrel becoming partially starved. Additionally, softened or melted plastic in this area could result in a completely starved condition where the feed throat is "bridged."

GETTING CLOSER TO CONTROL

At this point, it is fair to say that controlling the actual plastic temperature in a closed loop manner, for example 400°F, is not possible. Despite that, however, it is possible to control the plastic temperature within a small range to minimize the negative impacts of variations in this primary plastic processing condition.

I consider injection molding a "game of subtleties," in which small changes made with or without our knowledge alter the process slightly. As mentioned in *PT*'s March 2024 article, a change in one of the four primary plastic conditions will contribute to varying part dimensions along with potential changes in the type and severity of part defects.

Thus, for all parties that solely fault the process engineer with dimensional variations and inconsistencies, this is one of the fundamental reasons that plastic part dimensions change from shift to shift and day to day. This is the science of plastics and hence it is paramount to understand that constant machine settings do not equal constant part properties. PT

ABOUT THE AUTHOR: Umberto Catignani is president of Orbital Plastics Consulting Inc., a consulting firm that has more than 100 years of combined experience in scientific injection molding, training, material selection, part design review, in-mold instrumentation, project management and equipment selection. Catignani is past president of the Southern Section of SPE and has more than 28 years of hands-on injection molding experience. He has certified and trained hundreds of plastic professionals in the industry and has served as an expert witness. Past employers include IBM, General Motors, Delphi Automotive and Husky Injection Molding Systems. Catignani earned a master's degree in polymer engineering from The University of Akron and a bachelor's in materials engineering from the University of Cincinnati.
Contact: *404-849-6714*; *umberto@orbitalplastics.com*

EXTRUSION

A Guide to Single-Screw Mixers

To design the best mixers for single screws, you must completely understand how polymer moves through a mixer channel or groove.

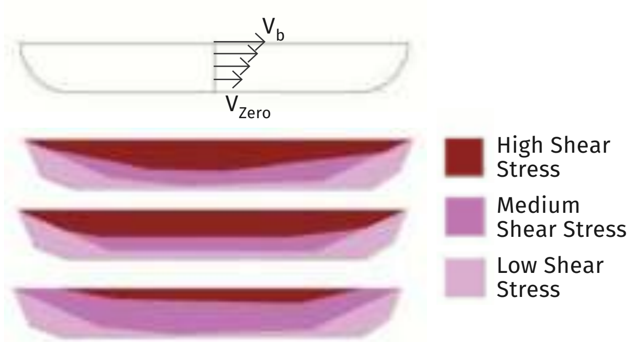


FIG 1 **This shows a single screw channel filled with melt with decreasing shear stress from the top sketch to the bottom sketch. This would be caused by either decreasing screw speed or decreasing polymer viscosity or both.**

By Jim Frankland

Several months ago, I wrote a column showing how melted polymer moves through the screw channels. Basically, it's dragged by the rotation of the barrel surface relative to the screw. The screw flights simply determine the angle of flow with the barrel surface being the moving force. The polymer is completely stuck to all the screw and barrel surfaces, and does not slip or slide at all once melted. Rather, it is sheared or stretched.

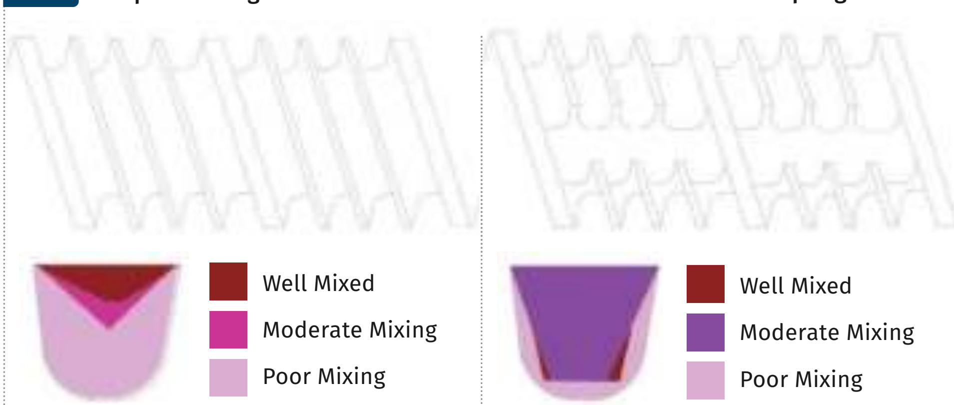
If you were to remove the barrel, the polymer will simply rotate with the screw with no forward movement. The highest shear and velocity occurs at the barrel wall (V_b) as it is the moving force in relation to the polymer and the lowest shear occurs near the bottom of the screw channel/groove (V_{zero}). There is zero shear stress (or no movement) on the screw channel walls as the polymer is assumed to rigidly stick to the walls and that can create "dead spots," depending on the level of shear stress, shape of the channel/groove and the polymer viscosity. Figure 1 shows the lower shear stress in the corners radii of the screw channel.

This shows a single-screw channel filled with melt with decreasing shear stress from the top sketch to the bottom sketch. This scenario would be caused by either decreasing screw speed or decreasing polymer viscosity, or both. At very low screw speed or viscosity, it can be difficult to achieve even a semiuniform melt flow condition throughout the channel.

Most mixing sections in single screws have similar flow characteristics as the screw channels. That is, they have the highest shear stress and flow rate near the barrel wall with generally narrower and usually deeper channels, making them even more restrictive of melt flows. As a result, they depend on pressure from the preceding screw flights to push the melted polymer through the mixing section. That naturally causes a pressure drop in the screw, negatively affecting output and causing uneven shear stress.

The first set of mixer grooves illustrates a condition with a complete melt but mixing is still nonuniform because of the decline of the shear stress level as it moves away from the barrel wall and deeper in the channel. Generally, the deeper and narrower the channels, the

FIG 2 **Simple Multiflighted Mixer** | **Same Mixer With Interrupting Cut**



Adding a configuration to the mixer that "turns the melt over" will greatly improve uniformity.

poorer the mixing. A better design will have a feature that "rolls over" the mass in the channel from top to bottom so the entire melt sees the same or at least similar overall shear stress to become more uniform. This can be accomplished in a number of ways.

Interestingly, one of the oldest and most widely used single-screw mixing sections does just that. It's the Union Carbide or Maddock mixing section that Mark Spalding described in detail his recent column. It forces the polymer to transfer from one flute to another over a barrier rib to pass through the mixer, thereby assuring that the polymer in the bottom of the channels/grooves becomes mixed with the polymer nearer the tops of the channel/grooves. This can be done in other ways to get the same mixing levels without the high shear rib typical of the Union Carbide mixer, which aids in melting as well as mixing.

Interrupting the grooves in a screw channel and compensating the volume for the same flow and pressure drop can "rotate" the melt and provide a better overall mix.

However, many of the mixing devices I see (such as pin mixers, Dulmage styles and parallel peg styles in various configurations) are all confronted by the same issue wherein they apply all the shearing or mixing force from the same side. It seems likely that many designers believe that by simply repeatedly dividing the melt, they are mixing it. That is somewhat true; enough divisions will result in a certain amount of mixing by opening new surfaces. However, full channel mixing is impossible as too many divisions will affect output and temperature. Deep, multichannel mixing devices can actually decrease mixing uniformity, particularly when substantially different polymer viscosities are present in the channel.

By simply adding some configuration to the mixer that "turns the melt over," uniformity can be greatly improved without these negatives. For example, making an interrupting cut in a multiflighted mixing section (Figure 2) will greatly increase the overall level of mixing by combining well-sheared polymer at the top of the channel to that below. Interrupting the grooves in the screw cannel can "rotate" the melt and provide a better overall mix. Similar changes to many of the mixers used today would provide similar improvements in uniformity, depending on the ingenuity of the designer. Deep, narrow channels tend to keep polymer segregated so that some form of interruption is required to bring the polymer from the bottom of the channel in contact with the polymer in the top of the channel. PT

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

TOOLING

PART 5

How to Design Three-Plate Molds

There are many things to consider and paying attention to the details can help avoid machine downtime and higher maintenance costs. In this installment, the focus is on design and placement of sucker/puller pins.

By Jim Fattori

In Part 4 of this series, I discussed several aspects of sucker pins, or puller pins in three plate molds, such as their installation method, tip shape, undercut and more. Now let's talk about how they should be designed and where they should be placed.

Figure 1A depicts one of the most common locations for a sucker pin in a three-plate mold — directly over the runner drop. Figure 1B is a slightly better design because it has a short runner overflow to help capture and retain any unwanted material, such as a cold slug. Figure 1C is a much better design because it has a longer runner overflow, and the sucker pin is situated beyond the runner drop. This location does not impede the material flow in any way.

That's particularly important for highly viscous materials and materials that have high percentages of fillers, such as glass or minerals. Abrasive materials have also been known to eat away at sucker pins, which does two things: reduces the holding power of the pin; and leaves small metallic particles on the molded parts. Additionally, the sucker pin in this design will be cooler than if it was directly above the runner drop because the material flow only contacts the pin initially and is not subjected to any shear heat as the material continues to flow into the cavity.

FIG 1A

FIG 1B

FIG 1C

Single sucker pin designs.
Source (all images): J. Fattori

Figure 2 shows alternate designs for sucker pins that do not impede the flow of material. Multiple sucker pins are an excellent means of pulling out large runner drops or drops with large gates that are difficult to break.

If an offset sucker pin design is having issues pulling out the runner drop and extending the cycle time, consider adding structural gussets, like those shown in Figure 3, connecting the runner to the well.

If you have a sucker pin directly over the runner drop, you need to ensure there is sufficient material flow around the pin and into the bore hole of the drop. This is accomplished by adding a well around the sucker pin in the back of the A-plate. If the well is too small or nonexistent, as shown in Figure 4A, there can be a large pressure drop — which can cause short shots and other molding issues.

Conversely, if the well is too large, as shown in Figure 4B, it wastes material and often requires an increased cycle time for the well to solidify sufficiently for the sucker pin to pull the drop out.

So how big should a well be? Simply put: the well should be large enough where it does not restrict the flow of material. At a minimum, the flow area around the two sides of a pin should be equal to the cross-sectional area of the pin itself. Figure 5 specifies some general guidelines for sizing sucker pin wells.

FIG 2

Offset sucker pin designs.

FIG 3

Gussets connecting a runner to a runner drop.

FIG 4A

FIG 4B

Restrictive and excessive sucker pin wells.

RUNNER DROPS

The first thing to consider about runner drops is their length and diameter. The longer and larger they are, the harder it will be to remove because there is more surface area trying to prevent their extraction. It's worth asking yourself if the A-plate can safely be a little thinner. A thinner A-plate will reduce the length of the runner drops and the amount of surface area. It will also reduce the weight of the A-plate, which is an added benefit.

The next thing to consider is the included angle of the drops. That can be anywhere between 1 and 4 degrees included, with 2 degrees included being the most common.

For most materials, the surface finish should be smooth — somewhere between a Plastics Industry Association B3 to A3 rating. However, some materials such as polyethylene and polypropylene tend to stick to a polished surface, and a D1 finish is usually preferable. A D1 finish is a 600-grit stone followed by a dry blast glass bead #11.

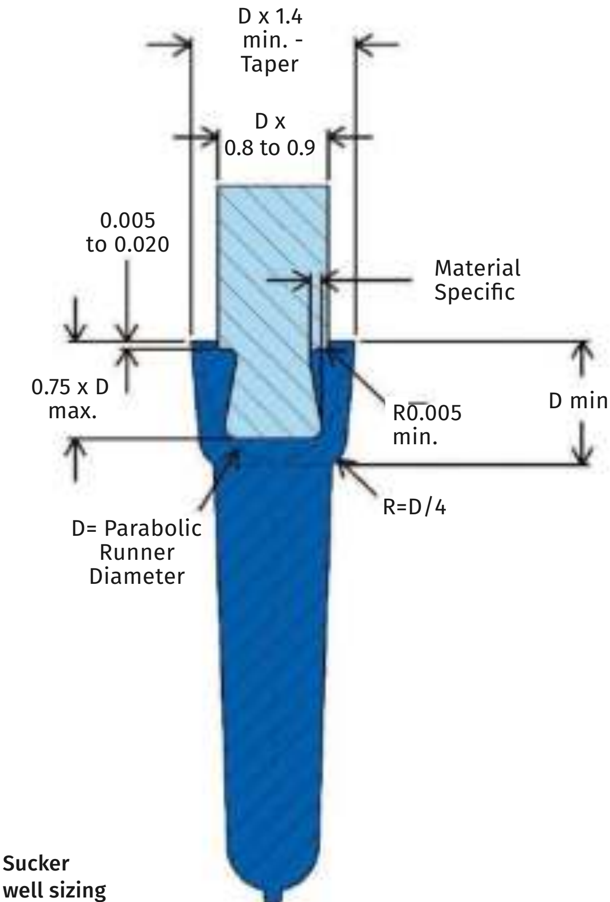
Regardless of the surface finish, it is extremely important that the stoning or polishing be done in the line of draw, even with a D1 finish. It's not critical to have small score lines parallel with the drop. But microscopic annular rings caused by rotary polishing act as undercuts, which can prevent the drops from being pulled out of their bore holes.

Anytime a runner drop passes through one plate into another or to a mold insert such as a cavity, a step must be added to prevent an undercut from forming due to even the slightest misalignment of the plates. Figure 6 shows a runner drop with two transitional steps. The steps are typically 0.002 inch to 0.010 inch per side.

FIG 6

A runner drop with two transitional steps.

FIG 5



Sucker well sizing guidelines

MACHINING COOLING CHANNELS

The mold's runner stripper plate and the A-plate should have cooling channels machined in them. The cooling channels help speed up the solidification of the runner, as well as help keep the sucker pins cool. If the pins get too hot, the cycle time may need to be increased so the material sufficiently solidifies around the pin, enabling it to pull the runner and runner drops out of the back of the A-plate.

This is one reason why the tapered sucker pin, which was discussed in Part 4 of this series, is a very good design. It has more direct contact with a cooled plate. If the sucker pin is controlling the cycle time because it is too hot, you might consider using sucker pins made of a copper alloy. They will wear faster because they are softer, but they cool off faster. To reduce the wear rate, copper alloys can be plated or coated with several different types of materials, such as Diamond Like Carbon (DLC), which has a surface hardness of over 90 Rc.

Scan for more expert advice in tooling.

FIG 7

Multiple runner drops.

Because the runner is usually the thickest portion of the molding, the cooling of the runner is critical in minimizing the cycle time. The ratio of cooling time to wall thickness is nonlinear. For example, let's say the wall thickness of the part was 0.100 inch and the wall thickness of the runner was twice that or 0.200 inch.

Even though it is twice as thick, it can take three, four or even five times longer to solidify, because once the outer skin solidifies, it insulates the molten center. This is where structural ribs, as discussed in Part 2 of this series, can help prevent ejection problems. The runner usually doesn't need to completely solidify. It just needs to be rigid enough for the sucker pins to pull out the drops.

Cooling lines should be located at the thickest sections, which would be the primary runner, runner intersections and especially the intersection of the runner and the drops. This is why you should have cooling lines in both the runner stripper plate and the A-plate located in close proximity to those areas.

Another cooling concern is when you have multiple runner drops in close proximity to each other, such as when gating into a small to medium-sized gear, as shown in Figure 7. In this situation, you might consider machining the runner drops in a cylindrical insert with water flowing around it.

It's also not a bad idea to put some cooling lines in the injection clamp plate. The molding machine's heated nozzle tip is always in contact with the extended sprue bushing. Over time, the heat will transfer to the clamp plate through both conduction and radiation. This could cause a thermal expansion issue which, in turn, could prematurely wear the sucker pin bore holes.

ABOUT THE AUTHOR: Jim Fattori is a third-generation injection molder with more than 40 years of experience in engineering and project management for custom and captive molders. He is the founder of Injection Mold Consulting LLC, an international consulting company. Contact *Jim@InjectionMoldConsulting.com*; *InjectionMoldConsulting.com*.

By Jim Callari
Editorial Director

Small Batches, Big Success

With no minimum order and an impeccable record of on-time delivery, Precision Color Compounds is becoming a force in the color masterbatch business.

Over the past 2½ years, Precision Color has expanded the capacity of its masterbatch production by adding new lines.

It's been said that he who hesitates is lost. Ten years ago, Erik Grotness didn't hesitate and now he isn't lost. Grotness, at the time a partner of an automation company, saw an opportunity to buy a fledgling color compounder and pounced. Today, Precision Color Compounds, Fort Wayne, Indiana, is an ISO-certified operation that produces color masterbatches to specification and focuses on speedy turnarounds and low-volume orders. Erik Grotness and his wife, Christiane, are equal partners in the business.

Grotness, the company's president and CEO, recalls, "At the automation company, I started a division for plastics and plastics machinery in 2003, and so I knew the industry. The original founders of Precision had backgrounds in polymers and compounding, but were unaccustomed to how startups work. It can take a long time before you get that first paycheck, so nine months in, they were looking for a way out. It so happened that one of the original owners approached one of my best friends, and he made me aware of the opportunity. Basically, I saw a young company that really hadn't gotten started yet, and it interested me a lot because I really loved the people that had I met up to that point in the plastics industry."

> ***"We might get asked if we can do 25 pounds of a yellow in acetal. The answer is yes."***

Initially, Grotness had four partners, but over time he bought them out. But the real challenge he faced at the onset was to how to make the company he just bought successful. "The funny part is that I thought I'd be approaching it from an engineering point of view, and once I realized all the chemistry that's involved, I thought, 'Oh boy.'"

Fortunately for Grotness, the former owners brought with them seasoned technical people, including key personnel in R&D and production. "In one of our first meetings with the technical staff," he says, "one of them was talking about an order and mentioned the LDR. I said, 'OK, what's LDR?' I learned it's short for letdown ratio, then learned what it meant. And that's, to this day, the great thing about people here and about people in plastics in general. They love what they're doing, and they love to share their knowledge."

What Grotness also found to his liking was Precision Color's value proposition serving the portion of the market that needed high-quality, small-batch orders delivered quickly. It's a good thing because, at the time, the company had smallish refurbished machines (three 34-mm twins, one 89-mm single screw) that Grotness says, "were old as rock," and weren't positioned to run high volumes anyway.

"I quickly realized that was a good place to be, selling service, quality and speed. The automation company I was at worked that way, so I was comfortable with that mindset and knew it did well in good times and tough ones. And, in the color masterbatch business, I figured I can't get a patent on this red or that orange, so let's position the company as one that delivers a great product, made to the customer's precise specifications and only the amount needed, and deliver it as promised." Not only is there a value in that proposition but Grotness soon realized there was a need. "Before I bought Precision Color, I spent a lot of time in the field talking to customers," he recalls. "And the more I spent, the more I heard that service was a problem in the industry. The color masterbatch business was changing. Bigger companies were buying smaller ones, and they were buying bigger and bigger machines so they could focus on the high-volume markets. We joked that most of our competitors would do a 250- or 500-pound order as a favor to a customer. The only small line they had was maybe in the lab. Everything else was churning out maybe 2,000 pounds/hr.

"On a big line, on a 250-pound order you'll probably make 250 pounds of scrap just to get those big screws turning before you make your first sellable pellet. So, right off the bat, the bigger companies are going to lose money on an order of that size. But that's our sweet spot." Precision Color offers 7-10 business day lead times; 48-hour color matching (upon request); and no order minimums. It runs mostly polyolefins but lately has added capabilities for engineering resins and biopolymers.

Notes Grotness, "With our location, we are in the epicenter of the plastics processing market. There is a lot of prototyping going on in the Midwest. A company in prototyping is not going to want to buy 500 pounds of material because it will be sitting on the shelf for a very long time.

Adds Tom Gavinski, Precision Color's national sales and marketing manager, "So many of our customers tell me 'We really enjoy the fact that, when we call, somebody picks up the phone.' Or 'I always hear back from you guys within an hour.'"

At Precision Color, the company changes orders an average of 3-4 times a day. On some occasions, though, that could amp up to 2-3 times per line, depending on the order quantity. In a perfect world in the color masterbatch business, Grotness notes, product runs would be scheduled light to dark and in similar color families (earth tones, for example) to help streamline the changeover process. "If our customers gave us their orders three months ahead of time, we could stagger them that way, but that's not reality."

So, Precision Color takes another approach, tackling product changeovers with a pit crew mentality. Grotness explains: "In my youth, I had a friend who was a sponsor for [legendary driver] A.J. Foyt, so I spent a lot of time with IndyCar racing. On our plant floor, we have a large photo of Foyt's pit crew in action to remind us of our mindset. But, just like in IndyCar racing, in color masterbatch production, not only do you have to be fast in color changeovers but you also have to be right. We know that if you leave one little speck of red hanging in the machine and you want to start running a white, well you just made pink and now you're just throwing the whole thing away. And we focus a lot on training so that all of our operators can work interchangeably on all the machines we have."

As part of this training, which involves in-house instruction from Leistritz Extrusion, one of Precision Color's operators is a "floater" who is cross-trained so that he/she can help execute a change on any machine the company has. Grotness explains, "A color change involves not only the extruder but everything downstream — the pelletizer [Precision Color runs both strand and underwater] and the classifier. Having a floater be familiar with all this equipment on all lines has allowed us to cut color-change times in half in some cases."

Changes typically involving purging and complete screw pulls. Says Grotness, "We have evolved to where we're testing purges and verifying which purges work best on each machine. And it's not always the same purge. On some lines, it might be a mechanical purge, and others a chemical purge. And we're evaluating hybrids now and we're getting close to choosing one. But, then in six months, we'll reevaluate."

The pit crew mentality also enables Precision Color to handle those last-minute requests that are typical in the masterbatch business. Says Grotness, "Our business model is not, for example, looking for orders that will constitute a three-, two- or even one-day run. Our business is being nimble and shifting quickly from one order to the next. Our manufacturing staff understands the mentality and they'll always figure out ways to sandwich in that 50-, 100- or 200-pound order that the customer needs right away. We can do a lot of things like that because we're in and out of so many different colors during the day."

Erik Grotness and his wife Christiane got into the color masterbatch business with the purchase of Precision Color Compounds. Source: Precision Color Compounds

ADDING CAPACITY

Precision Color has invested more than $2 million over the last 2 ½ years to expand. It's added 15,000 square feet of manufacturing capacity and is now in talks to add more. Precision Color's capacity these days is around 9-11 million pounds. Adds Grotness, "In our position in the market, stating an accurate capacity is not possible. We run so many orders with multiple different compounded additives, speckles, pearls, fluorescents and more, all with different LDRs. So, depending on the order, you may or may not be able to run at the machines' 'stated capacity.' In order to always have enough flexibility, however, our goal is to never use more than 80% of our capacity on a regular base. Meaning, if our lines continually are full, we add more capacity."

Precision Color still runs one of the older machines Grotness inherited when he bought the company, but it has added two new 27-mm twin-screw lines from Leistritz Extrusion, as well has an 18-mm lab line. This year, it is considering adding either another 89-mm and/or a smaller machine. Says Grotness, "We've settled on Leistritz as our primary supplier. We're very happy with their technology and especially their support and service."

Precision Color integrates the extruders in-house with all upstream material handling and downstream underwater pelletizing and classifying equipment. It has also recently added an ECON NWA400, a hybrid pelletizer that can shift from underwater to air pelletizing, enabling it to handle hygroscopic bioresins.

In terms of adding the bigger machines, Grotness notes that two is better than one. He elaborates, "For those orders in the 5,000-10,000 range, while we don't get that many of them, we get enough so that we don't want to risk a larger order monopolizing a smaller machine. So, we'll put them on the bigger machines and keep those machines sacred for the larger orders." The color concentrate compounder runs one shift, though Grotness anticipates that could change over time.

In the view of Gavinski, a seasoned sales professional who's worked in the sheet and profile extrusion business, these larger orders are usually made possible by successfully executing a smaller one. He says, "A lot of these small applications tend to be unusual. We might get asked if we can do 25 pounds of a yellow in acetal. The answer is yes. But, over time, when you perform like you said you would, these kinds of orders graduate to more and more business. If we can get the 25-pound order, it's amazing how quickly 25 becomes 50 becomes 100 pounds, and it kind of goes up like that and suddenly we're running a new material that five years ago we didn't even know how to spell."

Gavinski notes that the company's growth can be attributed evenly from new and existing customers. "Business has sometimes come to us because we are easy to work with. There are customers we got where bigger color houses didn't want to fill their 50-pound order. They'd give them the price for their 250-pound minimum order. When they come to us, not only do they get the 50 pounds they need, but they also get it the next week. So, with a molder, for instance, they are not only getting color quicker but are able to produce parts quicker.

"We're in the high 90% in terms on-time delivery, and it's really remarkable for plastics because 8- to 10-week lead times just don't work for a lot of people. We rarely miss a delivery date."

Adds Grotness, "Color is so important, yet it's generally the last thing people think about. No one in plastics gets to work and turns on the computer first thing and says, 'Let me call Precision Color and see what they are up to today.' But we are going to be there when you need us. It is 100% the people, our team and we get everybody involved. Sometimes one of our lab people will make a delivery because we want our customers to feel comfortable with multiple people in the company. Our most important asset walks out the door every night." PT

A Processor's Perspective:

What's Driving Growth in Heavy-Gauge Thermoforming

Recognizing that precision and efficiency are key to outstanding production, thermoformers are investing in six-axis robots and scanning technology. Source (all images): Ray Products

Key factors for the progress are innovative materials, advanced automation and precision engineering.

By Jason Middleton
Ray Products

The trajectory of heavy-gauge thermoforming has been one of continuous transformation, steered by the relentless pursuit of efficiency and the ever-growing demands for complex parts. Collective strides in this field are shaping a future where efficiency, functionality and environmental responsibility coalesce, marking a significant shift in the capabilities of custom manufacturing. This is a transformative time for thermoforming, with broad implications for the medical, automotive and high-tech industries that rely on these pivotal manufacturing advancements.

Utilizing pressure forming and vacuum forming solutions that exemplify the fusion of technology and craftsmanship, manufacturers are able to respond to complex challenges. The production of repeatable, high-quality components is being made possible by minimizing secondary processes, embracing cutting-edge, six-axis robotic trimming and pioneering material innovations.

It's this balance of meeting intricate design requirements while advancing the efficiency of production that underscores the modern era of heavy-gauge thermoforming. With a commitment to embracing the industry's trends, and refining processes and materials, manufacturers continue to drive the industry toward a future where precision and practicality converge, shaping the landscape of heavy-gauge thermoforming for the better.

> *Thermoformers are investing in six-axis robots and scanning technology, underscoring a commitment to excellence that transforms the very nature of their manufacturing process.*

DEMAND FOR COMPLEX PARTS

The balance between aesthetics and functionality is more critical than ever as manufacturers strive to exceed expectations. Today's manufacturers must adeptly meet the growing need for enhanced efficiency and sophisticated design features such as undercuts, slots and tabs that facilitate ►

seamless interlocking, thereby minimizing assembly time and enhancing the serviceability of devices.

Thermoformers can meet these multifaceted demands by mastering both vacuum forming and pressure forming — complementary branches of thermoforming that together offer a broad spectrum of solutions. Vacuum forming, known for its efficiency and simplicity, draws heated plastic into a mold using a vacuum. This tried-and-true method is well suited for a variety of applications.

On the other hand, pressure forming (a refined adaptation of thermoforming) adds additional air pressure between 80-to-100 psi to force the heated plastic and enabling more intricate designs. This technique takes advantage of pressurized air to push the plastic against the mold, creating parts with highly detailed and complex shapes that boast a crisp mold definition surpassing that which is typically achieved by vacuum forming alone.

The capabilities of pressure forming enable manufacturers to produce parts with the kind of detail usually seen in injection molding but with the benefits of lower tooling costs and faster lead times. By integrating precise details and high-quality surface finishes straight out of the mold, pressure forming often bypasses the need for additional secondary processes, further streamlining production.

Whether it's the robust simplicity of vacuum forming or the detailed precision of pressure forming, thermoformers can utilize each method's strengths to fabricate custom plastic parts. Ray Products has the capability to produce parts up to 10 by 18 ft.

GAINING EFFICIENCIES BY MINIMIZING SECONDARY PROCESSES

In the pursuit of efficiency, thermoformers are making significant strides in reducing the need for secondary processes, a leap forward marked by the adoption of molded-in color. This innovative approach has revolutionized the production line by eliminating the traditional steps of sanding, masking and painting.

The impact of this advancement resonates through every facet of production. Incorporating color into the very substance of its parts enriches the aesthetic appeal with a spectrum of hues from solid to metallic, while substantially cutting down on manufacturing time. The elimination of postmolding painting reduces handling time, speeds up overall production and minimizes the opportunity for scratches and defects of the paint during assembly or everyday use.

Ray Products used Kydex T material to manufacture this medical cart comprised of multiple pressure-formed parts in custom color.

The benefits are just as vibrant from an economic standpoint, as this production process streamlining translates into significant cost savings for customers, often reaching double digits. The efficiency gains also contribute to shortened lead times, providing customers with quicker turnarounds from conception to final delivery, an essential factor in today's fast-paced market.

TECHNOLOGY AT THE FOREFRONT: SIX-AXIS ROBOTS AND SCANNING

Recognizing that precision and efficiency are key to outstanding production, thermoformers are investing in six-axis robots and scanning technology, underscoring a commitment to excellence that transforms the very nature of their manufacturing process. For example, six-axis robots have been the backbone of Ray Products' CNC trimming operations for over 15 years, a testament to its foresight in adopting robotic automation early on.

These robotic systems offer a level of precision that manual processes could never achieve, ensuring each part meets stringent quality standards with consistent accuracy. These robots also have capabilities that extend beyond mere trimming. They enable complex, multidimensional movements, enabling the precise execution of intricate cuts and contours on thermoformed parts.

Incorporating advanced scanning technologies complements the robotic precision, providing real-time feedback and adjustments that further enhance the quality of each product. Scanning ensures that the specifications of every part are adhered to with meticulous detail, enabling the production of components that seamlessly integrate into the intended device. This combination of robotics and scanning delivers on the promise of high-speed production without compromising quality.

The flexibility afforded by these robotic systems is unparalleled. They adapt to the demands of various project complexi ties, while their robust design and servo-controlled rotating tables enable quick changes in tooling. This adaptation enables thermoformers to shift between jobs with minimal downtime, thereby ensuring a rapid response to customer need.

MATERIAL EVOLUTION ADDRESSES NEW CHALLENGES

A dedication to material innovation is a key driver of progress across industries, particularly noticeable in the burgeoning sector of electric vehicle (EV) production. As EVs continue to surge in popularity, there is a growing demand for materials that meet stringent durability and aesthetic standards, and align with increasingly stringent environmental concerns.

This demand has prompted a strategic shift from traditional thermoset materials toward cutting-edge thermoplastics, a change that thermoformers have been instrumental in leading. In active collaboration with material suppliers, Ray Products is pioneering the development of materials that offer improved performance and enhanced sustainability. These new materials boast advanced finishes with fire-retardant (FR-VO) ratings, compliance with stringent UL 746C standards and features like UV resistance, high-gloss and metallic finishes, all of which can significantly reduce the need for post-molding painting and is a boon for eco-friendly manufacturing practices.

Custom-color ABS replaced sheet metal in the covers of these industrial sorters.

Such innovations reflect a larger commitment to sustainability in the manufacturing process. Materials engineered for molded-in color processes are not only aesthetically versatile but also can be fully recyclable, addressing the eco-conscious market's demands. Furthermore, this shift to environmentally responsible production practices aligns with global sustainability goals, promoting a greener future across industry borders. This means that the parts created could be repurposed or recycled, minimizing waste and contributing to the health of our planet.

Moreover, the transition to thermoplastics has been underscored by their uniformity and reduced production variability. This translates to components that fit correctly right off the production line, eliminating the need for costly and time-consuming postproduction adjustments like hand sanding or kitting. Such efficiency is pivotal in high-tech industries where quality cannot be compromised and production speed is of the essence.

For medical applications, Ray Products has used materials such as Kydex T (acrylic/PVC alloys) due to its great chemical resistance, UL94 rating and custom color matching with metallics for the small handheld pieces that are part of its medical devices and carts. Kydex also offers an injection-grade material so all components are equivalent.

A new material we are using for outdoor EV applications is Kydex 1100UV, a weatherable, F1 UL746C, UL94 V0-rated material that also comes in custom colors including metallics.

EVOLVING APPLICATIONS IN THERMOFORMING

Thermoforming, especially the pressure forming technique, is becoming a sought-after method in sectors like medical and high-tech industries. The shift to thermoplastics through thermoforming introduces a level of previously unattainable precision, durability and cost-effectiveness.

One example of large parts are these lids for outdoor industrial waste containers made with HMW-PE.

The EV manufacturing arena is calling for intricate parts that fit flawlessly into sleek, modern designs and withstand the rigors of outdoor elements and the test of time. By utilizing advanced materials that include flame-retardant properties, UV resistance and robust outdoor weatherability, manufacturers are delivering components that eclipse traditional expectations of quality and functionality.

These innovations extend beyond material selection; they represent a reinvention of the assembly process itself. The ability to create complex, interlocking parts through thermoforming enables easier assembly and enhanced serviceability. Features that once required assembly time, like bosses and fasteners, are now replaced with molded-in design features because of the capabilities of heavy-gauge thermoforming.

Thermoformers are responding to the current needs and shaping the future of thermoforming, ensuring that the most complex, high-quality parts are within reach for industries embracing this evolution. PT

ABOUT THE AUTHOR: Jason Middleton is VP of sales and development at Ray Products, where he has worked since 2013. He works with customers on projects to determine if they are a fit for the thermoforming process by guiding them with designing, manufacturability and overall process evaluations. He has over 20 years in plastics manufacturing, with experience in vacuum forming, pressure forming, injection molding and the structural foam processes. Contact: 909-740-9037; JasonM@rayplastics.com; rayplastics.com.

Multilayer Solutions to Challenges in Blow Molding With PCR

For extrusion blow molders, challenges of price and availability of postconsumer recycled resins can be addressed with a variety of multilayer technologies, which also offer solutions to issues with color, processability, mechanical properties and chemical migration in PCR materials.

Monolayer PCR bottles in back are dull gray, while multilayer ReCo bottles in front show off coloring flexibility. Cross-sectional view shows how multilayer technologies can hide even very contaminated PCR. Source (all images): W. Müller GmbH

By Varinia Lück
W. Müller GmbH

With each passing year, governments worldwide enact new legislation dictating the extent to which postconsumer plastics must be recycled and how much of that PCR should be incorporated into new plastic products. This regulatory landscape presents a formidable challenge for converters who must navigate the complexities of acquiring and processing these materials.

At W. Müller, we are known for our production of extrusion heads for blow molding machines. What many may not realize is that we operate two technical centers which have provided us with early access to recycling materials in collaboration with material manufacturers and recyclers to conduct comprehensive tests under varying conditions. Over the years, we've evaluated more than 50 different recycled materials from over 15 manufacturers globally, testing them across all our technologies, from one to seven layers, in bottles from 70 mL to 1 L. This research has also enabled us to observe the evolution of commercially available PCR materials over time.

FIG 1

On left is a monolayer bottle of 100% PCR whose contaminants caused foaming and bottle distortion. On right is a three-layer ReCo bottle with the same PCR in the center main layer, while inner and outer virgin layers provide processing and mechanical stability, and aesthetic appearance.

Despite advances, blow molders still face numerous challenges in processing these materials. This article explores key challenges such as processability, odor, topload strength, migration, drop-test results, black specks, differences in color and material availability. The relevance of these challenges varies greatly, depending on the regional infrastructure for material separation, collection, sorting and processing.

THE BEST-CASE SCENARIO

Some PCR materials stand out for their excellent processability. They are typically colored white, ivory or a very light gray. In our tests with those materials, we started molding virgin HDPE into bottles and then changed to the good-quality PCR. We continued making bottles, adjusting the die gap to achieve the same bottle weight. Processing was very easy, there were no parison length variations and the process ran stable. Some bottles had a couple of dark specks, but nothing to worry about. These materials still had a characteristic PCR smell; however, it was more the smell of a not-too-overpowering cleaning agent. These materials ran well even in monolayer bottles. ►

Nonetheless, this high-quality PCR has two big problems: price and availability. A big effort goes into sorting, cleaning and removing volatiles from waste to make that PCR material. All this takes energy and resources, which are reflected in a high price per pound. If price is not an insurmountable obstacle, then you will face the next problem: After sorting so much waste out of the stream to get pure HDPE, the yield of high-quality material is relatively small. If everyone decides to make a 100% PCR bottle out of these premium PCR materials, there will only be enough material available for a few customers.

THE WORST CASE SCENARIO

Conversely, some recycled materials present formidable challenges. In one case, we tested a PCR material for a recycler. We started with monolayer construction. As soon as the material came out of the die, it was obvious that it was not a material for blow molding. It produced a foamed, black/green parison with a lot of fumes, a horrible smell and some sort of oil dripping out and sticking to the die, pin and blow pin. The bottle? Nonexistent. The rough foam structure would not allow a bottle to be formed. What was supposed to be a 1-L round bottle looked like an ugly flower vase instead (see Figure 1).

Adding coextruded outer and inner layers did not contribute much. This PCR material had some nylon in it, which has a higher melting point than HDPE. The unmelted nylon, together with the rough foam structure, still caused big holes in the bottles. After many tries with drying, filtering and changing processing parameters, it was possible to make three-layer bottles with 50% of this material in the center layer.

The good news is that the average real-world scenario lies somewhere in between the best and worst case scenarios described above. However, if it was possible to make the worst case scenario processable with three-layer technology, then there is a lot of hope for most recycled blow molding materials out there.

MULTILAYER TECHNOLOGIES: HOW TO CHOOSE?

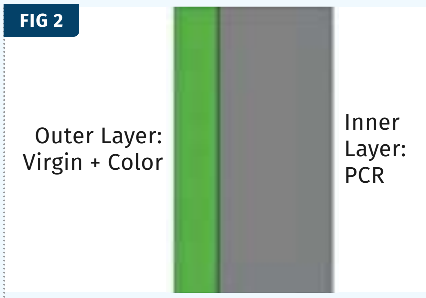
There are many multilayer blow molding technologies out there. We often hear about coextruding 11 layers or more in the film industry. But in blow molding, seven layers is the practical maximum. It is possible to make a head with more layers, but we haven't found an application that actually needs more than that.

At W. Müller, we offer, in addition to our single-layer technology (Mono), a diverse array of multilayer technologies. Among these are DeCo and ReCo, comprising two (DeCo) or three (ReCo) layers of an identical material type (such as all-HDPE with layers of virgin and PCR). Additionally, our portfolio includes CoEx technologies, which entail coextrusion of different material types to achieve specific performance functions or properties, such as coextruding HDPE with EVOH or nylon for UV barrier, chemical barrier or oxygen barrier (for examples, see this article at ***ptonline.com***).

Many of you hear "multilayer" and immediately think that multilayer is bad for recycling. That is only true if you combine different polymers with a fairly large proportion of the minor component — for example, more than 6% EVOH oxygen barrier in an HDPE bottle. However, W. Müller heads are capable of making bottles with EVOH layers under 6%, which give you a fully recyclable bottle with a barrier.

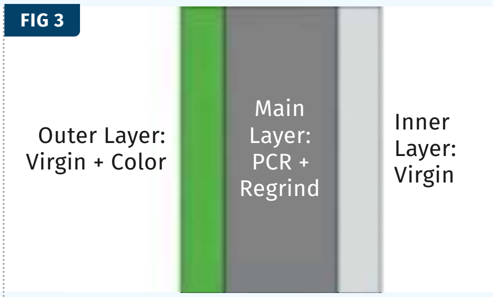
Furthermore, DeCo and ReCo are multilayer technologies that use only one polymer type (such as only HDPE or only PP), which makes the bottle 100% recyclable in any recycling stream.

FIG 2



W. Muller's two-layer DeCo technology facilitates coloring the bottle at minimum cost while hiding the PCR layer.

FIG 3



Three-layer ReCo technology can save masterbatch costs, avoid contact between a bottle and its contents, and improve mechanical properties of the bottle.

MULTILAYER TECHNOLOGIES FOR PCR PROCESSING

DeCo and ReCo offer monomaterial multilayer solutions for processing PCR, ensuring recyclability while maintaining product integrity. DeCo consists of two layers, usually a thicker PCR inner layer and a thinner outer layer with virgin material and color masterbatch (Figure 2). This enables you to color your bottle and hide the PCR while minimizing the use of masterbatch. The layers are easily customizable, so you can vary the thickness depending on your needs.

ReCo is a three-layer technology with a thinner outer layer, usually virgin with masterbatch; a thicker main or center layer, usually PCR with regrind; and an inner layer, usually just virgin (Figure 3). The goal here is to save masterbatch, cover the PCR material, avoid contact between your product and the PCR, and improve the mechanical properties of the bottle.

The good thing is that if you have a machine running with monolayer, you can retrofit this machine with a new W. Müller head to process with DeCo or ReCo. With a multilayer head from W. Müller, you have the flexibility to run either multilayer or monolayer bottles with that same head.

FIG 4

When HDPE waste arrives at a sorting facility, white bottles are segregated into one stream that becomes white or ivory PCR pellets (left), while all other colors are combined into a stream that becomes gray pellets (right).

FIG 5

Compare colors of a monolayer PCR bottle with 6% masterbatch (left), monolayer virgin bottle (center) with the same amount of masterbatch, and ReCo bottles with different three-layer structures and equal or lower masterbatch levels in just the outer virgin layer.

PROCESSABILITY ENHANCEMENTS

Many customers have complained about stability problems while processing PCR materials. Changes in parison length can cause problems such as fluctuation in bottle weight and changes in the position of the thickness profile, which lead to poor topload results.

The goal was to recognize and capture these differences objectively, and see if it is possible to reduce them. This project was a cooperation between the additive producer Baerlocher, recycler PreZero (active in Europe and the U.S.) and W. Müller. Baerlocher provided the additive Baeropol RST, which is made from a combination of commonly used, nonantioxidant polymer additives that together support polymer stability. This additive was compounded into a batch of PreZero PCR HDPE material. Then, batches of PCR HDPE with and without additive were sent to W. Müller for testing.

On our lab machine, cameras were installed on the front and on the side to take a picture of the parison at the same point during each cycle, which software analyzed to calculate the parison length. The gross and net weight of each bottle were measured, and the melt pressure in the extruder was controlled.

The process with the least variation in gross weight, melt pressure and parison length was that of the virgin bottle. The process with the most variation was monolayer PCR material without additive. When comparing the process variation for the PCR with and without additive, it was observed that the additive reduced the process variation when using the monolayer and ReCo technologies. It was also noted that using ReCo improved process stability for both the stabilized and unstabilized material. The variation in the parison length and melt pressure of the stabilized ReCo bottle was only slightly higher than that of the virgin bottle. This means that processing PCR with three layers can improve the stability of your process when compared with processing monolayer PCR.

ADDRESSING COLOR VARIATION AND IMPURITIES

Have you ever thought about how materials are sorted and why a lot of PCR materials are gray? When used plastic arrives at the sorting facility, white HDPE bottles usually will be sent to the white HDPE stream and colored bottles will be sent to the colored stream. Because all colors sent to the colored stream are mixed together, the resulting color of this mixture is gray. Depending on the colors sent, you get different shades of gray, but gray nonetheless. Because of the different shades of white and natural-color bottles entering the white stream, the result is a whiteish ivory material (Figure 4).

FIG 6

Black Specs on Grey Bottle

ReCo 3 Green Bottle

Monolayer PCR bottle (left) shows black specks, which are hidden in multilayer ReCo bottle (right).

It is tempting to buy those ivory colors and then add some color to make a nice PCR bottle. This is not the best approach to close the loop because you are taking material from the limited white stream and on the next product life cycle returning it to the gray stream, which few will want. If you buy the ivory PCR and mix in some white, then the bottle will end up again in the white stream and the loop is closed.

The only way to achieve widespread circularity is to find a place for those gray materials in PCR bottles. Does that mean that on your next trip to the drugstore you will only find gray PCR bottles? Not with our ReCo technology adding a virgin layer with color on the outside to cover the gray PCR material. With the DeCo and ReCo technologies, it is possible to use those gray PCR materials in nicely colored bottles. How much PCR can you use in this way? It depends on the technology and regrind use, but normally up to 80% in DeCo without regrind and up to 70% in ReCo without regrind or about 60% with regrind.

It is, of course, possible to use a gray PCR material in a multi-layer bottle and color the outer layer white. This is not recommended because the bottle would end up contaminating the white stream with gray materials.

Some of you might think you can just color the gray PCR materials. This is possible, but the resulting color of the bottle will be nowhere near your original color, even if you increase your masterbatch use level from 4% to 8%. You will have a colored bottle, but it will still have a grayish tone and you will be spending double the money on masterbatch. Better to make a three-layer bottle and just color the outside layer. You are free to increase the amount of masterbatch in the one layer; you will still be saving money. The best thing? Your color will be either the same as your original bottle or a lot closer to it.

Let's compare monolayer bottles (Figure 5). Suppose your bottle weighs 70 g and you used 4% masterbatch in your virgin bottle. If you double the masterbatch level to 8% when using a gray PCR, you will be going from 2.8 g masterbatch to 5.6 g. If you make that same bottle in three layers, where the outer layer is 20% of total thickness, and you add 4% masterbatch only to that layer, you will be using only 0.56 g of masterbatch. Even if you double the amount of masterbatch in that outer layer, it is still 1.12 g, which is 60% less than you had in your virgin bottle. Imagine saving 60% in masterbatch costs and still getting a better color match than using monolayer? And you have an added benefit when using ReCo: Any black specks are covered by the outer layer (Figure 6).

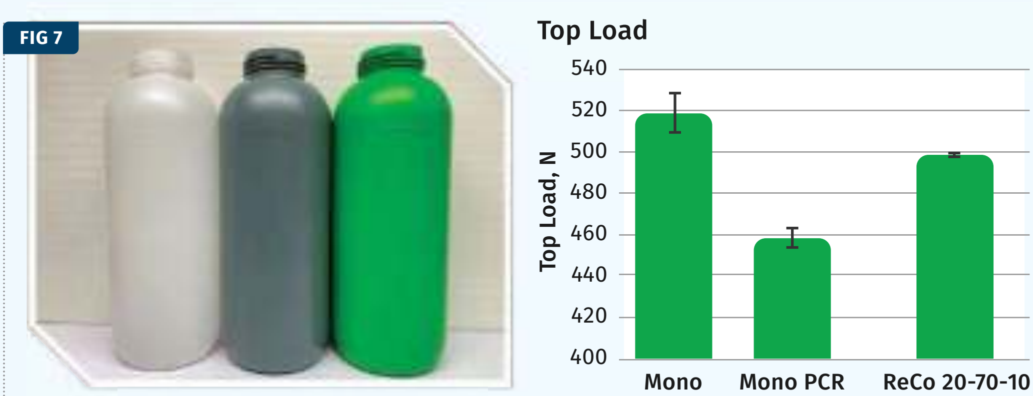
ENHANCED MECHANICAL PROPERTIES

For the topload test, three bottles were produced: a virgin monolayer bottle, a PCR monolayer bottle and a ReCo three-layer bottle with 70% PCR in the main (center) layer. This same test has been done with different bottle geometries and sizes.

Depending on the virgin material and the PCR material being used, the virgin bottle will most likely have the highest topload strength and the PCR monolayer bottle will have the lowest topload. With the ReCo structure, you will see an improvement in the topload strength.

This test was also performed with the bottles made with PreZero PCR HDPE material and the Baerlocher additive. The additive also improved topload. Interestingly, the topload for the three-layer stabilized bottle was higher than the topload of the virgin bottle. That means the ReCo technology alone already improves the topload, but material stabilization together with the ReCo technology could help reach or even improve topload results while using PCR.

FIG 7



Topload strength comparison of virgin (left), monolayer PCR (center) and ReCo bottle with PCR (right).

Also, when comparing results of using monolayer with PCR and regrind, and ReCo with PCR and regrind, improved topload was observed on the ReCo bottles (Figure 7).

These results depend highly on the virgin and PCR materials being used. Bottle size and geometry also play a role.

Some cheaper, more available HDPE PCR materials will have some PP in them. This comes from, for example, caps that were not sorted out properly. PP in HDPE will cause problems with the welding seam, which will not close properly. This will cause problems in the drop test, where the bottle will probably break at the welding seam.

A test was performed where a virgin bottle, a PCR monolayer bottle, and a ReCo bottle were each dropped a maximum of five times from 6.5 feet. The virgin bottle survived all five falls without breaking, while the PCR monolayer bottle broke after about two falls. The inner and outer layers of the ReCo bottle helped stabilize the bottle, and thus the bottle survived all five drops, just like the virgin bottle (Figure 8).

REDUCING MIGRATION

The Regulation (EC) No 1935/2004 is an EU legislation that governs the general requirements for materials and articles intended to come into contact with food. It establishes the principles and procedures for assessing the safety of such materials and articles, and includes provisions for labeling and traceability. Our tests were performed according to that legislation. They measure the migration of substances from the plastic material into the contents of the container. These results were evaluated for use in cosmetics containers.

One test measured global migration in a monolayer PCR bottle and a ReCo PCR bottle. Even though both bottles had a global migration under 10 mg/dm² (which is the legal limit), it is important to notice that the monolayer PCR bottle had a global migration of 4 mg/dm² while the ReCo bottle had a global migration under 1 mg/dm². This was repeated with a different PCR material, and the results were similar — the monolayer PCR bottle had a global migration of 3 mg/dm² while the ReCo bottle had a global migration under 1 mg/dm².

We also observed that fewer substances migrated from the ReCo bottle. Many of the substances migrating from the monolayer bottle could not be found in the test of the ReCo bottle. The substances that would still be found migrating from the ReCo bottle had, in most cases, a lower concentration. Only two substances were found in higher concentrations from the ReCo bottle than the monolayer bottle. These substances were additives that migrated from the virgin layer.

Migration tests with four different materials and two different bottle sizes/geometries showed that the migration in the ReCo bottles is under the legal limit and therefore safe to use in cosmetic products, both leave-on and rinse-off.

It is important to mention that the inner layer is not to be considered a functional barrier and will not allow you to use a non-food-grade PCR material for a food-grade application. However, it can help make your product safer. If you are making a cosmetic product and are using a substance that has a concentration limit, you would not want that substance to migrate from the PCR into your product in amounts sufficient to cause you to exceed the regulatory limit.

CHOICE OF HEAD AND EXTRUDER MATTERS

Depending on your chosen technology (be it DeCo, ReCo or CoEx), the required head and extruder setup can vary significantly. Furthermore, the selection of a head producer can significantly impact the outcomes of your operations.

When processing PCR, precision in the design of both the head and extruder is paramount to accommodate the necessary multilayer configurations. This precision ensures exceptional tolerance for MFI fluctuations, which is crucial when transitioning between materials and colors. Ensuring that settings remain valid across transitions minimizes downtime spent adjusting parameters.

At W. Müller, our team meticulously optimizes the channels of the head to streamline plastic flow, preventing the accumulation of deposits and abrasions. Neglecting this crucial step can lead to the introduction of additional black specks that may be erroneously attributed to the PCR material itself.

To effectively reduce masterbatch and plastic consumption, it's counterproductive to utilize a head with prolonged color and material changeover times, as each transition results in waste.

When processing multilayer materials, achieving uniform material distribution is vital. Poorly designed heads lead to inconsistencies in distribution, which lead to variations in layer thicknesses, resulting in either overuse of more expensive materials or localized thinning of inner layers in the final product, potentially leading to increased migration risks. Simulation software enables us to model the flow channels and identify potential design issues before manufacturing begins. By simulating the flow dynamics, we can pinpoint and address any problematic areas, ensuring optimal material distribution and minimizing risk of uneven layer thicknesses. This proactive approach enhances product quality and saves valuable time and resources by mitigating issues before they arise during production.

FIG 8

In drop tests, monolayer gray PCR bottle (left) split at the weld seam after two falls, while white ReCo bottle with PCR in main layer (right) survived five falls intact.

With multilayer technologies, it is possible to improve the mechanical properties of bottles while using PCR materials. A colored outer layer enables you to cover gray and black PCR materials, black specks and impurities, while saving in masterbatch and getting a color closer to your original color.

The inner layer can help you reduce the substances that migrate into your products. The easy adjustment of the layers, depending on availability of the PCR materials, can help you to stay flexible. It is important to make an informed decision when switching to PCR. Therefore, it is helpful for you to send us your virgin and PCR material ahead of time. We can help you adapt your mold to our machine, and we can sample and test the bottles for you. That way, you can pick the technology and materials that are best suited to your application.

ABOUT THE AUTHOR: Varinia Lück earned a bachelor's degree in chemical engineering from Universidad del Valle de Guatemala and a master's degree in product management from the University of Oulu in Finland. After internships at Colgate-Palmolive and A. Schulman (now LyondellBasell), Lück joined W. Müller GmbH in 2018, where she serves as head of the Technology Center. She is responsible for R&D, with a particular focus on circularity (using recycled materials and biomaterials), barrier technologies, color change and foaming. Contact *lab@w-mueller-gmbh.com; mullerheads.com*.

BLOW MOLDING

All-Electric Shuttle Debut at NPE

R&B Plastics Machinery launched its newest all-electric shuttle blow molder at NPE2024. Model RBS-E550D is a double-sided machine with 18-ton clamp and 550-mm stroke. It can be equipped with one to six parisons for containers from 200 mL to 5 L.

The unit on display is running a W. Muller 2 × 250-mm (center distance) trilayer die head with individual servo-electric wall-thickness controls. The machine is also demonstrating W. Muller's new WM-096 manual screen changer. The main extruder is a 100-mm, 26:1 model designed for processing PE regrind. The satellite extruders for inner and outer layers are 70 mm, 24:1.

The machine has a heavy-walled steel-tube and steel-plate frame with "walk-in" molding area and top-of-machine access platforms for maintenance and mold changes. This is the first R&B shuttle equipped with Yaskawa X absolute servomotors and drives, which offer "some of the fastest and smoothest machine motions available in the industry," according to R&B.

This new model also provides in-machine deflashing with "center-of-machine" scrap removal, which keeps the conveyor behind the clamp stations and enables for more open area to perform maintenance and mold changes. The in-machine servo-electric part takeout system includes a "center-of-machine" takeaway conveyor for a single-point container exit.

Servo-electric calibration stations with self-adjusting height compensation enable consistent shear-ring cutting. Controls are based on a Siemens IPC477ED industrial PC with 15" touchscreen. Remote machine access for technical support is also provided.

SIZE REDUCTION

Shredder Upgraded with Reinforced Pusher System

Rapid Granulator's Raptor Duo Shredder with integrated granulator now includes a newly designed reinforced pusher system. The system has upgraded pneumatic cylinders, enabling the operator to increase output, and thereby making the machine adaptable to a greater diversity of applications. The pusher body system now has an increased depth and reinforced side guides for support — this enables it to withstand irregular loads without loss of production. The newly designed corrugated floor opens up usage for demanding applications, such as with sheet, big bags and thin-wall materials. This floor design prevents jamming, reducing the need to use scrapers.

The Raptor Duo integrates a granulator into the base of a Raptor shredder, thereby minimizing footprint while providing further size reduction. The bolted modular design and open-hearted technology enables easy changing of wear parts.

INJECTION MOLDING

Robotic Speed and Precision on Display

Sepro has paired its fastest robot — an S5-25 Speed robot — with its 5X-25 unit, adept at complex and precise part maneuvering, in a demo where they take turns manipulating five blocks on a conveyor that runs between the two robots. The blocks, which have printed letters and logos on them, will be positioned by the robots to show different messages to attendees.

Initially, the Sepro logo is visible on the front face of each block, then in rapid fashion, the Speed robot turns the blocks so that letters on their faces spell out S-P-E-E-D. The blocks are conveyed down to the 5X robot, which uses its multiaxis servo wrist to twist and turn the blocks until the letters on the face spell A-G-I-L-E.

In between spelling, the robots undertake other tasks to demonstrate their capabilities. After spelling "SPEED," the Speed robot turns to a table to its right and stacks and unstacks a collection of oversized Jenga blocks in a matter of seconds.

After it has spelled AGILE and the blocks have started to return to the other end of the conveyor, the 5X-25 will pick up a larger block and show off its wrist functionality by manipulating the block in a choreographed pattern. The robot turns the block to show five different sides with words that spell out ... DISCOVER ... INFINITE... POSSIBILITIES ... WITH ... SEPRO 5X AND 7X.

Both robot lines are based on the same Cartesian platform, with a rigid structural frame and Prismatic linear guides to withstand acceleration stresses and support heavy payloads. Both utilize servo motors on the X,Y and Z axes of motion, while the 5X models have two additional servo axes in the wrist, and both use the Visual control system.

FEEDING

Feeder Line Offers Processors More Flexibility

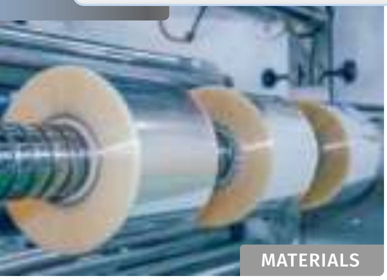
At NPE2024, Maguire Products unveiled its MGF Feeder family, showcasing a major expansion to its range of feeders. This comprehensive product line introduces several distinct series, providing processors more flexibility for various applications and processes.

The product line consists of: Maguire MVF, a volumetric feeder designed for simple volumetric color concentrate and/or additive material dosing; Maguire MGF, a well-established, fully automatic single-material feeder with rapid learning and self-calibration; Maguire MGF+ Line, which incorporates standard gravimetric feeder options for up to four feeders; Maguire MGF+ 100L Line, aimed at extrusion processors and furnished with up to four feeders; Maguire MGF+ 100X, which includes up to four feeders plus loss-in-weight hopper, plus an extrusion control package for streamlined process control in extrusion applications; and Maguire MGF+ 100B, aimed at injection molders, featuring a material collection bin with a level sensor for on-demand material dispensing. Processors can choose from a wide range of configurations on MGF Feeders, including one of up to four different-sized auger feeders installed on one compact machine throat flange to meet diverse processing requirements.

The new MGF Family Series Control features a single touch-screen for easy setup and operation. The user-friendly graphical interface enhances the operator's experience and streamlines installation and long-term maintenance, making it well suited for injection molding, blow molding and a wide range of extrusion applications.

MGF+ | MGF+ 100X MGF+ 100L | MGF+ 100B | MVF

Maguire also showed Fusion Gravimetric Blending and Feeding at NPE, enabling users to combine the best features of batch blending and gravimetric feeding for optimized processes. This is especially beneficial for installations with specific demands, faster color changes or when enhancing existing equipment capabilities.



MATERIALS

Clear Amorphous Nylon for Flexible Food Packaging

A transparent amorphous high-temperature 6I/6T nylon copolymer was launched at NPE2024 for packaging and precision molded applications by Nylon Corp. of America (NYCOA). The NY-Clear 6I/6T series is targeted for use in flexible food packaging and coated beverage paperboard stock requiring high strength, stiffness and hydrolysis resistance.

The NY-Clear portfolio consists of grades which are optimized for injection molding components with high dimensional stability and gloss as well as grades optimized for blown film and extrusion applications. These nylon copolymer grades boast high clarity and strong permeation resistance with up to 30% higher resistance on oxygen, CO_2 and water vapor transmission over competitive materials. Such copolymers are known to offer higher temperature resistance, lower moisture absorption and better retention of properties compared to nylons 6 and 66. Moreover, NY-Clear grades can be used in higher temperature applications such as oven bags. Amorphous nylons are known for their excellent dimensional stability, high Tg, heat deflection temperature (HDT), low creep at elevated temperatures and good chemical resistance compared to many high-performance engineering plastics.

EXTRUSION

New Rotary Die and Cam Lock Design for Tubing

Guill Tool has new, simplified designs for its cam lock feature and rotary die. The cam lock is the same as supplied on the Bullet and will be supplied on additional heads, where applicable. It enables quick and easy assembly and disassembly of the crosshead, and eliminates the socket head cap screws.

By removing and replacing the internals, a different profile can be extruded in minutes rather than hours. Because the cam lock resets the internals in the right configuration every time, there's far less chance of error, compared to the assembly and misalignment issues with socket set screws. The cam lock offers several features such as: it takes only a half turn to remove and install the deflector tip and no fastening hardware is required.

Additional features include fast tool changes (threaded retaining ring for the die and threaded tip retainer), dies remove from the front and tips from the back, tooling retainers for gum space adjustment, vacuum connections, simplified cleaning, and reduced downtime and operating costs.

Guill's new rotary head is a simplified design compared to its previous models. By rotating the tooling in relation to the material flow, a rotary head increases the wall strength of an extrusion, thereby enabling a thinner wall with less material. Features include only rotating the die, randomizing any gauge bands or thickness variations and, in some cases, improving material properties of the end product. Various sizes of tubing can easily be accommodated with the Guill cam-lock design that reduces setup and changeover times.

AUXILIARY EQUIPMENT

Dryer, Blender for 'Real Time' Regrind Usage

Auxiliary equipment leaders Dri-Air Industries and Maguire Products have combined to develop Dri-Air's second generation of on-demand drying/blending systems for the circular economy.

The machine builders note that processors for years have struggled with using regrind material in real time — adding it back into the process consistently and reliably while keeping the materials dry throughout the process. They say the answer comes with this newly developed solution.

Shown at NPE2024, the system combines Dri-Air's drying know-how and conveying capabilities with Maguire's blending technology, enabling molders to dry virgin material, reclaim and redry regrind material; add colorant; and blend these components just prior to conveying to the injection molding machine. This approach creates numerous efficiency advantages and reduces waste, the two companies say.

Dri-Air's unique approach dries materials separately at different temperatures and keeps materials isolated until the blending step. This eliminates the inventory issues and the waste of premixed materials that are no longer needed after the job runs out while keeping materials dry throughout the blending and conveying process. Other issues such as contaminated regrind can be quickly isolated and disposed of without contaminating hundreds of pounds of virgin material.

Positioned below the discharge of the drying hoppers is Maguire's weigh-scale blender (WSB series blender). Configured with a touchscreen control, it provides gravimetric accuracy, data recording/reporting and additional component flexibility. Once the dried components are blended, Dri-Air's closed loop, dry-air conveyance system ensures the blended material stays dry and properly blended during conveyance to the process. A small minimum inventory receiver is mounted on the feed throat.

Valuable floor space is also conserved as the drying/blending/conveyance package is all combined on a single portable frame. The castered blender can easily be removed for ease of cleaning and docked into position for production.

SIZE REDUCTION

Smart Granulator Control Integrates Size-Reduction Systems, Enables Predictive and Knife Maintenance

The new SG (Smart Granulator) control brings Conair's "common control" interface to its Viper line of granulators, integrates with size-reduction and material-handling equipment, and provides data to inform preventive maintenance tasks, including knife changes.

Displayed at NPE2024, the Smart Granulator control was designed for larger Viper granulators used in central size-reduction systems or inline applications processing continuous, high volumes of process scrap, such as bottle or film lines. The 10" SG color touchscreen HMI, now standard on Viper 17 and 23 Series of granulators (optional on Viper 12 Series), incorporates the shared look and feel of other Conair auxiliary controls. The standard SG Control also adds power-cabinet wiring and connections that integrate easily with other equipment (shredder, conveyor, evacuation systems and other support equipment) used in central bulk-fed or inline size-reduction systems. These power cabinet features eliminate the need for custom hardwiring while supporting the smooth operation of sequential pieces of size-reduction equipment.

SG Control was developed to enable predictive maintenance by tracking granulator performance to detect when tasks such as knife changes and bearing greasing are needed. It uses data from sensors located throughout the granulator, which record amperage, cutting chamber temperature, screen temperature, vibration and rpm. These trending key performance indicators are compared to performance norms and used to inform maintenance planning.

PELLETIZING

Pelletizing System for Engineered Resins and Recycled Materials for Optical Molding

Matsui America has introduced the Raptor 22 pelletizing system. According to Matsui, the system enables the reuse of engineered resins in critical molding applications — a use case which has not been possible with currently available technology.

Shown at NPE2024, the Raptor 22 has a proprietary screw design that prevents carbonization and eliminates material shear heat. It also has a carbide rotating blade that cuts the hot material strands at high speed, producing round, teardrop-shaped pellets. Finally, a vacuum-based conveying system cools the material as it is being transported to a cyclone receiver.

The use of a Raptor 22 pelletizing system makes it possible to process and reuse highly engineered recycled materials like LCP, COC, COP, PC, PA46 and PEEK, among others. A system configuration including the integration of Matsui's recently introduced molding defect elimination products with the Raptor enables the use of recycled materials, even for optical or cosmetically critical molding applications. Matsui's static eliminator, for example, removes material in powder form, eliminating black and white spots, burning and uneven blending and weighting.

"The Raptor 22 pelletizing system helps our customers to save significant material and operating costs with the ability to recycle and reuse extremely expensive materials like LCP, PEEK, among others. Additionally, our technology contributes to sustainable plastics use by reusing some of these materials instead of sending them to a landfill," says Mike Kott, GM of business development at Matsui America. The Raptor 22 produces clean and uniform pellets, with very little deterioration of physical material properties. It also features intuitive control technology and HMI, as well as an energy-efficient design.

Prices Drop for PP, Largely Flat for PE, PS, PVC, and PET

While the major correction in PP prices was finally underway, generally stable pricing was anticipated for the other four commodity resins.

By Lilli Manolis Sherman
Contributing Editor

Barring any major production or logistical disruptions, prices of PE, PS and PVC were largely expected to be stable through the second quarter, with those of PET likely to move up a bit this month driven by raw material formulation cost increases. The key outlier was PP with the months' long-anticipated major price correction taking place in the April-May time frame. Demand has been characterized as slowed across the board for all five commodity resins, though an upward trend was anticipated. This is largely due to prebuying for restocking primarily due to the upcoming hurricane season.

These are the views of purchasing consultants from Resin Technology Inc. (RTi); senior analysts from Houston-based PetroChemWire (*PCW*); CEO Michael Greenberg of The Plastics Exchange; Scott Newell, executive VP polyolefins at distributor/compounder Spartan Polymers; Mike Burns of Plastic Resin Market Advisors; and resin pricing expert Robin Chesshier.

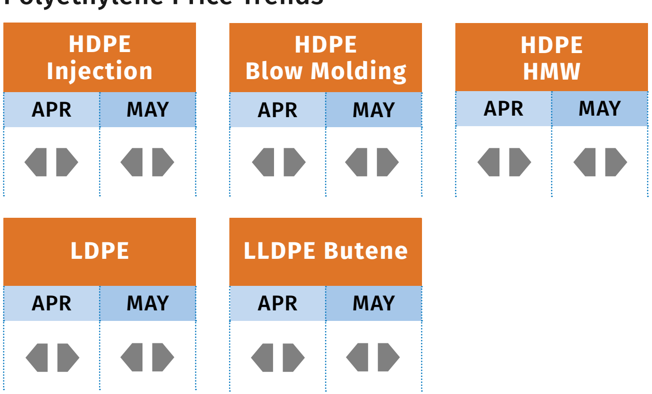
Market Prices Effective Mid-May 2024

Resin Grade	¢/lb
POLYETHYLENE (railcar)	
LDPE, LINER	62-64
LLDPE BUTENE, FILM	59-61
HDPE, G-P INJECTION	59-61
HDPE, BLOW MOLDING	57-59
HDPE, HMW FILM	62-64
POLYPROPYLENE (railcar)	
G-P HOMOPOLYMER, INJECTION	63-65
IMPACT COPOLYMER	66-68
POLYSTYRENE (railcar)	
G-P CRYSTAL	97-99
HIPS	102-104
PVC RESIN (railcar)	
G-P HOMOPOLYMER	56-58
PIPE GRADE	54-56
PET (truckload)	
U.S. BOTTLE GRADE	66.5-58.5

PE PRICES FLAT

Polyethylene prices in April were another rollover and this trend had a good likelihood of continuing into the May-June time frame, according to *PCW*'s associate director for PE, PP and PS David Barry; The Plastics Exchange's Greenberg; Mike Burns of Plastic Resin Market Advisors; and resin pricing expert Robin Chesshier. Meanwhile, suppliers reiterated their 3¢/lb increase initiatives and issued a May prices hike of 3¢/lb. Chesshier noted that demand for domestic products was down while 'cheap' imports continued to arrive and supplier inventories grew, and expected a relatively stable market for PE, barring a major production or supply event.

Polyethylene Price Trends



Burns saw the market as favoring processors and converters, venturing that discounted offers from suppliers and additional sufficient availability in the secondary market is expected to apply downward price pressure on the January 5¢/lb price hike. While *PCW*'s Barry also did not see potential for another increase and saw prices as remaining relatively stable, he did not anticipate the same scenario for the second half of this year as that of 2023. "We saw a big drop in prices in last year's second half, but there are some different factors at play, including increased prices in crude oil. Also, suppliers' inventories are more balanced, with exports now accounting for nearly 50% of sales," he notes.

Reporting on spot market trading, Greenberg reports that processors appeared to be amply supplied, saying, "We have been seeing fairly normal order flow, as opposed to the type of activity that signifies either inventory building or destocking."

PP PRICES DROP

Polypropylene prices dropped 10¢/lb in April, in step with propylene monomer, while some further decrease was also projected for May, with this month likely to level off, according to *PCW*'s Barry, Spartan Polymers' Newell and The Plastic Exchange's Greenberg. While suppliers were seeking to implement a margin improvement increase of 2¢/lb in April, these sources saw the outcome as unlikely.

Polypropylene Price Trends

Homopolymer	
APR	MAY
10¢/lb	

Copolymer	
APR	MAY
10¢/lb	

Spartan Polymers' Newell ventured the months' long anticipated major correction of PP prices, put off primarily due to planned and unplanned monomer shutdowns, could add up to about 15¢/lb. He notes that between August 2023 and March 2024, PP prices moved up 23¢/lb. Noting that spot prices were flat-to-lower, PCW's Barry ventured that suppliers reportedly had "ample line time available," indicating that contract buyers had postponed buying in April.

Demand was expected to be stronger in May, as processors anticipated lower prices. These sources described demand in nearly all sectors as slowed, with orders not materializing as was expected going into second quarter. Still, they anticipated that prebuying in May-June would bolster demand as processors looked to stock up, particularly due to the potential of a very active hurricane season.

The Plastics Exchange's Greenberg confirmed his company saw active trading as April was ending, reporting that spot market supply began to open up at lower prices, enabling more transactions. "It required slim margins to complete a number of the deals, but sellers were willing to unload material, some at losses, as lower cost replacement material began making its way into the market."

PS PRICES FLAT

Polystyrene prices appeared to be settling flat in April, and were likely to follow suit in May and possibly this month, according to *PCW*'s Barry and resin pricing expert Robin Chesshier. This, after moving up a total of 10¢/lb in the first quarter, driven primarily by benzene prices. Chesshier ventured that based on market fundamentals and barring any major supply disruption, the PS market prices could remain stable through much of second quarter. Demand was a bit better, but not compared to typical seasonal demand of past years, she noted.

Polystyrene Price Trends

GPPS	
APR	MAY
flat	flat

HIPS	
APR	MAY
flat	flat

PCW's Barry reported the implied styrene price based on a spot formula (30% ethylene, 70% benzene) varied by less than 1¢/lb through a six-week period leading to the last week of April. He characterized PS demand as lackluster with no supply issues reported, despite some temporary unplanned styrene monomer plant issues.

PVC PRICES UP, THEN FLAT

PVC prices moved up 1¢/lb in April, following the March 3¢/lb and February 2¢/lb hikes, back-to-back increases that have not taken place for a few years in this market, according to Paul Pavlov, RTi's VP of PP and PVC, and *PCW's* associate director PVC and pipe Donna Todd. Pavlov projected relatively flat pricing for the May-June time frame.

PVC Price Trends

Pipe	
APR	MAY
1¢/lb	flat

Gen. Purpose	
APR	MAY
1¢/lb	flat

Driven primarily by increased demand for infrastructure projects, demand for PVC was up between 5% and 7% over 2023, Pavlov notes. Commenting on the increases, Todd notes that with the April increase, suppliers would have achieved only 6¢/lb out of the 9¢/lb they had sought so far this year. "Generally speaking, May has been viewed as the last month in which a springtime price increase could be announced, as pricing normally flattens out for the summer barring a hurricane that takes down production facilities."

PET PRICES FLAT, THEN UP?

PET prices in April appear to be settling flat to slightly up after moving up 4¢/lb-to-5¢/lb in first quarter, all based on raw material formulation costs, according to Kevin Mekaru, RTi's senior business unit leader, commodity plastics. While he thought PET prices would be a rollover in May, he ventured that an increase could emerge for early June, due to a combination of anticipated prebuying by suppliers as processors built up inventories for the summer season and prices of key raw material paraxylene moving up as the gasoline season kicks in and its availability for PET production becomes tighter. Meanwhile, attractively priced imports continue to be an issue for domestic suppliers.

PET Price Trends

Bottle Grade	
APR	MAY
flat	flat

Processing Activity Nears Expansion Level

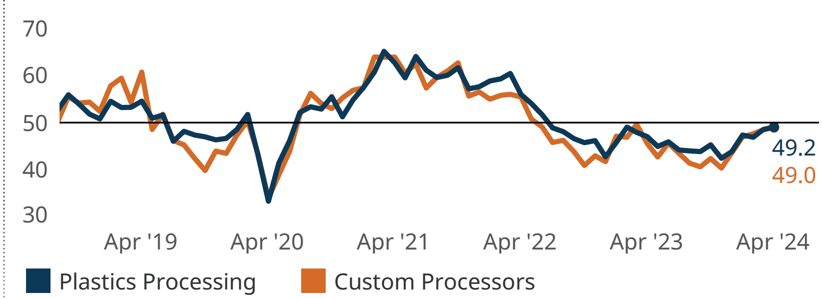
Plastics processing kept pushing along in April, landing less than one point shy of expansion.

By Jan Schafer

The Gardner Business Index (GBI) for Plastics Processing reached 49.2 in April, up 0.6 points from March's reading of 48.6. The index is based on survey responses from subscribers to *Plastics Technology*. Indices above 50 signal growth; below 50, contraction.

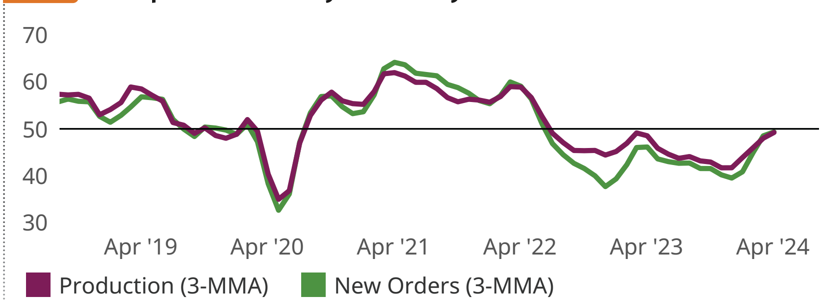
Slowed contraction primarily in new orders and production drove slowed overall contraction in April. Contraction in backlog slowed as well. Employment and export contraction were slightly accelerated and level, respectively. Supplier deliveries lengthened a little faster again, representing another encouraging sign that business is picking up. Optimism about future business has been positive and steady for about three months now. Overall business activity for custom plastics processing continued to closely parallel total plastics processing.

FIG 1 **Gardner Business Index (GBI): Plastics Processing**



Contraction for plastics processing overall and custom processing in particular slowed in April.

FIG 2 **Component Activity Generally Showed Slowed Contraction**



New orders and production lead slowed contraction in April.

ABOUT THE AUTHOR: Jan Schafer is director of market research for Gardner Business Media, parent company of both *Plastics Technology* magazine and Gardner Intelligence. She has led research and analysis in several industries for over 30 years. She has a BA in psychology from Purdue University and an MBA from Indiana University. She credits Procter & Gamble for 15 years of the best business education. Contact: *513-527-8952; jschafer@gardnerweb.com*.

Numbers in Perspective

By Perc Pineda
Plastics Industry Association

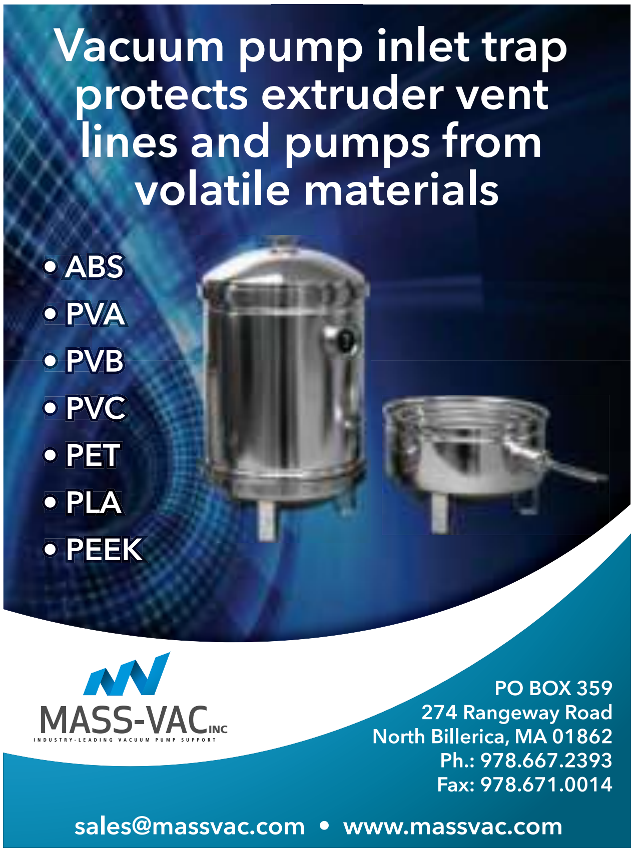
In the last six months, the GBI Plastics Processing Index has ranged from 42.6 to 49.2, illustrating a discernible pattern of fluctuation. Despite this, there now appears to be an overall positive trend, with values trending higher toward the latter end of the period.

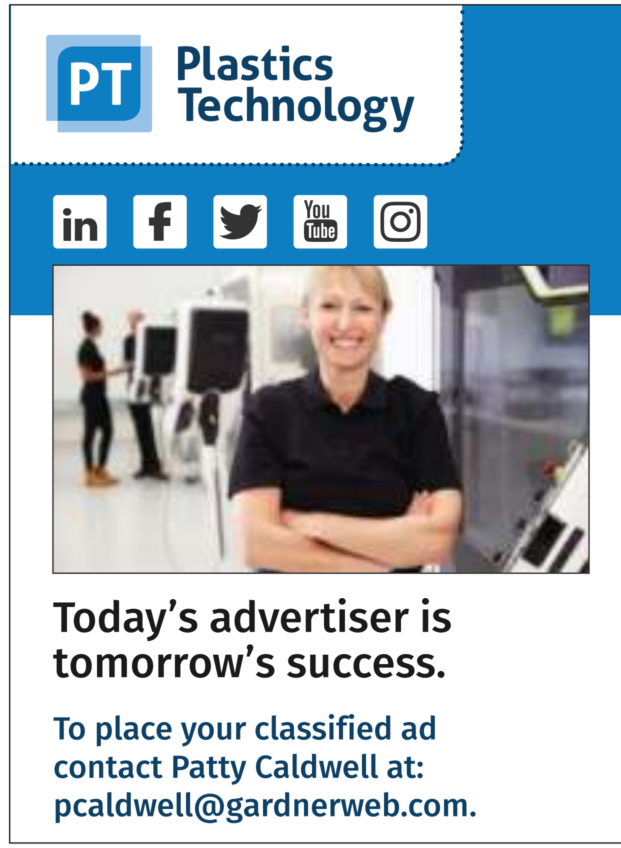
The Index dipped below the 50 mark in July 2022 (Figure 1), following the Federal Reserve's commencement of interest rate hikes in March 2022. Notably, the three-month treasury bill yield had previously remained near zero from March 2020 through March 2022, reflecting the Fed's decision to maintain its benchmark rate at 0 in response to the economic disruption caused by COVID-19. As short-term interest rates increased, reflecting heightened borrowing risks, they predictably had the opposite effect on the manufacturing sector, including the plastics industry.

Despite this, the U.S. economy continued to expand. Parsing the aggregate, however, reveals weaknesses in the housing market due to higher mortgage rates and zero growth in overall manufacturing so far. Fed funds interest rate cuts, the probability of which has decreased, will not automatically increase plastics production. Currently, the intersection between the eventual effects of the current prolonged monetary policy stance on the labor market and price levels, and market demand, will determine the shifts in plastics production for the rest of the year.

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

EXTRUSION AUXILIARY EQUIPMENT





SALES OFFICES

MID-ATLANTIC/NORTHEAST
Lou Guarracino
215/327-9248
Fax: 513/527-8801
loug@ptonline.com

MID-ATLANTIC/NORTHEAST/SOUTHEAST
Madeline Kline, District Manager
513/527-8950
513/488-5040 (mobile)
madeline.kline@gardnerweb.com

CENTRAL US/MOUNTAIN/WEST
Dale Jackman, District Manager
630/345-3469 Fax: 513/527-8801
630/360-5306 (mobile)
djackman@gardnerweb.com

EASTERN GREAT LAKES, INCLUDING CANADA
Jackie Dalzell, Regional V.P.
513/338-2185; Fax: 513/527-8801
216/233-6794 (mobile)
jdalzell@gardnerweb.com

CLASSIFIED/RECRUITMENT ADVERTISING
Patty Caldwell, Advertising Production Coordinator
513/527-8827
pcaldwell@gardnerweb.com

JAPAN
Toshiro Matsuda , Director of Overseas Operations
Plastics Age Co. Ltd.
03-256-1951

KOREA
Chang-Hwa Park
Far East Marketing Inc.
02-364-4182
Fax: 02-364-4184
femchp@unitel.co.kr

TAIWAN
May Hsiao
J&M Media Corp.
886-4-2296-5959
Fax: 886-4-2293-9730
may@jandm.com.tw
www.jandm.com.tw

CHINA
Erica Chang
Gedy Advertising
86-185-1531-1075
erica@gedyinc.com

INDIA
Paresh Navani
Vogel Business Media India Pvt. Ltd.
91-22-4123-4715
paresh.navani@vogel.de

EUROPE (except Italy/Spain/Portugal)
Simone Mas
Gardner Business Media Inc.
001-856-580-1414
smas@gardnerweb.com

ITALY
Sonia Villani
Globe Trotter sas
39-0532-909396
sonia.villani@gtrotter.it

SPAIN/PORTUGAL
Conchi Aranguren
Neben Consulting
34-600-424223
conchi@nebenconsulting.es

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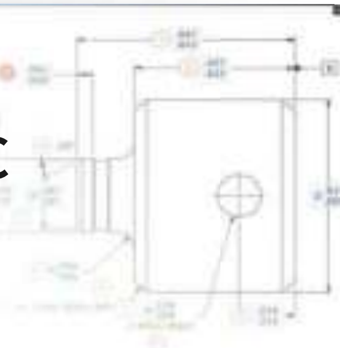
ALLEGHENY PERFORMANCE PLASTICS — LEETSDALE, PENNSYLVANIA

High-Tech Molder Goes Digital for QC



Allegheny Performance Plastics turned to 1factory's cloud-based manufacturing quality control software for streamlined, paperless quality systems.

By Tony Deligio
Executive Editor

Allegheny Performance Plastics is a high-tech molder creating high-tech parts for some very high-tech customers in markets such as automotive, aerospace, defense and medical. When it came to some aspects of its quality control, however, like many manufacturers, it relied on some very low-tech solutions: pencils, binders, disparate spreadsheets, manually entered data and screenshots turned into PDFs sent to customers.

"It's kind of crazy that we have this digital information available on these inspections but then we're taking that, creating a hard copy from it and then storing it in a banker's box," says Greg Shoup, Allegheny CTO.

Nika Martin, CMM operator at Allegheny Performance Plastics, completes a quality check. Source: Allegheny Performance

In the past, Allegheny used multiple systems for CAPA, supplier quality, PPAP, FAI and SPC, with paper-based record retention. SPC data was batch loaded into SPC software offline, with data from digital CMM reports transposed to handwritten retention records. Ultimately, this meant operators and technicians had minimal visibility to run chart data, while the manual process exposed the company to the potential for human error.

The 1factory software was created with companies like Allegheny in mind, providing cloud-based manufacturing quality control software that makes it easier to collect, manage, analyze and report inspection and testing data. "Companies that come to us say, 'We have several robust systems in place, but we're still doing all of our quality control on paper, and it's really becoming a bottleneck,'" explains Jon Facer, director of customer success at 1factory. "You don't want to have to spend production time just checking parts."

Under the former quality regime, Shoup says Allegheny had to create a new PPAP specific to each customer, eliminating the possibility of efficiency or commonality. For SPC, the records for in-process inspections were all handwritten on paper before being batch uploaded, creating "obvious transposing issues," Shoup says, which was also an issue with CMM reports, which were transposed to handwritten retention records.

Beyond the inefficiency and potential introduction of human error, Shoup says the former processes also didn't provide any real-time transparency to a production run's quality. "The biggest issue was operators and technicians that are working with these parts have minimal visibility to just a simple run chart to see where the data was trending," Shoup says.

Allegheny made the switch to 1factory and saw immediate benefits, including the ability to see SPC data in real time versus days later after bulk uploading. Since adopting the software, the company says the biggest savings in time and resources have come from ending manual transposing and navigating multiple systems to retrieve quality information.

The 1factory software automatically reads all dimensions on the print and copies them into the inspection plan. The quality engineer can then define sampling rules, inspection methods and other QC instructions. When it's time to inspect the part, the operators log into 1factory, input the part number and job number, and an inspection sheet is created, showing all instructions and requirements.

Not only does 1factory save several hours per week internally but Allegheny's customers are able to view a live feed of their jobs, including all SPC and process capability calculations.

"Customer access has saved us a lot of time, because we were screenshotting run charts, creating PDFs and sending them data," Shoup says. "Then we found out we can just say, 'Hey, customer X can see these plans or part numbers. When they're curious or they want to know something, they can go look at it.'" PT